UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 4, 2013

Mr. Jason Remer
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708

SUBJECT: DRAFT LICENSE RENEWAL INTERIM STAFF GUIDANCE, LR-ISG-2012-02, "AGING MANAGEMENT OF INTERNAL SURFACES, SERVICE LEVEL III AND OTHER COATINGS, ATMOSPHERIC STORAGE TANKS, AND CORROSION UNDER INSULATION"

Dear Mr. Remer:

I am writing to inform the Nuclear Energy Institute of the opportunity to comment on the draft license renewal interim staff guidance (LR-ISG), LR-ISG-2012-02, "Aging Management of Internal Surfaces, Service Level III and Other Coatings, Atmospheric Storage Tanks, and Corrosion under Insulation." Enclosed is a copy of the *Federal Register* notice that announces the U.S. Nuclear Regulatory Commission's (NRC's) request for comments and provides instructions on how to submit comments.

Based on recent industry operating experience (OE) and the staff's review of several license renewal applications, the NRC staff has determined that existing guidance in NUREG-1800, Revision 2, "Standard Review Plan for License Renewal Applications for Nuclear Power Plants," (SRP-LR) and NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," should be revised to address changes related to internal surface aging effects and atmospheric storage tanks. Similarly, this LR-ISG includes new recommendations for Service Level III and Other coatings and corrosion under insulation. The proposed revisions address:

- recurring internal corrosion
- a representative minimum sample size for periodic inspections in GALL Aging Management Program (AMP) AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"
- loss of coating integrity for Service Level III and Other coatings
- flow blockage of water-based fire protection system piping
- revisions to the scope and inspection recommendations of GALL AMP XI.M29, "Aboveground Metallic Tanks"
- corrosion under insulation
- external volumetric examination of internal piping surfaces of underground piping
- specific guidance for use of the pressurization option for inspecting elastomers in GALL AMP XI.M38
- key miscellaneous changes to the GALL Report

As discussed during the past two quarterly meetings between the NRC and NEI, this ISG covers several topics. The ISG contains more material than a normal ISG. In addition, it introduces several new considerations of aging effects. As such, we request specific input on the following:

- Should the ISG be split into multiple ISGs and what are the industry recommendations on how it should be split up if that is the recommended path?
- During the development of Section A of the LR-ISG, "Recurring Internal Corrosion," the staff considered other terms in relation to the currently published "recurring," including persistent and pervasive. Please comment on which term or an alternate term best communicates the concept as described in the ISG?
- The staff is using new further evaluation aging management review (AMR) items to address loss of material or change in material properties due to recurring internal corrosion. As an alternative, the staff is considering the concept of recurring aging effects being incorporated into multiple aging management programs instead of the new further evaluation AMR items (e.g., Open-Cycle Cooling Water, Closed-Cycle Cooling Water, Fire Water System, Aboveground Metallic Tanks, Selective Leaching, External Surfaces Monitoring of Mechanical Components, and Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components). Which approach would provide for more effective evaluation of the condition and incorporation into a license renewal application?

To inform other stakeholders of the opportunity to provide comments on the draft LR-ISG-2012-02, courtesy copies of this letter are being sent to subscribers of an NRC electronic mailing list on general license renewal topics.

If you have any questions, please contact William Holston of my staff by telephone at 301-415-8573 or by email at William.Holston@nrc.gov.

Sincerely,

John W. Lubinski, Director
Division of License Renewal
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/encl: Reactor License Renewal Stakeholder
Group Listserv

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- Should the ISG be split into multiple ISGs and what are the industry recommendations on how it should be split up if that is the recommended path?
- During the development of Section A of the LR-ISG, "Recurring Internal Corrosion," the staff considered other terms in relation to the currently published "recurring," including persistent and pervasive. Please comment on which term or an alternate term best communicates the concept as described in the ISG?
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Sincerely,
/RA/
John W. Lubinski, Director
Division of License Renewal
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/encl: Reactor License Renewal Stakeholder
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ADAMS Accession Nos.:ML12291A928 (Package), ML12291A918 (Letter), ML12291A920 (LR-ISG) ML12291A927 (FRN)

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Letter to Jason Remer from John W. Lubinski dated March 4, 2013

SUBJECT: DRAFT LICENSE RENEWAL INTERIM STAFF GUIDANCE, LR-ISG-2012-02, "AGING MANAGEMENT OF INTERNAL SURFACES, SERVICE LEVEL III AND OTHER COATINGS, ATMOSPHERIC STORAGE TANKS, AND CORROSION UNDER INSULATION"

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NUCLEAR REGULATORY COMMISSION

[NRC-2012-XXX]

Aging Management of Internal Surfaces, Service Level III and Other Coatings, Atmospheric Storage Tanks, and Corrosion under Insulation

AGENCY: Nuclear Regulatory Commission.

ACTION: Draft Interim Staff Guidance; request for public comment.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC or the Commission) requests public comment on the Draft License Renewal Interim Staff Guidance (LR-ISG), LR-ISG-2012-02, "Aging Management of Internal Surfaces, Service Level III and Other Coatings, Atmospheric Storage Tanks, and Corrosion under Insulation." The draft LR-ISG proposes to revise NRC staff-recommended aging management programs (AMP) and aging management review (AMR) items in NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," and the NRC staff's AMR procedure, acceptance criteria, and AMR items contained in NUREG-1800, Revision 2, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (SRP-LR) to address new recommendations related to internal surface aging effects of components, and atmospheric storage tanks within the scope of the Requirements for Renewal of Operating Licenses for Nuclear Power Plants. The ISG also includes new recommendations to address Service Level III and Other coatings and corrosion under insulation.

DATES: Submit comments by June 16, 2013. Comments received after this date will be considered, if it is practical to do so, but the NRC staff is able to ensure consideration only for comments received on or before this date.

ADDRESSES: You may access information and comment submissions related to this document, which the NRC possesses and are publicly available, by searching on *http://www.regulations.gov* under Docket ID **NRC-2012-XXX**. You may submit comments by any of the following methods:

- **Federal Rulemaking Web site:** Go to *http://www.regulations.gov* and search for Docket ID **NRC-2013-0170**. Address questions about NRC dockets to Carol Gallagher; telephone: 301-492-3668; e-mail: *Carol.Gallagher@nrc.gov*.
- **Mail comments to:** Cindy Bladey, Chief, Rules, Announcements, and Directives Branch (RADB), Office of Administration, Mail Stop: TWB-05-B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.
- **Fax comments to:** RADB at 301-492-3446.

For additional direction on accessing information and submitting comments, see "Accessing Information and Submitting Comments" in the **SUPPLEMENTARY INFORMATION** section of this document.

FOR FURTHER INFORMATION CONTACT: Mr. William Holston, Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; telephone: 301-415-8573; e-mail: *William.Holston@nrc.gov*.

SUPPLEMENTARY INFORMATION:

I. Accessing Information and Submitting Comments

A. *Accessing Information*

Please refer to Docket ID **NRC-2012-XXXX** when contacting the NRC about the availability of information regarding this document. You may access information related to this document, which the NRC possesses and are publicly available, by any of the following methods:

- **Federal Rulemaking Web Site:** Go to *http://www.regulations.gov* and search for Docket ID **NRC-2012-XXXX**.

- **NRC's Agencywide Documents Access and Management System (ADAMS):** You may access publicly available documents online in the NRC Library at *http://www.nrc.gov/reading-rm/adams.html*. To begin the search, select "*ADAMS Public Documents*" and then select "*Begin Web-based ADAMS Search*." For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1-800-397-4209, 301-415-4737, or by e-mail to *pdr.resource@nrc.gov*. The draft LR-ISG-2012-02 is available electronically under ADAMS Accession No. ML12291A920. The GALL Report and SRP-LR are available under ADAMS Accession Nos. ML103490041 and ML103490036, respectively.

- **NRC's PDR:** You may examine and purchase copies of public documents at the NRC's PDR, Room O1-F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

- **NRC's Interim Staff Guidance Web Site:** The LR-ISG documents are also available online under the "License Renewal" heading at *http://www.nrc.gov/reading-rm/doc-collections/#int*.

B. *Submitting Comments*

Please include Docket ID **NRC-2012-XXXX** in the subject line of your comment submission, in order to ensure that the NRC is able to make your comment submission available to the public in this docket.

The NRC cautions you not to include identifying or contact information that you do not want to be publicly disclosed in your comment submission. The NRC will post all comment submissions at http://www.regulations.gov as well as enter the comment submissions into ADAMS. The NRC does not routinely edit comment submissions to remove identifying or contact information.

If you are requesting or aggregating comments from other persons for submission to the NRC, then you should inform those persons not to include identifying or contact information that they do not want to be publicly disclosed in their comment submission. Your request should state that the NRC does not routinely edit comment submissions to remove such information before making the comment submissions available to the public or entering the comment submissions into ADAMS.

II. Background

The NRC issues LR-ISGs to communicate insights and lessons learned and to address emergent issues not covered in license renewal guidance documents, such as the GALL Report and SRP-LR. In this way, the NRC staff and stakeholders may use the guidance in an LR-ISG document before it is incorporated into a formal license renewal guidance document revision. The NRC staff issues LR-ISGs in accordance with the LR-ISG Process, Revision 2 (ADAMS Accession No. ML100920158), for which a notice of availability was published in the *Federal Register* on June 22, 2010 (75 FR 35510).

The NRC staff has developed draft LR-ISG-2012-02 to address: (a) recurring internal corrosion, (b) a representative minimum sample size for periodic inspections in GALL Aging Management Program (AMP) XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components," (c) loss of coating integrity for Service Level III and Other coatings, (d) flow blockage of water-based fire protection system piping, (e) revisions to the scope and inspection recommendations of GALL AMP XI.M29, "Aboveground Metallic Tanks," (f) corrosion under insulation, (g) external volumetric examination of internal piping surfaces of underground piping, (h) specific guidance for use of the pressurization option for inspecting elastomers in GALL AMP XI.M38, and (i) key miscellaneous changes to the GALL Report

III. Proposed Action

By this action, the NRC is requesting public comments on draft LR-ISG-2012-02. This LR-ISG proposes certain revisions to NRC guidance on implementation of the requirements in 10 CFR Part 54. The NRC staff will make a final determination regarding issuance of the LR-ISG after it considers any public comments received in response to this request.

Dated at Rockville, Maryland, this 4th day of April, 2013.

For the Nuclear Regulatory Commission.

John W. Lubinski, Director
Division of License Renewal
Office of Nuclear Reactor Regulation

DRAFT LICENSE RENEWAL INTERIM STAFF GUIDANCE

LR-ISG-2012-02

AGING MANAGEMENT OF INTERNAL SURFACES, SERVICE LEVEL III AND OTHER COATINGS, ATMOSPHERIC STORAGE TANKS, AND CORROSION UNDER INSULATION

INTRODUCTION

This draft license renewal interim staff guidance (LR-ISG) LR-ISG-2012-02, "Aging Management of Internal Surfaces, Service Level III and Other Coatings, Atmospheric Storage Tanks, and Corrosion under Insulation," provides changes to NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," and NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," (SRP-LR), as described below. These changes provide one acceptable approach for managing the associated aging effects for components within the scope of the License Renewal Rule (Title 10 of the *Code of Federal Regulations*, (10 CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants". A licensee may reference this LR-ISG in its license renewal application (LRA) until the guidance in this LR-ISG is incorporated into the next update to the license renewal guidance documents (i.e., GALL Report, SRP-LR).

DISCUSSION

Based on recent industry operating experience (OE) and the staff's review of several LRAs, the staff has determined that existing guidance in the GALL Report and SRP-LR related to aging management of internal surfaces of components (described in LR-ISG Sections A, B, D, and G), and atmospheric storage tanks should be revised. Similarly, this LR-ISG includes new recommendations for Service Level III and Other coatings and corrosion under insulation (CUI). Each of these areas is discussed in separate sections, A – I, of this LR-ISG as shown below. In addition, this LR-ISG clarifies the guidance for using the pressurization option for inspecting elastomers in GALL Report AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components." Each LR-ISG section includes the background for the change, examples of industry OE when applicable, and a summary of the changes to the license renewal guidance documents.

In developing these new recommendations, the staff:

- revised four existing GALL Report aging management programs (AMPs)
- developed a new GALL Report AMP for Service Level III and Other coatings
- developed a new further evaluation (FE) aging management review (AMR) item to address recurring internal corrosion
- developed new and revised many SRP-LR and GALL Report AMR items
- revised the Final Safety Analysis Report (FSAR) Supplement description for the affected AMPs and developed the FSAR supplement description for the new AMP
- revised three GALL Report definitions and developed four new definitions

The details of the above changes are contained in the appendices to this document. To assist the users of this LR-ISG, the staff developed Table 1, "Major Impacts of LR-ISG-2012-02," which immediately follows the section listing in this ISG. This table directs the user to the GALL Report AMPs that have changed as a result of each of the sections of this LR-ISG. In addition, the staff developed Appendix A, "Index of Changes," which directs the user to the specific pages in the attachments of this LR-ISG related to each section. The Sections of this LR-ISG are as follows:

A. recurring internal corrosion
B. a representative minimum sample size for periodic inspections in GALL Report AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"
C. loss of coating integrity for Service Level III and Other coatings
D. flow blockage of water-based fire protection system piping
E. revisions to the scope and inspection recommendations of GALL Report AMP XI.M29, "Aboveground Metallic Tanks"
F. corrosion under insulation
G. external volumetric examination of internal piping surfaces of underground piping
H. specific guidance for use of the pressurization option for inspecting elastomers in GALL Report AMP XI.M38
I. key miscellaneous changes to the GALL Report

Table 1 Major Impacts of LR-ISG-2012-02

	New FE AMR Item	XI.M27	XI.M29	XI.M36	XI.M38
Recurring internal corrosion	√				
Minimum representative sample					√
Loss of coating integrity	New GALL Report AMP, XI.M42				
Fire water system blockage		√			
Revised scope and inspections for tanks			√		
Corrosion under insulation			√	√	
Volumetric exam of underground piping					√
Pressurization of elastomers					√

Notes:

- XI.M27: GALL Report AMP "Fire Water System"
- XI.M29: GALL Report AMP "Aboveground Metallic Tanks"
- XI.M36: GALL Report AMP "External Surfaces Monitoring of Mechanical Components"
- XI.M38: GALL Report AMP "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"
- XI.M42: GALL Report AMP "Service Level III and Other Coatings Monitoring and Maintenance Program"

Table 2 Other GALL Report AMPs Referenced in this LR-ISG

XI.M20	Open-Cycle Cooling Water System
XI.M21A	Closed Treated Water Systems
XI.M30	Fuel Oil Chemistry
XI.M32	One-Time Inspection
XI.M33	Selective Leaching
XI.M41	Buried and Underground Piping and Tanks
XI.S8	Protective Coating Monitoring and Maintenance Program

A) Recurring Internal Corrosion

i) Background

When the staff reviewed recent LRAs and industry OE, it was evident that some plants have experienced repeated instances of internal corrosion in piping systems that should result in the aging effect to be considered to be recurring. Given that the GALL Report AMPs were developed based on expected typical operating conditions and industry OE, the aging management programs to be used during the period of extended operation (PEO) may have to be augmented to ensure that the recurring aging effect is adequately addressed. The staff identified the following examples of OE related to recurring internal corrosion aging effects during its review of applicant's corrective action databases, and in one instance, an industry OE search. These examples form the basis for the new recommendations included in this LR-ISG.

ii) OE examples

a) Selective leaching (dealloying) of aluminum bronze components.

The staff noted that dealloying has occurred at several plants. However, in most cases, there were a limited number of susceptible components and the licensees opted for a replacement strategy. In a recently submitted LRA, a plant-specific program was proposed to manage selective leaching of susceptible aluminum bronze components. In this instance, following a partial replacement strategy, there were a significant number of susceptible components for which the applicant proposed to manage the dealloying during the PEO by inspecting for leakage, and then replacing the component at the next available plant or system outage.

b) Microbiologically-influenced corrosion (MIC) in service water systems.

One plant experienced an increase in leakage locations because of MIC after receiving its renewed license. This plant had to shut down for over a week to perform repairs to its essential service water system because of leaks resulting in system inoperability. Two other sites experienced extensive MIC in their service water systems resulting in replacement of a significant quantity of the piping.

However, portions of the system that were still affected by MIC were left in service. At both plants, LRA changes were required to address staff requests for additional information (RAIs) about the rigor of the program to manage the loss of material.

c) MIC in a fire water system.

