LICENSE RENEWAL INTERIM STAFF GUIDANCE

LR-ISG-2012-02

AGING MANAGEMENT OF INTERNAL SURFACES, FIRE WATER SYSTEMS, ATMOSPHERIC STORAGE TANKS, AND CORROSION UNDER INSULATION

INTRODUCTION

This license renewal interim staff guidance (LR-ISG) LR-ISG-2012-02, "Aging Management of Internal Surfaces, Fire Water Systems, 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 cite 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., the GALL Report and SRP-LR).

DISCUSSION

Based on recent 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, C, and F), and atmospheric storage tanks should be revised (Section D). Atmospheric storage tanks are those with a design pressure at, or slightly above or below, atmospheric pressure. Similarly, this LR-ISG includes new recommendations for corrosion under insulation (CUI) (Section E) of component external surfaces. Each of these areas is discussed in separate sections 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 Aging Management Program (AMP) XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components," in Section G. Each LR-ISG section includes the background for the change, examples of OE when applicable, and a summary of the changes to the license renewal guidance documents.

In developing these new recommendations, the staff:

- Revised six existing GALL Report AMPs.
- Developed a new further evaluation (FE) item to address recurring internal corrosion.
- Revised many SRP-LR and GALL Report Aging Management Review (AMR) line items and developed new ones.
- Revised the final safety analysis report (FSAR) supplement description for the affected AMPs.
- Revised four GALL Report definitions and developed three 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 Sections of LR-ISG-2012-02 and Impacts on License Renewal Guidance Documents," 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. Representative Minimum Sample Size for Periodic Inspections in GALL Report AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"

C. Flow Blockage of Water-Based Fire Protection System Piping, GALL Report AMP XI.M27, "Fire Water System"

D. Revisions to the scope and inspection recommendations of GALL Report AMP XI.M29, "Aboveground Metallic Tanks"

E. Corrosion Under Insulation

F. External Volumetric Examination of Internal Piping Surfaces of Underground Piping Removed from GALL Report AMP XI.M41, "Buried and Underground Piping and Tanks"

G. Specific Guidance for Use of the Pressurization Option for Inspecting Elastomers in GALL Report AMP XI.M38

H. Key Miscellaneous Changes to the GALL Report and SRP-LR

Table 1 Major Sections of LR-ISG-2012-02 and Impacts on License Renewal Guidance Documents

LR-ISG Section	New FE items	XI.M27	XI.M29	XI.M36	XI.M38
Recurring internal corrosion	√				
Minimum representative sample					√
Fire water system blockage		√			
Revised scope and inspections for tanks			√		
Corrosion under insulation			√	√	
Volumetric exam of underground piping					√
Pressurization of elastomers					√

Notes:

- 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"

Table 2 Other GALL Report AMPs Cited 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

A) Recurring Internal Corrosion

i) Background

When the staff reviewed recent LRAs and 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 OE, the aging management programs to be used during the period of extended operation (PEO) might have to be augmented to ensure that instances of recurring aging effects are adequately addressed. The staff identified the following examples of OE related to recurring internal corrosion during its review of applicants' corrective action databases (and in one instance, during an OE search). These examples form the basis for the new recommendations included in this LR-ISG.

ii) OE examples

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

One plant experienced an increase in leakage locations in its essential service water system, principally because of MIC, after receiving its renewed license. Leakage resulted in the licensee declaring the system inoperable and shutting down to perform repairs (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102930369).

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 one site, LRA changes were required to address staff requests for additional information (RAIs) about the rigor of the program to manage the loss of material (ADAMS Accession No. ML12235A468). At the other site, extensive augmented inspections (beyond that recommended in GALL Report AMP XI.M20) were conducted before submitting the LRA, although LRA changes were also required for this site (ADAMS Accession No. ML120470084).

b) Erosion in service water system.

A plant experienced erosion in multiple locations in its essential cooling water system. The erosion was being managed by periodic inspections, and replacement of components when necessary. LRA changes were required to enhance the "parameters monitored/inspected," "detection of aging effects," and "corrective actions" program elements to clarify the inspection requirements and engineering evaluation of as-found conditions during the period of extended operation (ADAMS Accession No. ML12097A065).

c) Internal corrosion in a fire water system.

A plant experienced a significant number of occurrences of internal corrosion in its fire water system which initially came to the staff's attention based on a review of continuing degradation of flow testing results. During its audit of the applicant's program, the staff identified gaps in the aging management of loss of material in the system. The applicant addressed these gaps by revising its program to include augmented wall thickness inspections, increased flow testing frequency, and trending of occurrences of MIC (ADAMS Accession Nos. ML12220A162, ML12306A332, and ML13029A244).

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 aging effects with the same aging mechanism 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, numerous examples of inconsequential aging effects can occur. This LR-ISG is focused on recurring aging effects that degrade a component to such a significant degree that either the component 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 Nuclear Energy Institute (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.
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> 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 Branch Technical Position (BTP) RLSB-1 in Appendix A.1 of 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 whether they will be managed by a new or an existing program during the PEO. This is reinforced in Items 2 and 3 of Section A.1.2.3.10 of the SRP-LR (as modified in LR-ISG-2011-05, "Ongoing Review of Operating Experience" ADAMS Accession No. ML12044A215), which state:

> 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, the staff revised the SRP-LR and GALL Report to include new FE 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 item for SRP-LR Reactor Vessel, Internals and Reactor Coolant System (SRP-LR Section 3.1) because a staff review of OE did not find evidence of recurring degradation mechanisms in American Society of Mechanical Engineers (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, the staff revised program element 10, “operating experience,” for several GALL Report AMPs for which the staff expects that recurring internal corrosion 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 items.

b) The new FE items for recurring internal corrosion are applicable if the search of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle that has occurred over three or more sequential or nonsequential cycles for a 10-year OE search, or two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism and for which the aging effect resulted in the component not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent regardless of the minimum wall thickness.

- Significance of aging effect: 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. Therefore, the staff does not intend that the 50 percent or greater through-wall penetration criterion be interpreted to indicate that the in-scope component does or did not meet its intended function, but rather as an indicator of aging effects significant enough to warrant enhanced aging management actions. The applicant should use the significance of the aging effects as input in determining the necessary extent of enhancements (e.g., number of augmented inspections, frequency of augmented inspections). For example:

    - Two instances of wall-wastage with the deepest penetration being 65 percent through-wall and one through-wall leak occurred in close enough proximity to be considered a single flaw in a service water line. Refer to Subarticle IWA-3300, “Flaw Characterization,” in Section XI, “Rules for Inservice Inspection of Nuclear Components,” of the ASME Boiler & Pressure Vessel (B&PV) Code.
    - After cleaning an atmospheric waste drain line, three widely separated 50 percent through-wall small-diameter pits were detected.
    - Six leaks occurred during the past 5 years in the fire water system.

  The first and the third example would potentially warrant additional inspection points and more frequent inspections than the second example. The second example warrants a followup inspection because, even though the current state did not result in through-wall leakage and probably did not affect the structural integrity of the piping segments, the aging effects will probably continue and eventually a leak could occur that could result in the loss of the intended function of a nearby safety-related component.

  The staff further recognizes that, for many nonsafety-related, in-scope systems, wall thickness data might not be available during a search of plant-specific operating experience. The only indicator of an aging effect could be leakage discovered by plant personnel. Reliance on existing corrective action program documentation is sufficient to determine the applicability of this new further evaluation AMR item.

- Frequency of occurrence of aging effect: NEI 95-10, Section 4.4, “Operating Experience – Aging Effects Requiring Management,” states that “[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 FE item states, “[d]uring the search of plant-specific OE conducted during the LRA development, recurring internal corrosion can be identified by….” It also states, “[t]his further evaluation item is applicable if the search of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle that have occurred over three or more sequential or nonsequential cycles)....” These two sentences establish the staff’s intent that: (a) the period of time for the OE search need not exceed the 5- to 10-year period specified in NEI 95-10 and (b) occurrences are tied to refueling outage intervals. Given the variability in outage length and the number of years of plant-specific operating experience through which an applicant searches, the following intervals are available during which recurring internal corrosion events could have occurred:

Number of years for which plant-specific OE is searched	Refueling outage interval, months	Available intervals during which recurring internal corrosion events could have occurred
10	24	6
5	24	3
10	18	7
5	18	4

The staff chose to define the applicability of this further evaluation item based on a number of occurrences over a period of time rather than a number of <u>sequential</u> occurrences because the staff concludes that a long-term degradation trend might exist even when degradation does not occur in every outage interval. Given the limited number of available intervals during which recurring internal corrosion events could have occurred, the staff concludes that two occurrences are appropriate for a 5-year OE search and three are warranted for a 10-year OE search.

The appropriateness of using the number of significant aging effect events versus stating that the criterion is a number of significant aging effect events occurring in sequential outage intervals is illustrated by the following example. During a 10-year search with 18-month refueling outage intervals, the applicant identifies one occurrence in each of the oldest two intervals, followed by an interval with no occurrence, which is then followed by two intervals with one occurrence in each. If the sequential outage interval clause had been included in the frequency criterion, the further evaluation threshold would not have been met despite the fact that a continuing aging effect is occurring.

The staff recognizes that, by establishing thresholds for the significance of aging effects and the frequency of occurrence of aging effects, it could appear to be communicating that any degradation less significant and occurring less frequently than the thresholds is not important enough to consider changes to how the aging effect for the affected component(s) is managed. This is not the case. Although these thresholds provide clear indications of recurrent degradation, it is not possible to generically cover every possible plant-specific scenario that would be reasonably assessed as recurring degradation. The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented, even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis (CLB) intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

The details for the new SRP-LR and GALL Report items are included in Appendices B and J, and Appendices C and K, respectively. 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.

c) A summary of the recommendations contained in the new FE item follows:

- The applicant ensures that appropriate examination methods (e.g., volumetric versus external visual) are used to detect aging given the specific aging mechanism(s) of concern.
- Depending on 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 for this decision should be provided in the application.
- 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 components that are not easily accessed (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.

d) A new term to define a category of aging mechanisms, “recurring internal corrosion,” was added to GALL Report Table IX.F.

e) The staff revised the criteria for the use of GALL Report AMP XI.M38. The program description of GALL Report AMP XI.M38 stated, “[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 might not occur with sufficient frequency to manage such failures. This LR-ISG has revised this section of the AMP in two ways:

- The threshold for not using the program was changed to reference the new criteria for recurring internal corrosion contained in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, all titled “Loss of Material due to Recurring Internal Corrosion.”
- However, if the recurring internal corrosion criteria are met, the use of this program is allowed if it includes augmented requirements to ensure that any recurring aging effects are adequately managed as described in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, 3.4.2.2.6.

In conjunction with this change, the staff also revised the last sentence program description which used to state, “[f]ollowing 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.” It was revised to state, “[f]ollowing a failure, due to recurring internal corrosion, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest, or corrective actions have been taken to prevent recurrence of the recurring internal corrosion.” The staff made this change because it recognizes that there may be more ways to correct a degradation mechanism than replacing the material with a more corrosion-resistant material.

f) 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 line items.

B) Representative Minimum Sample Size for Periodic Inspections in GALL Report AMP XI.M38, “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components”

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 might not be available for one or more combinations of material, environment, and aging effects presented in the AMR line items where GALL Report AMP XI.M38 is cited.

b) The GALL Report contains AMPs used to sample a population in order 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 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 on 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 and other applicants did not.

iii) Summary of changes in this LR-ISG

a) 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. With the exception of a few GALL Report AMR line items in which preventive actions alone are considered sufficient to manage aging effects, 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. A summary follows:

- In each 10-year period during the PEO, the licensee ensures that 20 percent of each population of in-scope components, with a maximum sample size of 25 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., GALL Report AMP XI.M32 and GALL Report 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) Program element 4, "detection of aging effects," of GALL Report AMP XI.M38 was revised to state that 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.

c) Program element 4, "detection of aging effects," of GALL Report AMP XI.M38 was revised to state that inspection quantities from similar environments 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 would be expected from 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.

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

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

C) Flow Blockage of Water-Based Fire Protection System Piping, GALL Report AMP XI.M27, "Fire Water System"

i) Background

Operating Experience 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 OE examples, the staff revised the GALL Report and SRP-LR to include revised recommendations to manage the aging effects applicable to fire water system components. As stated in the U.S. Nuclear Regulatory Commission (NRC) Information Notice (IN) 2013-06, "Corrosion in Fire Protection Piping Due to Air and Water Interaction" (ADAMS Accession No. ML13031A618), degradation in fire protection systems can be detected before a loss of function by inspecting and testing the systems in accordance with National Fire Protection Association (NFPA) standards (e.g., NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.)"

In addition, as stated in IN 2013-06, degradation in fire protection systems can be detected before a loss of function by inspecting and testing the systems in accordance with NFPA standards.

ii) OE examples

a) In October 2010, a portion of a preaction water spray system failed its functional flow test because of blockage (as discussed in IN 2013-06, ADAMS Accession No. ML13031A618). 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. (ADAMS Accession No. ML13014A100).

b) In September 2011, portions of an intake structure building fire suppression sprinkler system were partially blocked and incapable of passing the required flow (as discussed in IN 2013-06. 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. This same licensee experienced prior flow blockage in other fire sprinkler systems. (The report of a special inspection team is available at ADAMS Accession No. ML11363A182).

c) In March 2012, staff and licensee personnel found that a portion of the internally galvanized piping of a 6-inch preaction sprinkler system 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 pipe showed that it contained residual water, that the galvanizing had been removed, and that significant quantities of corrosion products were present whereas in the upper dry portions, the galvanized coating was still intact. (As discussed in IN 2013-06).

