3.6 AGING MANAGEMENT OF ELECTRICAL AND INSTRUMENTATION AND CONTROLS

Review Responsibilities

Primary - Branches assigned responsibility by PM as described in SRP-LR Section 3.0 of this SRP-LR.

3.6.1 Areas of Review

This section addresses the AMR and the associated AMP of the electrical and instrumentation and controls (I&C). For a recent vintage plant, the information related to the Electrical and I&C is contained in Chapter 7, “Instrumentation and Controls,” and Chapter 8, “Electric Power,” of the plant’s FSAR, consistent with the “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (NUREG-0800) (Ref. 1). For older plants, the location of applicable information is plant-specific because an older plant’s FSAR may have predated NUREG-0800. Typical electrical and I&C components that are subject to an AMR for license renewal are electrical cables and connections, metal enclosed buses, fuse holders, high voltage insulators, transmission conductors and connections, and switchyard bus and connections.

The responsible review organization is to review the following LRA AMR and AMP items assigned to it, per SRP-LR Section 3.0:

AMRs

- AMR results consistent with the GALL Report
- AMR results for which further evaluation is recommended by the GALL Report
- AMR results not consistent with or not addressed in the GALL Report

AMPs

- Consistent with GALL Report AMPs
- Plant-specific AMPs

FSAR Supplement

- The responsible review organization is to review the FSAR Supplement associated with each assigned AMP.

3.6.2 Acceptance Criteria

The acceptance criteria for the areas of review describe methods for determining whether the applicant has met the requirements of the NRC’s regulations in 10 CFR 54.21.

3.6.2.1 AMR Results Consistent with the GALL Report

The AMRs and the AMPs applicable to the electrical and I&C components are described and evaluated in Chapter VI of NUREG-1801, “Generic Aging Lessons Learned (GALL) Report (Ref. 2).

The applicant’s LRA should provide sufficient information so that the NRC reviewer is able to confirm that the specific LRA AMR line-item and the associated LRA AMP are consistent with the cited GALL Report AMR line-item. The staff reviewer should then confirm that the LRA AMR line-item is consistent with the GALL Report AMR line-item to which it is compared. The NRC reviewer performs an audit to confirm consistency with the GALL Report and checks the validity of the AMP credited in the LRA. To validate the consistency with the GALL Report, the applicant will identify in the LRA AMR Tables the following footnotes as defined in the staff-endorsed NEI 95-10.

> Footnote A - Consistent with NUREG-1801 item for component, material, environment, and aging effect. Aging management program is consistent with NUREG-1801 aging management program.
>
> Footnote B - Consistent with NUREG-1801 item for component, material, environment, and aging effect. Aging management program takes some exceptions to NUREG-1801 aging management program.
>
> Footnote C - Component is different, but consistent with NUREG-1801 item for material, environment, and aging effect. Aging management program is consistent with NUREG-1801 aging management program.
>
> Footnote D - Component is different, but consistent with NUREG-1801 item for material, environment, and aging effect. Aging management program takes some exceptions to NUREG-1801 aging management program.
>
> Footnote E - Consistent with NUREG-1801 item for material, environment, and aging effect, but a different aging management program is credited, or a plant-specific aging management program.

When the applicant is crediting a different AMP than recommended in the GALL Report, the reviewer should confirm that the alternate AMP is valid to use for aging management and will be capable of managing the effects of aging as adequately as the AMP recommended by the GALL Report.

3.6.2.2 AMR Results for Which Further Evaluation is Recommended by the GALL Report

The basic acceptance criteria defined in Section 3.6.2.1 need to be performed first for all of the AMRs and AMPs reviewed as part of this section. In addition, if the GALL Report AMR line-item to which the LRA AMR line-item is compared identifies that “further evaluation is recommended,” then additional criteria apply as identified by the GALL Report for each of the following aging effect/aging mechanism combinations.

3.6.2.2.1 Electrical Equipment Subject to Environmental Qualification

Environmental qualification is a TLAA as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c)(1). The evaluation of this TLAA is addressed separately in Section 4.4, “Environmental Qualification (EQ) of Electrical Equipment,” of this SRP-LR. Table 3.6-1 of this SRP-LR, line item 1, invokes this subsection. The related GALL Report, Volume 2, item invoked by the subsection is VI.B, L-05.

3.6.2.2.2 Reduced Insulation Resistance due to Presence of Any Salt Deposits and Surface Contamination, and Loss of Material due to Mechanical Wear

Reduced insulation resistance due to presence of any salt deposits and surface contamination could occur in high voltage insulators. The GALL Report recommends further evaluation of a plant-specific AMP for plants located such that the potential exists for salt deposits or surface contamination (e.g., in the vicinity of salt water bodies or industrial pollution). Loss of material due to mechanical wear caused by wind blowing on transmission conductors could occur in high voltage insulators. The GALL Report recommends further evaluation of a plant-specific AMP to ensure that this aging effect is adequately managed. Acceptance criteria are described in Branch Technical Position RLSB-1 (Appendix A.1 of this SRP-LR). Table 3.6-1 of this SRP-LR, line items 2 and 5, invokes this subsection. The related GALL Report, Volume 2, items invoked by the subsection are VI.A, LP-32 and VI.A, LP-28.

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 Pre-load

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 pre-load could occur in transmission conductors and connections, and in switchyard bus and connections. The GALL Report recommends further evaluation of a plant-specific AMP to ensure that this aging effect is adequately managed. Acceptance criteria are described in Branch Technical Position RLSB-1 (Appendix A.1 of this SRP-LR). Table 3.6-1 of this SRP-LR, line items 3 and 4, invokes this subsection. The related GALL Report, Volume 2, items invoked by the subsection are VI.A, LP-39 and VI.A, LP-38.

3.6.2.2.4 Quality Assurance for Aging Management of Nonsafety-Related Components

Acceptance criteria are described in Branch Technical Position IQMB-1 (Appendix A.2 of this SRP-LR).

3.6.2.3 AMR Results Not Consistent with or Not Addressed in the GALL Report

Acceptance criteria are described in Branch Technical Position RLSB-1 (Appendix A.1 of this standard review plan).

3.6.2.4 Aging Management Programs

For those AMPs that will be used for aging management and are based on the program elements of an AMP in the GALL Report, the NRC reviewer performs an audit of AMPs credited in the LRA to confirm consistency with the GALL AMPs identified in GALL Report Chapters X and XI.

If the applicant identifies an exception to any of the program elements of the cited GALL Report AMP, the LRA AMP should include a basis demonstrating how the criteria of 10 CFR 54.21(a)(3) would still be met. The NRC reviewer should then confirm that the LRA AMP with all exceptions would satisfy the criteria of 10 CFR 54.21(a)(3). If, while reviewing the LRA AMP, the reviewer identifies a difference from the GALL Report AMP that should have been identified as an exception to the GALL Report AMP, this difference should be reviewed and properly dispositioned. The reviewer should document the disposition of all LRA-defined exceptions and staff-identified differences.

The LRA should identify any enhancements that are needed to permit an existing AMP to be declared consistent with the GALL Report AMP to which the LRA AMP is compared. The reviewer is to confirm both that the enhancement, when implemented, would allow the existing plant AMP to be consistent with the GALL Report AMP and also that the applicant has a commitment in the FSAR Supplement to implement the enhancement prior to the period of extended operation. The reviewer should review and document the disposition of all enhancements.

If the applicant chooses to use a plant-specific program that is not a GALL AMP, the NRC reviewer should confirm that the plant-specific program satisfies the criteria of Branch Technical Position RLSB-1 (Appendix A.1.2.3 of this SRP-LR).

3.6.2.5 FSAR Supplement

The summary description of the programs and activities for managing the effects of aging for the period of extended operation in the FSAR Supplement should be sufficiently comprehensive such that later changes can be controlled by 10 CFR 50.59. The description should contain information associated with the bases for determining that aging effects are managed during the period of extended operation. The description should also contain any future aging management activities, including enhancements and commitments, to be completed before entering the period of extended operation. Examples of the type of information required are provided in Table 3.6-2 of this SRP-LR.

3.6.3 Review Procedures

For each area of review, the following review procedures are to be followed:

3.6.3.1 AMR Results Consistent with the GALL Report

The applicant may reference the GALL Report in its LRA, as appropriate, and demonstrate that the AMRs and AMPs at its facility are consistent with those reviewed and approved in the GALL Report. The reviewer should not conduct a re-review of the substance of the matters described in the GALL Report. If the applicant has provided the information necessary to adopt the finding of program acceptability as described and evaluated in the GALL Report, the reviewer should find acceptable the applicant's reference to GALL Report in its LRA. 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 applicant has stated that the applicable aging effects and industry and plant-specific operating experience have been reviewed by the applicant and are evaluated in the GALL Report.

Furthermore, the reviewer should confirm that the applicant has addressed operating experience identified after the issuance of the GALL Report. Performance of this review requires the reviewer to confirm that the applicant has identified those aging effects for the electrical and I&C components that are contained in GALL as applicable to its plant.

The reviewer confirms that the applicant has identified the appropriate AMPs as described and evaluated in the GALL Report. If the applicant commits to an enhancement to make its LRA AMP consistent with a GALL AMP, then the reviewer is to confirm that this enhancement when implemented will indeed make the LRA AMP consistent with the GALL AMP. If the applicant identifies, in the LRA AMP, an exception to any of the program elements of the GALL AMP with which the applicant is claiming to be consistent, the reviewer is to confirm that the LRA AMP with the exception will satisfy the criteria of 10 CFR 54.21(a)(3). If the reviewer identifies a difference, not identified by the LRA, between the LRA AMP and the GALL AMP, with which the LRA claims to be consistent, the reviewer should confirm that the LRA AMP with this difference satisfies 10 CFR 54.21(a)(3). The reviewer should document the basis for accepting enhancements, exceptions or differences. The AMPs evaluated in GALL pertinent to the electrical and I&C components are summarized in Table 3.6-1 of this SRP-LR. In this table, the ID column provides a row identifier useful in matching the information presented in the corresponding table in the GALL Report Vol. 1. The related item column identifies the item number in the GALL Report Vol. 2, Chapters II through VIII, presenting detailed information summarized by this row.

3.6.3.2 AMR Results for Which Further Evaluation is Recommended by the GALL Report

The basic review procedures defined in Section 3.6.3.1 need to be performed first for all of the AMRs and AMPs provided in this section. In addition, if the GALL AMR line-item to which the LRA AMR line-item is compared identifies that further evaluation is recommended, then additional criteria apply as identified by the GALL Report for each of the following aging effect/aging mechanism combinations.

3.6.3.2.1 Electrical Equipment Subject to Environmental Qualification

Environmental qualification is a TLAA as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c)(1). The staff reviews the evaluation of this TLAA separately following the guidance in Section 4.4 of this SRP-LR.

3.6.3.2.2 Reduced Insulation Resistance due to Presence of Any Salt Deposits and Surface Contamination, and Loss of Material due to Mechanical Wear

The GALL Report recommends a plant-specific AMP for the management of reduced insulation resistance due to presence of any salt deposits and surface contamination for plants located such that the potential exists for salt deposits or surface contamination (e.g., in the vicinity of salt water bodies or industrial pollution), and loss of material due to mechanical wear caused by wind blowing on transmission conductors in high voltage insulators. The reviewer reviews the applicant's proposed program on a case-by-case basis to ensure that an adequate program will be in place for the management of these aging effects.

3.6.3.2.3 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 Pre-load

The GALL Report recommends a plant-specific AMP for the management of 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 pre-load in transmission conductors and connections, and in switchyard bus and connections. The reviewer reviews the applicant's proposed program on a case-by-case basis to ensure that an adequate program will be in place for the management of these aging effects.

3.6.3.2.4 Quality Assurance for Aging Management of Nonsafety-Related Components

The applicant's AMPs for license renewal should contain the elements of corrective actions, the confirmation process, and administrative controls. Safety-related components are covered by 10

CFR Part 50, Appendix B, which is adequate to address these program elements. However, Appendix B does not apply to non safety-related components that are subject to an AMR for license renewal. Nevertheless, the applicant has the option to expand the scope of its 10 CFR Part 50, Appendix B program to include these components and address these program elements. If the applicant chooses this option, the reviewer confirms that the applicant has documented such a commitment in the FSAR supplement. If the applicant chooses alternative means, the branch responsible for quality assurance should be requested to review the applicant's proposal on a case-by-case basis.

3.6.3.3 AMR Results Not Consistent with or Not Addressed in GALL Report

The reviewer should confirm that the applicant, in the license renewal application, has identified applicable aging effects, listed the appropriate combination of materials and environments, and AMPs that will adequately manage the aging effects. The AMP credited could be an AMP that is described and evaluated in the GALL Report or a plant-specific program. Review procedures are described in Branch Technical Position RLSB-1 (Appendix A.1 of this SRP-LR).

3.6.3.4 Aging Management Programs

The reviewer confirms that the applicant has identified the appropriate AMPs as described and evaluated in the GALL Report. If the applicant commits to an enhancement to make its LRA AMP consistent with a GALL Report AMP, then the reviewer is to confirm that this enhancement, when implemented, will make the LRA AMP consistent with the GALL Report AMP. If the applicant identifies, in the LRA AMP, an exception to any of the program elements of the GALL Report AMP with which the applicant is claiming to be consistent, the reviewer is to confirm that the LRA AMP with the exception will satisfy the criteria of 10 CFR 54.21(a)(3). If the reviewer identifies a difference, not identified by the LRA, between the LRA AMP and the GALL Report AMP, with which the LRA claims to be consistent, the reviewer should confirm that the LRA AMP with this difference satisfies 10 CFR 54.21(a)(3). The reviewer should document the basis for accepting enhancements, exceptions, or differences. The AMPs evaluated in the GALL Report pertinent to the engineered safety features components are summarized in Table 3.2-1 of this SRP-LR. The Related Item column identifies the item number in the GALL Report, Vol. 2, Chapters II through VIII, presenting detailed information summarized by this row.

Table 3.2-1 of this SRP-LR may identify a plant-specific AMP. If the applicant chooses to use a plant-specific program that is not a GALL AMP, the NRC reviewer should confirm that the plant-specific program satisfies the criteria of Branch Technical Position RLSB-1 (Appendix A.1.2.3 of this SRP-LR).

3.6.3.5 FSAR Supplement

The reviewer confirms that the applicant has provided information equivalent to that in Table 3.6-2 in the FSAR supplement for aging management of the Electrical and I&C System for license renewal. The reviewer also confirms that the applicant has provided information equivalent to that in Table 3.6-2 in the FSAR supplement for Section 3.6.3.3, "AMR Results Not Consistent with or Not Addressed in the GALL Report."

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior

NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 3.6-2, an applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should confirm that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

3.6.4 Evaluation Findings

If the reviewer determines that the applicant has provided information sufficient to satisfy the provisions of this section, then an evaluation finding similar to the following text should be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has demonstrated that the aging effects associated with the electrical and instrumentation and controls components will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).
>
> The staff also reviewed the applicable FSAR Supplement program summaries and concludes that they adequately describe the AMPs credited for managing aging of electrical and instrumentation and controls, as required by 10 CFR 54.21(d).

3.6.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

3.6.6 References

1. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, July 1981 or latest versions issued by the NRC.

2. NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," U.S. Nuclear Regulatory Commission, Revision 2, 2010 or later version issued by the NRC.

3. NEI 95-10, Rev 6, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule," Nuclear Energy Institute, June 1995?????????.