A plant has experienced a significant number of occurrences of MIC in its fire water system. During its audit of the applicant's program, the staff identified gaps in the aging management of loss of material in the system. RAIs associated with a broader search of plant-specific OE, the structural integrity analyses of the system given the current and projected degree of degradation, and augmented inspections are addressing these gaps.

iii) Identifying recurring internal corrosion during development of the LRA

a) The applicant's review of plant-specific OE during the LRA development should be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE, recurring aging effects can be identified by compiling all examples of OE with similar aging effects and aging mechanisms and determining the trend of its occurrence. This LR-ISG does not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. The staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects. This LR-ISG is focused on recurring aging effects in which the component's degree of degradation is significant such that it either does not meet plant-specific acceptance criteria (e.g., component had to be repaired or replaced, component was declared inoperable) or the degradation exceeds certain limits (see paragraph A. iv. b. below).

b) The breadth and detail of review of plant-specific OE necessary to identify recurring aging effects is consistent with NEI 95-10, "Industry Guidelines for Implementing The Requirements of 10 CFR 54 – The License Renewal Rule," Revision 6, Section 4.4, "Operating Experience Review," which states,

> A plant-specific operating experience review should assess the operating and maintenance history. A review of the prior five to ten years of operating and maintenance history should be sufficient. The results of the review should confirm consistency with documented industry operating experience. Differences with previously documented industry experience such as new aging effects or lack of aging effects allow consideration of plant-specific aging management requirements.
>
> Plant-specific operating experience with existing programs should be considered. The operating experience of aging management programs, including past corrective actions resulting in program enhancements or additional programs, should be considered. The review should provide objective evidence to support the conclusion that the effects of aging will be managed so that the intended function(s) will be maintained during the extended period of operation. Guidance for reviewing industry operating experience is presented in BTP RLSB-1 in Appendix A.1of the Branch Technical Positions in NUREG-1800.

c) While the latter paragraph from NEI 95-10 addresses existing AMPs, the review of plant-specific OE should consider all instances of documented degradation identified in the corrective action program regardless of whether they will be managed by a new or an existing program during the PEO. This is reinforced in Section A.1.2.3.10, Items 2 and 3 of the SRP-LR (reference LR-ISG-2011-05), which states:

> Currently available operating experience with existing programs should be discussed. The operating experience of existing programs, including past corrective actions resulting in program enhancements or additional programs, should be considered. A past failure would not necessarily invalidate an AMP because the feedback from operating experience should have resulted in appropriate program enhancements or new programs. This information can show where an existing program has succeeded and where it has not been fully effective 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.
>
> Currently available operating experience applicable to new programs should also be discussed. For new AMPs that have yet to be implemented at an applicant's facility, the programs have not yet generated any operating experience. However, there may be other relevant plant-specific or generic industry operating experience that is relevant to the program elements, even though the operating experience was not identified through implementation of the new program. Thus, when developing the elements for new programs, an applicant should consider the impact of relevant operating experience from implementation of its existing AMPs and from generic industry operating experience.

iv) Summary of changes in this LR-ISG

a) To address recurring internal corrosion aging effects, the staff revised the SRP-LR and GALL Report to include new FE AMR items for Engineered Safety Features Systems (SRP-LR Section 3.2), Auxiliary Systems (SRP-LR Section 3.3), and Steam and Power Conversion Systems (SRP-LR Section 3.4). The staff did not include a new FE AMR item for SRP-LR Reactor Vessel, Internals and Reactor Coolant System (SRP-LR Section 3.1) because a staff review of industry OE did not find evidence of recurring degradation mechanisms in ASME Code Class I systems that were not being appropriately managed at individual plants or as industrywide issues (e.g., recirculation piping cracking at boiling-water reactors (BWRs), Alloy 600 degradation at pressurized-water reactors (PWRs)). In addition, program element 10, "operating experience," was revised for several GALL Report AMPs in which the staff expects that recurring internal corrosion issues could be a concern. The revision includes a discussion of the breadth and depth of the expected review of plant-specific OE and a reference to the new FE AMR items.

b) The new FE AMR items are applicable if the search of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle) of aging effects with similar aging mechanisms in which the aging effect resulted in the component not meeting plant-specific acceptance criteria, or exceeding one or both of the following criteria:

- wall penetration greater than 50 percent regardless of the minimum wall thickness
- based on material testing, a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more (typically as a result of selective leaching)

The staff recognizes that in many instances a component would be capable of performing its intended function even if the degradation met this threshold. For example, localized 50 percent deep pits in typical service water systems do not challenge the pressure boundary function of a component. Nevertheless, the staff has established this threshold for further evaluation as a conservative way of identifying cases that could warrant consideration of augmented aging management actions (e.g., more frequent inspections, volumetric versus visual examinations).

c) Details for the new SRP-LR and GALL Report items are included in Appendix B and Appendix C. As stated in the appendices, further evaluation recommendations can be incorporated into a plant-specific AMP, or a new or existing program that is consistent with a GALL Report AMP could be modified to include the SRP-LR recommendations.

d) A new aging mechanism term, "recurring internal corrosion," was added to GALL Report Table IX.F.

e) A summary of the recommendations contained in the new FE AMR item is as follows:

- The applicant ensures that, given the aging mechanism(s), appropriate examination methods (e.g., volumetric versus external visual) are utilized to detect aging.
- Given the nature of the aging mechanism and its extent, augmented inspections may be required. Augmented inspections are those beyond the number of locations and frequency recommended in the GALL Report for a similar material, environment, and aging effect. Where augmented inspections are not planned to be implemented, the basis is to be provided in the application.
- Where the aging mechanism results in a change in material properties, the applicant states what parameters will be evaluated, the frequency of testing, and how the testing is to be performed (e.g., in-situ, coupon testing, removing samples from service).
- The AMP defines the parameters to be trended as well as the decision points where increased inspections would be implemented (e.g., extent of degradation at individual corrosion sites, rate of degradation change).
- The AMP addresses how inspections of not easily accessed components (e.g., buried, underground, imbedded inside plant walls) will be conducted. In addition, the AMP states how leaks in buried and underground components will be identified.

f) GALL Report AMP XI.M38 states, "[t]his program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in loss of intended function." GALL Report AMP XI.M38 is based on opportunistic inspections that may not occur as frequently as those for an AMP based on periodic inspections. As a result, if repetitive failures occur, with loss of intended function, it is expected that the program would not be used to age-manage in-scope components. This LR-ISG has revised the above statement to read, "[t]his program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in exceeding the threshold criteria contained in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, 'Loss of Material or Change in Material Properties due to Recurring Internal Corrosion.'" This change was made because the appropriate threshold for not using the opportunistic provisions of GALL Report AMP XI.M38 is the criteria contained in the new further evaluation AMR items, and not loss of intended function.

g) Program element 10, "operating experience," was revised for several GALL Report AMPs in which the staff expects that recurring internal corrosion issues could be a concern. The revision includes a discussion of the breadth and depth of the expected review of plant-specific OE, and a reference to the new further evaluation AMR items.

B) Representative Minimum Sample Size for Periodic Inspections in GALL Report AMP XI.M38

i) Background

a) GALL Report AMP XI.M38 recommends that inspections be performed during periodic system and component surveillances or during the performance of maintenance activities when the surfaces are made accessible for visual inspection. As stated in the program element 4, "detection of aging effects,", "[v]isual and mechanical inspections conducted under this program are opportunistic in nature; they are conducted whenever piping or ducting is opened for any reason." However, given the current recommendations in the AMP, it is possible that opportunistic inspections may not be available for one or more material, environment, and aging effect combinations presented in the AMR line items where GALL Report AMP XI.M38 is referenced.

b) The GALL Report contains AMPs used to sample a population to ensure that an aging effect is not occurring. GALL Report AMP XI.M33 uses one-time inspections for each sample population to determine whether loss of material because of selective leaching is occurring. GALL Report AMP XI.M32 also uses one-time inspections to confirm that either an aging effect is not occurring or that the aging effect is occurring very slowly. Both programs include a sample size of 20-percent of each population with the same material, environment, and aging effect, or a maximum of 25 components per population. Where practical, the population to be inspected is selected from components most susceptible to aging because of time in service and severity of operating conditions.

ii) OE Examples

This change is not based upon industry OE. During the staff's review of several LRAs, it was noted that some applicants incorporated a minimum sample size in their

Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program whereas others did not.

iii) Summary of changes in this LR-ISG

a) It is the staff's position that, to credit a GALL Report AMP for aging management, some assurance that a representative sample will be inspected is necessary. To ensure that the GALL Report AMP XI.M38 inspections include a representative sample, the staff revised program element 4, "detection of aging effects," to include minimum sample size, inspection location, and frequency recommendations. A summary is as follows:

- In each 10-year period during the PEO, the licensee ensures that 20 percent, with a maximum sample size of 25 components of each population of in-scope components has been inspected.
- The term "population of components" is described as those components with the same material, environment, and aging effect.
- Where practical, inspection locations are selected from bounding or lead components (e.g., low or stagnant flow) most susceptible to aging because of time in service, severity of operating conditions, and lowest design margin.

The sample size and inspection locations are consistent with the staff's sampling methodology recommendations in other GALL Report AMPs (i.e., AMP XI.M32 and AMP XI.M33). The staff selected a 10-year inspection frequency to allow a reasonable time period to obtain sufficient opportunistic samples while at the same time ensuring that there are sufficient inspections to detect aging before the loss of an in-scope component's intended function(s). The 10-year inspection frequency is consistent with GALL Report AMP XI.M41, a program that, like GALL Report AMP XI.M38, manages surfaces not typically observed during normal operations.

b) This minimum sample size does not override the opportunistic inspection basis of this AMP. Opportunistic inspections are still conducted even though in a given 10-year period, 20 percent or 25 components already might have been inspected. A statement to this effect was included in program element 4, "detection of aging effects," of GALL Report AMP XI.M38.

c) Similar environment inspection quantities may be combined. The staff's position on the "sameness" of the environment is that an inspection conducted of a component in a more severe environment also may be credited as an inspection in a less severe similar environment for the same material. For example, a moist air environment is more severe than an indoor controlled-air environment because the moisture is more likely to result in loss of material than the normally dry surfaces associated with the indoor controlled-air environment. Alternatively, similar environments for the same material can be combined into a larger group as long as the inspections occur on components located in the more severe environment. For example:

- An inspection of the interior surfaces of a steel valve with an internal uncontrolled-indoor air or moist air environment may be credited as an inspection conducted in the specific environment and for the controlled-indoor air and dry air environments. In this case, the more severe environments have the potential to contain more moisture.

- If the internal uncontrolled-indoor, controlled indoor, and dry air environments were combined into one group, the total number of inspections in each 10-year interval for that material would be based on the total population. Inspections occur in the most severe environment, internal uncontrolled-indoor.

Program element 4, "detection of aging effects," of GALL Report AMP XI.M38 was revised to reflect the above.

d) The details of the changes to GALL Report AMP XI.M38 are included in Appendix G.

e) Corresponding changes to the FSAR supplement description are shown in Appendix B, Table 3.0-1, "FSAR Supplement for Aging Management of Applicable Systems."

C) Loss of Coating Integrity for Service Level III and Other Coatings

i) Background

a) Industry OE indicates that degraded coatings have resulted in unanticipated or accelerated corrosion of the base metal and degraded performance of downstream equipment (e.g., heat exchangers). Based on industry OE examples, the staff revised the GALL Report and SRP-LR to include recommendations on managing the aging of Service Level III and Other coatings in which loss of the coating could result in accelerated or unanticipated corrosion of the base metal or could prevent an in-scope component from satisfactorily accomplishing any of its functions identified under 10 CFR 54.4(a)(1), (a)(2), or (a)(3) (e.g., reduction in flow, drop in pressure, reduction in heat transfer). For the purposes of this LR-ISG, the term coating includes inorganic (e.g., zinc-based) or organic (e.g., elastomeric or polymeric) coatings, linings (e.g., rubber, cementitious), and concrete surfacers that are designed to adhere to a component to protect its surface. Service Level I, Service Level III and Other coatings are included. "Other" coatings include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3), which states that all systems, structures, and components relied on in safety analyses or plant evaluations to perform a function that demonstrates compliance with the listed regulated events within the scope of license renewal.

b) The staff has noted that for AMR steel pipe with elastomer-lined items (such as SRP-LR Table 3.3-1, "Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report," ID 26), many applicants state that the elastomer lining is not credited for aging. The staff recognizes that the corrosion allowance used for the design of a component could have incorporated a general corrosion rate that reflects 40 or 60 years of service. However, if a small portion of the lining degraded and exposed the base material, accelerated corrosion could occur (e.g., where a galvanic couple exists). In addition, the loose coating becomes debris that can result in degraded performance of downstream equipment. Therefore, these coatings could be within the scope of license renewal and require aging management, whether or not such coatings are "credited" to prevent corrosion of the base material if the coating failure could prevent an in-scope item from performing its intended function identified under 10 CFR 54.4(a)(1), (a)(2), or (a)(3).

ii) OE examples

a) In 1982, a licensee experienced degradation of internal coatings in its spray pond piping system. Although this is not a newly identified industry OE, the issue contains many key aspects related to coating degradation. These include improper curing time, restricted availability of air flow leading to improper curing, installation layers that were too thick, and improper surface preparation (e.g., oils on surface, surface too smooth). The aging effects included severe blistering, moisture entrapment between layers of the coating, delamination, peeling, and widespread rusting. The failure to install the coatings to manufacturer recommendations resulted in flow restrictions to the ultimate heat sink and blockage of the emergency diesel generator governor oil cooler.

b) During an LRA AMP audit, the staff found that coating degradation, which occurred as a result of weakening of the adhesive bond of the coating to the base metal because of turbulent flow, resulted in the coating eroding away and leaving the base metal subject to aggressive erosion and corrosion. The licensee's corrective actions included revisions to its monitoring program to include more frequent volumetric inspections of the piping system.

c) In 1994, a licensee replaced a portion of its cement-lined steel service water piping with piping lined with a common polyvinyl chloride (PVC) polymeric material. The manufacturer stated that the lining material had an expected life of 15 to 20 years. The licensee conducted an inspection in 1997 that showed some bubbles and delamination in the coating material at a flange. The licensee conducted another inspection in 2002 that found some locations with impaired adhesion to the base metal. In 2011, diminished flow was observed in the downstream portions of this line. Inspections revealed that a majority of the lining in one piping segment was loose or missing. The missing material had clogged a downstream orifice. The licensee conducted another inspection in 2011 which resulted in no further evidence of delamination; however, localized areas showed bubbles and small waves in the liner material. The licensee sent a sample of the lining to a testing lab where it was determined that cracking was evident in the lining on both the base metal and water side and there was a noticeable increase in the hardness of the in-service sample as compared to an unused sample.

d) During an LRA AMP audit, the staff found that a licensee had experienced multiple instances of coating degradation in in-scope components, resulting in coating debris found downstream in heat exchanger end bells. As of March 2012, none of the debris was large enough to result in reduced heat exchanger performance. However, in a different out-of-scope system, coating degradation resulted in blocked tubes in a heat exchanger. This licensee also found polymeric coating debris downstream of a valve in its essential cooling water system.

e) A licensee experienced flow reduction over a 14-day period, resulting in the service water room cooler being declared inoperable. The flow reduction occurred because the rubber coating on a butterfly valve became detached.

f) At an international plant, cavitation in the piping system damaged the coating of a piping system which subsequently resulted in unanticipated corrosion through the pipe wall.

g) A licensee experienced degradation of the protective concrete lining that allowed brackish water to contact the unprotected carbon steel piping resulting in localized corrosion. The degradation of the concrete lining was likely caused by the high flow velocities and turbulence from the valve located just upstream of the degraded area.

iii) Industry guidance on degradation of coatings

a) The Electric Power Research Institute (EPRI) has provided the following input on the effect of loss of coating integrity in EPRI TR-103403, "Service Water Corrosion and Deposition Sourcebook," which states:

> All of these barrier linings possess some degree of permeability to water and ions; hence their protective capabilities are not perfect. Further, coatings will almost always contain small flaws ("holidays") where local anodic conditions can occur. In some situations, corrosion at these holidays (small anodic areas supported by a large cathode) produces a more severe corrosion problem than if the material had never been coated at all. While the effect of such coating failures on the corrosion of the underlying metal would take time (possibly years), the failed coating itself can have an instant impact on the system. Coatings that fail as sheets or in large pieces can cause blockage of safety-related heat exchangers.

b) EPRI 1010059, "Service Water Piping Guideline," states:

> All coatings exhibit some degree of permeability to water, so they provide a barrier that is effective but less than 100% effective in keeping the environment away from the metallic pressure boundary. Permeability will be a function of the coating type and the coating thickness. Coating life, where life is defined as the time period during which the coating is nearly 100% effective at protecting the metal from corrosion, will typically be less than the life of the component (less than 40 years). These considerations require that the condition of the coating be examined periodically and that coating repairs or replacements be anticipated during the life of the service water piping.

iv) Industry usage of the terms "coating" and "Service Level III coating"

a) During the development of this LR-ISG, the staff reviewed EPRI 1019157, "Guidelines on Nuclear Safety-Related Coatings," issued December 2009 and Regulatory Guide (RG) 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Plants," Revision 2, issued October 2010, as well as several ASTM International, formerly known as American Society for Testing and Materials (ASTM), standards related to coatings as referenced in RG 1.54. In its review of these documents, the staff recognized that clarification is needed to ensure a common understanding of terms used in this LR-ISG.

b) EPRI 1019157 and RG 1.54 state that Service Level III "coatings are used in areas outside the reactor containment where failure could adversely affect the safety function of a safety-related [system, structure, and component] SSC." However, in the context of license renewal this term is not completely sufficient because although the term sufficiently describes coatings with intended functions that meet the criterion of 10 CFR 54.4(a)(1) or 10 CFR 54.4(a)(2), the term does not adequately address coatings with intended functions that meet the criteria of 10 CFR 54.4(a)(3).

c) Section 1.5.1.1, Common Terms Related to Coating Work, in EPRI 1019157 defines paints/coatings/linings as, "[e]ssentially synonymous terms for liquid-applied materials consisting of pigments and fillers bound in a resin matrix that dry or cure to form a thin, continuous protective or decorative film. 'Linings' indicates an immersion environment." ASTM D 4538-05, "Standard Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities," defines a coating system as "polymeric protective film consisting of one or more coats, applied in a predetermined order by prescribed methods."

v) Usage of the term "Service Level III coating" in relation to license renewal and derivation of the term "Other" coating

a) The definition of the term "paints/coatings/linings" as stated in EPRI 1019157 is useful in understanding what is meant by a coating or lining; however, for purposes of the GALL Report, a new term, "coating," has been added to GALL Report Table IX.B, "Structures and Components," (see Appendix C of this LR-ISG). The definition of "coating" includes the following key aspects:

- Coatings include coatings, linings, and other items such as concrete surfacers and rubber or cementitious linings.
- Coatings can be constructed from inorganic (e.g., zinc-based) or organic (e.g., elastomeric or polymeric) materials.
- The term "Other" as used in the SRP-LR and GALL Report refers to coatings that are not Service Level I or III whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3). See the following discussion for the derivation of the term "Other."

b) The Service Level III coating definition used in EPRI 1019157 and RG 1.54 effectively addresses components that are within the scope of license renewal under 10 CFR 54.4(a)(1), (defined as "[s]afety-related systems, structures, and components which are those relied upon to remain functional during and following design-basis events"), because these functions are all safety-related. If the failure of the coating could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(1), this coating is within the scope of this LR-ISG. Examples include a coating applied to the inside of a safety-related diesel fuel oil storage tank, service water heat exchanger, or pipe.

c) The Service Level III coating definition used in EPRI 1019157 and RG 1.54 effectively addresses components within the scope of license renewal under 10 CFR 54.4(a)(2), (defined as "[a]ll nonsafety-related systems, structures, and components whose failure could prevent satisfactory accomplishment of any of the functions identified in paragraphs (a)(1)(i), (ii), or (iii) of this section"). If the failure of a coating on the inside surface of a nonsafety-related piping system could cause a safety-related component to not meet its intended function, these coatings would be in the scope of this LR-ISG. Coating-related degradation could result in a nonsafety-related piping system causing a safety-related component to not meet its intended function in several ways:

- The internal coating in a pipe could degrade such that the base metal corrodes through-wall and sprays adjacent safety-related switchgear.
- An in-scope, internally coated, nonsafety-related system that during normal operation is connected to a safety-related system through an isolation valve would be in the scope of this LR-ISG. The coatings could become detached because of aging and enter the safety-related system during routine operations and subsequently clog the system during an accident response. An example would be a nonsafety-related chemical injection system in which injections are performed through the safety-related auxiliary feedwater (AFW) system. Another example would be a nonsafety-related fire water system that is used as a backup source of water for the AFW system.

d) The Service Level III coating definition is too narrow in that it does not address components within the scope of license renewal under 10 CFR 54.4(a)(3), (defined as "[a]ll systems, structures, and components relied on in safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for fire protection (10 CFR 50.48), environmental qualification (10 CFR 50.49), pressurized thermal shock (10 CFR 50.61), anticipated transients without scram (10 CFR 50.62), and station blackout (10 CFR 50.63)"). Components within the scope of license renewal under 10 CFR 54.4(a)(3) could be in the scope of this LR-ISG even though they are nonsafety-related and may not affect a safety-related function. Two examples are as follows:

- A coating was installed to refurbish plant drains that drain water from a room during a fire event. If the coating degrades and blocks flow in the line, a fire water sprinkler discharge could flood the room and result in an in-scope component's intended function(s) not being maintained. Many plants have designated portions of their plant drain systems as in scope to ensure that the functions described in 10 CFR 54.4(a)(3) are successfully accomplished. For example, in relation to portions of its plant drain system, an applicant stated, "[i]t also meets 10 CFR 54.4(a)(3) because it is relied upon in safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for Fire Protection (10 CFR 50.48)."
- A nonsafety-related demineralized water tank is used as a backup source for the safety-related suction inventory of the auxiliary feedwater (AFW) system. The tank is relied upon during a station blackout. If the tank or its discharge piping is coated, degradation of that coating could result in a reduction of flow to the steam generators or reduction in suction pressure to the AFW pumps.