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. (Discussions as part of Requests for Additional Information (RAIs) are available at ADAMS Accession Nos. ML12220A162, ML12306A332, and ML13029A244).

iii) Summary of changes in this LR-ISG

a) As a result of this LR-ISG, a new table, Table 4a, "Fire Water System Inspection and Testing Recommendations," has been incorporated into program element 4, "detection of aging effects," of GALL Report AMP XI.M27 to include the appropriate inspections and tests recommended in NFPA 25. The new table specifies those inspections and tests that are related to age-managing applicable aging effects that are associated with loss of material and flow blockage for passive long-lived in-scope components in the fire water system. The staff cites the 2011 edition of NFPA 25 for the description of the scope and periodicity of specific inspections and tests as identified in Table 4a. If the plant's CLB calls for more frequent inspections than required by NFPA 25, the plant's CLB should continue to be met. Inspections and tests not related to passive long-lived functions of fire water system components should continue to be conducted in accordance with the CLB.

Before issuance of this LR-ISG, GALL Report AMP XI.M27 recommended 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, NFPA 25 Section 7.3.1 recommends flow testing every 5 years. For water spray systems, NFPA 25 Section 10.3 recommends yearly operational testing during which system pressure and nozzle spray patterns are checked to identify any blockage. For piping and branch lines, visual inspections for foreign organic and inorganic material are recommended every 5 years in NFPA 25 Section 14.2.1.

b) The program description, program element 3, "parameters monitored/inspected, and program element 4, "detection of aging effects," of GALL Report AMP XI.M27 were revised to eliminate the alternative of using wall thickness evaluations instead of flow tests or internal visual examinations for managing flow blockage. The basis for this 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 source of the corrosion products was portions of the normally dry sprinkler piping that were 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 might not be capable of identifying these impacts when general corrosion might be having a minor effect on wall thickness while generating sufficient corrosion products to cause flow blockage.

c) Program element 4, "detection of aging effects," of GALL Report AMP XI.M27 was revised to recommend that followup volumetric examinations be performed if internal visual inspections detect surface irregularities that could indicate wall loss below nominal pipe wall thickness because of corrosion. These followup exams are necessary to ensure that there is sufficient wall thickness in the vicinity of the irregularity.

d) Program element 4, “detection of aging effects,” of GALL Report AMP XI.M27 was revised to include augmented inspections of piping in the flow path that have been wetted but are normally dry. Based on a review of OE and testing such as flow tests, external visual examinations, hydrostatic tests, and main drain tests, the staff concludes that the inspections and tests described in NFPA 25, along with continuously monitoring the system’s pressure, are sufficient to age-manage fire water system piping that is typically filled with water.

   In contrast, based on the OE cited above, portions of the fire water system piping in the flow path that have been wetted but are normally dry warrant augmented tests and inspections if they include piping segments that cannot be drained or piping segments that allow water to collect. Augmented tests and inspections to ensure that flow blockage has not occurred include:

   - In each 5-year interval beginning with the 5-year period before the period of extended operation, perform either: (a) a flow test or flush sufficient to detect potential flow blockage, or (b) visual inspections on 100 percent of the internal surface of piping segments that cannot be drained or piping segments that allow water to collect. Given the number of OE examples related to fire water piping blockage and the magnitude of blockage, GALL Report AMP XI.M27 is being revised by this LR-ISG to include a recommendation that this testing begins before the period of extended operation.
   - In each 5-year interval commencing during the period of extended operation, 20 percent of the length of piping segments that cannot be drained or piping segments that allow water to collect is subject to volumetric wall thickness inspections. Data points are obtained to the extent that potential degraded conditions can be identified (e.g., general corrosion, MIC). The 20-percent of piping inspected in each 5-year interval should be in different locations than in previously inspected piping. 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 not to move any potential blockage to another portion of the system where it might not be detected. Portions of the normally dry piping that can be drained (e.g., pipe slopes towards a drain point) do not need these augmented inspections.

e) Program element 1, “scope of program,” of 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.

f) Some details in the program description that duplicated 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) In program element 4, “detection of aging effects,” of GALL Report AMP XI.M27 the statement 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) In program element 5, “monitoring and trending,” in GALL Report AMP XI.M27, the statement 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 are 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 cited 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 Appendices D and L.

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

n) New AMR line items have been 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 Appendices B and J, and Appendices C and K. Some of these AMR line 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, and 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, such piping is potentially subject to flow blockage from upstream steel corrosion products that could be transported to the stainless steel, copper alloy, or aluminum portions of the system.

o) GALL Report Items VII.G.A-23 and VII.G.AP-143, associated with SRP-LR item 3.3.1-89, 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) were revised. These items are included in the Fire Protection table of the GALL Report and therefore should be managed by GALL Report AMP XI.M27, “Fire Water System.” Because some applicants use VII.G.A-23 or VII.G.AP-143 for systems other than Fire Protection, the Aging Management Programs column for SRP-LR item 3.3.1-89 was revised to read, “[f]or fire water system components: Chapter XI.M27, 'Fire Water System,' or for other components: Chapter XI.M38, 'Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components.'" GALL Report AMR line items VII.G.A-23 and VII.G.AP-143 were likewise changed. Item VII.H2.A-23 was not revised because these items are associated with Emergency Diesel Generator Systems.

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 substances (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.

D) 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 inspections.

ii) OE examples

A licensee detected through-wall pitting in the bottom of an aluminum aboveground refueling water tank. During repairs to the degraded portion of the tank bottom, visual inspections revealed corrosion on the exterior surface; scattered pitting (hemispherical in shape), and patches of a loosely adherent white corrosion product (likely aluminum oxide). The licensee determined that the failure mechanism was galvanic corrosion. This occurred because of the absence of a seal between the tank bottom plates and the concrete ring wall, which permitted the periodic ingress of water into the sand/oil cushion layer beneath the tank. (The incident is discussed in a relief request with the ADAMS Accession No. ML003762390.)

The staff has issued IN 2013-18, "Refueling Water Storage Tank Degradation" (ADAMS Accession No. ML13128A118), which is directly related to the changes described in this section. The IN addresses degradation that occurred in tanks at Palisades, Kewaunee, and South Texas Project. A brief summary of examples from IN 2013-18 follows:

a) A licensee identified a boric acid deposit adjacent to the weld connecting the tank wall to the floor plate on a stainless steel tank with a capacity of 272,500 gallons located in the auxiliary building. No actual leakage of water from the tank was observed. The licensee postulated that the boric acid deposit was caused by a pinhole leak that resulted from an original weld defect or some form of stress corrosion cracking (e.g., chloride stress corrosion cracking).

b) Leakage into the auxiliary building's concrete roof structure was observed as a result of leakage from an aluminum 300,000-gallon tank located on the roof of the auxiliary building. During followup inspections, through-wall defects (leaks) were detected in the tank floor. Some of these defects were associated with welds of the tank floor to the penetration nozzles.

c) A licensee identified a spot of rust, traces of moisture, and some boric acid crystals at the floor-to-tank wall weld on a stainless steel tank with a capacity of 550,000 gallons located in the auxiliary building. During followup inspections, the licensee detected a crack that was transgranular and branched, which would be consistent with chloride stress corrosion cracking.

iii) Summary of changes in this LR-ISG

a) As a result of this OE, the staff revised GALL Report AMP XI.M29 to recommend that visual and (when applicable) surface inspections of tank internal surfaces be conducted. 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, as well as external inspections, are conducted throughout the PEO. GALL Report AMP XI.M29 currently 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. The changes to tank inspection recommendations have been consolidated into a new table, Table 4a, “Tank Inspection Recommendations.” This table specifies the inspection technique and frequency of inspection for each tank surface depending on the material, environment, and the aging effect requiring management (AERM).

b) Program element 1, “scope of program,” of GALL Report AMP XI.M29 was revised to include certain indoor large-volume tanks. Some licensees have large indoor storage tanks designed similarly to those included in the “outdoor” scope of GALL Report AMP XI.M29 prior to the issuance of this LR-ISG. 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 can occur. Most of these indoor tanks are currently managed with 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. While the current AMP does not explicitly state that it is limited to outdoor tanks, there were no GALL Report AMR line items for tanks exposed to indoor air that GALL Report AMP XI.M29 manages. Based on 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
- 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) Program element 3, “parameters monitored/inspected,” and program element 4, “detection of aging effects,” of GALL Report AMP XI.M29 were revised to include cracking caused by stress corrosion cracking as an aging effect to be managed for stainless steel and aluminum tanks because there are multiple OE examples related to cracking in stainless steel and aluminum tanks. The revised AMP, as shown in Table 4a, includes a recommendation for appropriate visual or surface examinations capable of detecting cracking, including the minimum surface area to be examined.

d) Details of the changes to GALL Report AMP XI.M29 are included in Appendices E and M.

e) 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 line items are shown in Appendices B and J, and Appendices C and K, respectively.

f) Corresponding changes to the FSAR supplement for the Aboveground Metallic Tank Program are shown in Appendices B and J, Table 3.0-1.

E) Corrosion Under Insulation

i) Background

Based on observations during audits as described below in OE examples, the staff is adding recommendations related to inspecting the external surfaces underneath insulation to the GALL Report. Loss of material and cracking can occur underneath insulation and remain undetected. NACE (formerly known as the National Association of Corrosion Engineers) Standard SP0198-2010, “Control of Corrosion Under Thermal Insulation and Fireproofing Materials – A Systems Approach,” categorizes this as CUI.

ii) OE examples

a) In November 1999, an ASME Code Class 2 two-inch unisolable drain line connected to a main steam isolation valve corroded through-wall. The drain line was insulated and located in an outdoor air environment. Sufficient moisture penetrated the insulation to cause corrosion. The degrading condition went undetected until the piping segment failed to meet the containment pressure boundary function.

b) During a recent license renewal AMP audit, the staff observed extensive general corrosion (i.e., corrosion with a wide extent based on its surface area but not its depth of penetration) underneath the insulation removed from an auxiliary feedwater suction line. The process fluid temperature was below the dew point for sufficient duration to accumulate condensation on the external pipe surface.

c) 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. Examples of where proposed aging management methods for CUI were not initially adequate are given in ADAMS Accession Nos. ML120470084, ML12220A162, and ML12306A332 (the latter two references are related).

iii) 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 during each 10-year period of the period of extended operation.

b) For all insulated outdoor components, except tanks, and all indoor insulated components exposed to condensation (because the in-scope component is being operated below the dew point), GALL Report AMP XI.M36 was revised to recommend removal of insulation and inspection of a minimum of 20 percent of the in-scope piping length for each material type (i.e., steel, stainless steel, copper alloy, and aluminum), or, for components with configurations that do not conform to a 1-foot axial length determination (e.g., valves, accumulators), 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) in which 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 insulated tank, and indoor insulated tanks exposed to condensation (because the in-scope component is being operated below the dew point), GALL Report AMP XI.M29 was revised to recommend removing insulation from either 25 1-square-foot sections or 20 percent of the surface area and inspecting the exterior surface of the tank. The recommendations include distributing the sample inspection points in such a way that inspections occur on the tank dome and sides, near the bottom, at points where structural supports or instrument nozzles penetrate the insulation, and where water might collect, such as on top of stiffening rings.

d) The GALL Report AMPs XI.M29 and XI.M36 were revised to recommend that inspection locations should be based on the likelihood of CUI occurring (e.g., alternate wetting and drying in environments in which trace contaminants could be present, length of time the system operates below the dew point).

Subsequent inspections may consist of examination of the exterior surface of the insulation for indications of damage to the jacketing or protective outer layer of the insulation when the following conditions are met based on the results of the initial inspection:

- no loss of material due to general, pitting or crevice corrosion, beyond that which could have been present during initial construction, and
- no evidence of SCC.

If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as performed for the initial inspections.

e) Program element 4, “detection of aging effects,” of GALL Report AMPs XI.M29 and XI.M36 were revised to address tightly adhering insulation. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of CUI is low for tightly adhering insulation. Tightly adhering insulation should be considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope accessible piping, or tank surfaces, that have tightly adhering insulation should be visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections would not be credited towards the inspection quantities for other types of insulation.

f) Details of the changes to GALL Report AMPs XI.M29 and XI.M36 are shown in Appendices E and M (GALL Report AMP XI.M29) and Appendices F and N (GALL Report AMP XI.M36).

g) All of the changes to the SRP-LR and GALL AMR items are shown in Appendices B and J, and Appendices C and K, respectively.

h) Corresponding changes to the FSAR supplement descriptions are shown in Appendices B and J, Table 3.0-1.

F) External Volumetric Examination of Internal Piping Surfaces of Underground Piping Removed from GALL Report AMP XI.M41, “Buried and Underground Piping and Tanks”

i) Background

GALL Report AMP XI.M41 included a recommendation for conducting external volumetric inspections to detect internal corrosion in underground piping. 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 the management of aging effects on external surfaces of buried and underground piping, not internal surfaces. This LR-ISG incorporates recommendations related to inspection of internal surfaces of underground piping in the appropriate AMP.

ii) OE examples

a) The original inclusion of this recommendation in GALL Report AMP XI.M41 was based on 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.

iii) Summary of changes in this LR-ISG

a) Program element 1, “scope of program,” of 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 accessible piping where the material, environment, and aging effects of the buried or underground component are similar to those of the accessible component.

b) In addition, program element 1, “scope of program,” of GALL Report AMP XI.M38 was revised to state that if inspections of the interior surfaces of accessible components with material, environment, and aging effects similar to those of the interior surfaces of buried or underground components were not conducted; internal visual or external volumetric inspections are to be conducted on the buried or underground piping.

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

G) Specific Guidance for Use of the Pressurization Option for Inspecting Elastomers in GALL Report AMP XI.M38

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) OE examples

a) This change is not based on OE.

iii) Summary of changes in this LR-ISG

a) Program element 1, "scope of program," of GALL Report AMP XI.M38 was revised to state that elastomeric material is sufficiently pressurized to expand the surface of the material in such a way that cracks or crazing are evident. The revised wording clarifies the intent of the pressure test option. Program element 4, "detection of aging effects," was likewise revised.