Table 3.6-1. Summary of Aging Management Programs for the Electrical Components Evaluated in Chapter VI of the GALL Report
Replace with New Table (SRP Section 3.6_Table 3.6-1_11-18-09) with **input based on latest GALL Master)**

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Related Item	Unique Item
1	**BWR/ PWR**	**Electrical equipment subject to 10 CFR 50.49 environmental qualification (EQ) requirements**	**Degradation due to various aging mechanisms**	**Environmental Qualification Of Electric Components**	**Yes, TLAA (See subsection 3.6.2.2.1)**	**L-05**	
2	**BWR/ PWR**	**Electrical cables, connections and fuse holders (insulation) not subject to 10 CFR 50.49 EQ requirements**	**Reduced insulation resistance and electrical failure due to various physical, thermal, radiolytic, photolytic, and chemical mechanisms**	**Electrical Cables and Connections Not Subject To 10 CFR 50.49 EQ Requirements**	**No**	**L-01** **LP-03**	
3	**BWR/ PWR**	**Conductor insulation for electrical cables and connections used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements that are sensitive to reduction in conductor insulation resistance (IR)**	**Reduced insulation resistance and electrical failure due to various physical, thermal, radiolytic, photolytic, and chemical mechanisms**	**Electrical Cables And Connections Used In Instrumentation Circuits Not Subject To 10 CFR 50.49 EQ Requirements**	**No**	**L-02**	

Table 3.6-1. Summary of Aging Management Programs for the Electrical Components Evaluated in Chapter VI of the GALL Report
Replace with New Table (SRP Section 3.6_Table 3.6-1_11-18-09) with **input based on latest GALL Master)**

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Related Item	Unique Item
4	**BWR/ PWR**	**Conductor insulation for inaccessible medium voltage (2 kV to 35 kV) cables (e.g., installed in conduit or direct buried) not subject to 10 CFR 50.49 EQ requirements**	**Localized damage and breakdown of insulation leading to electrical failure due to moisture intrusion, water trees**	**Inaccessible Medium Voltage Cables Not Subject To 10 CFR 50.49 EQ Requirements**	**No**	**L-03**	
5	**PWR**	**Connector contacts for electrical connectors exposed to borated water leakage**	**Corrosion of connector contact surfaces due to intrusion of borated water**	**Boric Acid Corrosion**	**No**	**L-04**	
6	**BWR/ PWR**	**Fuse Holders (Not Part of a Larger Assembly): Fuse holders – metallic clamp**	**Fatigue due to ohmic heating, thermal cycling, electrical transients, frequent manipulation, vibration, chemical contamination, corrosion, and oxidation**	**Fuse Holders**	**No**	**LP-01**	
7	**BWR/ PWR**	**Metal enclosed bus - Bus/connections**	**Loosening of bolted connections due to thermal cycling and ohmic heating**	**Metal Enclosed Bus**	**No**	**LP-04**	

Table 3.6-1. Summary of Aging Management Programs for the Electrical Components Evaluated in Chapter VI of the GALL Report Replace with New Table (SRP Section 3.6_Table 3.6-1_11-18-09) with **input based on latest GALL Master)**

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Related Item	Unique Item
8	**BWR/ PWR**	**Metal enclosed bus – Insulation/insulators**	**Reduced insulation resistance and electrical failure due to various physical, thermal, radiolytic, photolytic, and chemical mechanisms**	**Metal Enclosed Bus**	**No**	**LP-05**	
9	**BWR/ PWR**	**Metal enclosed bus – Enclosure assemblies**	**Loss of material due to general corrosion**	**Structures Monitoring Program**	**No**	**LP-06**	
10	**BWR/ PWR**	**Metal enclosed bus – Enclosure assemblies**	**Hardening and loss of strength due to elastomers degradation**	**Structures Monitoring Program**	**No**	**LP-10**	
11	**BWR/ PWR**	**High voltage insulators**	**Degradation of insulation quality due to presence of any salt deposits and surface contamination, Loss of material caused by mechanical wear due to wind blowing on transmission conductors**	**A plant-specific AMP is to be evaluated.**	**Yes, plant specific (See subsection 3.6.2.2.2)**	**LP-07 LP-11**	
12	**BWR/ PWR**	**Transmission conductors and connections, Switchyard bus and connections**	**Loss of material due to wind induced abrasion and fatigue, Loss of conductor strength due to corrosion, Increased resistance of connection due to oxidation or loss of preload**	**A plant-specific AMP is to be evaluated.**	**Yes, plant specific (see subsection 3.6.2.2.3)**	**LP-08 LP-09**	

Table 3.6-1. Summary of Aging Management Programs for the Electrical Components Evaluated in Chapter VI of the GALL Report
Replace with New Table (SRP Section 3.6_Table 3.6-1_11-18-09) with **input based on latest GALL Master)**

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Related Item	Unique Item
13	BWR/ PWR	Cable Connections – Metallic parts	Loosening of bolted connections due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation	Electrical Cable Connections Not Subject To 10 CFR 50.49 Environmental Qualification Requirements	No	LP-12	
14	BWR/ PWR	Fuse Holders (Not Part of a Larger Assembly) Insulation material	None	None	NA - No AEM or AMP	LP-02	

Table 3.6-2 FSAR Supplement for Aging Management of Electrical and Instrumentation and Control System

Program	Description of Program	Implementation Schedule*
Insulation Material for Non-Environmentally Qualified Electrical Cables and Connections exposed to an adverse localized environment caused by heat, radiation, or moisture. (AMP XI.E1)	Accessible electrical cables and connections installed in adverse localized environments are visually inspected at least once every 10 years for cable and connection insulation surface anomalies, such as embrittlement, discoloration, cracking, swelling, or surface contamination, which are precursor indications of conductor insulation aging degradation from heat, radiation, or moisture. An adverse localized environment is a condition in a limited plant area that is significantly more severe than the specified service condition for the electrical cable or connection.	First inspection for license renewal should be completed before the period of extended operation.
Insulation Material for Non-Environmentally Qualified Electrical Cables and Connections used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance, and are exposed to an adverse localized environment caused by heat, radiation, or moisture. (AMP XI.E2)	Electrical cables and connections used in circuits with sensitive, low-level current signals, such as radiation monitoring and nuclear instrumentation, are calibrated as part of the instrumentation loop calibration at the normal calibration frequency, which provides sufficient indication of the need for corrective actions based on acceptance criteria related to instrumentation loop performance. The review of calibration results is performed once every 10 years. In cases where cables are not part of calibration or surveillance program, a proven cable test (such as insulation resistance tests, time domain reflectometry tests, or other tests judged to be effective) for detecting deterioration of the insulation system are performed. The test frequency is based on engineering evaluation not to exceed 10 years.	First review of calibration results or cable tests for license renewal should be completed before the period of extended operation.

Program	Description of Program	Implementation Schedule*
Non-Environmentally Qualified Inaccessible Power Cables exposed to an adverse localized environment caused by moisture and voltage exposure. (AMP XI.E3)	Inaccessible or underground power (greater than or equal to 480 volts) cables exposed to significant moisture and system voltage are tested at least once every 5 years to provide an indication of the condition of the conductor insulation. The specific type of test performed will be determined prior to the initial test, and is to be a proven test for detecting deterioration of the insulation system due to wetting. The applicant can assess the condition of the cable insulation with reasonable confidence using one or more of the following techniques: Dielectric Loss (Dissipation Factor/Power Factor), AC Voltage Withstand, Partial Discharge, Step Voltage, Time Domain Reflectometry, Insulation Resistance and Polarization Index, Line Resonance Analysis or other testing that is state-of-the-art at the time the test is performed. A combination of different tests are required to determine the condition of the cables. Significant moisture is defined as periodic exposures that last more than a few days (e.g., cable wetting or submergence in water). Significant voltage exposure is defined as being subjected to system voltage. Significant moisture simultaneous with system voltage exposure is not significant for power cables that are designed for these conditions (e.g., continuous wetting or submergence are not significant for submarine cables). In addition, inspection for water collection should be established and performed based on plant-specific operating experience with cable wetting or submergence water in the manholes (i.e., operation of dewatering devices should be inspected and operation verified prior to any known or predicted flooding events). However, the inspection frequency should be at least annually.	First tests or first inspections for license renewal should be completed before the period of extended operation.
Boric Acid Corrosion (AMP XI.M10)	The program consists of (a) visual inspection of external surfaces that are potentially exposed to borated water leakage, (b) timely discovery of leak path and removal of the boric acid residues, (c) assessment of the damage, and (d) follow-up inspection for adequacy. This program is implemented in response to GL 88-05.	Existing program.
Plant-specific AMP	The description should contain information associated with the basis for determining that aging effects will be managed during the period of extended operation.	Program should be implemented before the period of extended operation.

Program	Description of Program	Implementation Schedule*
Fuse Holders (AMP XI.E5)	Fuse holders within the scope of license renewal will be tested at least once every 10 years to provide an indication of the condition of the metallic clamp portion of the fuse holders. Testing may include thermography, contact resistance testing, or other appropriate testing methods.	First tests for license renewal should be completed before the period of extended operation.
Metal Enclosed Bus (AMP XI.E4)	MEB internal surfaces are visually inspected for aging degradation, including cracks, corrosion, foreign debris, excessive dust buildup, and evidence of moisture intrusion. MEB insulating material is visually inspected for signs of embrittlement, cracking, chipping, melting, swelling, or discoloration, which may indicate overheating or aging degradation. The internal bus supports are visually inspected for structural integrity and signs of cracks. MEB external surfaces and bus enclosure supports are visually inspected for loss of material due to general corrosion. Accessible elastomers (e.g., gaskets, boots, and sealants) are inspected for degradation, including cracking, shrinkage, hardening and loss of strength. A sample of accessible bolted connections is inspected for increased resistance of connection by using thermography or by measuring connection resistance using a low range ohmmeter. These inspections are performed at least once every 10 years. As an alternative to thermography or measuring connection resistance of bolted connections covered with heat shrink tape, sleeving, insulating boots, etc., the applicant may use visual inspection of insulation material to detect surface anomalies, such as embrittlement, discoloration, cracking, chipping, melting, swelling, or surface contamination. When this alternative visual inspection is used to check bolted connections, the first inspection is completed before the period of extended operation and every 5 years thereafter.	First inspection for license renewal should be completed before the period of extended operation.

Program	Description of Program	Implementation Schedule*
Non-Environmentally Qualified Electrical Cable Connections (AMP XI.E6)	A representative sample of electrical cable connections within the scope of license renewal will be tested at least once prior to the period of extended operation to confirm that there are no aging effects requiring management during the period of extended operation. Testing may include thermography, contact resistance testing, or other appropriate testing methods without removing the connection insulation, such as heat shrink tape, sleeving, insulating boots, etc. The one-time test provides additional confirmation to support industry operating experience that shows electrical connections have not experienced a high degree of failures and that existing installation and maintenance practices are effective. As an alternative to thermography or measuring connection resistance of cable connections, for the accessible cable connections that are covered with heat shrink tape, sleeving, insulating boots, etc., the applicant may use visual inspection of insulation materials to detect surface anomalies, such as discoloration, cracking, chipping, or surface contamination. When this alternative visual inspection is used to check cable connections, the first inspection is completed before the period of extended operation and every 5 years thereafter.	First tests for license renewal should be completed before the period of extended operation.
Quality assurance	The 10 CFR Part 50, Appendix B program provides for corrective actions, the confirmation process, and administrative controls for AMPs for license renewal. The scope of this existing program will be expanded to include non safety-related structures and components that are subject to an AMR for license renewal.	Existing program.
* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.		

CHAPTER 4

TIME-LIMITED AGING ANALYSES

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4.1 IDENTIFICATION OF TIME-LIMITED AGING ANALYSES

Review Responsibilities

Primary - Branch responsible for the TLAA issues
Secondary - Other branches responsible for engineering, as appropriate

4.1.1 Areas of Review

This review plan section addresses the identification of time-limited aging analyses (TLAAs). The technical review of TLAAs is addressed in Sections 4.2 through 4.7. As explained in more detail below, the list of TLAAs are certain plant-specific safety analyses that are based on an explicitly assumed 40-year plant life (for example, aspects of the reactor vessel design). Pursuant to 10 CFR 54.21(c)(1), a license renewal applicant is required to provide a list of TLAAs, as defined in 10 CFR 54.3. The area relating to the identification of TLAAs is reviewed.

TLAAs may have developed since issuance of a plant’s operating license. As indicated in 10 CFR 54.30, the adequacy of the plant’s CLB, which includes TLAAs, is not an area within the scope of the license renewal review. Any questions regarding the adequacy of the CLB are addressed under the backfit rule (10 CFR 50.109) and are separate from the license renewal process.

In addition, pursuant to 10 CFR 54.21(c)(2), an applicant must provide a list of plant-specific exemptions granted under 10 CFR 50.12 that are based on TLAAs. However, the initial license renewal applicants have found no such exemptions for their plants. It is an applicant’s option to include more analyses than those required by 10 CFR 54.21(c)(1). The staff should focus its review to confirm that the applicant did not omit any TLAAs, as defined in 10 CFR 54.3.

Pursuant to 10 CFR 54.21(d), each application includes a FSAR supplement summary description for each TLAA that is identified in accordance with 10 CFR 54.3.

4.1.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.1.1 of this review plan section delineate acceptable methods for meeting the requirements of the NRC’s regulations in 10 CFR 54.21(c)(1). For the applicant’s list of exemptions to be acceptable, the staff should have reasonable assurance that there has been no omission of TLAAs from that list.

Pursuant to 10 CFR 54.3, TLAAs are those licensee calculations and analyses that:

1. *Involve systems, structures, and components within the scope of license renewal, as delineated in 10 CFR 54.4(a);*

2. *Consider the effects of aging;*

3. *Involve time-limited assumptions defined by the current operating term, for example, 40 years;*

4. *Were determined to be relevant by the licensee in making a safety determination;*

5. *Involve conclusions or provide the basis for conclusions related to the capability of the*

system, structure, or component to perform its intended function(s), as delineated in 10 CFR 54.4(b); and

6. *Are contained or incorporated by reference in the CLB.*

The reviewer reviews the FSAR supplement for each TLAA identified as being within the scope of the LRA, as defined in 10 CFR 54.3.

4.1.3 Review Procedures

For each area of review described in Subsection 4.1.1, the reviewer adheres to the following review procedures:

The reviewer uses the plant UFSAR and other CLB documents, such as staff SERs, to perform the review. The reviewer selects analyses that the applicant did not identify as TLAAs that are likely to meet the six criteria identified in Subsection 4.1.2. The reviewer verifies that the selected analyses, not identified by the applicant as TLAAs, do not meet at least one of the following criteria (Ref. 1).

Sections 4.2 through 4.6 identify typical types of TLAAs for most plants. Information on the applicant's methodology for identifying TLAAs also be useful in identifying calculations that did not meet the six criteria below.

1. *Involve systems, structures, and components within the scope of license renewal*, as delineated in 10 CFR 54.4(a). Chapter 2 of this SRP-LR provides the reviewer guidance on the scoping and screening methodology, and on plant level and various system level scoping results.

2. *Consider the effects of aging*. The effects of aging include, but are not limited to: loss of material, changes in dimensions, changes in material properties, loss of toughness, loss of prestress, settlement, cracking, and loss of dielectric properties.

3. *Involve time-limited assumptions defined by the current operating term* (e.g., 40 years). The defined operating term should be explicit in the analysis. Simply asserting that a component is designed for a service life or plant life is not sufficient. The assertion is supported by calculations or other analyses that explicitly include a time limit.

4. *Were determined to be relevant by the licensee in making a safety determination*. Relevancy is a determination that the applicant makes based on a review of the information available. A calculation or analysis is relevant if it can be shown to have a direct bearing on the action taken as a result of the analysis performed. Analyses are also relevant if they provide the basis for a licensee's safety determination and, in the absence of the analyses, the applicant might have reached a different safety conclusion.

5. *Show capability of the system, structure, or component to perform its intended function(s)*, as delineated. Involve conclusions or provide the basis for conclusions related to 10 CFR 54.4(b). Analyses that do not affect the intended functions of systems, structures, or components are not TLAAs.

6. *Are contained or incorporated by reference in the CLB*. The CLB includes the technical specifications as well as design basis information (as defined in 10 CFR 50.2), or licensee

commitments documented in the plant-specific documents contained or incorporated by reference in the CLB including, but not limited to: the FSAR, NRC SERs, the fire protection plan/hazards analyses, correspondence to and from the NRC, the quality assurance plan, and topical reports included as references to the FSAR. Calculations and analyses that are not in the CLB or not incorporated by reference in the CLB are not TLAAs. If a code of record is in the FSAR for particular groups of structures or components, reference material includes all calculations called for by that code of record for those structures and components.

TLAAs that need to be addressed are not necessarily those analyses that have been previously reviewed or approved by the NRC. The following examples illustrate TLAAs that need to be addressed and were not previously reviewed and approved by the NRC:

- The FSAR states that the design complies with a certain national code and standard. A review of the code and standard reveals that it calls for an analysis or calculation. Some of these calculations or analysis will be TLAAs. The actual calculation was performed by the applicant to meet the code and standard. The specific calculation was not referenced in the FSAR. The NRC had not reviewed the calculation.

- In response to a generic letter, a licensee submitted a letter to the NRC committing to perform a TLAA that would address the concern in the generic letter. The NRC had not documented a review of the applicant's response and had not reviewed the actual analysis.

The following examples illustrate analyses that are *not* TLAAs and need not be addressed under 10 CFR 54.21(c):

- Population projections (Section 2.1.3 of NUREG-0800) (Ref. 2).

- Cost-benefit analyses for plant modifications.

- Analysis with time-limited assumptions defined short of the current operating term of the plant, for example, an analysis for a component based on a service life that would not reach the end of the current operating term.

The number and type of TLAAs vary depending on the plant-specific CLB. All six criteria set forth in 10 CFR 54.3 (and repeated in Subsection 4.1.2) must be satisfied to conclude that a calculation or analysis is a TLAA. Table 4.1-1 provides examples of how these six criteria may be applied (Ref. 1). Table 4.1-2 provides a list of generic TLAAs that are included in the SRP-LR. Table 4.1-3 provides a list of other potential plant-specific TLAAs that have been identified by license renewal applicants. It is not expected that all applicants would identify all the analyses in these tables as TLAAs for their plants. Also, an applicant may perform specific TLAAs for its plant that are not shown in these tables.

As appropriate, staff members from other branches of NRR review the application in their assigned areas without examining the identification of TLAAs. However, they may come across situations in which they may question why the applicant did not identify certain analyses as TLAAs. The reviewer coordinates the resolution of any such questions with these other staff members and determine whether these analyses should be evaluated as TLAAs.

In order to determine whether there is reasonable assurance that the applicant has identified the TLAAs for its plant, the reviewer should find that the analyses omitted from the applicant's list are not TLAAs. Should an applicant identify a TLAA that is also a basis for a plant-specific exemption granted pursuant to 10 CFR 50.12 and the exemption is in effect, the reviewer verifies that the applicant also identified that exemption pursuant to 10 CFR 54.21(c)(2). However, the initial license renewal applicants have found no such exemptions for their plants.