In summary, all coatings installed in any in-scope component are to be considered to be in the scope of this LR-ISG if its degradation could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(1), (a)(2), or (a)(3). Service Level III coatings include functions identified under 10 CFR 54.4(a)(1) and (a)(2). Therefore, this LR-ISG added the term "Other" coatings to include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3).

vi) Basis for not including Service Level II coatings within the scope of this LR-ISG

RG 1.54 states that, "[s]ervice Level II coatings are used in areas where coating failure could impair, but not prevent, normal operating performance. The functions of Service Level II coatings are to provide corrosion protection and decontaminability in those areas outside the reactor containment that are subject to radiation exposure and radionuclide contamination. Service Level II coatings are not safety related." The staff did not include Service Level II coatings within the scope of this LR-ISG because it is not aware of industry OE demonstrating that these coatings have affected functions identified under 10 CFR 54.4(a)(1), (a)(2), and (a)(3). However, if plant-specific OE reveals age-related degradation of a Service Level II coating that could have or would affect a function identified in 10 CFR 54.4(a)(1), the applicant should develop a plant-specific AMP to address aging of the applicable Service Level II coatings.

vii) Summary of changes in this LR-ISG

a) To address the aging management of Service Level III and Other coatings, this LR-ISG implements a new GALL Report AMP XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program." The staff used GALL Report AMP XI.S8, EPRI 1019157, RG 1.54, and ASTM International standards referenced in RG 1.54 to develop the recommendations contained in the new GALL Report AMP XI.M42. The staff included the Service Level III and Other coatings AMP in the mechanical series of AMPs in place of the structural series because the components being age-managed by the program will principally be piping, piping components, heat exchangers, and tanks. Therefore, the AMP is numbered XI.M42 and not XI.S9.

A summary of the key recommendations in GALL Report AMP XI.M42 is as follows:

- Visual inspections will be conducted on all coatings that could affect a license renewal function. The periodicity of the visual inspections is to be based on the impact of coating failures (e.g., reduction of flow or drop in pressure, unanticipated or accelerated corrosion, reduction in heat transfer) on the in-scope component's intended function, potential problems identified during prior inspections, and known service life history. However, not-to-exceed inspection intervals have been established in the new AMP that are dependent on the age of the coating, whether material manufacturer installation specifications (e.g., surface prep, cure time, temperature, humidity, product selection) were met during installation, discovery of coating degradation that did not meet acceptance criteria, and whether repairs or replacement of coatings have occurred.
- Visual inspections are intended to identify defects, such as blistering; cracking; flaking, peeling, or delamination; rusting; and physical damage. Section 10.2 of ASTM D7167-12, "Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant," Includes a definition of these terms. For areas not readily accessible for direct inspection, such as pipelines, heat exchangers, and other equipment, consideration is given to the use of remote or robotic inspection tools.
- For coated surfaces determined to not meet the acceptance criteria such as delamination or blisters, physical testing is performed where physically possible

(i.e., sufficient room to conduct testing). The test consists of destructive or nondestructive adhesion testing using ASTM International standards endorsed in RG 1.54.

- The training and qualification of individuals involved in coating inspections is conducted in accordance with ASTM International standards endorsed in RG 1.54 including staff guidance associated with a particular standard.
- If corrosion of the base material is the only potential effect related to coating degradation, external wall thickness measurements can be performed to confirm the corrosion rate of the base metal instead of inspecting the coatings. Corrosion of base material might be the only consideration if Service Level III or Other coatings are installed in components in which degradation of the coating cannot result in downstream effects, such as reduction in flow, drop in pressure, or reduction in heat transfer in the system. The basis for this conclusion is to be explained in the LRA. An example would be a coating installed upstream of a cooling pond where there are no piping obstructions between the coating and the cooling pond and flow circulation in the pond is low enough that it would be expected that the debris would settle to the bottom and not transport to an inlet pipe.

b) New AMR items are included in SRP-LR Sections, Engineered Safety Features Systems (Section 3.2), Auxiliary Systems (Section 3.3), and Steam and Power Conversion Systems (Section 3.4), and in the corresponding GALL Report Tables. The staff did not revise SRP-LR Section 3.1, "Reactor Vessel, Internals, and Reactor Coolant System," because it is not aware of any industry OE related to the use of coatings in these components.

c) The new GALL Report AMP XI.M42 is included in Attachment H.

d) Details for the new SRP-LR and GALL Report items are included in Appendix B and Appendix C.

e) Corresponding changes to the FSAR supplement description are shown in Appendix B, Table 3.0-1.

f) A new material term, "coating," was added to GALL Report Section IX.C. A new aging effects term, "loss of coating integrity," was added to GALL Report Section IX.E.

D) Flow blockage of Water-Based Fire Protection System Piping, GALL Report AMP XI.M27

i) Background

Industry OE has indicated that flow blockages have occurred in dry sprinkler piping that would have resulted in failure of the sprinklers to deliver the required flow to combat a fire. Based on industry OE examples, the staff revised the GALL Report and SRP-LR to include revised recommendations for age-managing fire water system piping.

ii) OE Examples

a) In October 2010, a portion of a preaction water spray system failed its functional flow test because of blockage. The licensee found two branch lines with significant blockage. The blockage in one branch line was determined to be a buildup of corrosion products because of corrosion that occurred in improperly drained, normally dry piping. A rag was found in the other branch line.

b) In September 2011, an intake structural building fire suppression sprinkler system was unable to pass flow during functional flow testing. The licensee conducted subsequent visual inspections that identified blockages in the inspector's test valve, the piping leading to the inspector's test valves, and three vertical risers. The blockages were determined to be a buildup of corrosion products because of corrosion that occurred in improperly drained, normally dry piping.

c) In March 2012, staff and licensee personnel found a portion of 6-inch preaction sprinkler piping that could not be properly drained because the drainage points were located on a smaller diameter pipe that tied into the side of the 6-inch pipe. A boroscopic inspection of the lower portions of the internal galvanized pipe containing residual water showed they were corroded.

d) In October 2004, a fire main failed its periodic flow test because of a low cleanliness factor. The licensee attributed the low cleanliness factor to fouling because of an accumulation of corrosion products on the interior of the pipe wall and tuberculation. Subsequent chemical cleaning to remove the corrosion products from the pipe wall revealed several leaks. The licensee observed that corrosion products removed during the chemical cleaning settled out in normally stagnant sections of the water-based fire protection system, resulting in blockages in small diameter piping, and valve leak-by that was caused by the corrosion product deposition on the valve seat.

iii) Summary of changes in this LR-ISG

a) The alternative to use wall thickness evaluations instead of flow tests or internal visual examinations for managing flow blockage was removed from GALL Report AMP XI.M27. The basis for this is as follows.

In the first two OE examples, flow through dry pipe or preaction sprinkler system piping was blocked because of a buildup of corrosion products, causing a loss of a portion of the system's intended function. Fouling that consists of a buildup of corrosion products is not possible unless the system is experiencing loss of material. This corrosion could be occurring anywhere in the system (e.g., internal surfaces of a fire water storage tank); however, in the first two examples, the sources of the corrosion products were portions of the normally dry sprinkler piping that was not adequately designed to ensure drainage of water after testing or actuation. The resulting water and air mixture in the piping resulted in accelerated corrosion. GALL Report AMP XI.M27 recommends managing loss of material using flow testing or wall thickness evaluations, where wall thickness evaluations could be performed using internal visual inspections during maintenance or nonintrusive inspection techniques, such as volumetric examinations. Flow testing and internal visual inspections are capable of identifying flow blockage because of fouling; however, external wall thickness measurements may not be capable of identifying these impacts in situations in which general corrosion is having a minor effect on wall thickness while generating sufficient corrosion products to cause flow blockage.

b) While the option to use external wall thickness evaluations instead of flow tests or internal visual examinations was removed, the AMP was also revised to recommend that, if internal visual inspections detect surface irregularities because of corrosion, follow-up volumetric examinations are performed. These follow-up exams are necessary to ensure that there is sufficient wall thickness in the vicinity of the irregularity.

c) Based on a review of industry OE and testing such as flow tests, external visual examinations, hydrostatic tests, and main drain tests, the staff believes that the inspections and tests described in NFPA 25 (2011 Edition), "Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems," along with continuously monitoring the system's pressure, is sufficient to age-manage fire water system piping that is typically filled with water. In contrast, based on the above cited industry OE, for portions of water-based fire protection system components that are periodically subjected to flow but designed to be normally dry, such as dry-pipe or preaction sprinkler system piping and valves, GALL Report AMP XI.M27 was revised to include augmented testing beyond that of NFPA 25. These augmented inspections include:

   - Visual inspections on 100 percent of the length of piping that is not subjected to flow testing or flushing.
   - In each 5-year interval, 20 percent of piping is subject to volumetric wall thickness inspections. Data points are obtained to the extent that each linear foot of piping is tested at 12 locations dispersed along the length and circumference of the pipe.

   The 20 percent of piping inspected in each 5-year interval occurs in different locations than in past inspections. The 20 percent criterion is based on the sample size used in other AMPs, such as GALL Report AMP XI.M32 and is being added as part of this LR-ISG to GALL Report AMP XI.M38. Care must be taken during flow testing to not move any potential blockage to another portion of the system where it might not be detected. Portions of the normally dry piping configured to drain (e.g., pipe slopes towards a drain point) do not need these augmented inspections.

d) GALL Report AMP XI.M29 was revised to include a statement that the aging management of fire water storage tanks is conducted in accordance with GALL Report AMP XI.M27. The basis for this is that the inspection requirements in NFPA 25 Chapter 9, "Water Storage Tanks," are different than those in GALL Report AMP XI.M29 For example, NFPA 25 states that external inspections are conducted quarterly and interior inspections are conducted on a 3-year interval if the tank does not have internal corrosion protection; otherwise the inspections are conducted on a 5-year interval. In contrast, GALL Report AMP XI.M29 recommends that external inspections occur on a refueling outage interval and internal inspections are conducted every 10 years.

e) The frequency for flow testing and visual inspections was revised to reference NFPA 25 (2011 Edition) inspection intervals. GALL Report AMP XI.M27 recommends that inspections be performed on a representative number of locations on a reasonable basis, in which engineering evaluation determined the frequency. This is not consistent with industry standards. NFPA 25 recommends that every sprinkler system, deluge system, fixed water-spray, foam water, fire main, and standpipe and hose system be tested periodically. NFPA 25 Section 6.3.1 recommends flow testing every 5 years for standpipe and hose systems. For fire mains, Section 7.3.1

recommends flow testing every 5 years. For water spray systems, Section 10.3 recommends yearly operational testing during which system pressure and nozzle spray patterns are checked to identify any blockage. For all piping and branch lines, visual inspections for obstructions are recommended every 5 years in Section 14.2.1. While the NFPA 25 standard technical committee is considering removing the periodic obstruction inspection from the 2013 Edition, the staff recommends that visual inspections for obstructions continue to be performed based on recent industry OE.

f) Some details in the program description that were duplicative of recommendations in the ten program elements of GALL Report AMP XI.M27 were removed. Examples include details related to sprinkler testing and flow testing.

g) The statement in program element 4, "detection of aging effects," in GALL Report AMP XI.M27 related to general requirements for testing and maintenance of fire detection systems was deleted because these components are not part of the program for license renewal.

h) Program element 4, "detection of aging effects," in GALL Report AMP XI.M27 was revised to state that visual inspections need to be capable of detecting flow blockage because of fouling in addition to loss of material.

i) The statement in program element 5, "monitoring and trending," in GALL Report AMP XI.M27 related to "associated plant commitments pertaining to NFPA codes and standards" was removed. Plant-specific existing commitments to NFPA codes and standards typically are associated with construction standards, which are not related to aging management and not discussed in GALL Report AMP XI.M27. The activities discussed in the AMP are the activities that need to be monitored and trended for license renewal.

j) The term "flow rates" was added to program element 3, "parameters monitored/inspected" in GALL Report AMP XI.M27. Monitoring flow rates is necessary when internal visual inspections are not conducted to identify flow blockage.

k) Based on the staff's review of the 2011 Edition of NFPA 25, the referenced edition of NFPA 25 was updated to the 2011 Edition from the 1998 and 2002 Editions throughout GALL Report AMP XI.M27.

l) Details of the changes to GALL Report AMP XI.M27 are included in Appendix D.

m) Corresponding changes to the Final Safety Analysis Report supplement description are shown in Appendix B, Table 3.0-1.

n) New AMR items are being added to the GALL Report and SRP-LR to manage flow blockage because of fouling for components in water-based fire protection systems. The details for the new SRP-LR and GALL Report items are included in Appendix B and Appendix C. Some of these AMR items address flow blockage because of fouling in stainless steel, copper alloy, and aluminum piping exposed to raw water (e.g., VII.G.A-55, VII.G.A-404, 3.3.1-64, 3.3.1-65). The staff would not expect corrosion of stainless steel, copper alloy, and aluminum to generate voluminous quantities of corrosion products. However, given that stainless steel, copper alloy, or aluminum sprinkler piping could be installed downstream of steel piping, it is potentially subject to flow blockage from the upstream steel corrosion products and is therefore age-managed for flow blockage because of fouling.

o) GALL Report Items VII.G.A-23 and VII.G.AP-143 for steel and copper alloy components exposed to moist air or condensation (internal), which were being managed for loss of material by GALL Report AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components," were deleted. GALL Report AMP XI.M27 now manages these components.

p) The term "biofouling" was changed to "fouling" throughout GALL Report AMP XI.M27. Fouling can occur in water-based fire protection systems as the result of either organic (biofouling) or particulate substances.

q) A definition for the aging effect term, "flow blockage," was added to GALL Report Section IX.E.

r) The term "performance testing" was changed to "flow testing" for consistency throughout GALL Report AMP XI.M27.

E) Revisions to the Scope and Inspection Recommendations of GALL Report AMP XI.M29, "Aboveground Metallic Tanks"

i) Background

There have been several instances of OE related to degradation of tanks and their coatings. Tanks with defects variously described as wall thinning, pinhole leaks, cracks, and through-wall flaws have been identified by detecting external leakage rather than through internal inspections. In addition, internal blistering and delamination of coatings has been detected at one plant; rust stains, coating damage, and holidays have been found on the bottoms of tanks at a second plant.

ii) Summary of changes in this LR-ISG

a) None of the leaks or degraded coatings has resulted in a loss of intended function; however, the number of identified conditions adverse to quality and the continued aging of the tanks indicate a need to ensure that internal tank inspections are conducted throughout the PEO. As a result of this OE, the staff revised GALL Report AMP XI.M29, "Aboveground Metallic Tanks," to recommend that volumetric inspections of tank bottoms and visual/surface inspections of tank internal surfaces be conducted no less than once every 10 years. GALL Report AMP XI.M29 recommends ultrasonic testing (UT) thickness measurements of the tank bottoms whenever the tank is drained and at least once within 5 years of entering the PEO. The AMP had no recommendations related to visual or surface inspections of tank internal surfaces.

b) Some licensees have large indoor storage tanks. In one case, cracking at the base of the tank occurred. Although the likelihood of moisture penetrating the interface between these indoor tanks and the concrete surface on which they sit is low, corrosion could occur. Most of these indoor tanks are currently managed by GALL Report AMP XI.M36 and GALL Report AMP XI.M38. Neither of these AMPs has a recommendation to conduct periodic volumetric examinations of the bottom of the tank. The staff revised GALL Report AMP XI.M29 to expand its scope to include certain tanks located indoors. While the current AMP does not explicitly state that it is limited to outdoor tanks, there are no GALL Report items for tanks exposed to indoor air that GALL Report AMP XI.M29 manages. Based on industry OE, the staff has not included all indoor tanks within the scope of the AMP. The AMP was revised to include indoor welded storage tanks that meet all of the following criteria:

- have a large volume (i.e., greater than 100,000 gallons)
- are designed to near-atmospheric internal pressures
- sit on concrete or soil
- are exposed internally to water

GALL Report AMP XI.M29 does not manage the internal surfaces of tanks exposed to fuel oil because the guidance in the current recommended GALL Report AMP XI.M30 is consistent with the revised guidance for GALL Report AMP XI.M29.

c) The staff revised GALL Report AMP XI.M29 to include cracking because of stress corrosion cracking and fatigue as an aging effect to be managed for stainless steel and aluminum tanks because there are multiple industry OE examples related to cracking in stainless steel and aluminum tanks. The revised AMP includes a recommendation for appropriate visual or surface examinations capable of detecting cracking, including the minimum surface area to be examined.

d) GALL Report Items, VIII.E.SP-75 and VIII.G.SP-75 (SRP-LR Table 3.4-1, ID 12) address steel and stainless steel tanks exposed to treated water being managed for loss of material because of general (steel only), pitting, and crevice corrosion by GALL Report AMP XI.M2 and GALL Report AMP XI.M32. This LR-ISG revised these items to include cracking because of stress corrosion cracking (stainless steel only) and fatigue based on the industry OE. It also disallowed the use of GALL Report AMP XI.M32 because a one-time inspection is not sufficient. The items were revised to recommend GALL Report AMP XI.M29, which as described above, includes periodic inspections of the tank's internal surfaces. Revising these items in this manner creates a minor gap. A buried steel or stainless steel tank exposed to treated water would be age-managed on its interior surfaces by an aboveground tank program. The staff does not consider this a significant gap because in at least the last 15 LRAs, there have been no in-scope tanks with this material and environment combination. If a future applicant has an in-scope tank with this material and environment combination, the recommendations related to internal inspections in GALL Report AMP XI.M29 can be used regardless of whether the tank is buried or aboveground. Therefore, revising other existing GALL Report AMPs is not necessary.

e) Details of the changes to GALL Report AMP XI.M29 are included in Appendix E.

f) In addition to the changes described above, the staff included other additions or revisions to SRP-LR and GALL Report items to provide a more thorough listing of recommendations across the plant systems for managing the aging of tanks. All of the changes to the SRP-LR and GALL AMR items are shown in Appendix B and Appendix C, respectively.

g) Corresponding changes to the FSAR supplement for the Aboveground Metallic Tank Program are shown in Appendix B, Table 3.0-1.