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

H) Key Miscellaneous Changes to the GALL Report and SRP-LR

i) The definition of "hardening and loss of strength" in Section IX.E of the GALL Report was revised, as shown in Appendices C and K, 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, cracking and loss of sealing 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 definition of elastomer degradation in Section IX.F of the GALL Report was revised to include change in material properties as an aging effect example to make the definition more consistent with 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 so that the external surface condition is representative of the internal surface condition. The change was made to improve the consistency between the two programs.

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

v) The staff added or revised the following SRP-LR and corresponding GALL Report AMR line items:

a) The GALL Report and SRP-LR were revised to add high-density polyethylene (HDPE) piping exposed to an underground environment (Item 3.3.1-133 in SRP-LR Table 3.3-1 and Item VII.I.A-406 in the GALL Report). This change could reduce the number of nonconsistent items in an LRA because the material and environment will now be addressed in the GALL Report's AMR tables.

b) The GALL Report and SRP-LR were revised to add the waste water environment to item 3.3.1-72 in SRP-LR Table 3.3-1. Item VII.I.A-407 was added to the GALL Report. Selective leaching can occur in this combination of material and environment. This change could reduce the number of nonconsistent items in an LRA because the environment will now be addressed in the GALL Report's AMR tables for this combination of material, aging effect, and AMP.

c) The GALL Report and SRP-LR were s revised to add copper alloy, stainless steel, and steel materials exposed to raw water (nonsafety-related components not covered by NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment") being managed with GALL Report AMP XI.M38 for loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically influenced corrosion and fouling that leads to corrosion. Based on its review of the GALL Report, the staff also added heat exchanger components to the new AMR line items because the only existing program for copper alloy, stainless steel and steel exposed to raw water was GALL Report AMP XI.M20. New items (Item 3.3.1-134 in SRP-LR Table 3.3-1 and Items VII.C1.408 and VII.C1.409 in the GALL Report) were added.

These items were added because the "scope of program" program element of GALL Report AMP XI.M20 states that it includes "the service water system and any other cooling system exposed to raw water that transfers heat from safety-related SSCs [structures, systems, and components] to the UHS [ultimate heat sink]." Based on a review of GALL Report AMR line items for copper alloy, stainless steel, and steel materials exposed to raw water (with the exception of three items that cite GALL Report AMP XI.M27 and one item that cites GALL Report AMP XI.M38, all items cite GALL Report AMP XI.M20. The staff concluded that there is value added in including AMR line items for nonsafety-related components not covered by Generic Letter 89-13. Inclusion of these new AMR line items could reduce the number of AMR line items in an LRA that cite generic note E.

d) The GALL Report and SRP-LR were revised to add steel and stainless steel pump casings exposed to waste water being managed for loss of material due to general (steel only), pitting, crevice, and microbiologically influenced corrosion with GALL Report AMP XI.M36. The "scope of program" program element of GALL Report AMP XI.M36 allows the use of GALL Report AMP XI.M36 for managing internal aging effects for metallic components as long as the material and environment combinations are the same for the internal and external surfaces. With a submerged pump, this would be the case. The new items are Item 3.3.1-135 in SRP-LR Table 3.3-1 and Items VII.E5-410 and VII.E5-411 in the GALL Report. This change could reduce the number of nonconsistent items in an LRA because the material and environment will now be addressed in the GALL Report's AMR tables.

e) The GALL Report and SRP-LR were s revised to add jacketed calcium silicate insulation, fiberglass insulation, and foamglas® insulation (a cellular glass insulation supplied by Pittsburgh Corning) exposed to outdoor air and uncontrolled indoor air being managed with GALL Report AMP XI.M36 for degradation of thermal insulation due to moisture intrusion. The industry had proposed that this material and environment combination have no aging effect requiring management and no recommended AMP. The staff did not agree with that position. The staff concludes that where jacketing has been installed in accordance with plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc., external visual inspections of the jacketing that occur under the scope of GALL Report AMP XI.M36 are sufficient to ensure that the insulation's intended function will be met. Although leaks in piping systems that could impact the insulation could be viewed as event-driven, SRP-LR Section A.1.2.1, item 7, states "[h]owever, leakage from bolted connections should not be considered as abnormal events. Although bolted connections are not supposed to leak, experience shows that leaks do occur, and the leakage could cause corrosion. Thus, the aging effects from leakage of bolted connections should be evaluated for license renewal." In addition, insulation is susceptible to water intrusion during humid operational periods because water drips from components located above the insulated component. Based on the staff's research associated with a recent LRA, foamglas® insulation should be jacketed; otherwise, because of alternate freeze/thaw cycles, water intrusion will break down the insulation's structure. The staff revised GALL Report AMP XI.M36 to state that walkdowns of jacketing installed on in-scope insulation is acceptable as long as plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc., were used to install the jacketing. Alternatively, the applicant would need to propose an inspection methodology. A definition for a new term, "reduced thermal insulation resistance," was added to Section IX.E of the GALL Report and the following new items were included in the LR-ISG: Items 3.4.1-64 and 3.4.1-65 in SRP-LR Table 3.4-1 and Items VIII.I.S-403 and VIII.I.S-404 in the GALL Report.

ACTIONS

Applicants should use Appendices B through H 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, Markup Showing Changes to the SRP-LR

Appendix C, Markup Showing Changes to the GALL Report AMR Line Items and Definitions

Appendix D, Markup Showing Changes to GALL Report AMP XI.M27, “Fire Water System”

Appendix E, Markup Showing Changes to GALL Report AMP XI.M29, “Aboveground Metallic Tanks”

Appendix F, Markup Showing Changes to GALL Report AMP XI.M36, “External Surfaces Monitoring of Mechanical Components”

Appendix G, Markup Showing Changes to GALL Report AMP XI.M38, “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components”

Appendix H, Changes to Program Element 10, “Operating Experience,” in GALL Report AMPs XI.M20 and XI.M21A

Appendix I, Resolution of Public Comments

Appendix J, Revisions to the SRP-LR

Appendix K, Revisions to the GALL Report AMR Line Items and Definitions

Appendix L, Revised GALL Report AMP XI.M27, “Fire Water System”

Appendix M, Revised GALL Report AMP XI.M29, “Aboveground Metallic Tanks”

Appendix N, Revised GALL Report AMP XI.M36, “External Surfaces Monitoring of Mechanical Components”

Appendix O, Revised AMP XI.M38, “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components”

Unless otherwise noted, substantive changes in Appendices B through G are shown as crossed out for deleted text and underlined for added text. Appendix H was not annotated in this manner because it includes only new text added to program element 10, “operating experience,” for two GALL Report AMPs.

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APPENDIX A
INDEX OF CHANGES

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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 due to corrosion, including MIC, 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 the 2011 Edition of NFPA 25. and tTesting or replacement of sprinklers that have been in place for 50 years is performed in accordance with the 2011 Edition of NFPA 25. In addition to NFPA codes and standards, portions of the water-based fire protection system that are: (a) normally dry but periodically subjected to flow (e.g., dry-pipe or preaction sprinkler system components) and (b) cannot be drained or allow water to collect are to be subjected to augmented testing beyond that specified in NFPA 25, including: (a) periodic full flow tests at the design pressure and flow rate or internal visual inspections and (b) volumetric wall-thickness examinations. Flow testing and visual inspections are performed at intervals specified in the 2011 Edition of NFPA-25. 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 5 years before the prior to period of extended operation. Inspections of wetted normally dry piping segments that cannot be drained or that allow water to collect begin 5 years before the period of extended operation. The program's remaining inspections begin during the period of extended operation.	GALL VII / SRP 3.3

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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, and with sealant or caulking for outdoor tanks at the concrete-component interface. External visual and surface (when necessary to detect aging) inspectionexaminations during periodic system walkdowns should be are sufficient to monitor degradation of the protective paint, coating, and caulking, or sealant (when supplemented with physical manipulation), or uncoated surfaces. Surface exams are conducted to detect cracking when susceptible materials are used (e.g., stainless steel, aluminum). The external surfaces of insulated tanks are sampling-based inspected. Internal visual and surface (when necessary to detect cracking) examinations are conducted as well as 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.	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
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. A sample of outdoor component surfaces that are insulated and a sample of indoor insulated components exposed to condensation (due to the in-scope component being operated below the dew point), are periodically inspected every 10 years during the period of extended operation. When appropriate for the component and material, manipulation may be is used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength.	Program is implemented 6 months before the period of extended operation and inspections begin during the period of extended operation. Existing program	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4

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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.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 and piping elements, ducting, heat exchanger components, polymeric and elastomeric 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 indoor air; air – outdoor air; air with borated water leakage, condensation, moist air, diesel exhaust, and any water environment other than open-cycle cooling water, closed treated water, and fire water. 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 during the period of extended operation a representative sample of 20 percent of the population (defined as components having the same combination of material, environment, and aging effect) 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 (e.g., hydrotesting) 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 6 months before the period of extended operation and inspections begin during 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

APPENDIX B

MARK-UP SHOWING CHANGES TO THE SRP-LR

The following material is being added as new Further Evaluation AMR line 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 due to Recurring Internal Corrosion

3.3.2.2.8 Loss of Material due to Recurring Internal Corrosion

3.4.2.2.6 Loss of Material due to Recurring Internal Corrosion

Recurring internal corrosion 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 internal corrosion can be identified by the number of occurrences of aging effects 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 that has occurred over: (a) three or more sequential or nonsequential cycles for a 10-year OE search, or (b) two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism in which the aging effect resulted in the component either not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness.

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 adequate management of any recurring aging effect(s). 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), and additional trending parameters and decision points where increased inspections would be implemented. 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 effect 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., the extent of degradation at individual corrosion sites, the rate of degradation change), (d) how inspections of components that are not easily accessed (i.e., buried, underground) will be conducted, and (e) how leaks in any involved buried or underground components will be identified.

Each plant-specific operating experience example should be evaluated to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the operating experience should be evaluated to determine if the AMP that is proposed to manage the aging effect is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the CLB intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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

3.2.3.2.9 Loss of Material due to Recurring Internal Corrosion

3.3.3.2.8 Loss of Material due to Recurring Internal Corrosion

3.4.3.2.6 Loss of Material due to Recurring Internal Corrosion

The GALL Report recommends further evaluation to manage recurring internal corrosion aging effects. The reviewer conducts an independent review of plant-specific OE to determine whether the plant is currently experiencing recurring internal corrosion. The scope of this further evaluation AMR item includes recurring aging effects in which the plant-specific OE review reveals repetitive occurrences (e.g., one per refueling outage that has occurred over: (a) three or more sequential or nonsequential cycles for a 10-year OE search, or (b) two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism as a result of which the component either did not meet plant-specific acceptance criteria or experienced a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness.

The reviewer should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the operating experience should be evaluated to determine if the AMP that is proposed to manage the aging effect is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the CLB intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

The reviewer determines whether a proposed program is adequate to manage recurring internal corrosion by evaluating the proposed AMP against the criteria in SRP-LR Section 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
66	BWR/PWR	Metallic piping, piping components, and tanks exposed to raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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	Stainless steel or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No	V.D1.E-405 V.D2.E-405	N/A
68	BWR/PWR	Steel, stainless steel, or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No	V.D1.E-402 V.D2.E-402	N/A

APPENDIX B

MARK-UP SHOWING CHANGES TO THE SRP-LR

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	Insulated steel, stainless steel, copper alloy, or aluminum, piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or 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	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to treated water, treated borated water	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No	V.A.E-404 V.D1.E-404 V.D2.E-404	N/A N/A N/A
71	BWR/PWR	Insulated stainless steel, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No	V.A.E-406 V.B.E-406 V.C.E-406 V.D1.E-406 V.D2.E-406 V.E.E-406	N/A N/A N/A N/A N/A 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

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
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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	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	Chapter XI.M27, "Fire Water System"	No	VII.G.A-55	VII.G-19(A-55)
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)

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
72	BWR/PWR	Gray cast iron, Copper alloy (>15% Zn or >8% Al) Piping, piping components, and piping elements, Heat exchanger components exposed to Treated water, Closed-cycle cooling water, Soil, Raw water, Waste water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No	VII.A3.AP-31 VII.A3.AP-43 VII.A4.AP-31 VII.A4.AP-32 VII.A4.AP-43 VII.C1.A-02 VII.C1.A-47 VII.C1.A-51 VII.C1.A-66 VII.C2.A-50 VII.C2.AP-31 VII.C2.AP-32 VII.C2.AP-43 VII.C3.A-02 VII.C3.A-47 VII.C3.A-51 VII.E1.AP-31 VII.E1.AP-43 VII.E1.AP-65 VII.E3.AP-31 VII.E3.AP-32 VII.E3.AP-43 VII.E4.AP-31 VII.E4.AP-32 VII.E4.AP-43 VII.F1.AP-31 VII.F1.AP-43 VII.F1.AP-65 VII.F2.AP-31 VII.F2.AP-43 VII.E5.A-407	VII.A3-7(AP-31) VII.A3-6(AP-43) VII.A4-10(AP-31) VII.A4-9(AP-32) VII.A4-8(AP-43) VII.C1-12(A-02) VII.C1-10(A-47) VII.C1-11(A-51) VII.C1-4(A-66) VII.C2-8(A-50) VII.C2-9(AP-31) VII.C2-7(AP-32) VII.C2-6(AP-43) VII.C3-5(A-02) VII.C3-3(A-47) VII.C3-4(A-51) VII.E1-14(AP-31) VII.E1-13(AP-43) VII.E1-3(AP-65) VII.E3-12(AP-31) VII.E3-11(AP-32) VII.E3-10(AP-43) VII.E4-10(AP-31)