4.1.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of this section, and whether the staff's evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable list of TLAAs as defined in 10 CFR 54.3, and that no 10 CFR 50.12 exemptions have been granted on the basis of a TLAA, as defined in 10 CFR 54.3.

4.1.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein are used by the staff to evaluate conformance with NRC regulations.

4.1.6 References

1. NEI 95-10, Revision 6, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule," Nuclear Energy Institute, June 2005.

2. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports Nuclear Power Plants," July 1981.

Table 4.1-1 Sample Process for Identifying Potential Time-Limited Aging Analyses and Basis for Disposition

Example	Disposition
NRC correspondence requests a utility to justify that unacceptable cumulative wear did not occur during the design life of control rods.	Does not qualify as a TLAA because the design life of control rods is less than 40 years. Therefore, does not meet criterion (3) of the TLAA definition in 10 CFR 54.3.
Maximum wind speed of 100 mph is expected to occur once per 50 years.	Not a TLAA because it does not involve an aging effect.
Correspondence from the utility to the NRC states that the membrane on the containment basemat is certified by the vendor to last for 40 years.	The membrane was not credited in any safety evaluation, and therefore the analysis is not considered a TLAA. This example does not meet criterion (4) of the TLAA definition in 10 CFR 54.3.
Fatigue usage factor for the pressurizer surge line was determined not to be an issue for the current license period in response to NRC Bulletin 88-11.	This example is a TLAA because it meets all 6 criteria in the definition of TLAA in 10 CFR 54.3. The utility's fatigue design basis relies on assumptions defined by the 40-year operating life for this component, which is the current operating term.
Containment tendon lift-off forces are calculated for the 40-year life of the plant. These data are used during Technical Specification surveillance for comparing measured to predicted lift-off forces.	This example is a TLAA because it meets all 6 criteria of the TLAA definition in 10 CFR 54.3. The lift-off force curves are currently limited to 40-year values, and are needed to perform a required Technical Specification surveillance.

Table 4.1-2 Generic Time-Limited Aging Analyses

Reactor vessel neutron embrittlement (Subsection 4.2)
Metal fatigue (Subsection 4.3)
Environmental qualification of electrical equipment (Subsection 4.4)
Concrete containment tendon prestress (Subsection 4.5)
Inservice local metal containment corrosion analyses (Subsection 4.6)

Table 4.1-3 Examples of Potential Plant-Specific TLAAs

Intergranular separation in the heat-affected zone (HAZ) of reactor vessel low-alloy steel under austenitic SS cladding.
Low-temperature overpressure protection (LTOP) analyses
Fatigue analysis for the main steam supply lines to the turbine-driven auxiliary feedwater pumps
Fatigue analysis of the reactor coolant pump flywheel
Fatigue analysis of polar crane
Flow-induced vibration endurance limit for the reactor vessel internals
Transient cycle count assumptions for the reactor vessel internals
Ductility reduction of fracture toughness for the reactor vessel internals
Leak before break
Fatigue analysis for the containment liner plate
Containment penetration pressurization cycles
Metal corrosion allowance
High-energy line-break postulation based on fatigue cumulative usage factor
Inservice flaw growth analyses that demonstrate structure stability for 40 years

4.2 REACTOR VESSEL NEUTRON EMBRITTLEMENT ANALYSIS

Review Responsibilities

Primary - Branch responsible for the TLAA issues
Secondary - Branch responsible for reactor systems

4.2.1 Areas of Review

During plant service, neutron irradiation reduces the fracture toughness of ferritic steel in the reactor vessel beltline region of light-water nuclear power reactors. Areas of review to ensure that the reactor vessel has adequate fracture toughness to prevent brittle failure during normal and off-normal operating conditions are (a) upper-shelf energy, (b) pressurized thermal shock (PTS) for pressurized water reactors (PWRs), (c) heat-up and cool-down (pressure-temperature limits) curves, (d) Boiling Water Reactor Vessel and Internals Project (BWRVIP)-05 analysis for elimination of circumferential weld inspection and analysis of the axial welds, and (e) other plant-specific TLAAs on reactor vessel neutron embrittlement.

The adequacy of the analyses for these five areas is reviewed for the period of extended operation.

The branch responsible for reactor systems reviews neutron fluence and dosimetry information in the application.

4.2.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.2.1 of this review plan section delineate acceptable methods for meeting the requirements of the U.S. Nuclear Regulatory Commission's (NRC's) regulation in 10 CFR 54.21(c)(1).

4.2.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the extended period of operation; or

(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

For the first three areas of review for the analysis of reactor vessel neutron embrittlement, the specific acceptance criteria depend on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii).

4.2.2.1.1 Upper-Shelf Energy (USE)

10 CFR Part 50 Appendix G (Ref. 1) paragraph IV.A.1 requires that the reactor vessel beltline materials have a Charpy upper-shelf energy of no less than 68 J (50 ft-lb) throughout the life of the reactor vessel, unless otherwise approved by the NRC. An applicant may take any one of the following three approaches:

4.2.2.1.1.1 10 CFR 54.21(c)(1)(i)

The reactor vessel components evaluated in the existing upper-shelf energy analysis or NRC-approved equivalent margins analysis (EMA) are re-evaluated to demonstrate the existing analysis remains valid during the period of extended operation because the neutron fluence projected to the end of the period of extended operation is bound by the fluence assumed in the existing analysis.

4.2.2.1.1.2 10 CFR 54.21(c)(1)(ii)

The reactor vessel components evaluated in the existing upper-shelf energy analysis or NRC-approved EMA are re-evaluated to consider the period of extended operation in accordance with 10 CFR Part 50, Appendix G.

10 CFR Part 50, Appendix G, Section IV.A.1 (the rule) requires applicants to take further corrective actions for those cases where the 102 joules (J) (75 ft-lb) unirradiated USE (UUSE) criterion or 68 J (50 ft-lbs) end-of-life (EOL) USE criterion cannot be met (i.e., when the respective UUSE value falls below 75 ft-lb or the EOL USE falls below 50 ft-lb). When this occurs, the rule requires a licensee to submit a supplemental analysis for NRC approval for any case where the UUSE value is less than 102 J (75 ft-lb) or where the projected EOL USE value for a given material is projected to be less than the 68 J (50 ft-lb) acceptance criteria at the expiration of the operating license. Thus, if the USE value for a PWR reactor vessel (RV) material, as projected to the expiration of the period of extended operation, falls below either the 68 J (50 ft-lb) acceptance criterion or the USE value criterion specified in a previously NRC-approved EMA, or where the percent-drop in USE value for a BWR RV material, as projected to the expiration of the period of extended operation, falls below that percent-drop in USE value approved by the NRC in its safety evaluation of the BWRVIP's generic EMA for BWRs, an applicant will need to submit a plant-specific engineering analysis (usually an EMA) for NRC approval as supplemental information for license renewal. Otherwise, failure to meet the USE requirements of 10 CFR Part 50, Appendix G for the RV materials as evaluated using the neutron fluence that are projected for the period of extended operation mandates imposition of additional commitments or license condition on USE for the license renewal application.

4.2.2.1.1.3 10 CFR 54.21(c)(1)(iii)

Acceptance criteria under 10 CFR 54.21(c)(1)(iii) have yet to be developed. They will be evaluated on a case-by-case basis to ensure that the aging effects are managed such that the intended function(s) are maintained during the period of extended operation.

4.2.2.1.2 Pressurized Thermal Shock (for PWRs)

For PWRs, 10 CFR 50.61 (Ref. 2) requires that the "reference temperature" for reactor vessel beltline materials evaluated at EOL fluence, RT_{PTS}, be less than the "PTS screening criteria" at the expiration date of the operating license, unless otherwise approved by the NRC. The "PTS screening criteria" are 132°C (270°F) for plates, forgings, and axial weld materials, and 149°C (300°F) for circumferential weld materials. The regulations require updating of the PTS assessment upon a request for a change in the expiration date of a facility's operating license, or change of the projected material neutron fluence or change in the material properties in any of the reactor vessel beltline materials. Therefore, the RT_{PTS} value must be calculated for the entire life of the facility, including the period of extended operation. The PTS TLAA may be handled as follows.

4.2.2.1.2.1 10 CFR 54.21(c)(1)(i)

The existing PTS analysis remains valid during the period of extended operation because the neutron fluence projected to the end of the period of extended operation is bound by the fluence assumed in the existing analysis.

4.2.2.1.2.2 10 CFR 54.21(c)(1)(ii)

The PTS analysis is re-evaluated to consider the period of extended operation in accordance with 10 CFR 50.61. An analysis is performed in accordance with NRC Regulatory Guide (RG) 1.154 (Ref. 3) if the "PTS screening criteria" in 10 CFR 50.61 are exceeded during the period of extended operation.

4.2.2.1.2.3 10 CFR 54.21(c)(1)(iii)

The staff position for license renewal on this option is described in a May 27, 2004 letter from L.A. Reyes (EDO) to the Commission (Ref. 4) which states that if the applicant does not extend the TLAA, the applicant provides an assessment of the current licensing basis TLAA for PTS, a discussion of the flux reduction program implemented in accordance with 10 CFR 50.61(b)(3), if necessary, and an identification of the viable options that exist for managing the aging effect in the future.

4.2.2.1.3 Pressure-Temperature (P-T) Limits

10 CFR Part 50, Appendix G (Ref. 1) requires that the reactor pressure vessel (RPV) be maintained within established pressure-temperature (P-T) limits including during any condition of normal operation. This includes heatup and cooldown. These limits specify the maximum allowable pressure as a function of reactor coolant temperature. As the reactor pressure vessel becomes embrittled and its fracture toughness is reduced, the allowable pressure (given the required minimum temperature) is reduced.

P-T limits are TLAAs for the application if the plant currently has P-T limit curves approved for the expiration of the current period of operation (i.e., 32 EFPY or other licensed EFPY values at expiration of the current license). However, the P-T limits for the period of extended operation need not be submitted as part of the LRA since the P-T limits need to be updated through the 10 CFR 50.90 licensing process when necessary for P-T limits that are located in the limiting conditions of operation (LCOs) of the Technical Specifications (TS). For those plants that have approved pressure-temperature limit reports (PTLRs), the P-T limits for the period of extended operation will be updated at the appropriate time through the plant's Administrative Section of the TS and the plant's PTLR process. In either case, the 10 CFR 50.90 or the PTLR processes, which constitute the current licensing basis will ensure that the P-T limits for the period of extended operation will be updated prior to expiration of the P-T limit curves for the current period of operation.

P-T limits may be handled as follows.

4.2.2.1.3.1 10 CFR 54.21(c)(1)(i)

The existing P-T limits are valid during the period of extended operation because the neutron fluence projected to the end of the period of extended operation is bound by the fluence assumed in the existing analysis.

4.2.2.1.3.2 10 CFR 54.21(c)(1)(ii)

The P-T limits are reevaluated to consider the period of extended operation in accordance with 10 CFR Part 50, Appendix G (Ref. 1).

4.2.2.1.3.3 10 CFR 54.21(c)(1)(iii)

Updated P-T limits for the period of extended operation must be available prior to entering the period of extended operation. The 10 CFR 50.90 process for P-T limits located in the LCOs or the Administrative Controls Process for P-T limits that are administratively amended through a PTLR process can be considered adequate aging management programs within the scope of 10 CFR 54.21(c)(1)(iii) such that P-T limits will be maintained through the period of extended operation.

4.2.2.1.4 Elimination of Circumferential Weld Inspection (for BWRs)

Some BWRs have an approved technical alternative which eliminates the reactor vessel circumferential shell weld inspections for the current license term because they satisfy the limiting conditional failure probability for the circumferential welds at the expiration of the current license, based on BWRVIP-05 and the extent of neutron embrittlement (Refs. 5-7). An applicant for renewal of a license to operate such a BWR may provide justification to extend this relief into the period of extended operation in accordance with BWRVIP-74-A (Ref. 8), which is the revised and NRC approved version of BWRVIP-74 (Ref. 9). The staff's review of BWRVIP-74 (Ref. 9) is contained in an October 18, 2001 letter to C.Terry, BWRVIP Chairman (Ref. 10). Section A.4.5 of Report BWRVIP-74-A indicates that Appendix E of the staff's final safety evaluation report (FSER) conservatively evaluated BWR RPV's to have 64 effective full power years (EFPY), which is 10 EFPY greater than the maximum of what is realistically expected for the end of the license renewal period. Since this is a generic analysis, a licensee relying on BWRVIP-74-A should provide plant-specific information to demonstrate that at the end of the renewal period, the circumferential beltline weld materials meet the limiting conditional failure probability for circumferential welds specified in Appendix E of the FSER and that operator training and procedures are utilized during the license renewal term to limit the frequency for cold over-pressure events to the amount specified in the NRC FSER.

4.2.2.1.5 Axial Welds (for BWRs)

The staff's SER contained in a letter to Carl Terry dated March 7, 2000, "Supplement to Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report" (Ref. 11) discussed the staff's concern related to RPV failure frequency for axial welds and the BWRVIP's analysis of the RPV failure frequency of axial welds. These discussions are also presented in staff's FSER of BWRVIP-74 (Ref. 10). The SER indicates that the RPV failure frequency due to failure of the limiting axial welds in the BWR fleet at the end of 40 years of operation is less than 5×10^{-6} per reactor year, given the assumptions on flaw density, distribution, and location described in the SER. Since the BWRVIP analysis was generic, a licensee relying on BWRVIP-74-A should monitor axial beltline weld embrittlement. The applicant may provide plant-specific information to demonstrate that the axial beltline weld materials at the extended period of operation meet the criteria specified in the report or have a program to monitor axial weld embrittlement relative to the values specified by the staff in its May 7, 2000, (Ref. 11) letter.

4.2.2.2 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description contains information associated with the TLAAs regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21(c)(1).

4.2.3 Review Procedures

For each area of review described in Subsection 4.2.1, the following review procedures should be followed.

4.2.3.1 Time-Limited Aging Analysis

For the first three areas of review for the analysis of reactor vessel neutron embrittlement, the review procedures depend on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii). For each area, the applicant's three options under section 54.21(c)(1) are discussed in turn, as follows.

4.2.3.1.1 Upper-Shelf Energy

4.2.3.1.1.1 10 CFR 54.21(c)(1)(i)

The projected neutron fluence at the end of the period of extended operation is reviewed to verify that it is bound by the fluence assumed in the existing upper-shelf energy analysis.

4.2.3.1.1.2 10 CFR 54.21(c)(1)(ii)

The documented results of the revised upper-shelf energy analysis based on the projected neutron fluence at the end of the period of extended operation are reviewed for compliance with 10 CFR Part 50, Appendix G. The applicant may use NRC RG 1.99 Rev. 2 (Ref. 12) to project upper-shelf energy to the end of the period of extended operation. The applicant also may use ASME Code Section XI Appendix K (Ref. 13) for the purpose of performing an equivalent margins analysis to demonstrate that adequate protection for ductile failure is maintained to the end of the period of extended operation. The staff reviews the applicant's methodology for this evaluation. Branch Position MTEB 5-3, "Fracture Toughness Requirements," in Standard Review Plan (Ref. 14), Section 5.3.2, "Pressure Temperature limits, Upper-Shelf Energy, and Pressurized Thermal Shock" provides additional NRC positions on estimations of USE values for reactor vessel beltline materials.

The staff confirms that the applicant has provided sufficient information for all Upper Shelf Energy (USE) and/or equivalent margins analysis calculations for the period of extended operation as follows:

Neutron Fluence: The applicant identifies: (a) the neutron fluence at the 1/4T location for each beltline material at the expiration of the license renewal period; (b) the staff-approved methodology used to determine the neutron fluence or submits the methodology for staff review, and (c) whether the methodology follows the guidance in NRC RG 1.190 (Ref. 15).

To confirm that the USE analysis meets the requirements of Appendix G of 10 CFR Part 50 at the end of the license renewal period, the staff determines whether:

1. For each beltline material, the applicant has provided the unirradiated Charpy USE, and the projected Charpy USE at the end of the license renewal period, and whether the drop in Charpy USE was determined using the limit lines in Figure 2 of NRC RG 1.99, Revision 2 or from surveillance data and the percentage copper.

2. If an equivalent margins analysis is used to demonstrate compliance with the USE requirements in Appendix G of 10 CFR Part 50, the applicant provides the analysis or identifies an approved topical report that contains the analysis. Information the staff

considers to assess the equivalent margins analysis includes: the unirradiated USE (if available) for the limiting material, its copper content, the fluence (1/4T and at 1 inch depth), the EOLE USE (if available), the operating temperature in the downcomer at full power, the vessel radius, the vessel wall thickness, the J-applied analysis for Service Level C and D, the vessel accumulation pressure, and the vessel bounding heatup/cooldown rate during normal operation.

For Boiling Water Reactors, the staff confirms that the beltline materials are evaluated in accordance with the following Renewal Applicant Action Item in the staff's SER, for BWRVIP-74 (Letter to C. Terry dated October 18, 2001) (Ref.10). Action Item 10: To demonstrate that the beltline materials meet the Charpy USE criteria specified in Appendix B of BWRVIP-74-A or the NRC FSER, the applicant shall demonstrate that the percent reduction in Charpy USE for their beltline materials are less than those specified for the limiting BWR/3-6 plates and the non-Linde 80 submerged arc welds and that the percent reduction in Charpy USE for their surveillance weld and plate are less than or equal to the values projected using the methodology in NRC RG 1.99, Revision 2.