F) Corrosion Under Insulation (CUI)

i) Background

During a recent license renewal AMP audit, the staff observed extensive general corrosion (i.e., extent of corrosion from a surface area but not depth of penetration perspective) underneath the insulation removed from an AFW suction line. The process fluid temperature was below the dew point for sufficient duration to accumulate condensation on the external pipe surface. NACE, International (NACE), formerly known as National Association of Corrosion Engineers, standard SP0198-2010, "Control of Corrosion under Thermal Insulation and Fireproofing Materials – A Systems Approach," categorizes this as CUI. In addition, during AMP audits the staff has identified gaps in the proposed aging management methods for insulated outdoor tanks and piping surfaces. To date, these gaps have been associated with insufficient proposed examination of the surfaces under insulation.

ii) Summary of changes in this LR-ISG

a) To address CUI, GALL Report AMPs XI.M29 and XI.M36 were revised to recommend periodic inspections under the insulation during each 10-year period beginning 5 years before the PEO.

b) For all outdoor components, except tanks, and any indoor components operated below the dew point, remove the insulation and inspect a minimum of 20 percent of the in-scope piping length for each material type (i.e., steel, stainless steel, copper alloy, aluminum), or for components where its configuration does not conform to a 1-foot axial length determination (e.g., valve, accumulator), 20 percent of the surface area. Alternatively remove the insulation and inspect any combination of a minimum of 25 1-foot axial length sections and components for each material type. Inspections are conducted in each air environment (e.g., air-outdoor, moist air) where condensation or moisture on the surfaces of the component could occur routinely or seasonally. In some instances, although indoor air is conditioned, significant moisture can accumulate under insulation during high humidity seasons.

c) For each outdoor tank and indoor tanks operated below the dew point, remove the insulation from either 25 1-square-foot sections or 20 percent of the surface area and inspect the exterior surface of the tank. Distribute the sample inspection points such that inspections occur on the tank dome, sides, near the bottom, at points where structural supports or instrument nozzles penetrate the insulation, and where water collects such as on top of stiffening rings.

d) Details of the changes to GALL Report AMPs XI.M29 and XI.M38 are shown in Attachment E (AMP XI.M29) and Attachment F (AMP XI.M36).

e) Corresponding changes to the FSAR supplement descriptions are shown in Appendix B, Table 3.0-1.

f) New AMR items have been added to the SRP-LR, Appendix B and GALL Report, Appendix C.

G) External Volumetric Examination of Internal Piping Surfaces of Underground Piping Removed from GALL Report AMP XI.M41

i) Background

GALL Report AMP XI.M41 included a recommendation to conduct external volumetric inspections to detect internal corrosion. This recommendation was removed from the AMP with the issuance of LR-ISG-2011-03, "Changes to the Generic Aging Lessons Learned (GALL) Report Revision 2 Aging Management Program (AMP) XI.M41, 'Buried and Underground Piping and Tanks.'" The recommendation was removed because the scope of GALL Report AMP XI.M41 is aging management of external surfaces of buried and underground piping, not internal surfaces.

The original inclusion of this recommendation in GALL Report AMP XI.M41 was based on industry OE in which an underground pipe leaked because of internal corrosion and the vault's water removal capability function failed as well as its seal resulting in radioactive process fluid leaking into the ground. Given that the OE is related to internal corrosion instead of external corrosion, the inspection recommendations are being relocated to GALL Report AMP XI.M38.

ii) Summary of changes in this LR-ISG

a) GALL Report AMP XI.M38 was revised to allow the condition of internal surfaces of buried and underground piping to be based on inspections of the interior surfaces of aboveground piping where the aboveground and buried or underground component material, environment, and aging effects are similar.

b) In addition, GALL Report AMP XI.M38 was revised to state that where aboveground inspections with similar material, environment, and aging effects as the interior surfaces of buried or underground piping were not conducted; internal visual or external volumetric inspections are conducted on the buried or underground piping.

c) Details of the changes to GALL Report AMP XI.M38 are shown in Attachment G.

H) <u>Specific Guidance for Use of the Pressurization Option for Inspecting Elastomers</u>

i) Background

The program description of GALL Report AMP XI.M38 states, "[f]or certain materials, such as polymers, physical manipulation or pressurization (e.g., hydrotesting) to detect hardening or loss of strength are used to augment the visual examinations conducted under this program." The staff is removing the term "hydrotesting" from the program description because the term is typically associated with test pressures well above the normal operating and design pressures.

ii) Summary of changes in this LR-ISG

a) Program element 1, "scope of program," of GALL Report XI.M38 was revised to state that elastomeric material is sufficiently pressurized to expand the surface of the material such that cracks or crazing are evident. The revised wording clarifies the intent of the pressure test option.

b) Details of the changes to GALL Report AMP XI.M38 are shown in Attachment G.

l) Key Miscellaneous Changes to the GALL Report

i) The GALL Report, Section IX.E, definition of "hardening and loss of strength" was revised, as shown in Appendix C, to replace the term "weathered" with the term "degraded" because weathering is generally associated with aging as a result of contact with outdoor weather conditions. In addition, loss of sealing and cracking were added to the examples associated with degraded elastomers. These changes provide a more complete list of aging effects and result in the definition being more consistent with program element 3, "parameters monitored/inspected," of GALL Report AMP XI.M38. Likewise, program element 3, "parameters monitored/inspected," of GALL Report AMP XI.M38 was revised to include loss of sealing.

ii) The GALL Report, Section IX.F, definition of elastomer degradation was revised to include change in material properties as an example of aging to make the definition more consistent with the program element 3, "parameters monitored/inspected," of GALL Report AMP XI.M38.

iii) Program element 1, "scope of program," of GALL Report AMP XI.M38 was revised to include the provision for GALL Report AMP XI.M36, "External Surfaces Monitoring of Mechanical Components," which allows internal surfaces of polymers to be inspected from the external surface when the material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. The change was made to improve the consistency between the two programs.

iv) The GALL Report, Section IX.F, definition of fouling was revised to be more reflective of the above discussions related to loss of coating integrity and flow blockage of water-based fire protection system piping.

ACTIONS

Applicants should use Appendices B, C, D, E, F, G, H, and I in preparing their LRA to be consistent with the GALL Report.

NEWLY IDENTIFIED SYSTEMS, STRUCTURES, AND COMPONENTS UNDER 10 CFR 54.37(b)

The NRC is not proposing to treat the revised recommendations for managing internal aging effects and CUI of in-scope components as "newly identified" systems, structures, and components (SSCs) under 10 CFR 54.37(b). Therefore, any additional action on such materials, which the NRC may impose upon current holders of renewed operating licenses under 10 CFR Part 54, would not fall within the scope of 10 CFR 54.37(b). The NRC would have to address compliance with the requirements of 10 CFR 50.109, "Backfitting," before it may impose any new aging management requirements on current holders of renewed operating licenses (see discussion below).

BACKFITTING AND ISSUE FINALITY

This LR-ISG contains guidance on one acceptable approach for managing the associated aging effects during the PEO for components within the scope of license renewal. The staff's discussion on compliance with the requirements of the Backfit Rule, 10 CFR 50.109 is presented below.

Compliance with the Backfit Rule and Issue Finality

Issuance of this LR-ISG does not constitute backfitting as defined in 10 CFR 50.109(a)(1), and the NRC staff did not prepare a backfit analysis for issuing this LR-ISG. There are several rationales for this conclusion, depending on the status of the nuclear power plant licensee.

Licensees currently in the license renewal process - The backfitting provisions in 10 CFR 50.109 do not protect an applicant, as backfitting policy considerations are not applicable to an applicant. Therefore, issuance of this LR-ISG does not constitute backfitting as defined in 10 CFR 50.109(a)(1). There currently are no combined licenses (i.e., 10 CFR Part 52) license renewal applicants; therefore, the changes and new positions presented in the LR-ISG may be made without consideration of the issue finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

Licensees that already hold a renewed license - This guidance, as proposed, is nonbinding and the draft LR-ISG would not require current holders of renewed licenses to take any action (i.e., programmatic or plant hardware changes for managing the associated aging effects for components within the scope of this LR-ISG). If the draft LR-ISG were finalized as written, then current holders of renewed licenses should treat this guidance as OE and take actions as appropriate to ensure that applicable aging management programs are, and will remain, effective. If, in the future, the NRC decides to take additional action and impose requirements for managing the associated aging effects for components within the scope of this LR-ISG, then the NRC would follow the requirements of the Backfit Rule.

Current operating license or combined license holders that have not yet applied for renewed licenses - The backfitting provisions in 10 CFR 50.109 do not protect any future applicant, as backfitting policy considerations are not applicable to a future applicant. Therefore, issuance of this LR-ISG does not constitute backfitting as defined in 10 CFR 50.109(a)(1). The issue finality provisions of 10 CFR Part 52 do not extend to the aging management matters covered by 10 CFR Part 54, as evidenced by the requirement in 10 CFR 52.107, "Application for Renewal," stating that applications for renewal of a combined license must be in accordance with 10 CFR Part 54.

CONGRESSIONAL REVIEW ACT

This LR-ISG is a rule as designated in the Congressional Review Act (Title 5 of the United States Code, Part I, Chapter 8 (5 USC, Sec. 801)). However, the Office of Management and Budget has not found it to be a major rule as designated in the Congressional Review Act.

APPENDICES

Appendix A, Index of Changes

Appendix B, Mark-up Showing Changes to the SRP-LR

Appendix C, Mark-up Showing Changes to the GALL Report AMR Items and Definitions

Appendix D, Mark-up Showing Changes to GALL Report AMP XI.M27, "Fire Water System"

Appendix E, Mark-up Showing Changes to GALL Report AMP XI.M29, "Aboveground Metallic Tanks"

Appendix F, Mark-up Showing Changes to GALL Report AMP XI.M36, "External Surfaces Monitoring of Mechanical Components"

Appendix G, Mark-up Showing Changes to GALL Report AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"

Appendix H, GALL Report AMP XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"

Appendix I, Changes to Program Element 10, "Operating Experience," in GALL Report AMPs XI.M20 and XI.M21A

Unless otherwise noted, substantive changes in Appendices B - G are shown as crossed out for deleted text and underlined for added text. Appendix H and Appendix I were not annotated in this manner because they include a newly written GALL Report AMP and new text added to program element 10, "operating experience," for two GALL Report AMPs, respectively.

REFERENCES

5 USC, Sec. 801, Congressional Review of Agency Rulemaking, Office of the Law Revision Counsel of the House of Representatives, 2012.

10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities, Office of the Federal Register, National Archives and Records Administration, 2010.

10 CFR Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, 2011.

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

U.S. Nuclear Regulatory Commission. NUREG-1800, Revision 2, Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants, December 2010.

U.S. Nuclear Regulatory Commission, NRC Information Notice 85-24, Failures of Protective Coatings in Pipes and Heat Exchangers, March 26, 1985.

U.S. Nuclear Regulatory Commission, NRC Information Notice 2013-06, Corrosion in Fire Protection Piping Due to Air and Water Interaction, March 25, 2013.

NEI 95-10, Industry Guidelines for Implementing The Requirements of 10 CFR 54 – The License Renewal Rule, Revision 6.

EPRI 1019157, Plant Support Engineering: Guidelines on Nuclear Safety-Related Coatings, December 2009.

EPRI TR-103403, Service Water Corrosion and Deposition Sourcebook, December 1993.

EPRI 1010059, Service Water Piping Guideline, September 2005.

Regulatory Guide 1.54, Service Level I, II, and III Protective Coatings Applied to Nuclear Plants, Revision 2, October 2010.

ASTM D4538-05, Standard Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities.

ASTM D7167-12, Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant.

ASTM D5162-08, Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.

Regulatory Issue Summary (RIS) 2007-16, Revision 1, Implementation of the Requirements of 10 CFR 54.37(b) for Holders of Renewed Licenses.

NACE SP0198-201, Control of Corrosion Under Thermal Insulation and Fireproofing Materials – A Systems Approach.

NFPA 25, Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems, National Fire Protection Association, 2011 Edition.

APPENDIX A
INDEX OF CHANGES

LR-ISG Section and Topic	LR-ISG Text	SRP-LR UFSAR Supplement	SRP-LR AMR Items	GALL AMR Items	GALL Definitions	GALL Report AMPs
Recurring internal corrosion	3-7		B-4 B-5 B-6 B-10 B-15	C-1 C-4 C-8	C-11	Appendix D Appendix E Appendix F Appendix G Appendix I Program Element 10 only
Minimum representative sample in XI.M38	7-9	B-3				Appendix G
Loss of coating integrity for Service Level III and Other coatings	9-15	B-3	B-6 B-11 B-15	C-1 C-5 C-8	C-9 C-10	Appendix H
Fire water system blockage in XI.M27	15-19	B-1	B-9 B-10 B-12	C-3 C-4 C-5 C-6	C-9 C-10	Appendix D
Revised scope and inspections for tanks in XI.M29	19-20	B-2	B-6 B-7 B-10 B-11 B-14	C-1 C-2 C-3 C-5 C-7		Appendix E
Corrosion under insulation	21	B-2	B-7 B-13 B-16	C-2 C-6 C-8		Appendix E Appendix F
Volumetric exam of underground piping	22					Appendix G
Pressurization of elastomers	22					Appendix G

APPENDIX B

MARK-UP SHOWING CHANGES TO THE SRP-LR

Table 3.0-1 FSAR Supplement for Aging Management of Applicable Systems

GALL Chapter	GALL Program	Description of Program	Implementation Schedule*	Applicable GALL Report and SRP-LR Chapter References
XI.M27	Fire Water System	This program ~~consists of periodic full-flow flush tests, system performance tests to prevent corrosion from biofouling components in the fire protection system,~~ manages loss of material because of corrosion, including MIC, and fouling, and flow blockage because of fouling. This program manages the aging effects through the use of flow testing and visual inspections performed in accordance with NFPA 25. ~~and t~~Testing or replacement of sprinklers that have been in place for 50 years are performed in accordance with NFPA 25. In addition to NFPA codes and standards, portions of the water-based fire protection system that are periodically subjected to flow but normally dry, such as dry-pipe or preaction sprinkler system components, and not configured to drain are subjected to augmented testing beyond that of NFPA 25 including periodic full flow tests at the design pressure and flow rate or internally visual inspections, and volumetric wall thickness examinations. Flow testing and visual inspections are performed at intervals specified in NFPA-25 (2011 Edition) beginning 5 years before the period of extended operation. The water-based fire protection system is normally maintained at required operating pressure and is monitored such that loss of system pressure is immediately detected and corrective actions initiated. ~~The program relies on the testing of piping and components in the water-based fire protection system in accordance with applicable National Fire Protection Association (NFPA) commitments. In addition, this program can be modified to include (a) portions of the fire protection sprinkler system that are subjected to full flow tests prior to the period of extended operation, and (b) portions of the fire protection system exposed to water are internally visually inspected.~~	Program is ~~should be~~ implemented and inspections begin five years before the period of extended operation	GALL VII / SRP 3.3

MARK-UP SHOWING CHANGES TO THE SRP-LR

Table 3.0-1 FSAR Supplement for Aging Management of Applicable Systems

GALL Chapter	GALL Program	Description of Program	Implementation Schedule*	Applicable GALL Report and SRP-LR Chapter References
XI.M29	Aboveground Metallic Tanks	This program includes outdoor tanks sited on soil or concrete and indoor large volume tanks containing water designed with internal pressures approximating atmospheric pressure that are sited on concrete. The program includes preventive measures to mitigate corrosion by protecting the external surfaces of steel components, per standard industry practice, with sealant or caulking at the concrete-component interface. External visual and surface (when necessary to detect aging) ~~inspection~~examinations during periodic system walkdowns ~~should be~~ is sufficient to monitor degradation of the protective paint, coating, caulking, ~~or~~ sealant, or uncoated surfaces. The external surfaces of insulated tanks are sampling-based inspected. Internal visual and surface (when necessary to detect aging) examinations are conducted in conjunction with ~~Program effectiveness is determined by~~ measuring the thickness of the tank bottoms to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. Internal inspections are conducted whenever the tank is drained, although not to exceed every 10 years, beginning 5 years before the period of extended operation.	Program is implemented and inspections begin five years before the period of extended operation ~~Existing program~~	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4
XI.M36	External Surfaces Monitoring of Mechanical Components	This program is based on system inspections and walkdowns. It consists of periodic visual inspections of metallic and polymeric components, such as piping, piping components, ducting, polymeric components, and other components. The program manages aging effects through visual inspection of external surfaces for evidence of loss of material, cracking, and changes in material properties. Component surfaces that are insulated and operated below the dew point, and insulated outdoor components, are periodically inspected every 10 years beginning 5 years before to the period of extended operation. When appropriate for the component and material, manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength.	Program is implemented and inspections begin five years before the period of extended operation ~~Existing program~~	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4

Table 3.0-1 FSAR Supplement for Aging Management of Applicable Systems

GALL Chapter	GALL Program	Description of Program	Implementation Schedule*	Applicable GALL Report and SRP-LR Chapter References
XI.M38	Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components	The program consists of inspections of the internal surfaces of metallic piping, piping components, ducting, polymeric components, and other components and any water systems other than open-cycle cooling water, treated water, and fire water that are exposed to environments of air – indoor, uncontrolled; air – outdoor; condensation. These internal inspections are performed during the periodic system and component surveillances or during the performance of maintenance activities when the surfaces are made accessible for visual inspection. At a minimum, in each 10-year period beginning 10 years before the period of extended operation a representative sample of 20 percent of the population (defined as components having the same material, environment, and aging effect combination) or a maximum of 25 components per population is inspected. Where practical, the inspections focus on the bounding or lead components most susceptible to aging because of time in service, and severity of operating conditions. Opportunistic inspections continue in each period despite meeting the sampling limit. The program includes visual inspections to ensure that existing environmental conditions are not causing material degradation that could result in a loss of the component's intended function. For certain materials, such as polymers, physical manipulation or pressurization to detect hardening or loss of strength is used to augment the visual examinations conducted under this program. If visual inspection of internal surfaces is not possible, then the applicant needs to provide a plant-specific program.	Program is implemented and inspections begin 10 years before the period of extended operation ~~Existing program~~	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4 GALL VI / SRP 3.6
XI.M42	Service Level III and Other Coatings Monitoring and Maintenance Program	The program consists of visual inspections of all Service Level III and Other coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil or fuel oil. Other coatings include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3). For coated surfaces determined to not meet the acceptance criteria, physical testing is performed where physically possible (i.e., sufficient room to conduct testing). The test consists of destructive or nondestructive adhesion testing using ASTM International standards endorsed in RG 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Plants." The training and qualification of individuals involved in coating inspections are conducted in accordance with ASTM International standards endorsed in RG 1.54 including staff guidance associated with a particular standard.	Program is implemented no later than six months before the period of extended operation and inspections begin no later than the last refueling outage before the period of extended operation.	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4

APPENDIX B

MARK-UP SHOWING CHANGES TO THE SRP-LR

The following material is being added as new Further Evaluation AMR items to the Acceptance Criteria (3.X.2) and Review Procedure (3.X.3) portions of the SRP-LR. Given that it is all new material, the text was not formatted with underlining.