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
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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: 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 raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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	Steel, stainless steel, or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, or crevice corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VII.C3.A-401 VII.E5.A-401 VII.H1.A-401	N/A
129	BWR/PWR	Steel tanks exposed to soil or concrete; air-indoor uncontrolled, raw water, treated water, waste water, condensation	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
130	BWR/PWR	Metallic sprinklers exposed to air-indoor controlled, air-indoor uncontrolled, air-outdoor, moist air, condensation, raw water, treated water	Loss of material due to general (where applicable), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, “Fire Water System”	No	VII.G.A-403	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
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, and copper alloy only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No	VII.G.A-404	N/A
132	BWR/PWR	Insulated steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or 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 3.3-1 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
133	BWR/PWR	Underground HDPE piping, piping components, and piping elements in an air-indoor uncontrolled or condensation (external) environment	Cracking, blistering, change in color due to water absorption	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VII.I.A-406	N/A
134	BWR/PWR	Steel, stainless steel, or copper alloy piping, piping components, and piping elements, and heat exchanger components exposed to a raw water environment (for nonsafety-related components not covered by NRC GL 89-13)	Loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No	VII.C1.A-408 VII.C1.A-409	N/A N/A
135	BWR/PWR	Steel or stainless steel pump casings submerged in a waste water (internal and external) environment	Loss of material due to general (steel only), pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, "External Surfaces Monitoring of Mechanical Components"	No	VII.E5.A-410 VII.E5.A-411	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
136	BWR/PWR	Steel, stainless steel or aluminum fire water storage tanks exposed to air-indoor uncontrolled, air-outdoor, condensation, moist air, raw water, treated water	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	Chapter XI.M27, "Fire Water System"	No	VII.G.A-412	N/A
137	BWR/PWR	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to treated water, treated borated water	Loss of material due to general (steel only) pitting and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VII.C3.A-413 VII.E5.A-413 VII.H1.A-413	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
30	BWR/PWR	Steel, Stainless Steel, Aluminum Tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (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 (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No	VIII.E.SP-137 VIII.E.SP-139	N/A N/A
61	BWR/PWR	Metallic piping, piping components, and tanks exposed to raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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

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
62	BWR/PWR	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VIII.E.S-405 VIII.G.S-405	N/A N/A
63	BWR/PWR	Insulated steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy), pitting, or crevice corrosion, and cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) 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
64	BWR/PWR	Jacketed calcium silicate or fiberglass insulation in an air-indoor uncontrolled or air-outdoor environment	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No	VIII.I.S-403	N/A
65	BWR/PWR	Jacketed foamglas ® (glass dust) insulation in an air-indoor uncontrolled or air-outdoor environment	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No	VIII.I.S-404	N/A

APPENDIX C

MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR LINE 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-400 V.B.E-400 V.C.E-400 V.D1.E-400 V.D2.E-400		Piping, piping components, and tanks	Metallic	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant specific
V.D1.E-402 V.D2.E-402		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, or aluminum	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, “Aboveground Metallic Tanks,” (for tanks)	No
V.A.E-404 V.D1.E-404 V.D2.E-404		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel or aluminum	Treated water, treated borated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks,”	No
V.D1.E-405 V.D2.E-405		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No

APPENDIX C

MARK-UP SHOWING CHANGES TO THE GALL REPORT AMR LINE 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-406 V.B.E-406 V.C.E-406 V.D1.E-406 V.D2.E-406 V.E.E-406		Insulated piping, piping components, and tanks	Stainless steel, aluminum or copper alloy (> 15% Zn)	Condensation, air-outdoor	Cracking due to stress corrosion cracking	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

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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: 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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	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 AUXILIARY SYSTEMS

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No

VII AUXILIARY SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
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	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
VII.C3.A-401 VII.E5.A-401 VII.H1.A-401		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel; stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	Chapter XI.M29, “Aboveground Metallic Tanks”	No

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.G.A-402 VII.H1.A-402		Tanks	Steel	Soil or concrete; air-indoor uncontrolled, raw water, treated water, waste water, condensation	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VII.G.A-403		Sprinklers	Metallic	Air-indoor controlled, air-indoor uncontrolled, air-outdoor, moist air, condensation, raw water, treated water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No
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-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No

APPENDIX C

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-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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn)	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, "Aboveground Metallic Tanks" (for tanks only)	No
VII.I.A-406		Underground piping, piping components, and piping elements	HDPE	Air-indoor uncontrolled or condensation (external) environment	Cracking, blistering, change in color due to water absorption	Chapter XI.M41, "Buried and Underground Piping and Tanks	No
VII.E5.A-407		Piping, piping components, and piping elements, and heat exchanger components	Gray cast iron, copper alloy (>15% Zn or >8% Al)	Waste water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No

VII AUXILIARY SYSTEMS

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.C1.A-408		Piping, piping components, and piping elements, and heat exchanger components (for nonsafety-related components not covered by NRC GL 89-13)	Steel, copper alloy	Raw water	Loss of material due to general, pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.C1.A-409		Piping, piping components, and piping elements, and heat exchanger components (for nonsafety-related components not covered by NRC GL 89-13)	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.A-410		Pump Casing	Steel	Waste water (internal and external)	Loss of material due to general, pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.E5.A-411		Pump Casing	Stainless steel	Waste water (internal and external)	Loss of material due to pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, "External Surfaces Monitoring of Mechanical Components"	No

APPENDIX C

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.G.A-412		Fire water storage tanks	Steel, stainless steel, or aluminum	Air-indoor uncontrolled, air-outdoor, condensation, moist air, raw water, treated water	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; cracking due to stress corrosion cracking (aluminum and stainless steel only)	Chapter XI.M27, "Fire Water System"	No
VII.C3.A-413 VII.E5.A-413 VII.H1.A-413		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel, or aluminum	Treated water, treated borated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No

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-137		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Stainless steel	Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-138		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Stainless steel	External environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VIII.E.SP-139		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Aluminum	Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No

APPENDIX C

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-140		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Aluminum	External environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No
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	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, or copper alloy (> 15% Zn), aluminum	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, “Aboveground Metallic Tanks,” (for tanks only)	No
VIII.I.S-403		Jacketed insulation	Calcium silicate, fiberglass	Air-indoor uncontrolled or air-outdoor	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.I.S-404		Jacketed insulation	Foamglas® (glass dust)	Air-indoor uncontrolled or air-outdoor	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

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.S-405 VIII.G.S-405		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel, or aluminum	Treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No

GALL Report Section	Term	Definition as used in this document
IX.D	Condensation (internal/external)	Condensation on the surfaces of systems at temperatures below the dew point is considered “raw water” due to the potential for internal or external surface contamination. Under certain circumstances, the former terms “moist air” or “warm moist air” are subsumed by the definition of “condensation,” which describes an environment where there is enough moisture for corrosion to occur. Because of air in-leakage through minor gaps in insulation, condensation can occur underneath the insulation on components when the operating temperature of the component is below the dew point of the air on the external surfaces of the insulation.
IX.E	Flow blockage	Flow blockage is the reduction of flow or pressure, or both, in a component due to fouling, which can occur from an accumulation of debris such as particulate fouling (e.g., eroded coatings, corrosion products), biofouling, or macro fouling. Flow blockage can result in a reduction of heat transfer or the inability of a system to meet its intended safety function, or both. This definition is consistent with the definition of the term “pressure boundary” as found in SRP-LR Table 2.1-4(b), “Typical ‘Passive’ Component-Intended Functions.”
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.
IX.E	Reduced thermal insulation resistance	Impairment of thermal insulation’s ability to resist the transfer of heat between the ambient environment and the insulated structure or component. This is caused by the degradation of the insulation that typically occurs when insulation is exposed to moisture.

GALL Report Section	Term	Definition as used in this document
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~~ or others found in fresh and salt water) or micro-organisms (e.g., algae, microfouling tubercles~~, 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 a 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, and change in material properties ~~and weathering~~. [Ref. 24, 25]

GALL Report Section	Term	Definition as used in this document
IX.F	Recurring internal corrosion	Recurring internal corrosion is identified by both the number of occurrences of internal aging effects with the same aging mechanism 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 that has occurred over three or more sequential or nonsequential cycles for a 10-year OE search, or two or -more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism. 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 experiencing a reduction in wall thickness of greater than 50 percent (regardless of the minimum wall thickness). Recurring internal corrosion is evaluated based on the aging mechanisms observed. For example, multiple occurrences of loss of material (LOM) due to MIC, LOM due to pitting, or LOM due to galvanic corrosion would be considered three separate occurrences of aging mechanisms that could be grouped as recurring internal corrosion but that would be evaluated separately.

APPENDIX D

MARK-UP SHOWING CHANGES TO GALL REPORT 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, valve~~s~~ bodies, 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: (a) normally dry but periodically are subject to flow (e.g., dry-pipe or preaction sprinkler system piping and valves) and (b) that cannot be drained or allow water to collect, 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.

Either 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 the 2011 Edition of NFPA 25, "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~~ GALL Report 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~~in~~ the scope of water-based fire protection systems ~~exposed to water.~~, include items such as sprinklers, nozzles, fittings, valve~~s~~ bodies, 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 due to fouling from the buildup of corrosion products or sediment in the system could occur. Therefore, the parameters monitored are the system's ability to maintain required pressure, flow rates, and the system's internal 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 visual inspections are used to detect loss of material, the inspection technique is capable of detecting surface irregularities that could indicate wall loss to below nominal pipe wall thickness due to corrosion and corrosion product deposition. 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 are normally dry.

4. ***Detection of Aging Effects:*** All water-based fire protection system components are subject to flow testing (except for fire water storage tanks), other testing, and visual inspections. Testing and visual inspections are performed in accordance with Table 4a, "Fire Water System Inspection and Testing Recommendations."

   - Flow tests confirm the system is functional by verifying the capability of the system to deliver water to fire suppression systems at 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 V~~Visual inspections are capable of evaluating: ~~wall thickness to ensure against catastrophic failure~~ (a) the condition of the external surfaces of components, (b) the conditions of the internal surfaces of components that could indicate wall loss, and (bc) the inner diameter of the piping as it applies to the design flow of the fire protection system (i.e., to verify that corrosion product buildup has not resulted in flow blockage due to fouling). Internal visual inspections used to detect loss of material are capable of detecting surface irregularities that could be indicative of wall loss below nominal pipe wall thickness due to corrosion and corrosion product deposition. Where such irregularities are detected, followup volumetric examinations are performed.

- 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.

Table 4a Fire Water System Inspection and Testing Recommendations [1, 2, 5]	
Description	NFPA 25 Section
Sprinkler Systems	
Sprinkler inspections[5]	5.2.1.1
Sprinkler testing	5.3.1
Standpipe and Hose Systems	
Flow tests	6.3.1
Private Fire Service Mains	
Underground and exposed piping flow tests	7.3.1
Hydrants	7.3.2
Fire Pumps	
Suction screens	8.3.3.7
Water Storage Tanks	
Exterior inspections	9.2.5.5
Interior inspections	9.2.6[4], 9.2.7
Valves and System-Wide Testing	
Main drain test	13.2.5
Deluge valves[5]	13.4.3.2.2 through 13.4.3.2.5
Water Spray Fixed Systems	
Strainers (refueling outage interval and after each system actuation)	10.2.1.6, 10.2.1.7, 10.2.7
Operation test (refueling outage interval)	10.3.4.3
Foam Water Sprinkler Systems	
Strainers (refueling outage interval and after each system actuation)	11.2.7.1
Operational Test Discharge Patterns (annually)[6]	11.3.2.6
Storage tanks (internal – 10 years)	Visual inspection for internal corrosion
Obstruction Investigation	
Obstruction, internal inspection of piping[3]	14.2 and 14.3

1. All terms and references are to the 2011 Edition of NFPA 25. The staff cites the 2011 Edition of NFPA 25 for the description of the scope and periodicity of specific inspections and tests. This table specifies those inspections and tests that are related to age-managing applicable aging effects associated with loss of material and flow blockage for passive long-lived in-scope components in the fire water system. Inspections and tests not related to the above should continue to be conducted in accordance with the plant's current licensing basis. If the current licensing basis specifies more frequent inspections than required by NFPA 25 or this table, the plant's current licensing basis should continue to be met.
2. A reference to a section includes all sub-bullets unless otherwise noted (e.g., a reference to 5.2.1.1 includes 5.2.1.1.1 through 5.2.1.1.7).
3. The alternative nondestructive examination methods permitted by 14.2.1.1 and 14.3.2.3 are limited to those that can ensure that flow blockage will not occur.
4. In regard to Section 9.2.6.4, the threshold for taking action required in Section 9.2.7 is as follows: pitting and general corrosion to below nominal wall depth and any coating failure in which bare metal is exposed. Blisters should be repaired. Adhesion testing should be performed in the vicinity of blisters even though bare metal might not have been exposed. Regardless of conditions observed on the internal surfaces of the tank, bottom-thickness measurements should be taken on each tank during the first 10-year period of the period of extended operation.
5. Items in areas that are inaccessible because of safety considerations such as those raised by continuous process operations, radiological dose, or energized electrical equipment shall be inspected during each scheduled shutdown but not more often than every refueling outage interval.
6. Where the nature of the protected property is such that foam cannot be discharged, the nozzles or open sprinklers shall be inspected for correct orientation and the system tested with air to ensure that the nozzles are not obstructed.

Portions of water-based fire protection system components that have been wetted but are normally dry, such as dry-pipe or preaction sprinkler system piping and valves, are subjected to augmented testing and inspections beyond those of Table 4a. The augmented tests and inspections are conducted on piping segments that cannot be drained or piping segments that allow water to collect:

- In each 5-year interval, beginning 5 years prior to the period of extended operation, either conduct a flow test or flush sufficient to detect potential flow blockage, or conduct a visual inspection of 100 percent of the internal surface of piping segments that cannot be drained or piping segments that allow water to collect.

- In each 5-year interval of the period of extended operation, 20 percent of the length of piping segments that cannot be drained or piping segments that allow water to collect is subject to volumetric wall thickness inspections. Measurement points are obtained to the extent that each potential degraded condition can be identified (e.g., general corrosion, MIC). The 20 percent of piping that is inspected in each 5-year interval is in different locations than previously inspected piping.

If the results of a 100-percent internal visual inspection are acceptable, and the segment is not subsequently wetted, no further augmented tests or inspections are necessary. 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 Table 4a do not need to be augmented.

The inspections and tests of all water-based fire protection components occur at the intervals specified in the 2011 Edition of NFPA 25.