The applicant identifies whether there are two or more surveillance material samples available that are relevant to the RPV beltline materials. If there are two or more data points for a surveillance material, the applicant provides analyses of the data to determine whether the data are consistent with the NRC RG 1.99, Revision 2 methodology that was utilized in the BWRVIP-74-A analyses.

4.2.3.1.1.3 10 CFR 54.21(c)(1)(iii)

The applicant's proposal to demonstrate that the effects of aging on the intended function(s) will be adequately managed for the period of extended operation is reviewed on a case-by-case basis.

4.2.3.1.2 Pressurized Thermal Shock (for PWRs)

4.2.3.1.2.1 10 CFR 54.21(c)(1)(i)

The projected neutron fluence at the end of the period of extended operation is reviewed to verify that it is bound by the fluence assumed in the existing PTS analysis.

4.2.3.1.2.2 10 CFR 54.21(c)(1)(ii)

The documented results of the revised PTS analysis based on the projected neutron fluence at the end of the period of extended operation are reviewed for compliance with 10 CFR 50.61.

The staff confirms that the applicant has provided sufficient information for Pressurized Thermal Shock for the period of extended operation as follows:

Neutron Fluence: Identified the neutron fluence at the inside surface and the 1/4T location for each beltline material at the expiration of the license renewal period. Identified the staff-approved methodology used in determining the neutron fluence, or submit the methodology for staff review, and identified whether the methodology followed the guidance in NRC RG 1.190 (Ref. 15).

There are two methodologies from 10 CFR 50.61 that can be used in the PTS analysis based on the projected neutron fluence at the end of the period of extended operation. RT_{NDT} is the reference temperature (NDT means nil-ductility temperature) used as an indexing parameter to determine the fracture toughness and the amount of embrittlement of a material. RT_{PTS} is the reference temperature used in the PTS analysis and is related to RT_{NDT} at the end of the facility's operating license.

The first methodology does not rely on plant-specific surveillance data to calculate delta RT_{NDT} (i.e., the mean value of the adjustment or shift in reference temperature caused by irradiation). The delta RT_{NDT} is determined by multiplying a chemistry factor from the tables in 10 CFR 50.61 by a fluence factor calculated from the neutron flux using an equation.

The second methodology relies on plant-specific surveillance data to determine the delta RT_{NDT}. In this methodology, two or more sets of surveillance data are needed. A surveillance datum consists of a measured delta RT_{NDT} for corresponding neutron fluence. 10 CFR 50.61 specifies a procedure and a criterion for determining whether the surveillance data are credible. For the surveillance data to be defined as credible, the difference in the predicted value and the measured value for delta RT_{NDT} must be less than 28°F for weld metal. When a credible surveillance data set exists, the chemistry factor can be determined from these data in lieu of a value from the table in 10 CFR 50.61. Then the standard deviation of the increase in the RT_{NDT} can be reduced from 28°F to 14°F for welds.

To confirm that the Pressurized Thermal Shock analysis results in RT_{PTS} values below the screening criteria in 10 CFR 50.61 at the end of the license renewal period, the applicant provides the following:

1. For each beltline material provide the unirradiated RT_{NDT}, the method of calculating the unirradiated RT_{NDT} (either generic or plant-specific), the margin, the chemistry factor, the method of calculating the chemistry factor, the mean value for the shift in transition temperature and the RT_{PTS} value.

2. If there are two or more data for a surveillance material that is from the same heat of material as the beltline material, provide analyses to determine whether the data are credible in accordance with NRC RG 1.99, Revision 2 and whether the margin value used in the analysis is appropriate.

3. If a surveillance program does not include the vessel beltline controlling material, but two or more data seta are available from other beltline materials, then provide an analysis of the data in accordance with Regulatory Guide 1.99, Revision 2, Regulatory Position C.2.1, to show that the results either bound or are comparable to the values that would be calculated for the same materials using Regulatory Position C.1.1..

If the "PTS screening criteria" in 10 CFR 50.61 are exceeded during the period of extended operation, an analysis based on NRC RG 1.154 (Ref. 3) is reviewed**.**

4.2.3.1.2.3 10 CFR 54.21(c)(1)(iii)

The applicant's proposal to demonstrate that the effects of aging on the intended function(s) will be adequately managed for the period of extended operation will be reviewed on a case-by-case basis.

The license renewal application provides an assessment of the current licensing basis TLAA for PTS, a discussion of the flux reduction program implemented in accordance with §50.61(b)(3), if necessary, and an identification of the viable options that exist for managing the aging effect in the future.

A. The applicant explains its core management plans (e.g., operation with a low leakage core design and/or integral burnable neutron absorbers) from now through the end of the period of extended operation. Based on this core management strategy, the applicant:

   (1) Identifies the material in the RPV which has limiting RT_{PTS} value,
   (2) Provides the projected fluence value for the limiting material at end of license extended (EOLE),
   (3) Provides the projected RT_{PTS} value for the limiting material at EOLE, and
   (4) Provides the projected date and fluence values at which the limiting material will exceed the screening criteria in §50.61.

B. The applicant discusses aging management programs that it intends to implement which actively "manages" the condition of the facility's RPV, and hence, the risk associated with PTS. This discussion is expected to address, at least, the facility's reactor pressure vessel material surveillance program.

C. The applicant briefly discusses the options that it is considering with respect to "resolving" the PTS issue through EOLE. It is anticipated that this discussion includes some or all of the following:

   (1) Plant modifications (e.g., heating of ECCS injection water) which could limit the risk associated with postulated PTS events [see §50.61(b)(4) and/or (b)(6)],
   (2) More detailed safety analyses (e.g., using Regulatory Guide 1.154) which may be performed to show that the PTS risk for the facility is acceptably low through EOLE [see §50.61(b)(4)],
   (3) More advanced material property evaluation (e.g., use of Master Curve technology) to demonstrate greater fracture resistance for the limiting material [applies to §50.61(b)(4)] and/or,
   (4) The potential for RPV thermal annealing in accordance with §50.66 [see §50.61(b)(7)].

4.2.3.1.3 Pressure-Temperature (P-T) Limits

4.2.3.1.3.1 10 CFR 54.21(c)(1)(i)

The documented results of the projected neutron fluence at the end of the period of extended operation are reviewed to verify that it is bound by the embrittlement assumed in the existing P-T limit analysis.

4.2.3.1.3.2 10 CFR 54.21(c)(1)(ii)

The documented results of the revised P-T limit analysis based on the projected reduction in fracture toughness at the end of the period of extended operation is reviewed for compliance with 10 CFR Part 50, Appendix G.

The P-T limit evaluations are dependent upon the neutron fluence. The staff confirms that the applicant has identified the staff-approved methodology to determine the neutron fluence or has submitted the methodology for staff review and identified whether the methodology followed the guidance in NRC RG 1.190 (Ref. 15).

4.2.3.1.3.3 10 CFR 54.21(c)(1)(iii)

For Boiling Water Reactors, the staff confirms that the applicant addresses the following Renewal Applicant Action Item in the staff's SER, for BWRVIP-74 (Letter to C. Terry dated October 18, 2001) (Ref. 10).

> Action Item 9: Appendix A of the BWRVIP-74-A Report indicates that a set of P-T curves should be developed for the heat-up and cool-down operating conditions in the plant at a given EFPY in the license renewal period.

The staff understands this to mean that the applicant has not provided updated curves, but shall have a procedure for updating P-T limits in accordance with 10 CFR Part 50, Appendix G, that will cover 60 years.

4.2.3.1.4 Elimination of Circumferential Weld Inspection (for BWRs)

To demonstrate that the vessel has not been embrittled beyond the basis for the technical alternative and that cold over-pressure events are not likely to occur during the license renewal term, the applicant should provide: (a) a comparison of the neutron fluence, initial RT_{NDT} , chemistry factor amounts of copper and nickel, delta RT_{NDT}, and mean RT_{NDT} of the limiting circumferential weld at the end of the license renewal period to the 64 EFPY reference case in Appendix E of the staff's SER for BWRVIP-74 (Ref. 10), (b) an estimate of conditional failure probability of the RPV at the end of the license renewal term based on the comparison of the mean RT_{NDT} for the limiting circumferential welds and the reference case, and (c) a description of procedures and training that will be utilized during the license renewal term to limit the frequency of cold over-pressure events to the amount specified in the staff's SER for BWRVIP-74 (Ref. 10). The staff ensures that the applicant's plant is bound by the BWRVIP-74-A analysis and that the applicant has committed to actions that are the basis for the staff approval.

The circumferential weld and axial weld reactor pressure vessel integrity evaluations are dependent upon the neutron fluence. The staff should confirm that the applicant has identified the staff-approved methodology used in determining the neutron fluence or submitted the methodology for staff review, and identified whether the methodology followed the guidance in NRC RG 1.190 (Ref. 15). The staff also confirms that the applicant has addressed the following Renewal Applicant Action Item in the staff's SER, for BWRVIP-74 (Letter to C. Terry dated October 18, 2001) (Ref.10).

> Action Item 11: To obtain relief from the inservice inspection of the circumferential welds during the LR period, the BWRVIP report indicates each licensee will have to demonstrate that (a) at the end of the renewal period, the circumferential welds will satisfy the limiting conditional failure frequency for circumferential welds in the Appendix E of the staff's July 28, 1998 (Ref. 6), FSER, and (b) that they have implemented operator training and procedures that limit the frequency of cold over pressure events to the amount specified in the staff's FSER.

4.2.3.1.5 Axial Welds (for BWRs)

To demonstrate that the vessel has not been embrittled beyond the basis for the staff and BWRVIP analyses, the applicant should provide: (a) a comparison of the neutron fluence, initial RT_{NDT}, chemistry factor amounts of copper and nickel, delta RT_{NDT}, and mean RT_{NDT} of the limiting axial weld at the end of the license renewal period to the reference case in the BWRVIP and staff analyses and (b) an estimate of conditional failure probability of the RPV at the end of the license renewal term based on the comparison of the mean RT_{NDT} for the limiting axial welds and the reference case. If this comparison does not indicate that the RPV failure frequency for axial welds is less than 5 x 10^{-6} per reactor year, the applicant should provide a probabilistic analysis to determine the RPV failure frequency for axial welds. Consistent with the staff's supplemental safety evaluation report (SER) of BWR Vessel and Internals Project BWRVIP-05 Report, dated May 7, 2000 (Ref. 11), the staff should ensure that the applicant's plant is bounded by the BWRVIP-05 analysis or that the applicant has committed to a program to monitor axial weld embrittlement relative to the values specified by the staff in its May 7, 2000, SER. The staff also confirms that the applicant has addressed the following Renewal Applicant Action Item in the staff's SER, for BWRVIP-74 (Letter to C. Terry dated October 18, 2001) (Ref.10).

> Action Item 12: As indicated in the staff"s March 7, 2000, letter to Carl Terry, a license renewal (LR) applicant shall monitor axial beltline weld embrittlement. One acceptable method is to determine the mean RT_{NDT} of the limiting axial beltline weld at the end of the extended period of operation is less than the values specified in Table 1 of the staff's Oct. 18, 2001 FSER (Ref. 10).

4.2.3.2 FSAR Supplement

The reviewer verifies that the applicant has provided information to be included in the FSAR supplement that includes a summary description of the evaluation of the reactor vessel neutron embrittlement TLAA. Table 4.2-1 of this review plan section contains examples of acceptable FSAR supplement information for this TLAA. The reviewer verifies that the applicant has provided a FSAR supplement with information equivalent to that in Table 4.2-1.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 4.2-1, an applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.2.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of this section and whether the staff's evaluation supports conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that, for the reactor vessel neutron embrittlement TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on

the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR supplement contains an appropriate summary description of the reactor vessel neutron embrittlement TLAA evaluation for the period of extended operation as reflected in the license condition.

4.2.5 IMPLEMENTATION

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

4.2.6 References

1. 10 CFR Part 50 Appendix G, "Fracture Toughness Requirements."

2. 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events."

3. Regulatory Guide 1.154, "Format and Content of Plant-Specific Pressurized Thermal Shock Safety Analysis Reports for Pressurized Water Reactors," U.S. Nuclear Regulatory Commission, January 1987.

4. Letter to the Commission from L.A. Reyes (EDO), dated May 27, 2004 (ADAMS accession number ML041190564)

5. BWRVIP-05, "BWR Vessel and Internals Project, BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations," EPRI TR-105697, September 1995.

6. Letter to Carl Terry of Niagara Mohawk Power Company, BWRVIP Chairman, from Gus C. Lainas of NRC, "Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report (TAC No. M93925)," dated July 28, 1998.

7. Generic Letter 98-05, "Boiling Water Reactor Licensees Use of the BWRVIP-05 Report to Request Relief from Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds," U.S. Nuclear Regulatory Commission, November 10, 1998.

8. BWRVIP-74-A, "BWR Vessels and Internals Project, BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines for License Renewal," EPRI TR-1008872, June 2003.

9. BWRVIP-74, "BWR Vessels and Internals Project, BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines," EPRI TR-113596, September 1999.

10. Letter to Carl Terry of Niagara Mohawk Power Company, BWRVIP Chairman, from Christopher Grimes, of NRC, "Acceptance for Referencing of EPRI Proprietary Report TR-113596, BWR Vessel and Internals Project, BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines BWRVIP-74), and Appendix A, Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10CFR54.21)," dated October 18, 2001.

11. Letter to Carl Terry of Niagara Mohawk Power Company, BWRVIP Chairman, from Jack R. Strosnider, Jr., of NRC, “Supplement to Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report (TAC No. MA3395),” dated March 7, 2000.

12. Regulatory Guide 1.99 Rev. 2, “Radiation Embrittlement of Reactor Vessel Materials,” May, 1988.

13. Appendix K of ASME Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components.”

14. NUREG-0800, “U.S. Nuclear Regulatory Commission, Standard Review Plan,” U.S. Nuclear Regulatory Commission.

15. Regulatory Guide 1.190 Rev. 0, “Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence,” U.S. Nuclear Regulatory Commission, March 2001.

Table 4.2-1 Examples of FSAR Supplement for Reactor Vessel Neutron Embrittlement TLAA Evaluation

TLAA	Description of Evaluation	Implementation Schedule*
Upper-shelf energy	10 CFR Part 50 Appendix G paragraph IV.A.1 requires that the reactor vessel beltline materials must have Charpy upper-shelf energy of no less than 50 ft-lb (68 J) throughout the life of the reactor vessel unless otherwise approved by the NRC. The upper-shelf energy has been determined to exceed 50 ft-lb (68 J) to the end of the period of extended operation.	Completed
Pressurized thermal shock (for PWRs)	For PWRs, 10 CFR 50.61 requires the “reference temperature RT_{PTS}” for reactor vessel beltline materials be less than the “PTS screening criteria” at the expiration date of the operating license unless otherwise approved by the NRC. The “PTS screening criteria” are 270°F (132°C) for plates, forgings, and axial weld materials, or 300°F (149°C) for circumferential weld materials. The “reference temperature” has been determined to be less than the “PTS screening criteria” at the end of the period of extended operation.	Completed
Pressure-temperature (P-T) limits	10 CFR Part 50 Appendix G requires that heatup and cooldown of the RPV be accomplished within established P-T limits. These limits specify the maximum allowable pressure as a function of reactor coolant temperature. As the RPV becomes embrittled and its fracture toughness is reduced, the allowable pressure is reduced. 10 CFR Part 50 Appendix G requires periodic update of P-T limits based on projected embrittlement and data from a material surveillance program. The P-T limits will be updated to consider the period of extended operation.	Update should be completed before the period of extended operation.
Elimination of circumferential weld inspection and analysis of axial welds (for BWRs)	NRC has granted relief from the reactor vessel circumferential shell weld inspections because the applicant has demonstrated through plant-specific analysis that the plant meets the staff approved BWRVIP-74-A Report and has provided sufficient information that the probability of vessel failure due to embrittlement of axial welds is low.	Completed
Other miscellaneous TLAAs on RV neutron embrittlement	Provide sufficient information on how the calculations for plant-specific TLAAs were performed, what the limiting TLAA parameter was calculated to be in accordance with the neutron fluence projected for the period of extended operation, and why the TLAA is acceptable under either 10 CFR 54.21 (c)(1)(i), (ii), or (iii).	

* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.3 METAL FATIGUE AND FATIGUE FLAW GROWTH

Review Responsibilities

Primary - Branch responsible for the TLAA issues
Secondary - None

4.3.1 Area of Review

A metal component may progressively degrade and lose its structural integrity when it is subjected to fluctuating stresses, even at magnitudes less than the design static loads, due to a well-known degradation mechanism, fatigue. This mechanism of degradation can occur in flaw-free components by developing cracks during services. ASME Section III (Ref. 1) requires a fatigue analysis for Class 1 components that considers all transient loads based on the anticipated number of thermal and pressure transients, and includes calculation of a parameter "cumulative usage factor" (CUF) that is used for estimating the extent of fatigue damage in the component. The ASME Code limits the CUF to a value of less than or equal to one for acceptable fatigue design. A CUF of one assumes that a small but analyzable crack has been formed. If undetected or left untreated, the crack will propagate exponentially under fatigue loading and eventually lead to coolant leakage in reactor pressure boundary components, or even general structural failure. Metal fatigue of components may have been evaluated based on an assumed number of transients or cycles for the current operating term. The validity of such metal fatigue analysis is reviewed for the period of extended operation.