3.X.2.2 AMR Results for Which Further Evaluation is Recommended by the GALL Report

3.2.2.2.9 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

3.3.2.2.8 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

3.4.2.2.6 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

Recurring aging effects can result in the need to augment AMPs beyond the recommendations in the GALL Report. During the search of plant-specific OE conducted during the LRA development, recurring aging effects can be identified by the number of occurrences of aging effects with similar aging mechanisms and the extent of degradation at each localized corrosion site. This further evaluation item is applicable if the search of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle) of aging effects with similar aging mechanisms in which the aging effect resulted in the component not meeting either plant-specific acceptance criteria or wall penetration greater than 50 percent (regardless of the minimum wall thickness), or a change in material properties such that it would be expected that there is a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more (e.g., as a result of selective leaching).

The GALL Report recommends that a plant-specific AMP, or a new or existing AMP, be evaluated for inclusion of augmented requirements to ensure the recurring aging mechanism(s) is adequately managed. Potential augmented requirements include: alternative examination methods (e.g., volumetric versus external visual), augmented inspections (e.g., a greater number of locations, additional locations based on risk insights based on susceptibility to aging effect and consequences of failure, a greater frequency of inspections), additional trending parameters and decision points where increased inspections would be implemented, and periodic parameter testing (e.g., tensile strength, yield strength, fracture toughness) when the aging mechanism results in a change in material properties. Acceptance criteria are described in Appendix A.1, "Aging Management Review – Generic (Branch Technical Position RSLB-1)."

The applicant states: (a) why the program's examination methods will be sufficient to detect the recurring aging mechanism before affecting the ability of a component to perform its intended function, (b) the basis for the adequacy of augmented or lack of augmented inspections, (c) what parameters will be trended as well as the decision points where increased inspections would be implemented (e.g., extent of degradation at individual corrosion sites, rate of degradation change), (d) the basis for parameter testing frequency and how it will be conducted, (e) how inspections of not easily accessed components (i.e., buried, underground) will be conducted, and (f) if buried or underground components are involved, how leaks in buried, underground components will be identified.

3.X.3.2 AMR Results for Which Further Evaluation is Recommended by the GALL Report

3.2.3.2.9 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

3.3.3.2.8 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

3.4.3.2.7 Loss of Material or Change in Material Properties due to Recurring Internal Corrosion

The GALL Report recommends further evaluation to manage recurring aging effects. The reviewer conducts an independent review of plant-specific OE to determine if the plant is currently experiencing a recurring aging effect. The scope of this further evaluation AMR item includes recurring aging effects that are defined as those with similar aging mechanisms in which the plant-specific OE review reveals repetitive occurrences (e.g., one per refueling outage cycle) of aging effects with similar aging mechanisms and where the aging effect resulted in the component not meeting either plant-specific acceptance criteria or wall penetration greater than 50 percent (regardless of the minimum wall thickness), or change in material properties such that it would be expected that there is a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more (typically as a result of selective leaching).

The reviewer determines whether an adequate program will be used to manage recurring aging effects by evaluating the proposed AMP against the criteria in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, or 3.4.2.2.6.

Table 3.2-1 Summary of Aging Management Programs for Engineered Safety Features Evaluated in Chapter V of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
22	PWR	Stainless steel Piping, piping components, and piping elements~~; tanks~~ exposed to Treated water (borated)	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry" and Chapter XI.M32, "One-Time Inspection"	No	V.A.EP-41 V.D1.EP-41	V.A-27(EP-41) V.D1-30(EP-41)
66	BWR/PWR	Metallic piping, piping components, and tanks exposed to closed-cycle cooling water, raw water, treated water, waste water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, (See Subsection 3.2.2.2.9)	V.A.E-400 V.B.E-400 V.C.E-400 V.D1.E-400 V.D2.E-400	N/A N/A N/A N/A N/A
67	BWR/PWR	Metallic piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, or fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No	V.A.E-401 V.B.E-401 V.C.E-401 V.D1.E-401 V.D2.E-401	N/A N/A N/A N/A N/A
68	BWR/PWR	Steel; stainless steel, or aluminum tanks exposed to soil or concrete	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (stainless steel and aluminum only)	Chapter XI.M29, "Aboveground Metallic Tanks"	No	V.D1.E-402 V.D2.E-402	N/A

Table 3.2-1 Summary of Aging Management Programs for Engineered Safety Features Evaluated in Chapter V of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
69	BWR/PWR	Steel, stainless steel, copper, aluminum, or copper > 15% Zn components exposed to insulation and operated below the dew point; insulated outdoor tanks, piping, and piping components	Loss of material due to general (steel, copper, or copper > 15% Zn only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" and Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No	V.A.E-403 V.B.E-403 V.C.E-403 V.D1.E-403 V.D2.E-403 V.E.E-403	N/A N/A N/A N/A N/A N/A
70	BWR/PWR	Stainless steel and aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks" only) exposed to water	Loss of material due to pitting and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks;"	No	V.A.E-404 V.D1.E-404 V.D2.E-404	N/A

Table 3.2-2 Aging Management Programs Recommended for Aging Management of Engineered Safety Features	
GALL Report Chapter/AMP	**Program Name**
Chapter XI.M29	Aboveground Metallic Tanks
Chapter XI.M42	Service Level III and Other Coatings Monitoring and Maintenance Program

Table 3.3-2 Aging Management Programs Recommended for Aging Management of Auxiliary System	
Chapter XI.M42	Service Level III and Other Coatings Monitoring and Maintenance Program

Table 3.4-2 Aging Management Programs Recommended for Aging Management of Steam and Power Conversion Systems	
Chapter XI.M42	Service Level III and Other Coatings Monitoring and Maintenance Program

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MARK-UP SHOWING CHANGES TO THE SRP-LR

Table 3.3-1 Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
63	BWR/PWR	Steel Fire Hydrants exposed to Air – outdoor	Loss of material due to general, pitting, and crevice corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No	VII.G.AP-149	N/A
64	BWR/PWR	Steel, Copper alloy Piping, piping components, and piping elements exposed to Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No	VII.G.A-33 VII.G.AP-197	VII.G-24(A-33) VII.G-12(A-45)
65	BWR/PWR	Aluminum Piping, piping components, and piping elements exposed to Raw water	Loss of material due to pitting and crevice corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No	VII.G.AP-180	VII.G-8(AP-83)
66	BWR/PWR	Stainless steel Piping, piping components, and piping elements exposed to Raw water	Loss of material due to pitting and crevice corrosion; fouling that leads to corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No	VII.G.A-55	VII.G-19(A-55)

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MARK-UP SHOWING CHANGES TO THE SRP-LR

Table 3.3-1 Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
67	BWR/PWR	Steel Tanks exposed to Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VII.G.A-95 VII.H1.A-95	VII.H1-11(A-95)
89	BWR/PWR	Steel, Copper alloy Piping, piping components, and piping elements exposed to Moist air or condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No	~~VII.G.A-23~~ ~~VII.G.AP-143~~ VII.H2.A-23	~~VII.G-23(A-23)~~ ~~VII.G-9(AP-78)~~ VII.H2-21(A-23)
127	BWR/PWR	Metallic piping, piping components, and tanks exposed to closed-cycle cooling water, raw water, treated water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, (See Subsection 3.3.2.2.8)	VII.A2.A-400 VII.A3.A-400 VII.A4.A-400 VII.C1.A-400 VII.C2.A-400 VII.C3.A-400 VII.D.A-400 VII.E1.A-400 VII.E2.A-400 VII.E3.A-400 VII.E4.A-400 VII.E5.A-400 VII.F1.A-400 VII.F2.A-400 VII.F3.A-400 VII.F4.A-400 VII.G.A-400 VII.H1.A-400 VII.H2.A-400	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A

Table 3.3-1 Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
128	BWR/PWR	Metallic piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, or fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No	VII.A2.A-401 VII.A3.A-401 VII.A4.A-401 VII.C1.A-401 VII.C2.A-401 VII.C3.A-401 VII.D.A-401 VII.E1.A-401 VII.E2.A-401 VII.E3.A-401 VII.E4.A-401 VII.E5.A-401 VII.F1.A-401 VII.F2.A-401 VII.F3.A-401 VII.F4.A-401 VII.G.A-401 VII.H1.A-401 VII.H2.A-401	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
129	BWR/PWR	Steel tanks exposed to soil or concrete; water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VII.G.A-402 VII.H1.A-402	N/A N/A

Table 3.3-1 Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report

130	BWR/PWR	Sprinklers constructed of any material exposed to air or water environments	Loss of material due to general (where applicable), pitting, crevice, and microbiologically-induced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No	VII.G.A-403	N/A
131	BWR/PWR	Steel, stainless steel, copper alloy, or aluminum fire water system piping, piping components and piping elements exposed to air-indoor uncontrolled (internal), air-outdoor (internal), or condensation (internal)	Loss of material due to general (steel, copper only), pitting, crevice, and microbiologically-induced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No	VII.G.A-404	

Table 3.3-1 Summary of Aging Management Programs for Auxiliary Systems Evaluated in Chapter VII of the GALL Report

132	BWR/PWR	Steel, stainless steel, copper, aluminum, or copper > 15% Zn components exposed to insulation and operated below the dew point; insulated outdoor tanks, piping, and piping components	Loss of material due to general (steel, copper, and copper > 15% Zn only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" and Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No	VII.A2.A-405 VII.A3.A-405 VII.A4.A-405 VII.C1.A-405 VII.C2.A-405 VII.C3.A-405 VII.D.A-405 VII.E1.A-405 VII.E2.A-405 VII.E3.A-405 VII.E4.A-405 VII.E5.A-405 VII.F1.A-405 VII.F2.A-405 VII.F3.A-405 VII.F4.A-405 VII.G.A-405 VII.H1.A-405 VII.H2.A-405 VII.I.A-405	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A

Table 3.4-1 Summary of Aging Management Programs for Steam and Power Conversion System Evaluated in Chapter VIII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
12	BWR/PWR	Steel; stainless steel Tanks exposed to ~~Treated w~~Water	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (stainless steel only and fatigue)	Chapter XI.M2, "Water Chemistry," and ~~Chapter XI.M32, "One-Time Inspection"~~ Chapter XI.M29, "Aboveground Metallic Tanks"	No	VIII.E.SP-75 VIII.G.SP-75	VIII.E-40(S-13) VIII.G-41(S-13)
30	BWR/PWR	Steel, Stainless Steel, Aluminum Tanks exposed to Soil or Concrete, Air – outdoor (External)	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (stainless steel and aluminum only)	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VIII.E.SP-115 VIII.E.SP-138 VIII.E.SP-140 VIII.G.SP-116	N/A N/A N/A N/A
31	BWR/PWR	Stainless steel, Aluminum Tanks exposed to Soil or Concrete	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VIII.E.SP-137 VIII.E.SP-139	N/A N/A

Table 3.4-1 Summary of Aging Management Programs for Steam and Power Conversion System Evaluated in Chapter VIII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
61	BWR/PWR	Metallic piping, piping components, and tanks exposed to closed-cycle cooling water, raw water, treated water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, (See subsection 3.4.2.2.6)	VIII.A.S-400 VIII.B1.S-400 VIII.B2.S-400 VIII.C.S-400 VIII.D1.S-400 VIII.D2.S-400 VIII.E.S-400 VIII.F.S-400 VIII.G.S-400	N/A N/A N/A N/A N/A N/A N/A N/A N/A
62	BWR/PWR	Metallic piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, or fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No	VIII.A.S-401 VIII.B1.S-401 VIII.B2.S-401 VIII.C.S-401 VIII.D1.S-401 VIII.D2.S-401 VIII.E.S-401 VIII.F.S-401 VIII.G.S-401	N/A N/A N/A N/A N/A N/A N/A N/A N/A

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Table 3.4-1 Summary of Aging Management Programs for Steam and Power Conversion System Evaluated in Chapter VIII of the GALL Report

ID	Type	Component	Aging Effect/Mechanism	Aging Management Programs	Further Evaluation Recommended	Rev2 Item	Rev1 Item
63	BWR/PWR	Steel, stainless steel, copper, aluminum, or copper > 15% Zn components exposed to insulation and operated below the dew point; insulated outdoor tanks, piping, and piping components	Loss of material due to general (steel, copper, copper >15% Zn,), pitting, and crevice corrosion, and cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No	VIII.A.S-402 VIII.B1.S-402 VIII.B2.S-402 VIII.C.S-402 VIII.D1.S-402 VIII.D2.S-402 VIII.E.S-402 VIII.F.S-402 VIII.G.S-402 VIII.H.S-402	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A

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MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

V ENGINEERED SAFETY FEATURES							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
V.A.EP-41	V.A-27(EP-41)	Piping, piping components, and piping elements~~; tanks~~	Stainless steel	Treated water (borated)	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry" and Chapter XI.M32, "One-Time Inspection"	No
V.D1.EP-41	V.D1-30(EP-41)	Piping, piping components, and piping elements~~; tanks~~	Stainless steel	Treated water (borated)	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry" and Chapter XI.M32, "One-Time Inspection"	No
V.A.E-400 V.B.E-400 V.C.E-400 V.D1.E-400 V.D2.E-400		Piping, piping components, and tanks	Metallic	Closed-cycle cooling water, raw water, treated water, waste water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant specific
V.A.E-401 V.B.E-401 V.C.E-401 V.D1.E-401 V.D2.E-401		Piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings	Metallic with Service Level III or Other internal coating	Closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, or fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No
V.D1.E-402 V.D2.E-402		Tanks	Steel, stainless steel, or aluminum	Soil or concrete	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (stainless steel and aluminum only)	Chapter XI.M29, "Aboveground Metallic Tanks"	No

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MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

V	ENGINEERED SAFETY FEATURES						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
V.A.E-403 V.B.E-403 V.C.E-403 V.D1.E-403 V.D2.E-403 V.E.E-403		Piping, piping components, and tanks	Steel, stainless steel, copper, aluminum or copper > 15% Zn	Insulated and operated below the dew point; outdoor insulated	Loss of material due to general (steel, copper, or copper > 15% Zn only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" and Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No
V.A.E-404 V.D1.E-404 V.D2.E-404		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks" only	Stainless steel and aluminum	Water	Loss of material due to pitting and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks,"	No

VII AUXILIARY SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
~~VII.G.A-23~~	~~VII.G-23(A-23)~~	~~Piping, piping components, and piping elements~~	~~Steel~~	~~Moist air or condensation (Internal)~~	~~Loss of material due to general, pitting, and crevice corrosion~~	~~Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"~~	~~No~~
VII.G.A-33	VII.G-24(A-33)	Piping, piping components, and piping elements	Steel	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.A-55	VII.G-19(A-55)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting and crevice corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.A-95 VII.H1.A-95	VII.H1-11(A-95)	Tanks	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No
~~VII.G.AP-143~~	~~VII.G-9(AP-78)~~	~~Piping, piping components, and piping elements~~	~~Copper alloy~~	~~Condensation (Internal)~~	~~Loss of material due to general, pitting, and crevice corrosion~~	~~Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"~~	~~No~~
VII.G.AP-149		Fire Hydrants	Steel	Air – outdoor	Loss of material due to general, pitting, and crevice corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No

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VII AUXILIARY SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.AP-180	VII.G-8(AP-83)	Piping, piping components, and piping elements	Aluminum	Raw water	Loss of material due to pitting and crevice corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.AP-197	VII.G-12(A-45)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.A2.A-400 VII.A3.A-400 VII.A4.A-400 VII.C1.A-400 VII.C2.A-400 VII.C3.A-400 VII.D.A-400 VII.E1.A-400 VII.E2.A-400 VII.E3.A-400 VII.E4.A-400 VII.E5.A-400 VII.F1.A-400 VII.F2.A-400 VII.F3.A-400 VII.F4.A-400 VII.G.A-400 VII.H1.A-400 VII.H2.A-400		Piping, piping components, and tanks	Metallic	Closed-cycle cooling water, raw water, treated water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific

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MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

VII AUXILIARY SYSTEMS

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.A2.A-401 VII.A3.A-401 VII.A4.A-401 VII.C1.A-401 VII.C2.A-401 VII.C3.A-401 VII.D.A-401 VII.E1.A-401 VII.E2.A-401 VII.E3.A-401 VII.E4.A-401 VII.E5.A-401 VII.F1.A-401 VII.F2.A-401 VII.F3.A-401 VII.F4.A-401 VII.G.A-401 VII.H1.A-401 VII.H2.A-401		Piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings	Metallic with Service Level III or Other internal coating	Closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No
VII.G.A-402 VII.H1.A-402		Tanks	Steel	Soil or concrete; Water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VII.G.A-403		Sprinklers	All	Water; air	Loss of material due to general, pitting, crevice, and microbiologically-induced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No

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VII AUXILIARY SYSTEMS

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.G.A-404		Fire water system piping, piping components and piping elements	Steel, stainless steel, copper alloy, or aluminum	Air-indoor uncontrolled (internal), air-outdoor (internal), or condensation (internal)	Loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically-induced corrosion; flow blockage due to fouling; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.A2.A-405 VII.A3.A-405 VII.A4.A-405 VII.C1.A-405 VII.C2.A-405 VII.C3.A-405 VII.D.A-405 VII.E1.A-405 VII.E2.A-405 VII.E3.A-405 VII.E4.A-405 VII.E5.A-405 VII.F1.A-405 VII.F2.A-405 VII.F3.A-405 VII.F4.A-405 VII.G.A-405 VII.H1.A-405 VII.H2.A-405 VII.I.A-405		Piping, piping components, and tanks	Steel, stainless steel, copper, or copper > 15% Zn	Insulated and operated below the dew point; outdoor insulated tanks, piping, and piping components	Loss of material due to general (steel, copper, or copper > 15% Zn only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" and Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No

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MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

VIII	STEAM AND POWER CONVERSION SYSTEMS						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.SP-75 VIII.G.SP-75	VIII.E-40(S-13) VIII.G-41(S-13)	Tanks	Steel; stainless steel	Water	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (stainless steel only) and fatigue	Chapter XI.M2, "Water Chemistry," and Chapter ~~XI.M32, "One-Time Inspection~~ XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-137		Tanks	Stainless steel	Soil or Concrete	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-138		Tanks	Stainless steel	Air – outdoor (External)	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-139		Tanks	Aluminum	Soil or Concrete	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-140		Tanks	Aluminum	Air – outdoor (External	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue	Chapter XI.M29, "Aboveground Metallic Tanks"	No

MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

VIII STEAM AND POWER CONVERSION SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.A.S-400 VIII.B1.S-400 VIII.B2.S-400 VIII.C.S-400 VIII.D1.S-400 VIII.D2.S-400 VIII.E.S-400 VIII.F.S-400 VIII.G.S-400		Piping, piping components, and tanks	Metallic	Closed-cycle cooling water, raw water, treated water	Loss of material or change in material properties due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
VIII.A.S-401 VIII.B1.S-401 VIII.B2.S-401 VIII.C.S-401 VIII.D1.S-401 VIII.D2.S-401 VIII.E.S-401 VIII.F.S-401 VIII.G.S-401		Piping, piping components, heat exchangers, tanks with Service Level III or Other internal coatings	Metallic with Service Level III or Other internal coating	Closed-cycle cooling water, raw water, treated water, treated borated water, waste water, lubricating oil, fuel oil	Loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage	Chapter XI.M42, "Service Level III and Other Coatings Monitoring and Maintenance Program"	No
VIII.A.S-402 VIII.B1.S-402 VIII.B2.S-402 VIII.C.S-402 VIII.D1.S-402 VIII.D2.S-402 VIII.E.S-402 VIII.F.S-402 VIII.G.S-402 VIII.H.S-402		Piping, piping components, and tanks	Steel, stainless steel, copper, or copper > 15% Zn, aluminum	Insulated and operated below the dew point; outdoor insulated tanks, piping, and piping components	Loss of material due to general (steel, copper, copper >15% Zn, only), pitting, and crevice corrosion; cracking due to stress corrosion cracking and fatigue (aluminum, stainless steel and copper >15% zinc only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No

MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR ITEMS AND DEFINITIONS

GALL Report Section	Term	Definition as used in this document
IX.C	Coating	Coatings include inorganic (e.g., zinc-based) or organic (e.g., elastomeric or polymeric) coatings, linings (e.g., rubber, cementitious), and concrete surfacers designed to adhere to a component to protect its surface. Service Level I, Service Level III and Other coatings are included. "Other" coatings include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3).
IX.E	Flow blockage	Flow blockage is an aging effect that can affect the pressure boundary function of a component (e.g., deliver sufficient flow at an adequate pressure) as defined in SRP-LR Table 2.1-4(b), "Typical 'Passive' Component-Intended Functions." Flow blockage can result in aging effects such as reduction of flow, lower system pressure, or reduction of heat transfer as a result of particulate fouling (e.g., debris from eroded coatings, corrosion products, particulate in the atmosphere), or macro fouling (e.g., delaminated sheet-type failure of coatings, biofouling).
IX.E	Hardening and loss of strength	Hardening (loss of flexibility) and loss of strength (loss of ability to withstand tensile or compressive stress) can result from elastomer degradation of seals and other elastomeric components. ~~Weathered~~ Degraded elastomers can experience increased hardness, shrinkage, loss of sealing, cracking, and loss of strength.

GALL Report Section	Term	Definition as used in this document
IX.E	Loss of Coating Integrity	Loss of coating integrity is the disbondment of a coating from its substrate. For Service Level I, Service Level III, and Other (see GALL Report Table IX.B, "Structures and Components") coatings, loss of coating integrity can be due to a variety of aging mechanisms such as blistering, cracking, flaking, peeling, or physical damage. Where the aging mechanism results in exposure of the base material, unanticipated or accelerated corrosion of the base material can occur. Where the aging mechanism results in the coating not remaining adhered to the substrate, the coating can become debris that could prevent an in-scope component from satisfactory accomplishing any of its functions identified under 10 CFR 54.4(a)(1), (a)(2), or (a)(3) (e.g., reduction in flow, drop in pressure, reduction in heat transfer).
IX.F	Fouling	Fouling is an accumulation of deposits on the surface of a component or structure. This term includes accumulation and growth of aquatic organisms on a submerged metal surface or the accumulation of deposits (usually inorganic) on heat exchanger tubing. Biofouling, a subset of fouling, can be caused by either macro-organisms (e.g., barnacles, Asian clams, zebra mussels, and others found in fresh and salt water) or micro-organisms (e.g., algae, microfouling turbercles~~, etc.~~). Fouling also can be categorized as particulate fouling ~~from~~ (e.g., sediment, silt, dust, eroded coatings, and corrosion products), or ~~marine~~ biofouling, or macrofouling (e.g., ~~peeled~~ delaminated coatings, debris~~, etc.~~). Fouling in a raw water system can occur on the piping, valves, and heat exchangers. Fouling can result in a reduction of heat transfer, flow or pressure, or loss of material.
IX.F	Elastomer degradation	Elastomer materials are substances whose elastic properties are similar to those of natural rubber. The term elastomer is sometimes used to technically distinguish synthetic rubbers and rubber-like plastics from natural rubber. Degradation may include mechanisms such as cracking, crazing, fatigue breakdown, abrasion, chemical attacks, change in material properties, and weathering. [Ref. 24, 25]

GALL Report Section	Term	Definition as used in this document
IX.F	Recurring internal degradation	Recurring internal aging effects are identified by both the number of occurrences of internal aging effects with similar aging mechanisms and the extent of degradation at each localized site. In regard to the number of occurrences, aging effects are considered recurring if the search of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle) of aging effects with similar aging mechanisms. In regard to the extent of degradation, aging effects are considered recurring if the aging effect resulted in the component not meeting either plant-specific acceptance criteria or wall penetration greater than 50 percent (regardless of the minimum wall thickness), or change in material properties such that it would be expected that there is a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more (e.g., selective leaching).

APPENDIX D

MARK-UP SHOWING CHANGES TO AMP XI.M27, "FIRE WATER SYSTEM"

XI.M27 FIRE WATER SYSTEM

Program Description

This ~~aging management program (~~AMP~~)~~ applies to water-based fire protection system~~s that consist of~~ components, including sprinklers, nozzles, fittings, valves, fire pump casings, hydrants, hose stations, standpipes, water storage tanks, and aboveground, buried, and underground piping and components that are tested in accordance with the applicable National Fire Protection Association (NFPA) codes and standards. ~~Such testing assures the minimum functionality of the systems.~~ Full flow testing and visual inspections are conducted to ensure that loss of material due to general, pitting, and crevice corrosion, microbiologically influenced corrosion (MIC), or fouling, and flow blockage due to fouling is adequately managed. In addition to NFPA codes and standards, portions of the water-based fire protection system that are periodically subjected to flow but normally dry, such as dry-pipe or preaction sprinkler system piping and valves, are subjected to augmented testing or inspections. Also, ~~these~~ portions of the system~~s~~ (e.g., fire service main, standpipe) are normally maintained at required operating pressure and monitored such that loss of system pressure is immediately detected and corrective actions are initiated.

Sprinklers are replaced before reaching 50 years inservice or a~~A~~ representative sample of sprinklers ~~heads~~ from one or more sample areas is tested by using the guidance of NFPA 25 (2011 Edition), "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems" to ensure that signs of degradation, such as corrosion, are detected in a timely manner. ~~(1998 Edition), Section 2-3.1.1, or NFPA 25 (2002 Edition), Section 5.3.1.1.1. These NFPA sections state "where sprinklers have been in place for 50 years, they shall be replaced or representative samples from one or more sample areas shall be submitted to a recognized testing laboratory for field service testing." It also contains guidance to perform this sampling every 10 years after the initial field service testing.~~

~~The water-based fire protection system piping is subjected to required flow testing in accordance with guidance in NFPA 25 to verify design pressure or evaluated for wall thickness (e.g., non-intrusive volumetric testing or plant maintenance visual inspections) to ensure that aging effects are managed and that wall thickness is within acceptable limits. These inspections are performed before the end of the current operating term and at plant-specific intervals thereafter during the period of extended operation. The plant-specific inspection intervals are determined by engineering evaluation of the fire protection piping to ensure that degradation is detected before the loss of intended function. The purpose of the full flow testing and wall thickness evaluations is to ensure that corrosion, microbiologically influenced corrosion (MIC), or biofouling is managed such that the system function is maintained.~~

~~Chapter~~ AMP XI.M41, "Buried and Underground Piping and Tanks," is used to monitor ~~describes the aging management program AMP for~~ the external surfaces of buried and underground water-based fire protection system piping and tanks.

Evaluation and Technical Basis

1. ***Scope of Program:*** ~~The AMP focuses on managing loss of material due to corrosion, MIC, or biofouling of steel c~~Components within the scope of water-based fire protection systems ~~exposed to water.~~, include items such as sprinklers, nozzles, fittings, valves, fire pump

casings, hydrants, hose stations, fire water storage tanks, fire service mains, and standpipes. The internal surfaces of water-based fire protection system piping that is normally drained, such as dry-pipe sprinkler system piping, are included within the scope of the AMP. Fire hose stations and standpipes are considered ~~as~~ piping in the AMP. Fire hoses and gaskets can be excluded from the scope of license renewal if the standards that are relied upon to prescribe replacement of the hose and gaskets are identified in the scoping methodology description.

2. ***Preventive Actions:*** ~~To ensure that no significant corrosion, MIC, or biofouling has occurred in water-based fire protection systems, periodic flushing and system performance testing are conducted in accordance with NFPA 25~~ The Fire Water System program is a condition monitoring program. It does not include methods to mitigate or prevent age-related degradation.

3. ***Parameters Monitored/Inspected:*** Loss of material ~~due to corrosion and biofouling~~ could reduce wall thickness of the fire protection piping system components and result in system failure. Flow blockage could occur due to fouling from the buildup of corrosion products, sediment, or other unwanted materials in the system. Therefore, the parameters monitored are the system's ability to maintain required pressure, flow rates, and internal system corrosion conditions. Periodic flow testing, flushes, and internal and external visual inspections are ~~of the fire water system is performed using the guidelines of NFPA 25, or wall thickness evaluations may be~~ performed to ensure that the system maintains its intended function. Testing of sprinklers ensures that degradation is detected in a timely manner. When using visual inspections to detect loss of material, an inspection technique that is capable of detecting surface irregularities due to corrosion and corrosion product deposition is used. Where such irregularities are detected, follow-up volumetric wall thickness examinations are performed. Volumetric wall thickness inspections are conducted on portions of water-based fire protection system components that are periodically subjected to flow but normally dry.

4. ***Detection of Aging Effects:*** All water-based fire protection system components, except for the fire water storage tanks, are subject to flow testing and visual inspections. Flow testing and visual inspections are performed in accordance with NFPA 25 (2011 Edition). Flow tests ensure that the system functions by maintaining required pressures and flow rates. ~~The water-based fire protection system testing is performed to ensure that the system functions by maintaining required operating pressures. Wall thickness evaluations of fire protection piping are performed on system components using non-intrusive techniques (e.g., volumetric testing) to identify evidence of loss of material due to corrosion. These inspections are performed before the end of the current operating term and at plant-specific intervals thereafter during the period of extended operation. As an alternative to non-intrusive testing, the plant maintenance process may include a visual inspection of the internal surface of the fire protection piping upon each entry to the system for routine or corrective maintenance, as long as it can be demonstrated that inspections are performed (based on past maintenance history) on a representative number of locations on a reasonable basis.~~ These visual inspections are capable of evaluating the ~~wall thickness to ensure against catastrophic failure~~ (a) condition of external surfaces of components, (b) conditions on the internal surfaces of components that could be indicative of wall loss, and (~~b~~c) ~~the~~ inner diameter of the piping as it applies to the design flow of the fire protection system (i.e., ensuring that corrosion product buildup will not result in flow blockage due to fouling). Internal visual inspections used to detect loss of material capable of detecting

surface irregularities due to corrosion and corrosion product deposition are used. Where such irregularities are detected, follow-up volumetric examinations are performed.

Portions of water-based fire protection system components that are periodically subjected to flow but normally dry, such as dry-pipe or preaction sprinkler system piping and valves are subjected to augmented testing beyond that of NFPA 25 (2011 Edition). Portions of the normally dry piping that are not configured to drain are subjected to the following:

- Visual inspections are performed on 100 percent of the length of piping that is not subjected to flow testing or flushing.
- In each 5-year interval, 20 percent of piping is subject to volumetric wall thickness inspections. Data points are obtained to the extent that each linear foot of piping is tested at 12 locations dispersed along the length and circumference of the pipe.
- The 20 percent of piping that is inspected in each five-year interval is in different locations than past inspections.

For portions of the normally dry piping that are configured to drain (e.g., pipe slopes towards a drain point), the tests and inspections of NFPA 25 (2011 Edition) do not need to be augmented.

The inspections and tests of all water-based fire protection components occur at the intervals specified in NFPA 25 (2011 Edition), beginning five years before the period of extended operation.

Fire water storage tanks are inspected and tested to guidance in NFPA 25 (2011 Edition).

If the environmental (e.g., type of water, flowrate, temperature) and material ~~conditions~~ that exist on the interior surface of the ~~below grade~~ underground and buried fire protection piping are similar to the conditions that exist within the above grade fire protection piping, the results of the inspections of the above grade fire protection piping can be extrapolated to evaluate the condition of ~~below~~ buried and underground~~grade~~ fire protection piping for the purpose of identifying loss of material. If not, additional inspection activities are needed to ensure that the intended function of below grade fire protection piping is maintained consistent with the current licensing basis for the period of extended operation.

The water-based fire protection systems are normally maintained at required operating pressure and monitored such that loss of system pressure is immediately detected and corrected when acceptance criteria are exceeded. Continuous system pressure monitoring~~,~~ or equivalent methods (e.g., number of jockey fire pump starts or run time) are conducted. ~~system flow testing, and wall thickness evaluations of piping are effective means to ensure that corrosion and biofouling are not occurring and that the system's intended function is maintained.~~

~~General requirements of existing fire protection programs include testing and maintenance of fire detection and protection systems and surveillance procedures to ensure that fire detectors as well as fire protection systems and components are operable.~~

Visual inspection of yard fire hydrants, performed annually in accordance with NFPA 25 (2011 Edition), ensures timely detection of signs of degradation, such as corrosion. Fire hydrant hose hydrostatic tests, gasket inspections, and fire hydrant flow tests, performed annually, ensure that fire hydrants can perform their intended function and provide opportunities to detect degradation before a loss of intended function can occur.

Sprinklers are replaced before reaching 50 years inservice or a representative sample of ~~S~~sprinklers ~~heads~~ are tested before the end of the 50-year sprinkler ~~head~~ service life in accordance with NFPA 25 (2011 Edition) and at 10-year intervals thereafter during the period of extended operation to ensure that signs of degradation, such as corrosion, are detected in a timely manner.

5. ***Monitoring and Trending:*** System discharge pressure or equivalent methods (e.g., number of jockey fire pump starts or run time) are monitored continuously. Results of ~~system performance~~ flow testing (e.g., buried and underground piping, fire mains, sprinkler) are monitored and trended ~~as specified by the associated plant commitments pertaining to NFPA codes and standards~~. Degradation identified by ~~non-intrusive~~ flow testing or visual inspection is evaluated.

6. ***Acceptance Criteria:*** The acceptance criteria are (a) the water-based fire protection system is able to maintain required pressure and flow rates, (b) ~~no unacceptable signs~~ indications of degradation or fouling ~~are observed during non-intrusive or visual inspection of components~~ are evaluated by engineering, (c) minimum design wall thickness is maintained, and (d) no ~~bio~~fouling exists in the sprinkler systems that could cause flow blockage or corrosion in the sprinklers.

7. ***Corrective Actions:*** Repair and replacement actions are initiated as necessary. For fire water systems and components identified within scope that are subject to an aging management review (AMR) for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for corrective actions for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** For fire water systems and components identified within scope that are subject to an AMR for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for confirmation process for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls:*** For the water-based fire water systems and components identified within scope that are subject to an AMR for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for administrative controls for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** ~~Water-based fire protection systems designed, inspected, tested, and maintained in accordance with the NFPA minimum standards have demonstrated reliable performance.~~ Operating experience shows that water-based fire protection systems are subject to loss of material due to corrosion, MIC, or fouling and flow blockages due to

fouling. Loss of material has resulted in sprinkler system flow blockages, failed flow tests, and piping leaks. Inspections and testing performed in accordance with NFPA standards coupled with visual inspections are capable of detecting degradation prior to loss of intended function. The following industry operating experience may be of significance to an applicant's program:

a. In October 2004, a fire main failed its periodic flow test due to a low cleanliness factor. The low cleanliness factor was attributed to fouling because of an accumulation of corrosion products on the interior of the pipe wall and tuberculation. Subsequent chemical cleaning to remove the corrosion products from the pipe wall revealed several leaks. Corrosion products removed during the chemical cleaning were observed to settle out in normally stagnant sections of the water-based fire protection system, resulting in flow blockages in small diameter piping and valve leakby.

b. In October 2010, a portion of a preaction spray system failed its functional flow test because of flow blockages. Two branch lines were found to have significant blockages. The blockage in one branch line was determined to be a buildup of corrosion products. A rag was found in the other branch line.

c. In August 2011, an intake fire protection preaction sprinkler system was unable to pass flow during functional testing. Subsequent visual inspections identified flow blockages in the inspector's test valve, the piping leading to the inspector's test valves, and three vertical risers. The flow blockages were determined to be a buildup of corrosion products.

The review of plant-specific OE during the development of this program is to be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE conducted in conjunction with developing the license renewal application, recurring aging effects can be identified by compiling examples of operating experience related to components managed by the program with similar aging effects and aging mechanisms and determining the trend of its occurrence. Further evaluation AMR items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR items do not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. In addition, the staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects (e.g., minor corrosion that if left uncorrected would not affect the ability of the component to perform its intended function throughout the period of extended operation). The only plant-specific operating experience examples that need to be addressed as recurring aging effects in this regard are those in which the component's degree of degradation is significant as defined in the further evaluation AMR items.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NFPA 25, Standard for the *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, ~~1998~~ 2011 Edition, National Fire Protection Association.

~~NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, 2002 Edition, National Fire Protection Association.~~

U.S. Nuclear Regulatory Commission, NRC Information Notice 2013-06, Corrosion in Fire Protection Piping Due to Air and Water Interaction, March 25, 2013.

APPENDIX E

MARK-UP SHOWING CHANGES TO AMP XI.M29, "ABOVEGROUND METALLIC TANKS"

XI.M29 ABOVEGROUND METALLIC TANKS

Program Description

The Aboveground Metallic Tanks ~~aging management program (~~AMP~~)~~ manages the effects of loss of material and cracking on the ~~outer~~ outside and inside surfaces of aboveground tanks constructed on concrete or soil. All outdoor tanks, except fire water storage tanks, and some indoor tanks are included. If the tank exterior is fully visible and coated, tank outside surfaces may be inspected under the program for inspection of external surfaces ~~may be used instead~~ (AMP XI.M36). This program credits the standard industry practice of coating or painting the external surfaces of steel tanks as a preventive measure to mitigate corrosion. The program relies on periodic inspections to monitor degradation of the protective paint or coating. Tank inside surfaces are inspected by visual or surface examinations as required to detect the applicable aging effect.