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 inside diameter loss of material. If not, additional inspection activities are needed to ensure that the intended function of ~~below grade~~ buried and underground 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 in such a way 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. Sprinkler heads are tested before the end of the 50-year sprinkler head service life 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 of degradation are observed during non-intrusive or visual inspection of components, (c)~~ minimum design wall thickness is maintained, and (~~d~~c) no ~~bio~~fouling exists in the sprinkler systems that could cause corrosion in the sprinklers. Additionally, if the presence of sufficient foreign organic or inorganic material to obstruct pipe or sprinklers is detected during pipe inspections, the material is removed and its source is determined and corrected.

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 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 leak-by.

    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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence.

Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, “Loss of Material due to Recurring Internal Corrosion,” address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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 GALL REPORT 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 certain indoor tanks are included. If the tank exterior is fully visible, the tank's outside surfaces may be inspected under the program for inspection of external surfaces may be used instead (GALL Report AMP XI.M36) for visual inspections recommended in this AMP; surface examinations are conducted in accordance with the recommendations of this AMP. 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 applicable aging effects.

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 storage tanks (i.e., those with a capacity greater than 100,000 gallons) 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 (GALL Report AMP XI.M36). Aging effects for fire water storage tanks are managed using GALL Report AMP XI.M27. Visual inspections are conducted on tank insulation and jacketing when these are installed.

2. ***Preventive Actions:*** In accordance with industry practice, steel tanks may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the tank from environmental exposure. For outdoor tanks, except for cases in which the configuration of the tank bottom and foundation would dictate otherwise (e.g., the foundation is sloped in such a way that water cannot accumulate under the tank bottom), sealant or caulkingmay isbe 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 wcould 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, and 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 periodically removed or inspected to detect the potential for loss of material or cracking underneath the insulation.

4. ***Detection of Aging Effects:*** Tank inspections are conducted in accordance with Table 4a, "Tank Inspection Recommendations." 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. If the exterior surface is not coated, visual inspections of the tank's surface are conducted within sufficient proximity (e.g., distance, angle of observation) to detect loss of material. If the tank is insulated, the inspections include 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.

If the exterior surface of an outdoor tank or indoor tank exposed to condensation (because the in-scope component being 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 of 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 in such a way 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 could collect such as on top of stiffening rings. In addition, inspection locations should be based on the likelihood of corrosion under insulation occurring (e.g., given how often a potential inspection location is subject to alternate wetting and drying in environments where trace contaminants could be present, how long a system at a potential inspection location operates below the dew point).

Alternatives to Removing Insulation:

a. Subsequent inspections may consist of examination of the exterior surface of the insulation for indications of damage to the jacketing or protective outer layer of the insulation when the results of the initial inspection meet the following criteria:

   i. No loss of material due to general, pitting or crevice corrosion, beyond that which could have been present during initial construction is observed, and

ii. no evidence of SCC is observed.

If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or jacketing, or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as conducted for the initial inspection.

b. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of corrosion under insulation (CUI) is low for tightly adhering insulation. Tightly adhering insulation is considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation is visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections are not credited towards the inspection quantities for other types of insulation.

Potential corrosion of tank bottoms is determined ~~by taking~~ from ultrasonic testing (UT) thickness measurements of the tank bottoms that are taken whenever the tank is drained or at intervals not less than those recommended in Table 4a. ~~and at least once within 5-years of 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.

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

APPENDIX E

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

Table 4a Tank Inspection Recommendations[1, 2]

Material	Environment	AERM	Inspection Technique[3]	Inspection Frequency
Inspections to identify degradation of inside surfaces of tank shell, roof[4], and bottom Inside Surface (IS), Outside Surface (OS)[5, 6]				
Steel	Raw water Waste water	Loss of material	Visual from IS or Volumetric from OS[7]	Each 10-year period starting 10 years before the period of extended operation
Steel	Treated water	Loss of material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Stainless steel	Treated water	Loss of Material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Aluminum	Treated water	Loss of Material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Inspections to identify degradation of external surfaces of tank roof, tank shell, and bottom not exposed to soil or concrete[9]				
Steel	Air – indoor uncontrolled Air – outdoor	Loss of material	Visual from OS	Each refueling outage interval
Stainless steel	Air – indoor uncontrolled	Cracking	Surface [10, 11]	Each 10-year period starting 10 years before the period of extended operation
Stainless steel	Air-outdoor	Loss of material	Visual from OS	Each refueling outage interval
		Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Aluminum	Air – indoor uncontrolled	Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Aluminum	Air-outdoor	Loss of material	Visual from OS	Each refueling outage interval
		Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Inspections to identify degradation of external surfaces of tank bottoms and tank shells exposed to soil or concrete				
Steel	Soil or concrete	Loss of material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]
Stainless steel	Soil or concrete	Loss of material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]
Aluminum	Soil or concrete	Loss of Material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]

APPENDIX E

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

Table 4a Tank Inspection Recommendations[1, 2]				
Material	Environment	AERM	Inspection Technique[3]	Inspection Frequency

1. GALL Report AMP XI.M30, "Fuel Oil Chemistry," is used to manage loss of material on the internal surfaces of fuel oil storage tanks. However, for outdoor fuel oil storage tanks, inspections to identify aging of the external surfaces of tank bottoms and tank shells exposed to soil or concrete are conducted in accordance with GALL Report XI.M29. GALL Report AMP XI.M41 is used to manage loss of material and cracking for the external surfaces of buried tanks.
2. When one-time internal inspections in accordance with these footnotes are used in lieu of periodic inspections, the one-time inspection must occur within the 5-year period before the start of the PEO.
3. Alternative inspection methods may be used to inspect both surfaces (i.e., internal, external) or the opposite surface (e.g., inspecting the internal surfaces for loss of material from the external surface, inspecting for corrosion under external insulation from the internal surfaces of the tank) as long as the method has been demonstrated to be effective at detecting the AERM and a sufficient amount of the surface is inspected to ensure that localized aging effects are detected. For example, in some cases, subject to being demonstrated effective by the applicant, the low frequency electromagnetic technique (LFET) can be used to scan an entire surface of a tank. If followup ultrasonic examinations are conducted in any areas where the wall thickness is below nominal, an LFET inspection can effectively detect loss of material in the tank shell, roof, or bottom.
4. Nonwetted surfaces on the inside of a tank (e.g., roof, surfaces above the normal waterline) are inspected in the same manner as the wetted surfaces based on the material, environment, and AERM.
5. Visual inspections to identify degradation of the inside surfaces of tank shell, roof, and bottom should cover all the inside surfaces. Where this is not possible because of the tank's configuration (e.g., tanks with floating covers or bladders), the LRA should include a justification for how aging effects will be detected before the loss of the tank's intended function.
6. For tank configurations in which deleterious materials could accumulate on the tank bottom (e.g., sediment, silt), the internal inspections of the tank's bottom should include inspections of the side wall of the tank up to the top of the sludge-affected region.
7. At least 25 percent of the tank's internal surface is to be inspected using a method capable of precisely determining wall thickness. The inspection method should be capable of detecting both general and pitting corrosion and be demonstrated effective by the applicant.
8. At least one tank for each material and environment combination should be inspected at each site. The tank inspection can be credited towards the sample population for GALL Report AMP XI.M32.
9. For insulated tanks, the external inspections of tank surfaces that are insulated are conducted in accordance with the sampling recommendations in this AMP. If the initial inspections meet the criteria described in the preceding "Alternatives to Removing Insulation" portion of this AMP, subsequent inspections may consist of external visual inspections of the jacketing in lieu of surface examinations. Tanks with tightly adhering insulation may use the "Alternatives to Removing Insulation" portion of this AMP for initial and all follow-on inspections.
10. A one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if an evaluation conducted before the PEO and during each 10-year period during the PEO demonstrates the absence of environmental impacts in the vicinity of the plant due to: (a) the plant being located within approximately 5 miles of a saltwater coastline, or within 1/2 mile of a highway that is treated with salt in the wintertime, or in areas in which the soil contains more than trace amounts of chlorides, (b) cooling towers where the water is treated with chlorine or chlorine compounds, and (c) chloride contamination from other agricultural or industrial sources. The evaluation should include soil sampling in the vicinity of the tank (because soil results indicate atmospheric fallout accumulating in the soil and potentially affecting tank surfaces) and sampling of residue on the top and sides of the tank to ensure that chlorides or other deleterious compounds are not present at sufficient levels to cause pitting corrosion, crevice corrosion, or cracking.
11. A minimum of either 25 sections of the tank's surface (e.g., 1-square-foot sections for tank surfaces, 1-linear-foot sections of weld length) or 20 percent of the tank's surface are examined. The sample inspection points are distributed in such a way that inspections occur in those areas most susceptible to degradation (e.g., areas where contaminants could collect, inlet and outlet nozzles, welds).
12. When volumetric examinations of the tank bottom cannot be conducted because the tank is coated, an exception should be stated, and the accompanying justification for not conducting inspections should include the considerations in footnote 13, below, or propose an alternative examination methodology.
13. A one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if an evaluation conducted before the PEO and during each 10-year period during the PEO demonstrates that the soil under the tank is not corrosive using actual soil samples that are analyzed for each individual parameter (e.g., resistivity, pH, redox potential, sulfides, sulfates, moisture) and overall soil corrosivity. The evaluation should include soil sampling from underneath the tank.

    Alternatively, a one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if the bottom of the tank has been cathodically protected in such a way that the availability and effectiveness criteria 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'," Table 4c., "Inspections of Buried Tanks for all Inspection Periods," have been met beginning 5 years prior to the PEO, and the criteria continue to be met throughout the PEO.

APPENDIX E

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

5. ***Monitoring and Trending:*** The effects of corrosion of the ~~aboveground external~~ tank surfaces are detectable by visual and surface (for cracking) examination 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 surfaces 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:*** A review of OE reveals that there have been instances involving defects variously described as wall thinning, pinhole leaks, cracks, and through-wall flaws in tanks. 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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 Information Notice 2013-18, Refueling Water Storage Tank Degradation, September 13, 2013.

APPENDIX F

MARK-UP SHOWING CHANGES TO GALL REPORT 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 (of polymeric components). When appropriate for the component and material, physical manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength.

Reduced thermal insulation resistance due to moisture intrusion, associated with insulation which is jacketed, is managed by visual inspection of the condition of the jacketing when the insulation has been included in scope to reduce heat transfer from the insulated components. Outdoor insulated components, and indoor components exposed to condensation (because the in-scope component is operated below the dew point), have portions of the insulation inspected or removed to determine whether the exterior surface of the component is degrading or has the potential to degrade. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (GALL Report 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. Visual inspections are conducted on insulation jacketing to ensure that no aging effects are impairing the function of the thermal insulation. Visual inspections are also conducted on outdoor insulated components, and indoor components exposed to condensation (because the in-scope component is operated below the dew point) to determine whether the exterior surface of the component is degrading or has the potential to degrade. 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 GALL Report 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, GALL Report 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.~~ Depending on the material, components may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the component from environmental exposure. Insulation jacketing can limit or prevent water in-leakage for insulation.

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, insulation jacketing, 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 accessible only 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.*~~

In some instances, thermal insulation (e.g., calcium silicate) has been included in scope to reduce heat transfer from components to ensure that functions described in 10 CFR 54.4(a) are successfully accomplished. When metallic jacketing has been used, it is acceptable to conduct external visual inspections of the jacketing to ensure that there is no damage to the jacketing that would permit in-leakage of moisture as long as the jacketing has been installed in accordance with plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc. If plant-specific procedures do not include these features, an alternative inspection methodology should be proposed.

Component surfaces that are insulated and exposed to condensation (because the in-scope component is operated below the dew point), and insulated outdoor components, (except tanks, which are addressed by GALL Report 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 during the period of extended operation. For all outdoor components (except tanks) and any indoor components exposed to condensation (because the in-scope component is operated below the dew point), inspections are conducted of each material type (e.g., 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, significant moisture can accumulate under insulation during high humidity seasons even with conditioning of air. A minimum of 20 percent of the in-scope piping length, or 20 percent of the surface area for components whose configuration does not conform to a 1-foot axial length determination (e.g., valve, accumulator), 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. Inspection locations should focus on the bounding or lead components most susceptible to aging because of time in service, severity of operating conditions (e.g., amount of time that condensate would be present on the external surfaces of the component), and lowest design margin. The following are alternatives to removing insulation:

a. Subsequent inspections may consist of examination of the exterior surface of the insulation with sufficient acuity to detect indications of damage to the jacketing or protective outer layer of the insulation when the results of the initial inspection meet the following criteria:

   i. No loss of material due to general, pitting, or crevice corrosion, beyond that which could have been present during initial construction is observed, and

   ii. no evidence of SCC is observed.

   If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or jacketing, or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as conducted for the initial inspection.

b. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of corrosion under insulation (CUI) is low for tightly adhering insulation. Tightly adhering insulation is considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation is visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections are not credited towards the inspection quantities for other types of insulation.

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 inspections ~~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.

~~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 or a mottled appearance 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~~ dimensiona~~l~~ 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 are specified and may 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.

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 GALL REPORT 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 (GALL Report AMP XI.M20), closed treated water system, except elastomers in these systems can be managed by this program (GALL Report AMP XI.M21A), and fire water system (GALL Report 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, as written, is not intended for use on ~~piping and ducts~~ components in which~~where repetitive failures have occurred from loss of material that~~ recurring internal corrosion is evident based on a search of plant-specific OE conducted during the LRA development where repetitive occurrences of loss of material have occurred (e.g., one per refueling outage cycle that has occurred over three or more sequential or nonsequential cycles for a 10-year OE search, or two or -more sequential or nonsequential cycles for a 5-year OE search) with the same aging mechanism in which the aging effect resulted in the component either not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness).~~resulted in loss of function~~ If operating experience indicates that there ~~have~~ has been ~~repetitive failures caused by loss of material,~~recurring internal corrosion, a plant-specific program will be ~~required~~necessary unless this program, or another new or existing program, includes augmented requirements to ensure that any recurring aging effects are adequately managed (e.g., SRP-LR Section 3.2.2.2.9, 3.3.2.2.8, 3.4.2.2.6). Following ~~a~~ failure~~,~~ due to recurring internal corrosion, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest, or corrective actions have been taken to prevent recurrence of the recurring internal corrosion.