In addition, growth of postulated flaws and flaws discovered during in-service inspections might have been performed for the current operating term. The validity of such metal fatigue or flaw growth/tolerance evaluations is reviewed for the period of extended operation.

Areas of review to ensure that the metal fatigue or flaw growth/tolerance evaluations are valid for the period of extended operation include:

1. CUF calculations for ASME Code Class 1 components designed to ASME Section III requirements, and other Codes that are based on a CUF calculation [the 1969 edition of ANSI B31.7 (Ref. 3) for Class 1 piping, ASME NC-3200 vessels, ASME NE 3200 Class MC components, and metal bellows designed to ASME NC-3649.4(e)(3), ND 3649.4(e)(3), or NE-3366.2(e)(3)]. ASME Class 1 components, which include core support structures, are analyzed for metal fatigue.

2. Implicit fatigue-based maximum allowable stress calculations for piping components designed to USAS ANSI B31.1 (Ref. 2) requirements, and ASME Code Class 2 and 3 components designed to ASME Section III design requirements that are similar to the guidance in ANSI B31.1.

   ANSI B31.1 applies only to piping and does not call for an explicit fatigue analysis. It specifies allowable stress levels based on the number of anticipated thermal cycles. The specific allowable stress reductions due to thermal cycles are listed in Table 4.3-1. For example, the allowable stress would be reduced by a factor of 1.0, i.e., no reduction, for piping that is not expected to experience more than 7,000 thermal cycles during plant service, but would be reduced to half of the maximum allowable static stress for 100,000 or more thermal cycles.

3. Environmental fatigue calculations for ASME Code Class 1 components.

   Generic Safety Issue: The fatigue design criteria for nuclear power plant components have changed as the industry consensus codes and standards have developed. The fatigue design criteria for a specific component depend on the version of the design code that applied to that component, i.e., the code of record. There is a concern that the effects of the reactor coolant environment on the fatigue life of components were not adequately addressed by the code of record.

   The NRC has decided that the adequacy of the code of record relating to metal fatigue is a potential safety issue to be addressed by the current regulatory process for operating reactors (Refs. 4 and 5). The effects of fatigue for the initial 40-year reactor license period were studied and resolved under Generic Safety Issue (GSI)-78, "Monitoring of Fatigue Transient Limits for reactor coolant system," and GSI-166, "Adequacy of Fatigue Life of Metal Components" (Ref. 6). GSI-78 addressed whether fatigue monitoring was necessary at operating plants. As part of the resolution of GSI-166, an assessment was made of the significance of the more recent fatigue test data on the fatigue life of a sample of components in plants where Code fatigue design analysis had been performed. The efforts on fatigue life estimation and ongoing issues under GSI-78 and GSI-166 for 40-year plant life were addressed separately under a staff generic task action plan (Refs. 7 and 8). The staff documented its completion of the fatigue action plan in SECY-95-245 (Ref. 9).

   SECY-95-245 was based on a study described in NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components" (Ref. 10). In NUREG/CR-6260, sample locations with high fatigue usage were evaluated. Conservatisms in the original fatigue calculations, such as actual cycles versus assumed cycles, were removed, and the fatigue usage was recalculated using a fatigue curve considering the effects of the environment. The staff found that most of the locations would have a CUF of less than the ASME Code limit of 1.0 for 40 years. On the basis of the component assessments, supplemented by a 40-year risk study, the staff concluded that a backfit of the environmental fatigue data to operating plants could not be justified. However, because the staff was less certain that sufficient excessive conservatisms in the original fatigue calculations could be removed to account for an additional 20 years of operation for renewal, the staff recommended in SECY-95-245 that the samples in NUREG/CR-6260 should be evaluated considering environmental effects for license renewal. GSI-190, "Fatigue Evaluation of Metal Components for 60-year Plant Life," was established to address the residual concerns of GSI-78 and GSI-166 regarding the environmental effects on fatigue of pressure boundary components for 60 years of plant operation.

   The scope of GSI-190 included design basis fatigue transients. It studied the probability of fatigue failure and its effect on core damage frequency (CDF) of selected metal components for 60-year plant life. The results showed that some components have cumulative probabilities of crack initiation and through-wall growth that approach one within the 40- to 60-year period. The maximum failure rate (through-wall cracks per year) was in the range of 10-2 per year, and those failures were generally associated with high cumulative usage factor locations and components with thinner walls, i.e., pipes more vulnerable to through-wall cracks. In most cases, the leakage from these through-wall cracks is small and not likely to lead to core damage. It was concluded that no generic regulatory action is necessary and that GSI-190 is resolved based on results of probabilistic analyses and sensitivity studies, interactions with the industry (NEI and EPRI), and different approaches available to licensees to manage the effects of aging (Refs. 11 and 12).

However, the calculations supporting resolution of this issue, which included consideration of environmental effects, indicate the potential for an increase in the frequency of pipe leaks as plants continue to operate. Thus, the staff concluded that licensees are to address the effects of coolant environment on component fatigue life as aging management programs are formulated in support of license renewal.

The applicant's consideration of the effects of coolant environment on component fatigue life for license renewal is an area of review.

4. Potential fatigue assessments for BWR vessel internals components (potential TLAAs based on applicable applicant action items identified in applicable BWRVIP reports).

   For Boiling Water Reactors, license renewal applications that reference the following BWR Vessels and Internals Project (BWRVIP) reports should identify and evaluate the projected fatigue CUFs as a potential TLAA issue, which may impact the structural integrity of the subject reactor pressure vessel internal components.

   - BWRVIP-18-A (Ref. 16, action item #4) for core spray internals

   - BWRVIP-27-A (Ref. 17, action item #4) for standby liquid control system/core plate ΔP

   - BWRVIP-47-A (Ref. 18, action item #4) for lower plenum.

   In addition, license renewal applications that reference the BWRVIP-74-A report (Ref. 19) for reactor pressure vessel, should address the following renewal applicant action items in the staff's SER for BWRVIP-74-A report.

   Item #8: For the license renewal period, verify that the original fatigue analysis is valid and also address environmental fatigue for the following components: closure studs, nozzles, penetrations, safe ends, vessel support skirt, and vessel external attachments.

   Item #14: Components that have indications that were previously analytically evaluated in accordance with ASME Section XI Subsection IWB-3600 until the end of the 40-year service period shall be reevaluated for the period corresponding to the license renewal term.

5. Potential fatigue-based growth of postulated flaws and fracture mechanics analysis, including those for high energy line break, reactor coolant pump (RCP) flywheel, reactor vessel metal bellows, and reactor vessel underclad cracking of SA-508 Class 2 or 3 forgings, as appropriate.

The design criteria used to determine the postulated high-energy line break design locations include the calculated fatigue CUF based on the number of design transients assumed for the 40-year life of the plant. The aging effect of concern for the RCP flywheel is fatigue crack initiation and growth in the flywheel bore keyway from stresses due to starting the motor during start/stop cycles of the RCP during the 40-year design. Similarly, the primary containment process metal bellows are designed for a specific number of cycles of expansion and contraction for 40 years of operation. The fracture toughness (including the effects of neutron irradiation) and flaw growth analyses for underclad cracks that are postulated in the internal cladding of SA-508 Class 2 and 3 alloy steel components are also based upon 40-year design transients. The validity of these analyses is reviewed for the period of extended operation.

4.3.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.3.1 of this review plan section delineate acceptable methods for meeting the requirements of the NRC's regulations in 10 CFR 54.21(c)(1).

4.3.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following:

(i) the analyses remain valid for the period of extended operation,

(ii) the analyses have been projected to the end of the extended period of operation, or

(iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Specific acceptance criteria for metal fatigue are:

4.3.2.1.1 ASME Code Class 1 Components Designed to ASME Section III and other Codes based on CUF

For components designed or analyzed to ASME Class 1 requirements or other Codes that are based on a CUF calculation, the acceptance criteria, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.3.2.1.1.1 10 CFR 54.21(c)(1)(i)

The existing CUF calculations remain valid because the number of assumed transients would not be exceeded during the period of extended operation.

4.3.2.1.1.2 10 CFR 54.21(c)(1)(ii)

The CUF calculations have been reevaluated based on an increased number of assumed transients to bound the period of extended operation. The resulting CUF remains less than or equal to unity for the period of extended operation.

4.3.2.1.1.3 10 CFR 54.21(c)(1)(iii)

In Chapter X of the GALL report (Ref. 13), the staff has evaluated a program for monitoring and tracking the number of critical thermal and pressure transients for the selected reactor coolant system components. The staff has determined that this program is an acceptable aging management program to address metal fatigue of the reactor coolant system components according to 10 CFR 54.21(c)(1)(iii). The GALL report may be referenced in a license renewal application and should be treated in the same manner as an approved topical report. In referencing the GALL report, the applicant should indicate that the material referenced is applicable to the specific plant involved and should provide the information necessary to adopt the finding of program acceptability as described and evaluated in the report. The applicant should also verify that the approvals set forth in the GALL report for the generic program apply to the applicant's program.

4.3.2.1.2 Piping Components Designed to USAS ANSI B31.1 Requirements and ASME Code Class 2 and 3 Components Designed to ASME Section III Requirements

For piping designed or analyzed to B31.1 guidance or ASME Code Class 2 and 3 components designed to ASME Section III cyclic design requirements, the acceptance criteria, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.3.2.1.2.1 10 CFR 54.21(c)(1)(i)

The existing fatigue strength reduction factors remain valid because the number of cycles would not be exceeded during the period of extended operation.

4.3.2.1.2.2 10 CFR 54.21(c)(1)(ii)

The fatigue strength reduction factors have been reevaluated based on an increased number of assumed thermal cycles and the stress reduction factors (e.g., Table 4.3-1) given in the applicant's code of record to bound the period of extended operation. The adjusted fatigue strength reduction factors are such that the component design basis remains valid during the period of extended operation.

4.3.2.1.2.3 10 CFR 54.21(c)(1)(iii)

The effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The component could be replaced and the allowable stresses for the replacement will be sufficient as specified by the code during the period of extended operation.

Alternative acceptance criteria under 10 CFR 54.21(c)(1)(iii) have yet to be developed. They will be evaluated on a case-by-case basis to ensure that the aging effects will be managed such that the intended functions(s) will be maintained during the period of extended operation.

4.3.2.1.3 Environmental Fatigue Calculations for Code Class 1 Components

The staff recommendation for the closure of GSI-190 is contained in a December 26, 1999 memorandum from Ashok Thadani to William Travers (Ref. 11). The staff recommended that licensees address the effects of the coolant environment on component fatigue life as aging management programs are formulated in support of license renewal. For reactor coolant pressure boundary components, one method acceptable to the staff for satisfying this recommendation is to assess the impact of the reactor coolant environment on a sample of critical components. These critical components should include, as a minimum, those selected in NUREG/CR-6260 (Ref. 10). The sample of critical components can be evaluated by applying environmental correction factors to the existing ASME Code fatigue analyses. Formulas for calculating the environmental life correction factors are:

- Those contained in NUREG/CR-6583 (Ref. 14) for carbon and low-alloy steels and in NUREG/CR-5704 (Ref. 15) for austenitic SSs.

- Those contained in Section C of NRC Regulatory Guide (RG) 1.207 (Ref. 20) and described in Appendix A of NUREG/CR-6909 (Ref. 21) for carbon and low-alloy steels, austenitic stainless steels, and Ni-alloys.

- A staff approved technical equivalent.

Any one set of formulas may be used for calculating the environmental life correction factors for all materials, but not a combination of one set for one material and another set for other materials. However, since the environmental correction factor for Ni-alloys is not defined in the first set of formulas, the formulas defined in RG 1.207 for Ni-alloys may be used when using the formulas in NUREG/CR-6583 and NUREG/CR-5704 for carbon and low-alloy steels and austenitic stainless steels, respectively.

4.3.2.1.4 Potential Fatigue Assessments for BWR Vessel Internals Components

The acceptance criteria in Subsection 4.3.2.1.1 of this review plan section apply.

4.3.2.1.5 Potential flaw growth and fracture mechanics analysis

Depending on the choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), the acceptance criteria are:

4.3.2.1.5.1 10 CFR 54.21(c)(1)(i)

The existing analyses remain valid because the number of cycles assumed for the 40-year life would not be exceeded during the period of extended operation.

4.3.2.1.5.2 10 CFR 54.21(c)(1)(ii)

The validity of the analyses has been reevaluated based on an increased number of assumed transients that bound the period of extended operation.

4.3.2.1.5.3 10 CFR 54.21(c)(1)(iii)

The acceptance criteria under 10 CFR 54.21(c)(1)(iii) will be evaluated on a case-by-case basis to ensure that the aging effects will be managed such that the intended functions(s) of the subject components will be maintained during the period of extended operation.

4.3.2.2 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

> The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description should contain information associated with the TLAAs regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21(c)(1).

4.3.3 Review Procedures

For each area of review described in Subsection 4.3.1, the following review procedures should be followed:

4.3.3.1 Time-Limited Aging Analysis

4.3.3.1.1 ASME Code Class 1 Components Designed to ASME Section III and Other Codes based on CUF

For components designed or analyzed to ASME Class 1 requirements or other Codes that are based on a CUF calculation, the review procedures, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.3.3.1.1.1 10 CFR 54.21(c)(1)(i)

The operating transient experience and a list of the assumed transients used in the existing CUF calculations for the current operating term are reviewed to ensure that the number of assumed transients would not be exceeded during the period of extended operation.

4.3.3.1.1.2 10 CFR 54.21(c)(1)(ii)

The operating transient experience and a list of the increased number of assumed transients projected to the end of the period of extended operation are reviewed to ensure that the transient projection is adequate. The revised CUF calculations based on the projected number of assumed transients are reviewed to ensure that the CUF remains less than or equal to one at the end of the period of extended operation.

The code of record should be used for the reevaluation, or the applicant may update to a later code edition pursuant to 10 CFR 50.55a. In the latter case, the reviewer verifies that the requirements in 10 CFR 50.55a are met.

4.3.3.1.1.3 10 CFR 54.21(c)(1)(iii)

The applicant may reference the GALL report in its license renewal application, as appropriate. The review should verify that the applicant has stated that the report is applicable to its plant with respect to its program that monitors and tracks the number of critical thermal and pressure transients for the selected reactor coolant system components. The reviewer verifies that the applicant has identified the appropriate program as described and evaluated in the GALL report. The reviewer also ensures that the applicant has stated that its program contains the same program elements that the staff evaluated and relied upon in approving the corresponding generic program in the GALL report. No further staff evaluation is necessary.

4.3.3.1.2 Piping Components Designed to USAS ANSI B31.1 Requirements and ASME Code Class 2 and 3 Components Designed to ASME Section III Requirements

For piping designed or analyzed to ANSI B31.1 guidance or ASME Code Class 2 and 3 components designed to ASME Section III cyclic design requirements, the review procedures, depending on the applicant’s choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.3.3.1.2.1 10 CFR 54.21(c)(1)(i)

The operating cyclic experience and a list of the assumed thermal cycles used in the existing allowable stress determination are reviewed to ensure that the number of assumed thermal cycles would not be exceeded during the period of extended operation.

4.3.3.1.2.2 10 CFR 54.21(c)(1)(ii)

The operating cyclic experience and a list of the increased number of assumed thermal cycles projected to the end of the period of extended operation are reviewed to ensure that the thermal cycle projection is adequate. The revised allowable stresses based on the projected number of assumed thermal cycles and the stress reduction factors given in the applicant’s code of record are reviewed to ensure that they remain sufficient as specified by the code during the period of extended operation. Typical stress reduction factors based on thermal cycles are given in Table 4.3-1.

The code of record should be used for the reevaluation, or the applicant may use the criteria of 10 CFR 50.55a. In the latter case, the reviewer verifies that the requirements in 10 CFR 50.55a are met.

4.3.3.1.2.3 10 CFR 54.21(c)(1)(iii)

The applicant's proposed program to ensure that the effects of aging on the intended function(s) will be adequately managed for the period of extended operation is reviewed. If the applicant proposed a component replacement before it exceeds the assumed thermal cycles, the reviewer verifies that the allowable stresses for the replacement will remain sufficient as specified by the code during the period of extended operation. Other applicant-proposed programs will be reviewed on a case-by-case basis.

4.3.3.1.3 Environmental Fatigue Calculations for Code Class 1 Components

The reviewer verifies that the applicant has addressed the staff recommendation for the closure of GSI-190 contained in a December 26, 1999 memorandum from Ashok Thadani to William Travers (Ref. 11). The reviewer verifies that the applicant has addressed the effects of the coolant environment on component fatigue life as aging management programs are formulated in support of license renewal. If an applicant has chosen to assess the impact of the reactor coolant environment on a sample of critical components, the reviewer verifies the following:

1. The critical components include, as a minimum, those selected in NUREG/CR-6260 (Ref. 10).

2. The sample of critical components has been evaluated by applying environmental correction factors to the existing ASME Code fatigue analyses.

3. Formulas for calculating the environmental life correction factors are those contained in (a) NUREG/CR–6583 (Ref. 14) for carbon and low-alloy steels, and in NUREG/CR-5704 (Ref. 15) for austenitic SSs, (b) Section C of NRC RG 1.207 (Ref. 20) and described in NUREG/CR-6909 (REF. 21) for carbon and low-alloy steels, austenitic stainless steels, and Ni-alloys, or (c) an approved technical equivalent.