~~However,~~ For storage tanks supported on earthen or concrete foundations, corrosion may occur at inaccessible locations, such as the tank bottom. Accordingly, verification of the effectiveness of the program is performed to ensure that significant degradation in inaccessible locations is not occurring and that the component's intended function is maintained during the period of extended operation. For reasons set forth below, an acceptable verification program consists of thickness measurements of the tank bottom surface.

Evaluation and Technical Basis

1. ***Scope of Program:*** ~~The program consists of periodic inspections of metallic tanks (with or without coatings) to manage the effects of corrosion on the intended function of these tanks. Inspections cover the entire outer surface of the tank.~~ Tanks within the scope of this program include all outdoor tanks constructed on soil or concrete. Indoor large volume (i.e., greater than 100,000 gallons) storage tanks designed to internal pressures approximating atmospheric pressure and exposed internally to water are also included. ~~Because lower portions of the tank are on concrete or soil, this program includes the bottom of the tank as well.~~ If the tank exterior is fully visible, tank outside surfaces may be inspected under the program for inspection of external surfaces ~~may be used instead~~ (AMP XI.M36). Fire water storage tanks are age-managed by AMP XI.M27.

2. ***Preventive Actions:*** In accordance with industry practice, tanks may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the tank from environmental exposure. Except in cases where the configuration of the tank bottom and foundation would dictate otherwise (e.g., the foundation is sloped such that water cannot accumulate under the tank bottom), sealant or caulking ~~may~~ is~~be~~ applied at the external interface between the tank and concrete or earthen foundation to mitigate corrosion of the bottom surface of the tank by minimizing the amount of water and moisture penetrating the interface, which ~~w~~could lead to corrosion of the bottom surface.

3. ***Parameters Monitored/Inspected:*** The program consists of periodic inspections of metallic tanks (with or without coatings) to manage the effects of corrosion and cracking on the intended function of these tanks. Inspections cover all surfaces of the tank (i.e., outside uninsulated surfaces, outside insulated surfaces, bottom, and interior surfaces). The AMP ~~utilizes~~ uses periodic plant inspections to monitor degradation of coatings, sealants, and caulking because it is a condition directly related to the potential loss of material~~s~~. ~~Additionally,~~ Thickness measurements of the bottoms of the tanks are made periodically for

the tanks monitored by this program as an additional ~~measure~~ way to ensure that loss of material is not occurring at locations ~~that are~~ inaccessible for inspection. Periodic internal visual inspections and surface examinations, as required to detect applicable aging effects, are performed to detect degradation that could be occurring on the inside of the tank. Where the exterior surface is insulated for outdoor tanks and indoor tanks operated below the dew point, a representative sample of the insulation is removed during periodic inspections to detect if loss of material or cracking is occurring underneath the insulation.

4. ***Detection of Aging Effects:*** Degradation of an exterior metallic surface can occur in the presence of moisture; therefore, an inspection of the coating is performed to ensure that the surface is protected from moisture. Conducting periodic visual inspections at each outage to confirm that the paint, coating, sealant, and caulking are intact is an effective method to manage the effects of corrosion on the external surface of the component. When the exterior surface is not coated, visual inspections of the entire surface are conducted within sufficient proximity (e.g., distance, angle of observation, lighting) to detect loss of material. When the tank is insulated, the inspection includes inspecting for locations where potential leakage past the insulation could be accumulating.

   When necessary to detect cracking (e.g., stainless steel, aluminum), the program includes surface examinations. When surface examinations are required to detect an aging effect, the program states how many surface examinations will be conducted, the area covered by each examination, and how examination sites will be selected. At a minimum, during each 10-year period starting 5 years before the period of extended operation, a minimum of either 25 1-square-foot sections or 20 percent of the tank's surface are examined. The sample inspection points are distributed such that inspections occur in those areas most susceptible to cracking (e.g., areas where contaminants could collect, inlet and outlet nozzles, welds). When conducting surface examinations of welds, the 1-square-foot section is oriented along the length of the weld.

   When the exterior tank surface of an outdoor tank or indoor tank operated below the dew point is insulated, sufficient insulation is removed to determine the condition of the exterior surface of the tank. At a minimum, during each 10-year period starting 5 years before the period of extended operation, a minimum of either 25 1-square-foot sections or 20 percent of the surface area of insulation is removed to permit inspection of the exterior surface of the tank. The sample inspection points are distributed such that inspections occur on the tank dome (if it is flat), near the bottom, at points where structural supports, pipe, or instrument nozzles penetrate the insulation and where water collects such as on top of stiffening rings.

   Potential corrosion of tank bottoms is determined by taking ultrasonic testing (UT) thickness measurements of the tank bottoms whenever the tank is drained; however, examinations are conducted at least once every 10 years ~~and at least once~~ and begin within the 5-year period ~~of~~ before entering the period of extended operation. Measurements are taken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation.

   Internal visual inspections are conducted to detect loss of material and cracking. Visual inspections cover all of the tank's internal surfaces. When necessary to detect cracking, the program includes surface examinations. The program states how many surface examinations will be conducted, the area covered by each examination, and how examination sites will be selected. At a minimum, during each 10-year period starting 5 years before the period of extended operation, a minimum of either 25 1-square-foot sections or 20 percent of the tank's inside surface is inspected.

When inspections are conducted on a sampling basis, subsequent inspections are conducted in different locations unless the program states the basis for why repeat inspections will be conducted in the same location.

5. ***Monitoring and Trending:*** The effects of corrosion of the ~~aboveground external~~ tank surfaces are detectable by visual and surface examination (for cracking) techniques. Based on operating experience, ~~plant~~periodic inspections ~~during each outage~~ provide for timely detection of aging effects. The effects of corrosion ~~of~~on the inaccessible external surface are detectable by UT thickness measurements of the tank bottom and are monitored and trended if significant material loss is detected ~~where multiple~~ and successive measurements are available.

6. ***Acceptance Criteria:*** Any degradation of paints or coatings (cracking, flaking, or peeling), or evidence of corrosion is reported and requires further evaluation. Drying, cracking, or missing sealant and caulking are unacceptable and need to be evaluated using the corrective action program. The evaluation will determine the need to repair the sealant and caulking. Indications of cracking are analyzed in accordance with the applicable design requirements for the tank. UT thickness measurements of the tank bottom are evaluated against the design thickness and corrosion allowance.

7. ***Corrective Actions:*** The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls. Flaws in the caulking or sealant are repaired.

8. ***Confirmation Process:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** Coating degradation, such as flaking and peeling, has occurred in safety-related systems and structures (U.S. Nuclear Regulatory Commission [NRC] Generic Letter 98-04). Corrosion damage near the concrete-metal interface and sand-metal interface has been reported in metal containments (NRC Information Notice IN 89-79; IN 89-79, Supplement 1; IN 86-99; and IN 86-99, Supplement 1). A review of industry operating experience reveals that there have been instances involving defects variously described as wall thinning, pinhole leaks, cracks, and through-wall flaws. In addition, internal blistering, delamination of coatings, rust stains, and holidays have been found on the bottom of tanks.

    The review of plant-specific OE during the development of this program is to be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE conducted in conjunction with developing the license renewal application, recurring aging effects can be identified by compiling examples of operating experience related to components managed by the program with similar aging effects and aging mechanisms and determining the trend of its occurrence. Further evaluation AMR items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR items do not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. In addition, the staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects (e.g., minor corrosion that if left uncorrected would not affect the ability of the component to perform its intended function throughout the period of extended operation). The only plant-specific operating experience examples that need to be addressed as recurring aging effects in this regard are those in which the component's degree of degradation is significant as defined in the further evaluation AMR items.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 98-04, *Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment*, U.S. Nuclear Regulatory Commission, July 14, 1998.

NRC Information Notice 86-99, *Degradation of Steel Containments*, U.S. Nuclear Regulatory Commission, December 8, 1986.

NRC Information Notice 86-99, Supplement 1, *Degradation of Steel Containments*, U.S. Nuclear Regulatory Commission, February 14, 1991.

NRC Information Notice 89-79, *Degraded Coatings and Corrosion of Steel Containment Vessel*, U.S. Nuclear Regulatory Commission, December 1, 1989.

NRC Information Notice 89-79, Supplement 1, *Degraded Coatings and Corrosion of Steel Containment Vessel*, U.S. Nuclear Regulatory Commission, June 29, 1990.

APPENDIX F

MARK-UP SHOWING CHANGES TO AMP XI.M36, "EXTERNAL SURFACES MONITORING OF MECHANICAL COMPONENTS"

XI.M36 EXTERNAL SURFACES MONITORING OF MECHANICAL COMPONENTS

Italicized text was revised as a result of LR-ISG-2011-03.

Program Description

The External Surfaces Monitoring of Mechanical Components program is based on system inspections and walkdowns. This program consists of periodic visual inspections of metallic and polymeric components, such as piping, piping components, ducting, polymeric components, and other components within the scope of license renewal and subject to aging management review (AMR) ~~in order~~ to manage aging effects. The program manages aging effects through visual inspection of external surfaces for evidence of loss of material, cracking, and changes in material properties. When appropriate for the component and material, manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength. Outdoor insulated components, and indoor components operated below the dew point, have portions of the insulation removed to inspect the exterior surface of the component. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (AMP XI.M10).

Evaluation and Technical Basis

1. ***Scope of Program:*** This program visually inspects the external surface of in-scope mechanical components and monitors external surfaces of metallic components in systems within the scope of license renewal and subject to AMR for loss of material and leakage. Cracking of stainless steel components exposed to an air environment containing halides may also be managed. This program also visually inspects and monitors the external surfaces of polymeric components in mechanical systems within the scope of license renewal and subject to AMR for changes in material properties (such as hardening and loss of strength), cracking, and loss of material due to wear. This program manages the effects of aging of polymer materials in all environments to which these materials are exposed.

   The program ~~may~~ also may be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for ~~situations~~cases in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program ~~should~~ describes the component's internal environment and the credited similar external component environment inspected.

   Underground piping and tanks which are below grade but are contained within a tunnel or vault, such that they are in contact with air and are located where access for inspection is restricted, are managed by AMP XI.M41, Buried and Underground Piping and Tanks. Below-grade components that are accessible during normal operations or refueling outages for which access is not restricted are managed by this program, AMP XI.M36.

2. ***Preventive Actions:*** ~~The External Surfaces Monitoring of Mechanical Components program is a condition monitoring program that does not include preventive actions.~~

APPENDIX F

MARK-UP SHOWING CHANGES TO AMP XI.M36, "EXTERNAL SURFACES MONITORING OF MECHANICAL COMPONENTS"

Components may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the component from environmental exposure.

3. ***Parameters Monitored/Inspected:*** ~~The External Surfaces Monitoring of Mechanical Components~~ This program ~~utilizes~~uses periodic plant system inspections and walkdowns to monitor for material degradation and leakage. This program inspects components such as piping, piping components, ducting, polymeric components, and other components. For metallic components, coatings deterioration is an indicator of possible underlying degradation. The aging effects for flexible polymeric components may be monitored through a combination of visual inspection and manual or physical manipulation of the material. "Manual or physical manipulation of the material" means touching, pressing on, flexing, bending, or otherwise manually interacting with the material. The purpose of the manual manipulation is to reveal changes in material properties, such as hardness, and to make the visual examination process more effective in identifying aging effects such as cracking.

   Examples of inspection parameters for metallic components include:

   - corrosion and material wastage (loss of material)
   - leakage from or onto external surfaces (loss of material)
   - worn, flaking, or oxide-coated surfaces (loss of material)
   - corrosion stains on thermal insulation (loss of material)
   - protective coating degradation (cracking, flaking, and blistering)
   - leakage for detection of cracks on the external surfaces of stainless steel components exposed to an air environment containing halides

   Examples of inspection parameters for polymers include:

   - surface cracking, crazing, scuffing, and dimensional change (e.g., "ballooning" and "necking")
   - discoloration
   - exposure of internal reinforcement for reinforced elastomers
   - hardening as evidenced by a loss of suppleness during manipulation where the component and material are appropriate to manipulation

4. ***Detection of Aging Effects:*** This program manages aging effects of loss of material, cracking, and changes in material properties using visual inspection. For coated surfaces, confirmation of the integrity of the paint or coating is an effective method for managing the effects of corrosion on the metallic surface.

   When required by the ASME Code, inspections are conducted in accordance with the applicable code requirements. In the absence of ~~applicable code~~ such requirements; plant-specific visual inspections are performed of metallic and polymeric component surfaces using plant-specific procedures implemented by inspectors qualified through plant-specific programs. The inspections are capable of detecting age-related degradation and are performed at a frequency not to exceed one refueling cycle. This frequency accommodates inspections of components that may be in locations ~~that are~~ normally only accessible during outages (e.g., high dose areas) ~~*or access is physically restricted (underground)*~~. Surfaces that are not readily visible during plant operations and refueling outages are inspected when they are made accessible and at such intervals that would ensure the components' intended functions are maintained. ~~*The inspections of underground components shall be conducted during each 10 year period beginning 10 years prior to entering the period of extended operation. These normally underground components should be clearly identified in the program scope and inspection intervals provided.*~~

Component surfaces that are insulated and operated below the dew point, and insulated outdoor components, (except tanks, reference AMP XI.M29) ~~may be inspected when the external surface is exposed (i.e., during maintenance) at such intervals that would ensure that the components' intended functions are maintained. The intervals of inspections may be adjusted, as necessary, based on plant-specific inspection results and industry operating experience.~~ are periodically inspected every 10 years beginning 5 years before the period of extended operation. For all outdoor components, except tanks, and any indoor components operated below the dew point inspections are conducted of each material type (.e., steel, stainless steel, copper alloy, aluminum) and environment (e.g., air-outdoor, moist air, air accompanied by leakage) where condensation or moisture on the surfaces of the component could occur routinely or seasonally. In some instances, although indoor air is conditioned, significant moisture can accumulate under insulation during high humidity seasons. A minimum of 20 percent of the in-scope piping length, or for components in which its configuration does not conform to a 1-foot axial length determination (e.g., valve, accumulator), 20 percent of the surface area is inspected after the insulation is removed. Alternatively any combination of a minimum of 25 1-foot axial length sections and components for each material type is inspected.

Visual inspection will identify indirect indicators of flexible polymer hardening and loss of strength, ~~and~~ includeing the presence of surface cracking, crazing, discoloration, and, for elastomers with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Visual inspection ~~should be~~ cover 100 percent of accessible components surfaces. Visual inspection will identify direct indicators of loss of material due to wear to include dimensional change, scuffing, and, for flexible polymeric materials with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Manual or physical manipulation can be used to augment visual inspection to confirm the absence of hardening and loss of strength for flexible polymeric materials (e.g., HVAC flexible connectors) where appropriate. The sample size for manipulation ~~should be~~ is at least 10 percent of available surface area. Hardening and loss of strength and loss of material due to wear for flexible polymeric materials are expected to be detectable ~~prior to~~before any loss of intended function.

Visual inspection and manual or physical manipulation activities are performed and associated personnel are qualified in accordance with site controlled procedures and processes.

~~This program is credited with managing the following aging effects.~~

- ~~loss of material and cracking for external surfaces~~

- ~~loss of material for internal surfaces exposed to the same environment as the external surface~~
- ~~cracking and change in material properties (hardening and loss of strength) of flexible polymers~~

5. ***Monitoring and Trending:*** ~~Visual inspection and manual or physical manipulation activities are performed and associated personnel are qualified in accordance with site controlled procedures and processes. The External Surfaces Monitoring of Mechanical Components~~ This program uses standardized monitoring and trending activities to track degradation. Deficiencies are documented using approved processes and procedures, such that results can be trended. However, the program does not include formal trending. Inspections are performed at frequencies identified in Element 4, Detection of Aging Effects.

6. ***Acceptance Criteria:*** For each component~~/~~ and aging effect combination, the acceptance criteria are defined to ensure that the need for corrective actions will be identified before loss of intended functions. For metallic surfaces, any indications of relevant degradation ~~detected~~ are evaluated. For stainless steel surfaces, a clean, shiny surface is expected. The appearance of discoloration may indicate the loss of material on the stainless steel surface. For aluminum and copper alloys exposed to marine or industrial environments, any indications of relevant degradation that could ~~impact~~affect ~~their~~the component's intended function are evaluated. For flexible polymers, a uniform surface texture and uniform color with no ~~unanticipated~~ dimension~~al~~ change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. For flexible materials, changes in physical properties (e.g., the hardness, flexibility, physical dimensions, and color of the material are unchanged from when the material was new) ~~should be~~ are evaluated for continued service in the corrective action program. Cracks are absent within the material. For rigid polymers, surface changes affecting performance, such as erosion, cracking, crazing, ~~checking,~~ and chalking, are subject to further investigation. Acceptance criteria include design standards, procedural requirements, current licensing basis, industry codes or standards, and engineering evaluation.

7. ***Corrective Actions:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.

8. ***Confirmation Process***: As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls***: As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** External surface inspections through system inspections and walkdowns have been in effect at many utilities since the mid 1990s in support of the Maintenance Rule (10 CFR 50.65) and have proven effective in maintaining the material

condition of plant systems. The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice.

The review of plant-specific OE during the development of this program is to be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE conducted in conjunction with developing the license renewal application, recurring aging effects can be identified by compiling examples of operating experience related to components managed by the program with similar aging effects and aging mechanisms and determining the trend of its occurrence. Further evaluation AMR items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR items do not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. In addition, the staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects (e.g., minor corrosion that if left uncorrected would not affect the ability of the component to perform its intended function throughout the period of extended operation). The only plant-specific operating experience examples that need to be addressed as recurring aging effects in this regard are those in which the component's degree of degradation is significant as defined in the further evaluation AMR items.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI Technical Report 1007933, *Aging Assessment Field Guide*, December 2003.

EPRI Technical Report 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004.

INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

APPENDIX G

MARK-UP SHOWING CHANGES TO AMP XI.M38, "INSPECTION OF INTERNAL SURFACES IN MISCELLANEOUS PIPING AND DUCTING COMPONENTS"

Program Description

The program consists of inspections of the internal surfaces of metallic piping, piping components, and piping elements, ducting, heat exchanger components, polymeric and elastomeric components, and other components ~~that are~~ exposed to ~~indoor~~ uncontrolled indoor air ~~indoor uncontrolled~~, outdoor air ~~outdoor~~, air with borated water leakage, condensation, moist air, diesel exhaust, and any water system other than open-cycle cooling water system (AMP XI.M20), closed treated water system, except elastomers in these systems can be managed by this program (AMP-XI.M21A), and fire water system (AMP XI.M27). These internal inspections are performed during the periodic system and component surveillances or during the performance of maintenance activities when the surfaces are made accessible for visual inspection. The program includes visual inspections to ensure that existing environmental conditions are not causing material degradation that could result in a loss of a component's intended functions. For certain materials, such as polymers, physical manipulation or pressurization ~~(e.g., hydrotesting)~~ to detect hardening or loss of strength ~~should be~~ is used to augment the visual examinations conducted under this program. If visual inspection of internal surfaces is not possible, then the applicant needs to provide a plant-specific program.