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 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., the component is sufficiently pressurized to expand the surface of the material in such a way 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.

For situations in which the material and environment combinations are similar for the internal and external surfaces such that the external surface condition is representative of the internal surface condition, external inspections of components may be credited for managing: (a) loss of material from internal surfaces of metallic components and (b) loss of material, cracking, and change in material properties from the internal surfaces of polymeric components. When credited, the program describes the component's internal environment and the credited external component's environment inspected and provides the basis to justify that the external and internal surface condition and environment are sufficiently 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., involving manipulation or pressurization 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 would be expected from the normally dry surfaces associated with the latter environment). Alternatively, similar environments (e.g., internal uncontrolled indoor, controlled indoor, dry air environments) can be combined into a larger population provided that the inspections occur on components located in the most severe environment.

To determine the condition of internal surfaces of buried and underground piping, inspections of the interior surfaces of accessible piping may be credited if the accessible and buried or underground component material, environment, and aging effects are similar. When inspections of the interior surfaces of accessible components with similar material, environment, and aging effects as the interior surfaces of buried or underground piping are not conducted, the sample population will be inspected using 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 carried out using plant-specific procedures by inspectors qualified through plant-specific programs. The inspection procedures 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 or pressurization 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~~ accessible 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.

APPENDIX G

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

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 or a mottled appearance 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 a~~For~~ flexible material's properties (e.g., hardness, flexibility, physical dimensions, and color) 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 are specified and may 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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

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:

- GALL Report AMP XI.M20, "Open-Cycle Cooling Water System"
- GALL Report AMP 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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Note: The Nuclear Energy Institute (NEI) submitted comments by letter dated June 14, 2013 (ADAMS Accession No. ML13168A397), which integrated multiple industry comments on the subject LR-ISG. NEI provided three attachments in its letter:

1. Attachment 1, “LR-ISG-2012-02 Significant Industry Comments and Considerations”
2. Attachment 2, “Detailed Industry Comments”
3. Attachment 3, “Supplemental Details”

The text of Attachments 1 and 3 are not included in this Appendix because the specific details and NRC resolution of comments are covered in the table below.

As requested by the staff, NEI provided input related to the potential to split the LR-ISG into multiple parts. The industry requested that the portion of the LR-ISG addressing Service Level III and Other coatings be removed from LR-ISG-2012-02 and addressed in a new LR-ISG. This would allow for further discussion on the recommendations associated with Service Level III and Other coatings, while progressing with issuance of LR-ISG-2012-02. The staff agreed with this change. A new ISG, LR-ISG-2013-01, “Aging Management of Service Level III and IV Coatings,” has been initiated. As such, industry comments numbered 5, 6, and 74 through 81 will be addressed as the new LR-ISG proceeds through development, public comment, and final issuance.

The location, comment, and discussion columns were copied from the NEI letter with minimal editorial edits and merged into a single column. In several places, NEI annotated changes in red. Given that color might not be consistently legible in all formats, the staff converted the input to struck-through text for deleted text and underlined text for added text; the staff also deleted NEI’s in-text statements about “(new text shown in red text)”, “(changes noted in red text)”, etc.

#	Location, Comment, Discussion	Staff Resolution
1	The Industry suggests the [use] of the term "Recurring Internal Corrosion" rather than Persistent/Pervasive Internal Corrosion. Provides a response to a Staff cover letter question as well as provides consistency throughout the ISG.	No changes are required. The staff used “recurring internal corrosion” in the draft version for public comment and the final version.
2	Revise this change description to reference "recurring internal degradation" as follows: "The new FE AMR items <u>for recurring internal degradation</u> are acceptable if the search of plant-specific OE reveals repetitive occurrences..." Editorial change to indicate consistency with the definition of recurring internal degradation noted in Appendix C.	The staff agrees that an editorial change is appropriate; however, the staff inserted the term “recurring internal corrosion” for consistency with the further evaluation AMR item title and SRP-LR and GALL Report Tables.

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#	Location, Comment, Discussion	Staff Resolution
3	LR-ISG Section A).iv).b). App B Further Evaluations 3.X.2.2. and 3.X.3.2 One of the criteria for the recurring internal corrosion (RIC) further evaluation requires a change of material properties that involve "a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more (typically as a result of selective leaching)." This criteria should be deleted since it primarily applies to change in material properties associated with selective leaching. Based on the proposed AMPs and associated aging effects, the wall penetration criteria is the more appropriate for metallic loss of material. A plant specific acceptance criteria is more appropriate for change in material properties of polymeric components. Change in material properties for RIC further evaluations associated with metallic components should be deleted since it primarily applies to selective leaching. AMP XI.M33, Selective Leaching, requires a one-time inspection (OTI) of selected materials. If selective leaching is occurring or when a component with selective leaching has been repaired, a plant-specific program is required. Because AMP XI.M33 is an OTI that requires a follow-up evaluation and possible expansion of the inspection sample size, a plant-specific program would be put in place before a RIC further evaluation is performed. A separate ISG for the AMP XI.M33 is recommended if additional plant-specific program criteria are required. In addition the change in material properties criteria implies destructive testing, which may only be performed in a limited number of cases. It's not clear what criteria a licensee would use to "expect" such a reduction in properties. Based on adding RIC further evaluations to AMP XI.M27 and XI.M38, the applicable aging effects would be loss of material for metallic components and change of material properties (hardening and loss of strength) in polymeric components.	The staff agrees with this comment based on the following: • The change of material properties that involve a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more was intended to apply only to selective leaching. • The “scope of program” program element of GALL Report XI.M33, “Selective Leaching,” states, “[f]or materials and environments where selective leaching is currently occurring or for materials in environments where the component has been repaired with the same material, a plant-specific program is required.” • The “corrective actions” ” program element of GALL Report XI.M33 states, “[u]nacceptable inspection findings result in additional inspection(s) being performed, which may be on a periodic basis, or in component repair or replacement.” • Based on the above two excerpts from GALL Report AMP XI.M33, the staff recognizes that plant-specific requirements would be implemented at a station where selective leaching was detected. For example, in one known instance in which recurring selective leaching occurred at a station before development of its LRA, the applicant appropriately developed a plant-specific program. • The staff will address gaps in proposed plant-specific programs through the RAI process. At such time that OE demonstrates an increased trend in the occurrence of recurring selective leaching the staff will consider developing an LR-ISG to address changes to GALL Report AMP XI.M33. • The staff is not aware of any OE related to recurring aging of polymeric or elastomeric materials (with the exception of internal coatings which will be addressed in LR-ISG-2013-01) as defined in this LR-ISG (i.e., frequency and consequence) and therefore, this LR-ISG does not address hardening and loss of strength in polymeric components. The text "a reduction of ultimate tensile strength, yield strength, or fracture toughness properties of 40 percent or more,” was removed from the LR-ISG.

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#	Location, Comment, Discussion	Staff Resolution
4	LR-ISG Section B).ii).a). first bullet and App G element 4 In Section B of the LR-ISG, revise the first bullet to state that inspections start beginning 10 years prior to the PEO as follows. In each 10-year period ~~during the PEO~~ beginning 10 years before 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. In Appendix G (AMP XI.M38), revise element 4 second sentence to be consistent with the implementation schedule in SRP-LR and the changes to Section B. This change is required for consistency of the XI.M38 implementation schedule in LR-ISG-2012-02 in Section B, Appendix B SRP-LR Table 3.0-1 for XI.M38) and Appendix G (AMP XI.M38). Changes should be consistent with SRP-LR Table 3.0-1 which states: 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.	The staff agrees that each section of the LR-ISG should be consistent. It was not the staff's intent to extend the inspections for GALL Report AMP XI.M38 into the period prior to the period of extended operation. In this case, in lieu of revising Section B of the LR-ISG, Appendix B, SRP-LR Table 3.0-1 for XI.M38 was corrected to state that the inspections are conducted during each 10-year period of the period of extended operation. Each section of the LR-ISG that refers to GALL Report AMP XI.M38 now states: "[a]t 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."
5		To be addressed in LR-ISG-2013-01
6		
7	LR-ISG Section D).iii).c). Replace the last sentence of the first paragraph with the following: "Fire water system piping in the flow path that is not subjected to flow testing or flushing will include the following augmented inspections of piping segments that cannot be drained or piping segments that allow water to collect:". Clarification is needed to confirm that the augmented inspections apply to those piping segments that cannot be drained or allow water to collect in the flow path of fire water system piping that is not subjected to subsequent flow testing or flushing.	The staff agrees that clarification is appropriate. The proposed change is editorial because the intent of the wording has not changed. The staff revised the wording to reflect that only portions of normally dry fire water piping that have been wetted may be subject to the augmented tests or inspections. The subject paragraph closes with, "[t]he augmented tests and inspections are conducted on piping segments that cannot be drained or piping segments that allow water to collect."

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#	Location, Comment, Discussion	Staff Resolution
8	LR-ISG Section D).iii).c). First bullet Clarify the first bullet as follows: In each 5-year interval, visual inspections on 100 percent of the ~~length~~ internal surface of ~~piping that is not subjected to flow testing or flushing~~ piping segments that cannot be drained or piping segments that allow water to collect. Clarification is needed to confirm visual inspections are performed on piping segments that cannot be drained or piping segments that allow water to collect.	The staff agrees with this change. The proposed change is editorial because the intent of the wording has not changed. The staff revised the bullet to make it clear that two options are available, as follows, “[i]n each 5-year interval, either conduct a flow test or flush sufficient to detect potential flow blockage, or conduct a visual inspection of 100 percent of the internal surface of piping segments that cannot be drained or piping segments that allow water to collect. If the results of a 100 percent internal inspection are acceptable, and the segment is not subsequently wetted, no further augmented tests or inspections are necessary.”
9	LR-ISG Section D).iii).c). Second bullet Clarify the first sentence of the second bullet as follows: In each five year interval, 20 percent of the length of piping segments cannot be drained or piping segments that allow water to collect are subject to volumetric wall thickness measurements. The data points for volumetric wall thickness measurements should be determined by engineering evaluations and be consistent with similar AMPs that measure wall thickness (XI.M20, XI.M17, XI.M1, etc.). Clarification is needed to confirm testing is performed in the length of pipe associated with piping segments that cannot be drained or piping segments that allow water to collect. The data points required for the volumetric wall thickness measurements are overly prescriptive and may not focus on the proper locations. The data points should be consistent with similar AMP that measure wall thickness (XI.M20, XI.M17, XI.M1, etc.) and determined by engineering evaluation that considers piping configuration, accessibility, and be sufficient to identify degraded conditions.	The staff agrees with this change. The first proposed change is editorial because the intent of the wording has not changed. See the response and changes described for Comment No. 7. The staff agrees with the intent of the second change because the number of wall thickness measurement points should be selected based on the applicable piping configuration. In some cases, more data points might be necessary to determine that an aging effect is not occurring. Accordingly, the wording was revised to state, “[m]easurement points are obtained to the extent that each potential degraded condition can be identified (e.g., general corrosion, MIC).”

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#	Location, Comment, Discussion	Staff Resolution
10	LR-ISG Section D).iii).d). App B Table 3.0-1, AMP XI.M27,App. D Some installations may have tanks that function as a fire water supply storage tanks as well as other purposes. Recommend that the description in AMP XI.M27 be revised to read "…standpipes, dedicated fire water storage tanks, and…". Recommend a corresponding wording change to the Appendix E, AMP XI.M29, program description to read "… outdoor tanks, except dedicated fire water storage tanks, and ...". This will clearly indicate that multiuse tanks are to be included with the aboveground metallic tanks program. AMP XI.M27 program description includes fire water storage tanks. XI.M29 program description includes tanks except fire water storage tanks. Some installations may have tanks that function as a fire water supply storage tanks as well as other purposes. NFPA 25 (2011) paragraph 9.1.1.1 indicates that the NFPA inspection and test requirements only apply to tanks that are dedicated to fire water use. Since the inspection requirements are significantly different between AMP XI.M29 and XI.M27/NFPA 25, clarification should be provided as to which AMP should be used for multi-use tanks	The staff does not agree with this comment. NFPA 25, Section 9.1.1.1 states, "[t]his chapter shall provide the minimum requirements for the routine inspection, testing, and maintenance of water storage tanks dedicated to fire protection use." There is no wording in NFPA 25 related to dual-purpose tanks. The staff does not agree that the term "dedicated" in NFPA 25 means solely used for fire protection. The staff concludes that if one of the functions of a tank is to support fire protection, it should be in the scope of GALL Report AMP XI.M27. Dual-purpose tanks are inspected in accordance with GALL Report AMP XI.M27, not GALL Report AMP XI.M29.
11	LR-ISG Section D).iii).c). Recommend limiting internal inspections of fire water system piping segments that cannot be drained or piping segments that allow water to collect to accessible piping segments that can be inspected with a boroscope. Pipe cutting or disassembly should not be required to complete internal inspections. 100% internal inspection may not be feasible in some piping configurations. Even relatively short sections of piping that have multiple bends may not be accessible with a boroscope. Pipe cutting or disassembly should not be required to complete internal inspections.	The staff does not agree with this comment. Given the OE as described in Information Notice 2013-06, corrosion products can block fire water system flow. Based on Comment Nos. 7 through 9, the staff clarified its intent by stating that these inspections are only recommended when applicable portions of water-based fire protection system components have been wetted. Absent the presence of water in the pipe, there is limited potential for extensive corrosion. However, once water is present, multiple bends provide an ideal location for these products to accumulate. The change incorporated as a result of Comment No. 8 makes it clear that a flow test or flush sufficient to detect potential flow blockage may be used in lieu of disassembly. The staff added the following to program element 4, "scope of program," of AMP XI.M27: "[i]f the results of a 100 percent internal inspection are acceptable, and the segment is not subsequently wetted, no further augmented tests or inspections are necessary." Although the staff retains the recommendation to conduct internal visual inspections regardless of the need to cut the pipe, or perform flow tests or flushes, this change removes the need to conduct subsequent inspections if the segment is not re-wetted. The change is appropriate because if the pipe segment is not re-wetted subsequent to an acceptable inspection, accelerated corrosion should not occur.