4.3.3.1.4 Potential Fatigue Assessments for BWR Vessel Internals Components

The review procedures in Subsection 4.3.3.1.1 of this review plan section apply.

4.3.3.1.5 Potential flaw growth and fracture mechanics analysis

Depending on the choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), the review procedures are:

4.3.3.1.5.1 10 CFR 54.21(c)(1)(i)

The operating cyclic experience and a list of the assumed cycles used in the existing analyses are reviewed to ensure that the number of assumed cycles would not be exceeded during the period of extended operation.

4.3.3.1.5.2 10 CFR 54.21(c)(1)(ii)

The operating cyclic experience and a list of the increased number of assumed cycles projected to the end of the period of extended operation are reviewed to ensure that the projection of fatigue cycles is adequate.

4.3.3.1.5.3 10 CFR 54.21(c)(1)(iii)

The applicant's proposed program to ensure that the effects of aging on the intended function(s) of the subject component will be adequately managed for the period of extended operation will be reviewed on a case-by-case basis.

4.3.3.2 FSAR Supplement

The reviewer verifies that the applicant has provided information, to be included in the FSAR supplement, that includes a summary description of the evaluation of the metal fatigue TLAA. Table 4.3-2 contains examples of acceptable FSAR supplement information for this TLAA. The reviewer verifies that the applicant has provided a FSAR supplement with information equivalent to that in Table 4.3-2.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 4.3-2, an applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.3.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of this section and whether the staff's evaluation supports conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that, for the metal fatigue TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR Supplement contains an appropriate summary description of the metal fatigue TLAA evaluation for the period of extended operation as reflected in the license condition.

4.3.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

4.3.6 References

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Power Plant Components,” American Society of Mechanical Engineers.

2. ANSI/ASME B31.1, “Power Piping,” American National Standards Institute.

3. ANSI/ASME B31.7-1969, “Nuclear Power Piping,” American National Standards Institute.

4. SECY-93-049, “Implementation of 10 CFR Part 54, ‘Requirements for Renewal of Operating Licenses for Nuclear Power Plants,’” March 1, 1993.

5. Staff Requirements Memorandum from Samuel J. Chilk, dated June 28, 1993.

6. NUREG-0933, “A Prioritization of Generic Safety Issues,” Supplement 20, July 1996.

7. Letter from William T. Russell of NRC to William Rasin of the Nuclear Management and Resources Council, dated July 30, 1993.

8. SECY-94-191, “Fatigue Design of Metal Components,” July 26, 1994.

9. SECY-95-245, “Completion of The Fatigue Action Plan,” September 25, 1995.

10. NUREG/CR-6260, “Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components,” March 1995.

11. Letter from Ashok C. Thadani of the Office of Nuclear Regulatory Research to William D. Travers, Executive Director of Operations, dated December 26, 1999.

12. NUREG/CR-6674, “Fatigue Analysis of Components for 60-Year Plant Life,” June 2000.

13. NUREG-1801, “Generic Aging Lessons Learned (GALL),” U.S. Nuclear Regulatory Commission, March 2001.

14. NUREG/CR-6583, “Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low–Alloy Steels,” March 1998.

15. NUREG/CR-5704, “Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels,” April 1999.

16. NRC Acceptance for Referencing of BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines for Compliance with the License Renewal Rule (10CFR Part 54), Dec. 7, 2000, in BWRVIP-18-A, “BWR Vessel and Internals Project BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines,” EPRI TR-1011469, February 2005.

17. NRC Acceptance for Referencing of Report, “BWR Vessel and Internals Project, BWR Standby Liquid Control System/Core Plate □P Inspection and Flaw Evaluation Guidelines,” for Compliance with the License Renewal Rule (10CFR Part 54), Dec. 20, 1999, in BWRVIP-27-A, “BWR Vessel and Internals Project BWR Standby Liquid Control System/Core Plate □P Inspection and Flaw Evaluation Guidelines,” EPRI TR-1007279, August 2003.

18. NRC Acceptance for Referencing of Report, "BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines," for Compliance with the License Renewal Rule (10CFR Part 54), Dec. 7, 2000, in BWRVIP-47-A, "BWR Vessel and Internals Project BWR Lower Plenum Inspection and Flaw Evaluation Guidelines," EPRI TR-1009947, June 2004.

19. NRC Acceptance for Referencing of EPRI Proprietary Report TR-113596, "BWR Vessel and Internals Project, BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines," and Appendix A, "Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10CFR 54.21)," Oct. 18, 2001, in BWRVIP-74-A, "BWR Vessel and Internals Project BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines," EPRI TR-1008872, June 2003.

20. Regulatory Guide RG-1.207, "Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components due to the Effects of the Light-Water Reactor Environment for New Reactors," U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

21. NUREG/CR-6909, "Effect of LWR Coolant Environments on Fatigue Life of Reactor Materials" (Final Report), February 2007.

Table 4.3-1 Stress Range Reduction Factors

Number of Equivalent Full Temperature Cycles	Stress Range Reduction Factor
7,000 and less	1.0
7,000 to 14,000	0.9
14,000 to 22,000	0.8
22,000 to 45,000	0.7
45,000 to 100,000	0.6
100,000 and over	0.5

Table 4.3-2 Example of FSAR Supplement for Metal Fatigue TLAA Evaluation

10 CFR 54.21(c)(1)(iii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Metal fatigue	The aging management program monitors and tracks the number of critical thermal and pressure test transients, and monitors the cycles for the selected reactor coolant system components. The aging management program will address the effects of the coolant environment on component fatigue life by assessing the impact of the reactor coolant environment on a sample of critical components that include, as a minimum, those components selected in NUREG/CR-6260. The sample of critical components can be evaluated by applying environmental correction factors to the existing ASME Code fatigue analyses. Formulas for calculating the environmental life correction factors are as follows: (a) those contained in NUREG/CR-6583 for carbon and low-alloy steels and in NUREG/CR-5704 for austenitic SSs; (b) those contained in Section C of RG 1.207 for carbon and low-alloy steels, austenitic stainless steels, and Ni-alloys; or (c) an approved technical equivalent.	Evaluation should be completed before the period of extended operation

* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.4 ENVIRONMENTAL QUALIFICATION (EQ) OF ELECTRIC EQUIPMENT

Review Responsibilities

Primary - Branch responsible for electrical engineering
Secondary - Plant Systems Branch (Mechanical Equipment only)

4.4.1 Areas of Review

The NRC has established environmental qualification requirements in 10 CFR Part 50, Appendix A, Criterion 4, and 10 CFR 50.49. Section 50.49 specifically requires each nuclear power plant licensee to establish a program to qualify certain electric equipment (not including equipment located in mild environments) so that such equipment, in its end-of-life condition, will meet its performance specifications during and following design basis accidents under the most severe environmental conditions postulated at the equipment's location after such an accident. Such conditions include, among others, conditions resulting from loss of coolant accidents (LOCAs), high energy line breaks (HELBs), and post-LOCA radiation. Equipment qualified by test must be preconditioned by aging to its end-of-life condition (i.e., the condition at the end of the current operating term). Those components with a qualified life equal to or greater than the duration of the current operating term are covered by TLAAs.

In a related subject, some nuclear power plants have mechanical equipment that was qualified in accordance with the provisions of Criterion 4 of Appendix A to 10 CFR Part 50. If a plant has qualified mechanical equipment, it is typically documented in the plant's master EQ list. If this qualified mechanical equipment requires a performance of a TLAA, it should be performed in accordance with the provisions of SRP-LR Section 4.7, "Other Plant-Specific Time-Limited Aging Analyses." If a TLAA of qualified mechanical equipment is necessary, usually it will involve assessments of the environmental effects on components such as seals, gaskets, lubricants, fluids for hydraulic systems, or diaphragms.

4.4.1.1 Time-Limited Aging Analysis

All operating plants must meet the requirements of 10 CFR 50.49 for certain important-to-safety electrical components. 10 CFR 50.49 defines the scope of components to be included, requires the preparation and maintenance of a list of in-scope components, and requires the preparation and maintenance of a qualification file that includes component performance specifications, electrical characteristics, and environmental conditions. 10 CFR 50.49(e)(5) contains provisions for aging that require, in part, consideration of all significant types of aging degradation that can affect component functional capability. 10 CFR 50.49(e) also requires component replacement or refurbishment prior to the end of designated life, unless additional life is established through ongoing qualification. 10 CFR 50.49(f) establishes four methods of demonstrating qualification for aging and accident conditions. 10 CFR 50.49(k) and (l) permit different qualification criteria to apply based on plant and component vintage. Supplemental environmental qualification regulatory guidance for compliance with these different qualification criteria is provided in NRC RG 1.89, Rev. 1, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants" (Ref. 1), the Division of Operating Reactors (DOR) Guidelines (Ref. 2), and NUREG-0588 (Ref. 3). The principal nuclear industry qualification standards for electric equipment are IEEE STD. 323-1971 (Ref. 4) and IEEE STD. 323-1974 (Ref. 5). These standards contain explicit environmental qualification considerations based on TLAAs. Compliance with 10 CFR 50.49 provides reasonable assurance that the component can perform its intended functions during accident conditions after experiencing the effects of in-service aging.

4.4.1.1.1 DOR Guidelines

The qualification of electric equipment that is subject to significant known degradation due to aging where a qualified life was previously required to be established in accordance with Section 5.2.4 of the DOR Guidelines are reviewed for the period of extended operation according to those requirements. If a qualified life was not previously established, the qualification is reviewed in accordance with Section 7 of the DOR Guidelines.

4.4.1.1.2 NUREG-0588, CATEGORY II (IEEE STD. 323-1971)

The qualification of certain electric equipment important to safety for which qualification was required in accordance with NUREG-0588, Category II, are reviewed for conformance to those requirements for the period of extended operation to assess the validity of the extended qualification. These requirements include IEEE STD. 382-1972 (Ref. 6) for valve operators, and IEEE STD. 334-1971 (Ref. 7.)

4.4.1.1.3 NUREG-0588, CATEGORY I (IEEE STD. 323-1974)

The qualification of certain electric equipment important to safety for which qualification was required in accordance with NUREG-0588, Category I, are reviewed for conformance to those requirements for the period of extended operation to assess the validity of the extended qualification.

4.4.1.2 Generic Safety Issue

Regulatory Issue Summary (RIS) 2003-09 was issued on May 2, 2003, (Ref. 8) to inform addressees of the results of the technical assessment of GSI-168, "Environmental Qualification of Electrical Equipment," (Ref. 9). This RIS requires no action on the part of the addressees.

4.4.1.3 FSAR Supplement

The detailed information on the evaluation of TLAAs is contained in the renewal application. A summary description of the evaluation of TLAAs for the period of extended operation is contained in the applicant's FSAR supplement. The FSAR supplement is an area of review.

4.4.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.4.1 of this review plan section delineate acceptable methods for meeting the requirements of the NRC's regulations in 10 CFR 54.21(c)(1).

4.4.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following:

(i) the analyses remain valid for the period of extended operation,

(ii) the analyses have been projected to the end of the extended period of operation, or

(iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Specific acceptance criteria for environmental qualification of certain electric equipment important to safety analyzed to Section 5.2.4 of the DOR Guidelines; NUREG-0588, Category II

(Section 4); or NUREG-0588, Category I, depend on the applicant’s choice, that is, 10 CFR 54.21(c)(1)(i), (ii), or (iii), and are:

4.4.2.1.1 10 CFR 54.21(c)(1)(i)

The existing qualification is based on previous testing, analysis, or operating experience, or combinations thereof, that demonstrate that the equipment is qualified for the period of extended operation. For option (i), the aging evaluation existing at the time of the renewal application for the component remains valid for the period of extended operation, and no further evaluation is necessary.

4.4.2.1.2 10 CFR 54.21(c)(1)(ii)

Qualification of the equipment is extended for the period of extended operation by testing, analysis, or operating experience, or combinations thereof, in accordance with the current licensing basis. For option (ii), a reanalysis of the aging evaluation is performed in order to project the qualification of the component through the period of extended operation. Important reanalysis attributes of an aging evaluation include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions if acceptance criteria are not met. These reanalysis attributes are discussed in Table 4.4-1.

4.4.2.1.3 10 CFR 54.21(c)(1)(iii)

In Chapter X of the GALL Report (Ref. 10), the staff has evaluated the environmental qualification program (10 CFR 50.49) and determined that it is an acceptable aging management program to address environmental qualification according to 10 CFR 54.21(c)(1)(iii). The GALL Report may be referenced in a license renewal application, and should be treated in the same manner as an approved topical report. However, the GALL Report contains one acceptable way and is not the only way to manage aging for license renewal.

In referencing the GALL Report, the applicant should indicate that the material referenced is applicable to the specific plant involved and should provide the information necessary to adopt the finding of program acceptability as described and evaluated in the report. The applicant should also verify that the approvals set forth in the GALL Report for the generic program apply to the applicant’s program.

4.4.2.2 Generic Safety Issue

Not applicable.

4.4.2.3 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

> The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description should contain information associated with the TLAA regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21(c)(1).

4.4.3 Review Procedures

For each area of review described in Subsection 4.4.1, the following review procedures should be followed:

4.4.3.1 Time-Limited Aging Analysis

For electric equipment qualified to the requirements of 10 CFR 50.49, the review procedures, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.4.3.1.1 10 CFR 54.21(c)(1)(i)

The documented results, test data, analyses, etc., of the previous qualification, which consisted of an appropriate combination of testing, analysis, and operating experience, are reviewed to confirm that the original qualified life remains valid for the period of extended operation.

4.4.3.1.2 10 CFR 54.21(c)(1)(ii)

The results of projecting the qualification to the end of the period of extended operation are reviewed. The qualification methods include testing, analysis, operating experience, or combinations thereof.

The reanalysis of an aging evaluation is normally performed to extend the qualification by reducing excess conservatisms incorporated in the prior evaluation. Such a reanalysis is performed on a routine basis as part of an environmental qualification program. A component life-limiting condition may be due to thermal, radiation, or cyclical aging; the vast majority of component aging limits are based on thermal conditions. Conservatisms may exist in aging evaluation parameters, such as the assumed ambient temperature of the component, unrealistically low activation energy, or in the application of a component (de-energized versus energized). The reanalysis of an aging evaluation is documented in accordance with the plant's quality assurance program which provides for the verification of assumptions and conclusions. For reanalysis, the reviewer verifies that an applicant has completed its reanalysis, addressing attributes of analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions if acceptance criteria are not met (See Table 4.4-1). The reviewer also verifies that the reanalysis has been completed in a timely manner prior to the end of qualified life.

4.4.3.1.3 10 CFR 54.21(c)(1)(iii)

The applicant may reference the GALL Report in its license renewal application, as appropriate. The review should verify that the applicant has stated that the report is applicable to its plant with respect to its environmental qualification program. The reviewer verifies that the applicant has identified the appropriate program as described and evaluated in the GALL Report. The reviewer also ensures that the applicant has stated that its environmental qualification program contains the same program elements that the staff evaluated and relied upon in approving the corresponding generic program in the GALL Report. No further staff evaluation is necessary.

If the applicant does not reference the GALL Report in its renewal application, additional staff evaluation is necessary to determine whether the applicant's program is acceptable for this area of review.

4.4.3.2 Generic Safety Issue

Not applicable.

4.4.3.3 FSAR Supplement

The reviewer verifies that the applicant has provided information to be included in the FSAR supplement that includes a summary description of the TLAA evaluation of the environmental qualification of electric equipment. Table 4.4-2 contains examples of acceptable FSAR supplement information for this TLAA. The reviewer verifies that the applicant has provided a FSAR supplement with information equivalent to that in Table 4.4-2.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement, at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. The staff will review any such changes when the next update is submitted. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 4.4-2, an applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.4.4 Evaluation of Findings

The reviewer determines whether the applicant has provided information sufficient to satisfy the provisions of this section and whether the staff's evaluation supports conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.2 (c)(1), that, for the environmental qualification of Electric Equipment TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR supplement contains an appropriate summary description of the environmental qualification of electric equipment TLAA evaluation for the period of extended operation as reflected in the license condition.

4.4.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specific portions of the NRC's regulations, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

4.4.6 References

1. Regulatory Guide 1.89, Rev. 1, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," June 1984.

2. “Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors,” (DOR Guidelines), November 1979.

3. NUREG-0588, “Interim Staff Position on Environmental Qualification of Safety-Related Equipment,” July 1981.

4. IEEE STD. 323-1971, “IEEE Trial Use Standard; General Guide for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.”

5. IEEE STD. 323-1974, “IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.”

6. IEEE STD. 382-1972, “Standard for Qualification of Actuators for Power Operated Valve Assemblies with Safety Related Functions for Nuclear Power Plants.”

7. IEEE STD. 334-1971, “IEEE Standard for Type Tests of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations.”

8. NRC Regulatory Issue Summary 2003-09, “Environmental Qualification of Low-Voltage Instrumentation and Control Cables,” dated May 2, 2003.