This program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in ~~loss of function~~exceeding the threshold criteria contained in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion." If operating experience indicates that there have been repetitive failures caused by loss of material, a plant-specific program will be ~~required~~ necessary. Following a failure, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest.

Evaluation and Technical Basis

1. ***Scope of Program:*** For metallic components, the program calls for the visual inspection of the internal surface of in-scope components that are not included in other aging management programs for loss of material. For metallic components with polymeric coatings ~~liners~~ or for polymeric and elastomeric components, the program includes visual inspections of the internal polymer surfaces when coupled with additional augmented techniques, such as manipulation or pressurization (i.e., sufficiently pressurized to expand the surface of the material such that cracks or crazing would be evident). This program also includes metallic piping with or without polymeric coatings ~~linings~~, piping elements, ducting, and components in an internal environment. The program also calls for visual inspection and monitors the internal surfaces of polymeric and elastomeric components in mechanical systems for hardening and loss of strength, cracking, and for loss of material due to wear. The program manages the effects of aging of polymer materials in all environments to which these materials are exposed. Inspections are performed when the internal surfaces are accessible during the performance of periodic surveillances or during maintenance activities or scheduled outages. This program is not intended for piping and ducts where failures have occurred from loss of material from corrosion.

   External inspections of components may be credited for managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for the internal and external surfaces such that the external surface condition is representative of the internal surface condition. When credited, the program describes the component's internal environment and the credited external component's environment inspected and justify why the external and internal surface condition and environment are similar.

2. ***Preventive Actions:*** This program is a condition monitoring program to detect signs of degradation and does not provide guidance for prevention.

3. ***Parameters Monitored/Inspected:*** Parameters monitored or inspected include visible evidence of loss of material in metallic components.

   This program manages loss of material and ~~possible~~ changes in material properties. This program monitors for evidence of surface discontinuities. For changes in material properties, the visual examinations are supplemented, so changes in the properties are readily ~~observable~~detectable.

   Examples of inspection parameters for metallic components include the following:

   - corrosion and material parameters wastage (loss of material)
   - leakage from or onto internal surfaces (loss of material)
   - worn, flaking, or oxide-coated surfaces (loss of material)

   Examples of inspection parameters for polymers are as follows:

   - surface cracking, crazing, scuffing, loss of sealing, and dimensional change (e.g., "ballooning" and "necking")
   - discoloration
   - exposure of internal reinforcement for reinforced elastomers
   - hardening as evidenced by a loss of suppleness during manipulation where the component and material are appropriate to manipulation

4. ***Detection of Aging Effects:*** Visual and mechanical (e.g., manipulation of elastomers) inspections conducted under this program are opportunistic in nature; they are conducted whenever piping or ducting are opened for any reason. At a minimum, in each 10-year period during the period of extended operation, a representative sample of 20 percent of the population (defined as components having the same material, environment, and aging effect combination) or a maximum of 25 components per population is inspected. Where practical, the inspection includes a representative sample of the system population and focuses on the bounding or lead components most susceptible to aging because of time in service and severity of operating conditions. This minimum sample size does not override the opportunistic inspection basis of this AMP. It would be expected that opportunistic inspections would still be conducted even though in a given 10-year period, 20 percent or 25 components might have already been inspected. An inspection conducted of a component in a more severe environment may be credited as an inspection for the specified environment and for the same material and aging effects in a less severe environment (e.g., a moist air environment is more severe than an indoor controlled-air environment because the moisture in the former environment is more likely to result in loss of material than the normally dry surfaces associated with the latter environment). Alternatively, similar environments (e.g., internal uncontrolled indoor, controlled indoor, and dry air environments) can be combined into a larger population provided that the inspections occur on components located in the most severe environment.

APPENDIX G

MARK-UP SHOWING CHANGES TO AMP XI.M38, "INSPECTION OF INTERNAL SURFACES IN MISCELLANEOUS PIPING AND DUCTING COMPONENTS"

To determine the condition of internal surfaces of buried and underground piping, inspections of the interior surfaces of aboveground piping may be credited if the aboveground and buried or underground component material, environment, and aging effects are similar. When aboveground inspections of the interior surfaces of components with similar material, environment, and aging effects as the interior surfaces of buried or underground piping were not conducted, the sample population includes volumetric or internal visual inspections capable of detecting loss of material on the internal surfaces of the buried or underground piping.

Visual inspections ~~should~~ include all accessible surfaces. Unless otherwise required (e.g., by the ASME code) all inspections ~~should~~ are to be carried out using plant-specific procedures by inspectors qualified through plant specific programs. The inspection procedures ~~utilized~~used must be capable of detecting the aging effect(s) under consideration. These inspections provide for the detection of aging effects ~~prior to~~ before the loss of component function. Visual inspection of flexible polymeric components is performed whenever the component surface is accessible. Visual inspection can provide indirect indicators of the presence of surface cracking, crazing, and discoloration. For elastomers with internal reinforcement, visual inspection can detect the exposure of reinforcing fibers, mesh, or underlying metal. Visual and tactile inspections are performed when the internal surfaces become accessible during the performance of periodic surveillances or during maintenance activities or scheduled outages. Visual inspection provides direct indicators of loss of material due to wear, including dimensional change, scuffing, and the exposure of reinforcing fibers, mesh, or underlying metal for flexible polymeric materials with internal reinforcement.

Manual or physical manipulation of flexible polymeric components is used to augment visual inspection, where appropriate, to assess loss of material or strength. The sample size for manipulation is at least 10 percent of available surface area, including visually identified suspect areas. For flexible polymeric materials, hardening, loss of strength, or loss of material due to wear is expected to be detectable ~~prior to~~ before any loss of intended function.

5. ***Monitoring and Trending:*** ~~The Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components~~ This program uses standardized monitoring and trending activities to track degradation. Deficiencies are documented using approved processes and procedures such that results can be trended. However, the program does not include formal trending. Inspections are performed at frequencies identified in Element 4, Detection of Aging Effects.

6. ***Acceptance Criteria:*** For each component~~/~~ and aging effect combination, the acceptance criteria are defined to ensure that the need for corrective actions is identified before the loss of intended functions. For metallic surfaces, any indications of relevant degradation detected are evaluated by engineering. For stainless steel surfaces, a clean, shiny surface is expected. Discoloration may indicate the loss of material on the stainless steel surface. Any abnormal surface condition may be an indication of an aging effect for metals.

For flexible polymers, a uniform surface texture and uniform color with no ~~unanticipated~~ dimension~~al~~ change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. Changes in ~~For~~ flexible material's properties (e.g., hardness, flexibility, physical dimensions, and color of the material) are evaluated. For example, for sealants, the flexibility of the component is sufficient to ensure that it will properly adhere to surfaces. Changes in hardness of polymeric couplings could be a leading indicator of subsequent failure. ~~to be considered acceptable, the inspection results should indicate that the flexible polymer material is in "as new" condition (e.g., the hardness, flexibility, physical dimensions, and color of the material are unchanged from when the material was new).~~ Cracks ~~should be~~ are absent within the material. For rigid polymers, surface changes affecting performance, such as erosion, cracking, crazing, checking, and chalks, are subject to further investigation.

Acceptance criteria include design standards, procedural requirements, current licensing basis, industry codes or standards, and engineering evaluation.

7. ***Corrective Actions:*** The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.

8. ***Confirmation Process:*** As discussed in the Appendix for GALL, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** Inspections of internal surfaces during the performance of periodic surveillance and maintenance activities have been in effect at many utilities in support of plant component reliability programs. These activities have proven effective in maintaining the material condition of plant systems, structures, and components. The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice and staff expectations. ~~However, because the inspection frequency is plant-specific and depends on the plant operating experience, the applicant's plant-specific operating experience or applicable generic operating experience is further evaluated for the period of extended operation.~~ The applicant evaluates recent operating experience and provides objective evidence to support the conclusion that the effects of aging are adequately managed.

The review of plant-specific OE during the development of this program is to be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE conducted in conjunction with developing the license renewal application, recurring aging effects can be identified by compiling examples of operating experience related to components managed by the program with similar aging effects and aging mechanisms and determining the trend of its occurrence. Further evaluation AMR items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR items do not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. In addition, the staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects (e.g., minor corrosion that if left uncorrected would not affect the ability of the component to perform its intended function throughout the period of extended operation). The only plant-specific operating experience examples that need to be addressed as recurring aging effects in this regard are those in which the component's degree of degradation is significant as defined in the further evaluation AMR items.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI Technical Report 1007933, *Aging Assessment Field Guide*, December 2003.

EPRI Technical Report 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004.

INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

APPENDIX H

NEW PROGRAM: GALL REPORT AMP XI.M42 SERVICE LEVEL III AND OTHER COATINGS MONITORING AND MAINTENANCE PROGRAM

AMP XI.M42 Service Level III and Other Coatings Monitoring and Maintenance Program

Program Description

Proper maintenance of Service Level III (as defined in RG 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Plants," Revision 2, or latest version) and Other coatings is essential to ensure that the intended functions of in-scope components are met. Other coatings include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3). Degradation of coatings can lead to unanticipated or accelerated corrosion of base materials and downstream effects such as reduction in flow, reduction in pressure or reduction in heat transfer when coatings become debris. The program consists of periodic visual inspections of Service Level III and Other coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, fuel oil, and lubricating oil. Where the visual inspection of the coated surfaces determines that the coating is deficient, or degraded physical tests are performed in conjunction with the visual inspection. EPRI Report 1019157, "Guidelines for Inspection and Maintenance of Safety-related Protective Coatings," provides information on the ASTM standard guidelines and coatings.

Evaluation and Technical Basis

1. ***Scope of Program:*** The minimum scope of the program is Service Level III and Other coatings exposed to closed-cycle cooling water, raw water, treated water, treated borated water, waste water, fuel oil, and lubricating oil. "Other" coatings include those whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3).

2. ***Preventive Actions:*** The program is a condition monitoring program and does not recommend any preventive actions. However, for plants that credit coatings to minimize loss of material, this program is a preventive action.

3. ***Parameters Monitored/Inspected:*** Visual inspections are intended to identify coatings that do not meet acceptance criteria, such as peeling and delamination. The definition of these terms is included in Section 10.2 of ASTM D7167-12, "Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant." Physical testing is intended to identify potential delamination of the coating.

4. ***Detection of Aging Effects:*** The periodicity of visual inspections is based on the effect of coating failures on the in-scope component's intended function, potential problems identified during prior inspections, and known service life history. However inspection intervals do not exceed those in Table 4a, "Inspection Intervals for Coatings."

APPENDIX H

NEW PROGRAM: GALL REPORT AMP XI.M42 SERVICE LEVEL III AND OTHER COATINGS MONITORING AND MAINTENANCE PROGRAM

Table 4a. Inspection Intervals for Coatings

Coating Inspection Categories		**Installed Age of Coating**	
		Less than 20 years	**Greater than 20 years**
A	Installation records used to apply the coating included material manufacturer installation specifications	6 years	2 years[1]
B	Installation records used to apply the coating did not include material manufacturer installation specifications	2 years	2 years
C	Portion of coating did not meet acceptance criteria	2 years	2 years
D	Repaired or replaced coatings	2 years[2]	2 years[2]

Notes:

1. If the identical coating material was installed with the same installation requirements in redundant trains with the same operating conditions, the inspection interval may be extended to four years as long as one of the trains is inspected every two years.
2. The inspection interval can revert to coating inspection category A, when those conditions are met, if the inspection subsequent to a repair or replacement (i.e., 2 years later) reveals that the coating meets all acceptance criteria.

Inspections begin one refueling outage before the period of extended operation. The inspection scope includes all coating surfaces except those captured between interlocking surfaces (e.g., flanges). For areas not readily accessible for direct inspection, such as small pipelines, heat exchangers, and other equipment, consideration is given to the use of remote or robotic inspection tools.

For coated surfaces determined to not meet the acceptance criteria because of delamination or blisters, physical testing is performed where physically possible (i.e., sufficient room to conduct testing). The test consists of destructive or nondestructive adhesion testing using ASTM International standards endorsed in RG 1.54. A minimum of three sample points adjacent to the defective area is tested.

The above recommendations for inspection of coatings may be omitted if the degradation of coatings cannot result in downstream effects such as reduction in flow, drop in pressure, or reduction in heat transfer for in-scope components; however, the recommendations for inspections is to be met if corrosion rates or inspection intervals have been based on the integrity of the coatings. In this case, loss of coating integrity could result in unanticipated or accelerated corrosion rates of the base metal. Alternatively, if corrosion of the base material is the only issue related to coating degradation of the component, external wall thickness measurements can be performed to confirm the corrosion rate of the base metal.

The training and qualification of individuals involved in coating inspections is conducted in accordance with an ASTM International standard endorsed in RG 1.54 including staff guidance associated with a particular standard.

5. ***Monitoring and Trending:*** A pre-inspection review of the previous two inspections is conducted that includes reviewing the results of inspections and any subsequent repair activities. An individual knowledgeable and experienced in nuclear coatings work prepares the reports to include: a list and location of all areas evidencing deterioration, a prioritization of the repair areas into areas that must be repaired before returning the system to service and areas where repair can be postponed to the next inspection, and where possible, photographic evidence indexed to inspection locations.
6. ***Acceptance Criteria:*** Acceptance criteria are as follows:
   a. Indications of peeling and delamination are not acceptable.
   b. The cause of blisters needs to be determined if the blister is not repaired. If coatings are credited for corrosion prevention, the component's base material in the vicinity of the blister is inspected to determine if unanticipated corrosion has occurred. Physical testing is conducted to ensure that the blister is completely surrounded by sound coating bonded to the surface.
   c. Indications such as cracking, flaking, and rusting are to be evaluated by an individual qualified in accordance with an ASTM International standard endorsed in RG 1.54 accompanied by staff guidance associated with a particular standard.
   d. Cementitious coatings may exhibit minor cracking and spalling provided there is no evidence that the coating is debonding from the base material.
   e. Wall thickness measurements meet design minimum wall requirements.
   f. Adhesion testing results meet or exceed the degree of adhesion recommended in engineering documents specific to the coating and substrate, although not less than 200 psi.
7. ***Corrective Actions:*** Coatings that do not meet acceptance criteria are repaired or replaced. The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.
8. ***Confirmation Process:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.
9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls..
10. ***Operating Experience:*** Operating experience shows that coatings are subject to degradation. Examples include:
    a. In 1982, a licensee experienced degradation of internal coatings in its spray pond piping system. This issue contains many key aspects related to coating degradation. These

include installation details such as improper curing time, restricted availability of air flow leading to improper curing, installation layers that were too thick, and improper surface preparation (e.g., oils on surface, surface too smooth). The aging effects included severe blistering, moisture entrapment between layers of the coating, delamination, peeling, and widespread rusting. The failure to install the coatings to manufacturer recommendations resulted in flow restrictions to the ultimate heat sink and blockage of an emergency diesel generator governor oil cooler.

b. Coating degradation, which occurred as a result of weakening of the adhesive bond of the coating to the base metal due to turbulent flow, resulted in the coating eroding away and leaving the base metal subject to aggressive erosion/corrosion.

c. In 1994, a licensee replaced a portion of its cement-lined steel service water piping with piping lined with a common PVC polymeric material. The manufacturer stated that the lining material had an expected life of 15-20 years. An inspection in 1997 showed some bubbles and delamination in the coating material at a flange. A 2002 inspection found some locations that had lack of adhesion to the base metal. In 2011, diminished flow was observed downstream of this line. Inspections revealed that a majority of the lining in one piping segment was loose or missing. The missing material had clogged a downstream orifice. Subsequent inspections in 2011 resulted in no further evidence of delamination; however, localized areas showed bubbles and small waves in the liner material. A sample of the lining was sent to a testing lab where it was determined that cracking was evident on both the base metal and water side of the lining and there was a noticeable increase in the hardness of the in-service sample as compared to an unused sample.

d. A licensee has experienced multiple instances of coating degradation resulting in coating debris found downstream in heat exchanger end bells. To date, none of the debris has been large enough to result in reduced heat exchanger performance; however, in an out-of-scope system, coating degradation resulted in blocked tubes in a heat exchanger. This licensee also found polymeric coating debris downstream of a valve in its essential cooling water system.

e. A licensee experienced continuing flow reduction over a 14-day period, resulting in the service water room cooler being declared inoperable. The flow reduction occurred due to the rubber coating on a butterfly valve becoming detached

f. At an international plant, cavitation in the piping system damaged the coating of a piping system which subsequently resulted in unanticipated corrosion through the pipe wall.

g. A licensee experienced degradation of the protective concrete lining which allowed brackish water to contact the unprotected carbon steel piping resulting in localized corrosion. The degradation of the concrete lining was likely caused by the high flow velocities and turbulence from the valve located just upstream of the degraded area.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASTM D7167-12, Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant.

EPRI Report 1019157, *Guideline on Nuclear Safety-Related Coatings*, Revision 2, (Formerly TR-109937 and 1003102), Electric Power Research Institute, December 2009.

NRC RG 1.54, Rev. 2, *Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, October 2010.

U.S. Nuclear Regulatory Commission, NRC Information Notice 85-24, Failures of Protective Coatings in Pipes and Heat Exchangers, March 26, 1985.

ASTM D4538-05, Standard Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities.

APPENDIX I

CHANGES TO PROGRAM ELEMENT 10, "OPERATING EXPERIENCE," IN GALL REPORT AMP XI.M20 AND AMP XI.M21A

The text below will be added to program element 10, "Operating Experience," for the following AMPs as a new paragraph following the existing paragraph:

- XI.M20, "Open-Cycle Cooling Water System"
- XI.M21A, "Closed Treated Water Systems"

The review of plant-specific OE during the development of this program is to be broad and detailed enough to detect instances of aging effects that have occurred repeatedly. During the review of plant-specific OE conducted in conjunction with developing the license renewal application, recurring aging effects can be identified by compiling examples of operating experience related to components managed by the program with similar aging effects and aging mechanisms and determining the trend of its occurrence. Further evaluation AMR items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material or Change in Material Properties due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR items do not address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. In addition, the staff recognizes that as a plant ages there can be numerous examples of inconsequential aging effects (e.g., minor corrosion that if left uncorrected would not affect the ability of the component to perform its intended function throughout the period of extended operation). The only plant-specific operating experience examples that need to be addressed as recurring aging effects in this regard are those in which the component's degree of degradation is significant as defined in the further evaluation AMR items.