#	Location, Comment, Discussion	Staff Resolution
12	LR-ISG Section D).iii).c)., D).iii).d)., and D).iii).e).App B Table 3.0-1AMP XI.M27,App D LR-ISG Section D, Appendix B Table 3.0-1 AMP XI.M27, and Appendix D, AMP XI.M27, make numerous reference to NFPA 25 (2011) for guidance but do not specifically refer to the sections within NFPA 25 that apply to each particular concern. Recommend that the specific criteria or requirements for each specific area where NFPA 25 is referenced for guidance should be identified in the revised AMP (e.g. identify the frequencies for flow testing, identify exterior and internal surface inspections for tank inspections, etc.). Reference to NFPA 25 (2011) in the AMP should be avoided. LR-ISG Section D can reference specific NFPA 25 (2011) sections as the source of the requirements specified in the AMP. The referenced sections goes beyond currently approved fire protection plans. Some plants are not committed to NFPA 25 in their CLB. Specific criteria or requirements for each specific inspection/test where NFPA 25 is referenced for guidance should be identified in the revised AMP (e.g. identify the frequencies for flow testing, identify exterior and internal surface inspections for tank inspections, etc.). For example, only a small part of NFPA 25 (2011) Chapter 9 would apply to external surface, internal surface, and foundation inspections of fire water storage tanks. NFPA 25 (2011) addresses many other requirements such as controls, instrumentation, motors, etc that are not applicable to license renewal aging management.	The staff agrees with this comment in part and has incorporated a new table, Table 4a, “Fire Water System Inspection and Testing Recommendations,” in GALL Report AMP XI.M27. The new table specifies those inspections and tests that are related to age-managing applicable aging effects for passive long-lived in-scope components in the fire water system that are associated with loss of material and flow blockage. The staff does not agree with the statements that, “[r]eference to NFPA 25 (2011) in the AMP should be avoided,” and “t]he referenced sections goes beyond currently approved fire protection plans.” The staff is referring to the 2011 Edition of NFPA 25 as a common reference for the description of the scope and periodicity of specific inspections and tests. To ensure that the staff’s use of NFPA 25 is not misunderstood, footnote (1) was added to the new Table 4a. This footnote states: All terms and references are to the 2011 Edition of NFPA 25. The staff cites the 2011 Edition of NFPA 25 for the description of the scope and periodicity of specific inspections and tests. This table specifies those inspections and tests that are related to age-managing applicable aging effects associated with loss of material and flow blockage for passive long-lived in-scope components in the fire water system. Inspections and tests not related to the above should continue to be conducted in accordance with the plant’s current licensing basis. If the current licensing basis specifies more frequent inspections than required by NFPA 25 or this table, the plant’s current licensing basis should continue to be met.

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#	Location, Comment, Discussion	Staff Resolution
13	LR-ISG Section D).iii).e) Revise the 8th sentence of paragraph (e) as follows: For fire water piping with conditions that could cause obstructed piping; if the condition is not corrected, or the condition is one that could result in obstruction of the piping despite any previous flushing activities, then visual inspections for obstructions are recommended every 5 years consistent with NFPA 25 (2011) in Section 14.3.2.1. The section of NFPA 25 that addresses this issue is 14.3.2.1, not 14.2.1. NFPA 25 guidance does not recommend internal visual inspections of all piping but rather just the piping that meets the criteria noted in the proposed revision to the 8th sentence of section D).iii).e).	The staff agrees with this comment in part. NFPA 25 Section 14.2.1 is the appropriate reference. It states that internal visual examinations shall be conducted every 5 years. However, the comment is correct in that the inspections do not encompass "all" piping and branch lines. Section 14.2.1 requires that for each wet pipe system, one flushing connection is opened and one sprinkler is removed. The term "all" was deleted. Additionally, the term "obstruction" was revised to "foreign organic or inorganic" to align with Section 14.2.1. Section 14.3.2.1, "Obstruction Investigations and Preventions," is invoked when an obstruction investigation is warranted by the criteria contained in paragraph 14.3.1 (e.g., discharge of obstructive material during routine water tests, plugged sprinklers, pinhole leaks).
14	LR-ISG Section D).iii).o). AMR line items VII.G.A-23, VII.G.AP-143 line items should not be deleted because the aging affects are still applicable for components where recurring internal corrosion has not occurred. The ISG should also identify the GALL AMR lines in GALL section VII.G that will manage loss of material; for steel components in a condensation (internal) environment with AMP XI.M27, Fire Water Systems. The aging effects are still applicable for components where recurring internal corrosion has not occurred, and these inspections should be conducted.	The staff agrees with this comment. Rather than deleting AMR line items VII.G.A-23 and VII.G.AP-143, the Aging Management Programs column for SRP-LR item 3.3.1-89 was revised to read, "[f]or fire water system components: Chapter XI.M27, 'Fire Water System,' or for other components: Chapter XI.M38, 'Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components'." SRP-LR item 3.3.1-89 cites 3 GALL Report AMR line items. GALL Report AMR line items VII.G.A-23 and VII.G.AP-143 were likewise changed. Item VII.H2.A-23 was not changed as shown in GALL Report Revision 2 because these items are associated with emergency diesel generator systems.
15	LR-ISG Section E).ii).a) The frequency of tank bottom UT testing requires revision to be consistent with Appendix E, AMP XIM29 element 4. Inspections should be conducted whenever the tank is drained and begin with the five year period before entering the period of extended operation, rather than within 5 years of entering PEO. The phrase "within 5 years of entering PEO" may be misinterpreted to mean the 5 year period which starts on day one of PEO and extends to 5 years after entering PEO. Revision to state "begin with the five year period before entering the period of extended operation" is recommended.	The staff agrees with this change. The proposed change is editorial because the intent of the wording has not changed. The purpose of this sentence is to set the historical context of what GALL Report AMP XI.M29 currently states. The sentence was revised to include the term "currently," as follows: "[t]he GALL Report AMP XI.M29 currently 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."

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16	LR ISG Section E).ii).b). The third bullet of this section for indoor welded storage tanks should be revised to delete "or soil". Soil should be deleted from this discussion on indoor welded storage tanks to be consistent with LR-SRP Table 3.0-1 description for AMP XI.M29.	The staff agrees with this change. It is not likely that there are any inside large volume atmospheric storage tanks located solely on soil in lieu of concrete. The staff conducts a walkdown of all tanks within the scope of GALL Report AMP XI.M29 during AMP audits. Therefore, this would be noted if there is such a unique configuration.
17	LR-ISG Section F).ii).d). Editorial: AMP XI.M36 should be specified instead of AMP XI.M38. Also change the word Attachment to "Appendix". This section of the ISG is discussing corrosion under insulation which is discussed in AMP XI.M36, not XI.M38, Internal Surfaces Monitoring.	The staff agrees with this change. The change was incorporated as requested.
18	LR-ISG Section F).ii).a). XI.M29 inspections of tank exterior surfaces under insulation will be required at least 3 times: once prior to PEO and every 10 years thereafter per this ISG. If an inspection under insulation is performed 5 years before the PEO and the results of the inspection demonstrate there is no loss of intended function due to aging, no further action should be needed unless integrity of the exterior surface of the insulation has been damaged or there is evidence of water intrusion through the insulation (e.g. water seepage through insulation seams/joints). If an inspection under insulation has been performed within 5 years of the PEO; when there is 35 plus years of operating experience, and the operating experience indicates no problems over the 35 plus years, then there is reasonable assurance to suspect that problems will not occur during the PEO, unless the integrity of the insulation has been damaged or there is evidence of water intrusion through the insulation. In this case an exterior surface inspection of the insulation should be sufficient to ensure the insulation is intact or detect water seepage through insulation seams/joints. Also, whenever new "holes" and associated patches are introduced to the insulation jacketing/surface, the probability of leakage through the patches is increased.	The staff agrees with this comment and appropriate changes were made.

#	Location, Comment, Discussion	Staff Resolution
19	LR-ISG Section F).ii).a).App. Element 4 Recommend relaxing the recommendation for removal of tank insulation for periodic inspections of tank surfaces to a one-time inspection. After the one-time inspection, the exterior insulation surface of insulated tanks should be inspected periodically for damage. Damaged insulation would be evaluated by the plant's corrective action program. If an inspection of the insulated tank surface has been performed within 5 years of the PEO; when there is 35 plus years of operating experience, and the operating experience indicates no problems over the 35 plus years, then there is reasonable assurance to suspect that problems will not occur during the PEO. Some types of insulation are tightly adherent and difficult to remove. For example pyrocrete may be used for fire protection and insulation. Other examples include urethane foam or Neoprene foam insulation that may be tightly adherent and allow little or no moisture intrusion. Periodic removal of tank insulation for periodic inspections could potentially degrade the ability of the insulation to perform its intended function of insulation and potentially provide water seepage pathways through the insulation to the tank surface.	The staff agrees with this comment in part. This comment is substantially the same as Comment No. 18. See the staff's response to Comment No. 18. However, Comment No. 19 has one unique aspect, "[d]amaged insulation would be evaluated using the site's corrective action program." The staff concludes that if damage to the exterior surfaces of the insulation has occurred, inspections of the external surfaces of the component should be performed. Although it could be assumed that this would be the outcome of the corrective action program (CAP), during AMP audit walkdowns, the staff has observed multiple plants with damaged insulation jacketing and no corresponding entries in the CAP or inspections under the insulation being documented. The staff added the following to program element 4, "detection of aging effects," of GALL Report AMP XI.M29: If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or jacketing, or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as conducted for the initial inspection.
20	LR-ISG Section H).ii).a). Also revise element 4 of AMP XI.M38 as follows to be consistent with the pressurization clarification made to element 1: "Visual and mechanical (e.g., manipulation <u>or pressurization</u> of elastomers) inspections conducted under this program are opportunistic in nature:.". This proposed change to element 4 will also require a change to LR-ISG Section H).ii).a). LR-SRP Section A.1.2.3.4, Detection of Aging Effects, states: (a) how the program element would be capable of detecting or identifying the occurrence of age related degradation or an aging effect prior to a loss of structure and component (SC) - intended function. Pressurization of an elastomer is how the aging effect cracking may be detected and needs to be identified in AMP XI.M38 element 4.	The staff agrees with this comment. The editorial changes were incorporated.

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#	Location, Comment, Discussion	Staff Resolution
21	LR-ISG Section G).ii). and Appendix G AMP element 4 Replace the word "aboveground" with "accessible" when referring to piping with similar materials, environment, and aging effects that will be inspected instead of buried or underground piping. Piping does not have to be "aboveground" to meet this criteria. Some piping may exist below-grade level in tunnels or areas that ARE normally accessible, or within buildings but below grade level. Internal inspections of any accessible piping with similar materials, environment, and aging effects as buried or underground piping should be allowed to be substituted.	The staff agrees with this comment. Inspections of accessible piping above or below ground meet the intent of the criteria. The staff made the recommended changes.
22	App B, Table 3.0-1, M27 schedule Revise AMP XI.M27 implementation schedule to delete the requirement to implement and begin inspections five years before the PEO. AMP XI.M27 is an existing AMP, licensees should have the flexibility to implement Fire Water program enhancements and complete testing/inspections before the PEO and not be constrained by the 5 year period prior to the PEO. The enhancement Implementation schedule should consider fire protection suppression system reliability and performance capabilities. In addition, the need to resolve recurring corrosion may require an earlier implementation schedule.	The staff agrees with this comment in part. The augmented volumetric examinations of wetted but normally dry piping segments that cannot be drained or piping segments that allow water to collect, and the testing in Table 4a should commence during the period of extended operation. However, given the number of OE examples related to fire water piping blockage and the magnitude of blockage, the flow test or flush sufficient to detect potential flow blockage, or visual inspections on 100 percent of the internal surface of piping segments that cannot be drained or piping segments that allow water to collect should commence in the 5-year period prior to the period of extended operation. This provides reasonable assurance that the fire water piping can meet its intended function on entry into the period of extended operation. Program element 4, "detection of aging effects," of GALL Report AMP XI.M27 and Table 3.0-1 clearly reflect the above staff position.
23	App B, Table 3.0-1, schedule The implementation schedule for AMP XI.M27, XI.M29, XI.M36, and XI.M38 should state that the program is implemented and inspections are conducted within the five (or ten) year period before the period of extended operation. The SRP-LR Table 3.0-1 implementation schedule as written requires inspections to begin at the fifth year or tenth year before the PEO. Licensees should have the flexibility to perform the inspections within the five (or ten) year period before the PEO.	The staff agrees with this comment; however, comment resolution is specific to each program as follows. • GALL Report AMP XI.M27: The only testing and inspections that commence prior to the period of extended operation are those for normally dry piping segments that cannot be drained or piping segments that allow water to collect. The implementation schedule in Table 3.0-1 was changed accordingly. • GALL Report AMP XI.M29: The implementation schedule was changed to 10 years prior to the period of extended operation. Given that inspections are periodic in nature (i.e., every 10 years) there is no need to recommend that the first inspection occur in the 35 to 40 year period of the original license. The implementation schedule was changed to, "[p]rogram is implemented and inspections begin 10 years before the period of extended operation." • GALL Report AMP XI.M36: The implementation schedule was changed to, "[p]rogram is implemented and inspections begin during the period of extended operation." • GALL Report AMP XI.M38: No inspections occur prior to the PEO; so the implementation schedule was changed to, "[p]rogram is implemented and inspections begin during the period of extended operation."