9. GSI-168, “Environmental Qualification of Electrical Equipment”, dated ?.

10. NUREG-1801, “Generic Aging Lessons Learned (GALL) Report,” U.S. Nuclear Regulatory Commission, July 2001.

8. Deleted.

9. Deleted.

10. Deleted.

11. Deleted.

12. Deleted.

13. Deleted.

15. Deleted.

Table 4.4-1 Environmental Qualification Reanalysis Attributes

Reanalysis Attributes	Description
Analytical methods	The analytical models used in the reanalysis of an aging evaluation should be the same as those previously applied during the prior evaluation. The Arrhenius methodology is an acceptable thermal model for performing a thermal aging evaluation. The analytical method used for a radiation aging evaluation is to demonstrate qualification for the total integrated dose (that is, normal radiation dose for the projected installed life plus accident radiation dose). For license renewal, one acceptable method of establishing the 60-year normal radiation dose is to multiply the 40-year normal radiation dose by 1.5 (that is, 60 years/40 years). The result is added to the accident radiation dose to obtain the total integrated dose for the component. For cyclical aging, a similar approach may be used. Other models may be justified on a case-by-case basis.
Data collection and reduction methods	Reducing excess conservatisms in the component service conditions (for example, temperature, radiation, cycles) used in the prior aging evaluation is the chief method used for a reanalysis. Temperature data used in an aging evaluation should be conservative and based on plant design temperatures or on actual plant temperature data. When used, plant temperature data can be obtained in several ways, including monitors used for technical specification compliance, other installed monitors, measurements made by plant operators during rounds, and temperature sensors on large motors (while the motor is not running). A representative number of temperature measurements are conservatively evaluated to establish the temperatures used in an aging evaluation. Plant temperature data may be used in an aging evaluation in different ways, such as (a) directly applying the plant temperature data in the evaluation, or (b) using the plant temperature data to demonstrate conservatism when using plant design temperatures for an evaluation. Any changes to material activation energy values as part of a reanalysis should be justified. Similar methods of reducing excess conservatisms in the component service conditions used in prior aging evaluations can be used for radiation and cyclical aging.
Underlying assumptions	Environmental qualification component aging evaluations contain sufficient conservatisms to account for most environmental changes occurring due to plant modifications and events. When unexpected adverse conditions are identified during operational or maintenance activities that affect the environment of a qualified component, the affected environmental qualification component is evaluated, and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions.
Acceptance criteria and corrective actions	The reanalysis of an aging evaluation should extend the qualification of the component. If the qualification cannot be extended by reanalysis, the component must be refurbished, replaced, or requalified prior to exceeding the current qualified life. A reanalysis should be performed in a timely manner (such that sufficient time is available to refurbish, replace, or requalify the component if the reanalysis is unsuccessful).

Table 4.4-2 Examples of FSAR Supplement for Environmental Qualification of Electric Equipment TLAA Evaluation

10 CFR 54.21(c)(1)(i) Example

TLAA	Description of Evaluation	Implementation Schedule*
Environmental qualification of electric equipment	The original environmental qualification qualified life has been shown to remain valid for the period of extended operation.	Completed

10 CFR 54.21(c)(1)(ii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Environmental qualification of electric equipment	The environmental qualification has been projected to the end of the period of extended operation. Reanalysis addresses attributes of analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions.	Completed

10 CFR 54.21(c)(1)(iii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Environmental qualification of electric equipment	The existing environmental qualification process, in accordance with 10 CFR 50.49, will adequately manage aging of environmental qualification equipment for the period of extended operation because equipment will be replaced prior to reaching the end of its qualified life. Reanalysis addresses attributes of analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, corrective actions if acceptance criteria are not met, and the period of time prior to the end of qualified life when the reanalysis will be completed.	Existing program

* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.5 CONCRETE CONTAINMENT TENDON PRESTRESS ANALYSIS

Review Responsibilities

Primary - Branch responsible for TLAA issues
Secondary - Branch responsible for structural engineering

4.5.1 Areas of Review

The prestressing tendons in prestressed concrete containments lose their prestressing forces with time due to creep and shrinkage of concrete, and relaxation of the prestressing steel. During the design phase, engineers estimate these losses to arrive at the end of operating life (Refs. 1 and 2), normally forty years. The operating experiences with the trend of prestressing forces indicate that the prestressing tendons lose their prestressing forces at a rate higher than predicted due to sustained high temperature (Ref. 3). Thus, it is necessary to ensure that the applicant addresses existing TLAAs for the extended period of operation.

The adequacy of the prestressing forces in prestressed concrete containments is reviewed for the period of extended operation.

4.5.2 Acceptance Criteria

The acceptance criteria for the area of review described in Subsection 4.5.1 delineate acceptable methods for meeting the requirements of the NRC's regulations in 10 CFR 54.21(c)(1).

4.5.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the extended period of operation; or

(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Accordingly, the specific options for satisfying the acceptance criterion are:

4.5.2.1.1 10 CFR 54.21(c)(1)(i)

The existing prestressing force evaluation remains valid because (a) losses of the prestressing force are less than the predicted losses as evidenced from the trend lines constructed from the recent inspection, (b) the period of evaluation covers the period of extended operation, and (c) the trend lines of the measured prestressing forces remain above the minimum required prestress force specified at anchorages for each group of tendons for the period of extended operation.

4.5.2.1.2 10 CFR 54.21(c)(1)(ii)

The trend line of prestressing forces for each group of tendons developed for 40 years of operation should be extended to 60 years. The applicant should demonstrate that the trend lines of the measured prestressing forces will stay above the design Minimum Required Value (MRV) in the CLB for each group of tendons during the period of extended operation (Ref. 4). If this cannot be done, the applicant should develop a systematic plan for retensioning selected tendons so that the trend lines will remain above the minimum required prestress force specified at anchorages for each group of tendons during the period of extended operation, or perform a reanalysis of containment to demonstrate design adequacy.

4.5.2.1.3 10 CFR 54.21(c)(1)(iii)

In Chapter X of the GALL Report (Ref. 4), the staff evaluated a program that assesses the concrete containment tendon prestressing forces, and has determined that it is an acceptable aging management program to address concrete containment tendon prestress according to 10 CFR 54.21(c)(1)(iii), except for operating experience. The GALL Report recommends further evaluation of the applicant's operating experience related to the containment prestress force. However, the GALL report contains one acceptable way and not the only way to manage aging for license renewal.

The GALL report may be referenced in a license renewal application, and is treated in the same manner as an approved topical report. However, the GALL report contains one acceptable way, but not the only way, to manage aging for license renewal.

In referencing the GALL report, an applicant indicates that the material referenced is applicable to the specific plant involved and should provide the information necessary to adopt the finding of program acceptability as described and evaluated in the report. An applicant also verifies that the approvals set forth in the GALL report for the generic program apply to the applicant's program.

4.5.2.2 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description must contain information associated with the TLAAs regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21(c)(1).

4.5.3 Review Procedures

For each area of review described in Subsection 4.5.1, the following review procedures should be followed:

4.5.3.1 Time-Limited Aging Analysis

For a concrete containment prestressing tendon system, the review procedures, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.5.3.1.1 10 CFR 54.21(c)(1)(i)

The results of a recent inspection to measure the amount of prestress loss are reviewed to ensure that the reduction of prestressing force is less than the predicted loss in the existing analysis. The reviewer verifies that the trend line of the measured prestressing force when plotted on the predicted prestressing force curve shows that the existing analysis will cover the period of extended operation.

4.5.3.1.2 10 CFR 54.21(c)(1)(ii)

The reviewer reviews the trend lines of the measured prestressing forces to ensure that individual tendon lift-off forces (rather than average lift-off forces of the tendon group) are considered in the regression analysis, as discussed in IN 99-10 (Ref. 3). Either the reviewer verifies that the trend lines will stay above the minimum required prestressing forces for each group of tendons during the period of extended operation or, if the trend lines fall below the minimum required prestressing forces during this period, the reviewer verifies that the applicant has a systematic plan for retensioning the tendons to ensure that the trend lines will return to being, and remain, above the minimum required prestressing forces for each group of tendons during the period of extended operation. If the applicant chooses to reanalyze the containment, the reviewer verifies that the design adequacy is maintained in the period of extended operation.

4.5.3.1.3 10 CFR 54.21(c)(1)(iii)

An applicant may reference the GALL Report in its license renewal application, as appropriate. The reviewer verifies that the applicant has stated that the report is applicable to its plant with respect to its program that assesses the concrete containment tendon prestressing forces. The reviewer verifies that the applicant has identified the appropriate program (i.e., GALL Chapter X.S1) as described and evaluated in the GALL Report. The reviewer also ensures that the applicant has stated that its program contains the same program elements that the staff evaluated and relied upon in approving the corresponding generic program in the GALL Report.

The GALL Report recommends further evaluation of the applicant's operating experience related to the containment prestress force. The applicant's program should incorporate the relevant operating experience that occurred at the applicant's plant as well as at other plants. The applicant considers applicable portions of the experience with prestressing systems described in Information Notice 99-10 (Ref. 3). Tendon operating experience could vary among plants with prestressed concrete containments. The difference could be due to the prestressing system design (for example, button-heads, wedge or swaged anchorages), environment, or type of reactor (PWR or BWR). The reviewer reviews the applicant's program to verify that the applicant has adequately considered plant-specific operating experience.

If the applicant does not reference the GALL Report in its renewal application, additional staff evaluation is necessary to determine whether the applicant's program is acceptable for this area of review. The reviewer uses the guidance provided in Branch Technical Position RLSB-1 of this SRP-LR to ensure that loss of prestress in the concrete containment prestressing tendons is adequately managed for the period of extended operation.

4.5.3.2 FSAR Supplement

The reviewer verifies that the applicant has provided information, to be included in the FSAR supplement, that includes a summary description of the evaluation of tendon prestress TLAA. Table 4.5-1 contains examples of acceptable FSAR supplement information for this TLAA. The reviewer verifies that the applicant has provided a FSAR supplement with information equivalent to that in Table 4.5-1.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior

NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 4.5-1, an applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.5.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of Section 4.5 and whether the staff's evaluation supports conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that, for the concrete containment tendon prestress TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR supplement contains an appropriate description of the concrete containment tendon prestress TLAA evaluation for the period of extended operation as reflected in the license condition.

4.5.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

4.5.6 References

1. Regulatory Guide 1.35, Rev. 3, "Inspection of Ungrouted Tendons in Prestressed Concrete Containments," July 1990.

2. Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments," July 1990.

3. NRC Information Notice 99-10, "Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments," April 1999.

4. NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," U.S. Nuclear Regulatory Commission, Revision 2, December 2010.

Table 4.5-1 Examples of FSAR Supplement for Concrete Containment Tendon Prestress TLAA Evaluation

10 CFR 54.21(c)(1)(i) and 10 CFR 54.21(c)(1)(ii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Concrete containment tendon prestress	The prestressing tendons are used to impart compressive forces in the prestressed concrete containments to resist the internal pressure inside the containment that would be generated in the event of a LOCA. The prestressing forces generated by the tendons diminish over time due to losses in prestressing forces in the tendons and in the surrounding concrete. The prestressing force evaluation has been determined to remain valid to the end of the period of extended operation, and the trend lines of the measured prestressing forces will stay above the minimum required prestressing forces for each group of tendons to the end of this period.	Completed

10 CFR 54.21(c)(1)(iii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Concrete containment tendon prestress	The prestressing tendons are used to impart compressive forces in the prestressed concrete containments to resist the internal pressure inside the containment that would be generated in the event of a LOCA. The prestressing forces generated by the tendons diminish over time due to losses of prestressing forces in the tendons and in the surrounding concrete. The aging management program developed to monitor the prestressing forces should ensure that, during each inspection, the trend lines of the measured prestressing forces show that they meet the requirements of 10 CFR 50.55a(b)(2)(viii)(B). If the trend lines cross the PLLs, corrective actions will be taken. The program will also incorporate any plant-specific and industry operating experience.	Program should be implemented before the period of extended operation.

* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

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4.6 CONTAINMENT LINER PLATE, METAL CONTAINMENTS, AND PENETRATIONS FATIGUE ANALYSIS

Review Responsibilities

Primary - Branch responsible for mechanical engineering
Secondary - Branch responsible for structural engineering

4.6.1 Areas of Review

The interior surface of a concrete containment structure is lined with thin metallic plates to provide a leak-tight barrier against the uncontrolled release of radioactivity to the environment, as required by 10 CFR Part 50. The thickness of the liner plates is generally between 1/4 inch (6.2 millimeter) and 3/8-inch (9.5 millimeter). The liner plates are attached to the concrete containment wall by stud anchors or structural rolled shapes or both. The design process assumes that the liner plates do not carry loads. However, normal loads, such as from concrete shrinkage, creep, and thermal changes, imposed on the concrete containment structure, are transferred to the liner plates through the anchorage system. Internal pressure and temperature loads are directly applied to the liner plates. Thus, under design-basis conditions, the liner plates could experience significant strains. Some plants may have metal containments instead of concrete containments with liner plates. The metal containments are designed to carry gravity and seismic loads in addition to the internal pressure and temperature loads. Additionally, the BWR containment suppression pool chamber and the vent system are designed or evaluated for hydrodynamic loads associated with actuation of safety relief valves and the discharge into the suppression pool chamber.

Fatigue of the liner plates or metal containments may be considered in the design based on an assumed number of loading cycles for the current operating term. The cyclic loads include reactor building interior temperature variation during the heatup and cooldown of the reactor coolant system, a LOCA, annual outdoor temperature variations, thermal loads due to the high energy containment penetration piping lines (such as steam and feedwater lines), seismic loads, and pressurization due to periodic Type A integrated leak rate tests. The BWR containment suppression pool chamber and the vent system are designed or evaluated for the hydrodynamic cyclic loads as described in Section 6.2.1.1.C, “Pressure-Suppression Type BWR Containments,” of NUREG-0800, “Standard Review Plan” (Ref. 1).

High energy piping penetrations and the fuel transfer tubes in some plants are equipped with stainless steel bellow assemblies. These are designed to accommodate relative movements between the containment wall (including the liner) and the adjoining structures. The penetrations have sleeves (up to 10 feet in length, with a 2 to 3-inch annulus around the piping) to penetrate the concrete containment wall and allow movement of the piping system. Dissimilar metal welds connect the piping penetrations to the bellows or stainless steel plates to provide essentially leak-tight penetrations.

The containment liner plates, metal containments, BWR containment suppression chamber and the vent system, penetration sleeves (including dissimilar metal welds), and penetration bellows may be designed in accordance with requirements of Section III of the ASME Boiler and Pressure Vessel Code. If a plant’s code of record requires a fatigue analysis, then this analysis may be a TLAA and must be evaluated in accordance with 10 CFR 54.21(c)(1) to ensure that the effects of aging on the intended functions are adequately managed for the period of extended operation.

The adequacy of the fatigue analyses of the containment liner plates (including welded joints), metal containments, BWR containment suppression chamber and the vent system, penetration sleeves, dissimilar metal welds, and penetration bellows is reviewed in this section for the period of extended operation. The fatigue analyses of the pressure boundary of process piping are reviewed separately following the guidance in SRP-LR Section 4.3, “Metal Fatigue.”

4.6.1.1 Time-Limited Aging Analysis

The containment liner plates (including welded joints), metal containments, BWR containment suppression chamber and the vent system, penetration sleeves, dissimilar metal welds, and penetration bellows may be designed and/or analyzed in accordance with ASME code requirements. The ASME code contains explicit metal fatigue or cyclic considerations based on TLAAs. Specific requirements are contained in the design code of reference for each plant.

4.6.1.1.1 ASME Section III, MC or Class 1

ASME Section III Division 2, “Code for Concrete Reactor Vessel and Containments,” Subsection CC, “Concrete Containment,” and Division 1, Subsection NE, “Class MC Components,” (Ref. 2) require a fatigue analysis for liner plates, metal containments, and penetrations that considers all cyclic loads based on the anticipated number of cycles. Containment components also may be designed to ASME Section III Class 1 requirements. A Section III, MC or Class 1 fatigue analysis requires the calculation of the cumulative usage factor (CUF) based on the fatigue properties of the materials and the expected fatigue service of the component. The ASME code limits the CUF to a value less than or equal to one for acceptable fatigue design. The fatigue resistance of the liner plates or metal containments, and penetrations during the period of extended operation is an area of review.

4.6.1.1.2 Other Evaluations Based on CUF

Other evaluations also contain metal fatigue analysis requirements based on a CUF calculation, such as metal bellows designed to ASME NC-3649.4(e)(3) or NE-3366.2(e)(3). For these cases, the discussion relating to ASME Section III, MC or Class 1, in Subsection 4.6.1.1.1 applies.

4.6.1.2 FSAR Supplement

Detailed information on the evaluation of TLAAs is contained in the renewal application. A summary description of the evaluation of TLAAs for the period of extended operation is contained in the applicant’s FSAR supplement. The FSAR supplement is an area of review.

4.6.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.6.1 delineate acceptable methods for meeting the requirements of the NRC’s regulations in 10 CFR 54.21(c)(1).

4.6.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1), an applicant must demonstrate one of the following:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the extended period of operation; or

(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Specific acceptance criteria for fatigue of containment liner plates, metal containments, liner plate weld joints, dissimilar metal welds, penetration sleeves, and penetration bellows are:

4.6.2.1.1 ASME Section III, MC or Class 1

For containment liner plates, metal containments, BWR containment suppression chamber and the vent system, and penetrations designed or analyzed to ASME MC or Class 1 requirements, the acceptance criteria, depending on the applicant’s choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.6.2.1.1.1 10 CFR 54.21(c)(1)(i)

The existing CUF calculations remain valid because the number of assumed cyclic loads will not be exceeded during the period of extended operation.

4.6.2.1.1.2 10 CFR 54.21(c)(1)(ii)

CLB fatigue analysis, per ASME Code Section III, was conducted for a 40-year life. The CUF calculations are re-evaluated based on an increased number of assumed cyclic loads to cover the period of extended operation. All cyclic loads considered in the original fatigue analyses (including Type A and Type B leak rate tests) are re-evaluated and revised, as necessary. The revised analysis shows that the CUF does not exceed one, as required by the ASME code, during the period of extended operation.

4.6.2.1.1.3 10 CFR 54.21(c)(1)(iii)

An aging management program provided by the applicant shall demonstrate that the effects of aging on the component's intended function(s) will be adequately managed during the period of extended operation. If the proposed aging management program relies on mitigation or inspection, it shall be evaluated against the 10 elements described in Branch Technical Position RLSB-1 (Appendix A.1 of this standard review plan). However, if the component is replaced, the CUF for the replacement must be less than or equal to one during the period of extended operation.

4.6.2.1.2 Other Evaluations Based on CUF

The acceptance criteria in Subsection 4.6.2apply.

4.6.2.2 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

> The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description should contain information associated with the TLAAs regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21(c)(1).

4.6.3 Review Procedures

For each area of review described in Subsection 4.6.1, the following review procedures is followed:

4.6.3.1 Time-Limited Aging Analysis

4.6.3.1.1 ASME Section III, MC or Class 1

For containment liner plates, metal containments, BWR containment suppression chamber and the vent system, and penetrations designed or analyzed to ASME MC or Class 1 requirements, the review procedures, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), are:

4.6.3.1.1.1 10 CFR 54.2l(c)(1)(i)

The number of assumed transients used in the existing CUF calculations for the current operating term is compared to the extrapolation to 60 years of operation of the number of operating transients experienced to date. The comparison confirms that the number of transients in the existing analyses will not be exceeded during the period of extended operation.

4.6.3.1.1.2 10 CFR 54.21(c)(1)(ii)

Operating transient experience and a list of the increased number of assumed cyclic loads projected to the end of the period of extended operation are reviewed to ensure that the cyclic load projection is adequate. The revised CUF calculations based on the projected number of assumed cyclic loads are reviewed to ensure that the CUF remains less than one at the end of the period of extended operation.

The code of record is used for the reevaluation, or the applicant may update to a later code edition pursuant to 10 CFR 50.55a. In the latter case, the reviewer verifies that the requirements in 10 CFR 50.55a are met.

4.6.3.1.1.3 10 CFR 54.21(c)(1)(iii)

The applicant's proposed aging management program to ensure that the effects of aging on the intended function(s) are adequately managed for the period of extended operation is reviewed. If the program relies on mitigation or inspection, it shall be reviewed against the 10 elements described in Branch Technical Position RLSB-1 (Appendix A.1 of this standard review plan). If the applicant proposes a component replacement before its CUF exceeds one, the reviewer verifies that the CUF for the replacement will remain less than or equal to one during the period of extended operation.

Applicant proposed programs are reviewed on a case-by-case basis.

4.6.3.1.2 Other Evaluations Based on CUF

The review procedures in Subsection 4.6.3.1 apply.

4.6.3.2 FSAR Supplement

The reviewer verifies that the applicant has provided information, to be included in the FSAR supplement that includes a summary description of the evaluation of containment liner plate, metal containments, BWR containment suppression chamber and the vent system, and penetrations fatigue TLAA. Table 4.6-1 contains examples of acceptable FSAR supplement information for this TLAA. The reviewer verifies that the applicant has provided a FSAR supplement with information equivalent to that in Table 4.6-1.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to

10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition will be necessary.

As noted in Table 4.6-1, the applicant need not incorporate the implementation schedule into its FSAR. However, the review should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

4.6.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of this section and to support conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that the containment liner plate or metal containment, BWR containment suppression chamber and the vent system, and penetrations fatigue TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR supplement contains an appropriate summary description of the containment liner plate or metal containment, BWR containment suppression chamber and the vent system, and penetrations fatigue TLAA evaluation for the period of extended operation as reflected in the license condition.

4.6.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein will be used by the staff in its evaluation of conformance with NRC regulations.

4.6.6 References

1 NUREG-0800, "Standard Review Plan, U.S Nuclear Regulatory Commission," U.S. Nuclear Regulatory Commission, March 2007.

2. ASME Boiler and Pressure Vessel Code, Section III, Division 2, "Code for Concrete Reactor Vessels and Containments," Subsection CC, "Concrete Containment," and Division 1, Subsection NE, "MC Components," American Society of Mechanical Engineers, New York, New York, 1989 or other editions as approved in 10 CFR 50.55a.

Table 4.6-1. Examples of FSAR Supplement for Containment Liner Plates, Metal Containments, and Penetrations Fatigue TLAA Evaluation

10 CFR 54.21(c)(1)(i) Example

TLAA	Description of Evaluation	Implementation Schedule*
Containment liner plates (or metal containment) and penetrations fatigue	The containment liner plates (or metal containment), BWR containment suppression chamber and the vent system, liner weld joints, penetration sleeves, dissimilar metal welds, and penetration bellows that provide an essentially leak-tight barrier. A Section III, MC or Class 1 fatigue analysis limits the CUF to a value less than or equal to one for acceptable fatigue design. The existing CUF evaluation has been determined to remain valid because the number of assumed cyclic loads would not be exceeded during the period of extended operation.	Completed

10 CFR 54.21(c)(1)(ii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Containment liner plates (or metal containment) and penetrations fatigue	The containment liner plates (or metal containment), BWR containment suppression chamber and the vent system, liner weld joints, penetration sleeves, dissimilar metal welds, and penetration bellows that provide an essentially leak-tight barrier. A Section III, MC or Class 1 fatigue analysis limits the CUF to a value less than or equal to one for acceptable fatigue design. The CUF calculations have been reevaluated based on an increased number of assumed cyclic loads to cover the period of extended operation. The revised CUF will not exceed one during the period of extended operation.	Completed

10 CFR 54.21(c)(1)(iii) Example

TLAA	Description of Evaluation	Implementation Schedule*
Containment liner plates (or metal containment) and penetrations fatigue	The containment liner plates (or metal containment), BWR containment suppression chamber and the vent system, liner weld joints, penetration sleeves, dissimilar metal welds, and penetration bellows that provide an essentially leak-tight barrier. A Section III, MC or Class 1 fatigue analysis limits the CUF to a value less than or equal to one for acceptable fatigue design. If the component is replaced, the CUF for the replacement will be shown to be less than one during the period of extended operation.	Program should be implemented before the period of extended operation.

Note: All containment components need not meet the same requirement. It is likely that the liner plate and the bellows may be evaluated per 10CFR54.21(c)(1)(i), while high energy penetrations may be evaluated per 10CFR54.21(c)(1)(ii).

* An applicant need not incorporate the implementation schedule into its FSAR. However, the reviewer should verify that the applicant has identified and committed in the license renewal application to any future aging management activities to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant will complete these activities no later than the committed date.

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4.7 OTHER PLANT-SPECIFIC TIME-LIMITED AGING ANALYSES

Review Responsibilities

Primary - NRR branch responsible for the TLAA issues
Secondary - Other branches responsible for systems, as appropriate

4.7.1 Areas of Review

There are certain plant-specific safety analyses that may have been based on an explicitly assumed 40-year plant life (for example, aspects of the reactor vessel design) and may, therefore, be TLAAs. Pursuant to 10 CFR 54.21(c), a license renewal applicant is required to evaluate TLAAs. The definition of TLAAs is provided in 10 CFR 54.3 and in Section 4.1 of this SRP-LR.

Plant-specific TLAAs may have evolved since issuance of a plant's operating license. As indicated in 10 CFR 54.30, the adequacy of the plant's CLB, which includes TLAAs, is not an area within the scope of the license renewal review. Any questions regarding the adequacy of the CLB must be addressed under the backfit rule (10 CFR 50.109) and are separate from the license renewal process.

License renewal reviews focus on the period of extended operation. Pursuant to 10 CFR 54.30, if the reviews required by 10 CFR 54.21(a) or (c) show that there is not reasonable assurance during the current license term that licensed activities will be conducted in accordance with the CLB, the licensee is required to take measures under its current license to ensure that the intended function of those systems, structures, or components are maintained in accordance with the CLB throughout the term of the current license. The adequacy of the measures for the term of the current license is not within the scope of the license renewal review.

Pursuant to 10 CFR 54.21(c), an applicant must provide a listing of TLAAs and plant-specific exemptions that are based on TLAAs. The staff reviews the applicant's identification of TLAAs and exemptions separately, following the guidance in Section 4.1 of this SRP-LR.

Based on lessons learned in the review of the initial license renewal applications, the staff has developed review procedures for the evaluation of certain TLAAs. If an applicant identifies these TLAAs as applicable to its plant, the staff reviews them separately, following the guidance in Sections 4.2 through 4.6. The reviewer reviews other TLAAs that are identified by the applicant following the generic guidance in this section. For particular systems, the reviewers from branches responsible for those systems may be requested to assist in the review, as appropriate.

The following areas relating to a TLAA are reviewed:

4.7.1.1 Time-Limited Aging Analysis

The evaluation of the TLAA for the period of extended operation is reviewed.

4.7.1.2 FSAR Supplement

The FSAR supplement summarizing the evaluation of the TLAA for the period of extended operation in accordance with 10 CFR 54.21(d) is reviewed.

4.7.2 Acceptance Criteria

The acceptance criteria for the areas of review described in Subsection 4.7.1 of this section delineate acceptable methods for meeting the requirements of the NRC's regulations in 10 CFR 54.21(c)(1).

4.7.2.1 Time-Limited Aging Analysis

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following for the TLAAs:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the extended period of operation; or

(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

4.7.2.2 FSAR Supplement

The specific criterion for meeting 10 CFR 54.21(d) is:

The summary description of the evaluation of TLAAs for the period of extended operation in the FSAR supplement is appropriate such that later changes can be controlled by 10 CFR 50.59. The description contains information associated with the TLAAs regarding the basis for determining that the applicant has made the demonstration required by 10 CFR 54.21 (c)(1).

4.7.3 Review Procedures

For certain applicants, plant-specific analyses may meet the definition of a TLAA as given in 10 CFR54.3. The concern for license renewal is that these analyses may not have properly considered the length of the extended period of operation, which may change conclusions with regard to safety and the capability of SSCs within the scope of the Rule to perform or one or more safety functions. The review of these TLAAs provides the assurance that the aging effect is properly addressed through the period of extended operation.

For each area of review described in Subsection 4.7.1, the following review procedures are followed:

4.7.3.1 Time-Limited Aging Analysis

For each TLAA identified, the review procedures depend on the applicant's choice of methods of compliance from those identified in 10 CFR 54.21(c)(1)(i), (ii), or (iii), as follows:

4.7.3.1.1 10 CFR 54.21(c)(1)(i)

Justification provided by the applicant is reviewed to verify that the existing analyses are valid for the period of extended operation. The existing analyses should be shown to be bounding even during the period of extended operation.

The applicant describes the TLAA with respect to the objectives of the analysis, assumptions used in the analysis, conditions, acceptance criteria, relevant aging effects, and intended function(s). The applicant shows that (a) conditions and assumptions used in the analysis already address the relevant aging effects for the period of extended operation, and (b) acceptance criteria are maintained to provide reasonable assurance that the intended function(s) is maintained for renewal. Thus, no reanalysis is necessary for renewal.

In some instances, the applicant may identify activities to be performed to verify the assumption basis of the calculation, such as cycle counting. An evaluation of that activity is provided by the applicant. The reviewer assures that the applicant's activity is sufficient to confirm the calculation assumptions for the 60-year period.

If the TLAA must be modified or recalculated to extend the period of evaluation to consider the period of extended operation, the reevaluation should be addressed under 10 CFR 54.21(c)(1)(ii).

4.7.3.1.2 10 CFR 54.21(c)(1)(ii)

The documented results of the revised analyses are reviewed to verify that their period of evaluation is extended such that they are valid for the period of extended operation (e.g., 60 years). The applicable analysis technique can be the one that is in effect in the plant's CLB at the time of filing of the renewal application.

The applicant may recalculate the TLAA using a 60-year period to show that the TLAA acceptance criteria continue to be satisfied for the period of extended operation. The applicant also may revise the TLAA by recognizing and reevaluating any overly conservative conditions and assumptions. Examples include relaxing overly conservative assumptions in the original analysis, using new or refined analytical techniques, and performing the analysis using a 60-year period. The applicant provides a sufficient description of the analysis and documents the results of the reanalysis to show that it is satisfactory for the 60-year period.

As applicable, the plant's code of record is used for the reevaluation, or the applicant may update to a later code edition pursuant to 10 CFR 50.55a. In the latter case, the reviewer verifies that the requirements in 10 CFR 50.55a are met.

In some cases, the applicant identifies activities to be performed to verify the assumption basis of the calculation, such as cycle counting. An evaluation of that activity is provided by the applicant. The reviewer assures that the applicant's activity is sufficient to confirm the calculation assumptions for the 60-year period.

4.7.3.1.3 10 CFR 54.21(c)(1)(iii)

Under this option, the applicant proposes to manage the aging effects associated with the TLAA by an aging management program in the same manner as described in the IPA in 10 CFR 54.21(a)(3). The reviewer reviews the applicant's aging management program to verify that the effects of aging on the intended function(s) are adequately managed consistent with the CLB for the period of extended operation.

The applicant identifies the structures and components associated with the TLAA. The TLAA is described with respect to the objectives of the analysis, conditions, assumptions used, acceptance criteria, relevant aging effects, and intended function(s). In cases where a mitigation or inspection program is proposed, the reviewer uses the guidance provided in Branch Technical Position RLSB-1 of this standard review plan to ensure that the effects of aging on the structure and component intended function(s) are adequately managed for the period of extended operation.

4.7.3.2 FSAR Supplement

The reviewer verifies that the applicant has provided information, to be included in the FSAR supplement that includes a summary description of the evaluation of each TLAA. Each such summary description is reviewed to verify that it is appropriate such that later changes can be controlled by 10 CFR 50.59. The description should contain information that the TLAAs have been dispositioned for the period of extended operation. Sections 4.2 through 4.6 of this standard review plan contain examples of acceptable FSAR supplement information for TLAA evaluation.

The staff expects to impose a license condition on any renewed license to require the applicant to update its FSAR to include this FSAR supplement at the next update required pursuant to 10 CFR 50.71(e)(4). As part of the license condition, until the FSAR update is complete, the applicant may make changes to the programs described in its FSAR supplement without prior NRC approval, provided that the applicant evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59. If the applicant updates the FSAR to include the final FSAR supplement before the license is renewed, no condition is necessary.

As noted in Sections 4.2 through 4.6, an applicant need not incorporate the implementation schedule into its FSAR. However, the review should verify that the applicant has identified and committed in the license renewal application to any future aging management activities, including enhancements and commitments to be completed before the period of extended operation. The staff expects to impose a license condition on any renewed license to ensure that the applicant completes these activities no later than the committed date.

4.7.4 Evaluation Findings

The reviewer determines whether the applicant has provided sufficient information to satisfy the provisions of Section 4.7 and whether the staff's evaluation supports conclusions of the following type, depending on the applicant's choice of 10 CFR 54.21(c)(1)(i), (ii), or (iii), to be included in the staff's safety evaluation report:

> On the basis of its review, as discussed above, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that, for the (name of specific) TLAA, [choose which is appropriate] (i) the analyses remain valid for the period of extended operation, (ii) the analyses have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation. The staff also concludes that the FSAR supplement contains an appropriate summary description of this TLAA evaluation for the period of extended operation as reflected in the license condition.

4.7.5 Implementation

Except in those cases in which the applicant proposes an acceptable alternative method, the method described herein is used by the staff in its evaluation of conformance with NRC regulations.

4.7.6 References

None

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APPENDIX A

BRANCH TECHNICAL POSITIONS

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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) is adequately managed so their intended functions is 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 of four types of aging management programs (AMPS): prevention, mitigation, condition monitoring, and performance monitoring. *Prevention program*s 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 erosion-corrosion 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 degradations 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 U.S. Nuclear Regulatory Commission (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 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 Generic Aging Lessons Learned (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 water chemistry, coating, or cathodic protection as an AMP.

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 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 degradations 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

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

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 preventative/mitigative programs, how the program would be capable of preventing or mitigating their occurrence prior to a loss of a SC intended function. 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 industry-wide operating experience. 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, 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 should also be included on expanding the sample size when degradation is detected in the initial sample.

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 mitigative program, the “detection of aging effects” program element should discuss and establish the monitoring methods that the program will use to monitor for the preventative 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 predictability of the extent of degradation and thus effect timely corrective or mitigative actions. Plant-specific and/or industry-wide 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 is 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 under 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 erosion-corrosion. An AMP for erosion-corrosion 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 NRC-endorsed codes and standards; 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 methodologies 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 ensures that the structure and component intended function(s) are maintained consistent with the CLB.

3. Implementation of the “corrective actions” criterion in 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, preventative 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 is described. It 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 is 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 are 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 is described. They 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 includes 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. Operating experience with existing programs should be discussed. The operating experience of AMPs, 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.

2. 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 result from its past implementation of its existing AMPs 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 may have to commit to providing operating experience in the future 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, June 2005 (Revision 6).

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

Element	Description
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	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.

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