#	Location, Comment, Discussion	Staff Resolution
24	App. B XI.M29 description The preventive action of caulking or sealants should not apply to indoor tanks in AMP XI.M29, Aboveground Metallic Tanks Program. The preventive actions of caulking and sealants for above ground steel tanks are designed to minimize corrosion between the tank bottom and the foundation by keeping rain water out. Indoor tanks would not be exposed to rain water and do not require caulking and sealants.	The staff agrees with this change. The change was incorporated by inserting the phrase “For outdoor tanks,” at the beginning of the sentence “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 be applied at the external interface between the tank and concrete...”
25	App B XI.M29 description Editorial: Frequency specification is unclear for UT thickness measurements of tank bottoms. Suggest rewording to be consistent with Appendix E element 4 which states: "Potential corrosion of tank bottoms is determined by taking (UT) thickness measurements of the tank bottoms whenever the tank is drained; however, examinations are conducted at least once every 10 years and begin within 5-year period before entering the period of extended operation." is drained, at least once every 10 years…" As worded, it's not clear if a surveillance interval or a frequency is specified.	The staff agrees with this comment. The change was incorporated by deleting the timing and frequency of tank bottom thickness inspections from Table 3.0-1. Adequate detail is provided in the new Table 4a, “Tank Inspection Recommendations,” for all inspections. The periodicity of tank bottom thickness measurements would be plant specific based on soil conditions underneath the tank.
26	App.B AMP XI.M38 App. G Element 4 In AMP.XI.M38 revise the second sentence of the first paragraph of element 4 to state; At a minimum beginning with the 10 year period prior to the period of extended operation and in each ten year period during the period of extended operation, a representative sample.....". Revise the SRP-LR Table 3.0-1 for AMP XI.M38 in Appendix B to be consistent with the AMP XI.M38 change. If a ten-year periodic inspection interval is established, and with a first inspection performed prior to the PEO, it shouldn't matter if the initial inspection is performed more than 5 years prior to PEO provided the ten year interval is maintained.	The staff agrees with the intent of this comment; however, the change was incorporated by deleting the recommendation to commence inspections 5 years prior to the period of extended operation. The text in Table 3.0-1 stating that “inspections begin 10 years before the period of extended operation” was inadvertently inserted by the staff.

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#	Location, Comment, Discussion	Staff Resolution
27	App. B, Table 3.0-1, XI.M38 description Recommend rewording applicability sentence at beginning of paragraph to read as follows: "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 ~~and any water environment other than open-cycle cooling water, treated water, and fire water~~ that are exposed to environments ~~of air – indoor,~~ uncontrolled indoor air, ~~air~~ outdoor air, air with borated water leakage, condensation, moist air, diesel exhaust, and any water environment other than open-cycle cooling water, closed treated water, and fire water. " Changes are required to be consistent with the applicability statement in Appendix G for AMP XI.M38.	The staff agrees with this comment. The change was incorporated.
28	App. B, Table 3.0-1, XI.M38 Editorial: Underline the following sentence to show that it has been added as a change to XI.M38: "Opportunistic inspections continue in each period despite meeting the sampling limit".	The staff agrees with this comment. The editorial change was incorporated.
29	App B further evaluations 3.X.2.2 and 3.X.3.2 Rather than specify a plant-specific program to address recurrent internal corrosion in selected AMPs, consider revising those AMPs to indicate that recurrent corrosion warrants program augmentation. Such OE suggests that the program may be ineffective, and improvements may be warranted, rather than implementation of another program to manage the same components. Program improvements could be changes in detection methods, operational practices, preventive measures, design changes, etc. Existing programs that should manage aging effects should be augmented to address issues for which the program may be ineffective. Recurrent issues should be addressed, and corrected, via the corrective action program instead of creating a plant-specific program.	The staff does not agree that a change is warranted. The further evaluation item allows an applicant to: (a) develop a plant-specific AMP, (b) augment an existing AMP, or (c) augment a new AMP. It is solely at the discretion of an applicant whether it develops a plant-specific AMP. Program element 10, “operating experience,” was revised in the draft LR-ISG in each of the GALL Report AMPs that are likely to be candidates to be augmented to alert the user to evaluate for recurring internal corrosion. The wording includes a reference to further evaluation AMR line items SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, “Loss of Material Due to Recurring Internal Corrosion.” With regard to the comment statement, “[r]ecurrent issues should be addressed, and corrected, via the corrective action program instead of creating a plant-specific program,” the staff concludes that the additional recommendations in the new further evaluation items are warranted. Operating Experience, as evidenced during the review of several recent license renewal applications, has demonstrated that the GALL Report AMPs should be augmented when recurring internal corrosion occurs.

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<table>
<tr><th>#</th><th>Location, Comment, Discussion</th><th>Staff Resolution</th></tr>
<tr><td>30</td><td>APP. B further evaluation 3.X.2.2 and 3.X.3.2

The further evaluation criteria for wall penetration criteria greater than 50% should be liberalized.

Based on license renewal intended functions or system design, wall penetration criteria greater than 50% may not be appropriate for systems such as waste water systems, open cycle cooling water, or fire protection systems that require further evaluation of operating experience for recurring internal corrosion. For example, for service water piping this wall thickness could be less than 25% due to low operating/design pressure of the system.</td><td>The staff does not agree that a change is warranted. The staff recognizes that some systems flaws can be deeper than 50 percent and still meet plant-specific acceptance criteria. This is reinforced by existing wording in the LR-ISG.

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).

However, the staff provided further clarification in relation to its intent in establishing the 50 percent or greater through-wall penetration criterion by adding the following wording to the ISG:

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. Therefore, the staff does not intend that the 50 percent or greater through-wall penetration criterion be interpreted to indicate that the in-scope component does or did not meet its intended function, but rather as an indicator of aging effects significant enough to warrant enhanced aging management actions. The applicant should use the significance of the aging effects as input in determining the necessary extent of enhancements (e.g., number of augmented inspections, frequency of augmented inspections). For example, consider the following hypothetical scenarios:

▪ Two instances of wall-wastage with the deepest penetration being 65 percent through-wall and one through-wall leak have occurred in close enough proximity to be considered a single flaw line (refer to Subarticle IWA-3300, “Flaw Characterization,” in Section XI, “Rules for Inservice Inspection of Nuclear Components,” of the ASME B&PV Code) in a service water.
▪ After cleaning an atmospheric waste drain line, three widely separated 50 percent through-wall small-diameter pits were detected.
▪ Six leaks have occurred during the past 5 years in the fire water system.

The first and the third example would potentially warrant additional inspection points and more frequent inspections than the second example. The second example warrants a followup inspection because, even though the current state did not result in through-wall leakage and probably did not affect the structural integrity of the piping segments, the aging effects will probably continue and eventually a leak could occur that could result in the loss of the intended function of a nearby safety-related component.

The staff further recognizes that, for many nonsafety-related, in-scope systems, wall thickness data might not be available during a search of plant-specific operating experience. The only indicator of an aging effect could be leakage discovered by plant personnel. Reliance on existing corrective action program documentation is sufficient to determine the applicability of this new further evaluation AMR item.</td></tr>
</table>

#	Location, Comment, Discussion	Staff Resolution
31	App. B Table 3.2-1item 66 Table 3.3.1 item 127 Table 3.4-1 item 61 and associated AMR lines Aggressive environments such as raw water and waste water should be evaluated for recurring internal corrosion. Delete closed cycle cooling water and treated water environments from the SRP-LR Table 3.2-1 item 66, Table 3.3-1 item 127, and Table 3.4-1 item 61 and associated AMR lines. Industry operating experience supports evaluating components in aggressive internal (or submerged) environments such as raw water and waste water for recurring internal corrosion. Industry operating experience indicates closed cycle cooling water and treated water environments are not aggressive environments that would be subject to recurring internal corrosion. Closed cycle cooling water programs require chemistry control of the environment in addition to periodic inspections (every 10 years). Treated water environments are managed by AMP XI.M2 Water Chemistry programs and AMP XI.M32 One-Time Inspection Program to verify chemistry effectiveness. Aging that impacts intended functions identified as a result of the One-Time Inspection would require separate corrective action.	The staff agrees with this comment. The change was incorporated. Operating Experience to date has demonstrated that each recurring aging effect instance has been associated with the raw water environment. If a plant-specific recurring aging effect associated with closed cycle cooling water or treated water environment were to occur, it would be evident in the OE review conducted for the new further evaluation items 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6. The following text was added to the LR-ISG, FE AMR items, and the “operating experience” program element of the applicable AMPs. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.
32	App. B Table 3.2-1item 69 App. C.V.A.E-403 series Editorial: Revise "copper" to "copper alloy" to be consistent other usage within GALL.	The staff agrees with this comment. The editorial changes were incorporated.

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#	Location, Comment, Discussion	Staff Resolution
33	App. B Table 3.2-1item 12 App. C.V.A.E.-404 series Change the environment from "Water" to "Treated Water (Borated) or Treated Water" to be consistent with GALL Chapter XI.D environment definitions and other ECCS water environments noted in GALL Chapter V. For the treated water or treated water (borated) lines, delete the aging effect of cracking due to stress corrosion cracking (stainless steel) and fatigue. Create a separate line for treated water greater than 140F or treated water (borated) greater than 140F for stainless steel tank that manages the aging effect of cracking due to stress corrosion cracking. The program specified in the line item is the Water Chemistry AMP which manages treated water or treated water (borated). The change would also revise the environment consistent with GALL Chapter XI.D environment definitions and other ECCS water environments noted in GALL Chapter V. A separate line for treated water greater than 140F or treated water (borated) greater than 140F for stainless steel tanks that manages the aging effect of cracking due to stress corrosion cracking should be created. GALL section IX.D identifies a temperature threshold of 140F for stainless steels in treated water/treated water (borated) systems that manage halogens. There is no industry operating experience associated with cracking due to fatigue in large volume storage tanks.	The reference to SRP-LR Table 3.2-1 item 12 appears to be a typo, The correct reference is item 3.2.1-70. The staff agrees with this comment; however it has changed the LR-ISG in a different manner. SRP-LR Table 3.2-1 item 3.2.1-70 and the corresponding GALL Report items were originally added to principally address SCC and fatigue in tanks. The staff recognizes that stress corrosion cracking in tanks exposed to treated water has originated on the outside of the tanks because of contaminants. Therefore, there is no need to add these GALL Report AMR line items to address cracking for internal treated water environments. The new SRP-LR Table 3.2-1 item 3.2.1-70 and the corresponding GALL Report items were revised to address only loss of material due to pitting and crevice corrosion. The internal aging effects for stainless steel tanks, as well as piping, exposed to treated water (borated) and treated water (borated) >60°C (>140°F) are addressed in existing GALL Report items, E-12 and EP-41. The GALL Report items manage loss of material due to pitting and crevice corrosion (and cracking due to SCC when the environment is >60°C (>140°F)). However, the items recommend Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection." Based on its review of OE, the staff concludes that for stainless steel and aluminum tanks, at least one tank for each material and environment combination should be inspected at each site when implementing GALL Report AMP XI.M32. Therefore, the new Table 4a, "Tank Inspection Recommendations," in GALL Report AMP XI.M29 includes a corresponding footnote which states, "[a]t least one tank for each material and environment combination should be inspected at each site. The tank inspection can be credited towards the sample population for GALL Report AMP XI.M32." Therefore AMR line items that recommend GALL Report AMP XI.M29 for stainless steel and aluminum tanks are appropriate. SRP-LR Table 3.2-1 item 3.2-1-70, and the new Table 3.3-1 item 3.3.1-137, Table 3.4-1 item 3.4.1-62, and corresponding GALL Report items, reflect the above. The LR-ISG had addressed SCC caused by external contaminants in the changes to SRP-LR Table 3.2-1 item 3.2-1-68 (revised to 3.2.1-67) and the corresponding GALL Report items; however this item was revised to include the following external environments: air-outdoor, air-indoor uncontrolled, and moist air. In addition, SRP-LR Table 3.3-1 item 3.3.1-128 was added and SRP-LR Table 3.4-1 item 3.4.1-30 was revised to include these environments and aging effects. This ensures that tanks will be externally inspected for cracks due to SCC in all applicable environments. The change to delete the term "tanks" from the scope of AMR line items SRP-LR Table 3.2-1, item 22 and the corresponding changes to GALL Report items V.A.EP-41 and V.D1.EP-41 are no longer necessary and have been removed from the LR-ISG. With regard to fatigue cracking, the staff has deleted this aging mechanism from the LR-ISG because the surface examinations (added to the recommended inspection parameters by this LR-ISG) of stainless steel and aluminum tanks will detect cracking whether it occurs due to SCC or fatigue.

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#	Location, Comment, Discussion	Staff Resolution
34	App B. Table 3.2-1item 69 Table 3.3-1item 132; App. C items V.A.E-403 et al. VII.A2.A-405 et al Change the aging management program for AMR lines associated with steel, stainless steel, copper, aluminum, or copper>15% Zinc components exposed to insulation and operated below the dew point or insulated outdoor tanks, piping, and piping components to identify AMP XI.M36 OR AMP XI..M29, not AMP XI.M36 AND AMP XI.M29 as currently written. Only one of the programs would be applicable. AMP XI.M29 should be used for outdoor tanks and indoor tanks greater than 10,000 gallons. AMP XI.M36 can be used if the tank exterior is fully visible.	The staff agrees with this comment. The changes were incorporated as requested.
35	App. B Table 3.3.1 item 63 App.CVII.G.AP-149 Do not add flow blockage due to fouling as an aging effect/mechanism to the line item in LR-SRP Table 3.3-1 and associated GALL AMR line VII.G.AP-149. The aging effect/mechanism of flow blockage due to fouling is not applicable for these AMR lines. The aging effect/mechanism associated with these AMR lines is for steel fire hydrants in an air-outdoor environment. Flow blockage due fouling is aging effect manifested in the internal environment of fire water piping/hydrants, not the external air-outdoor environment.	The staff agrees with this comment. Flow blockage due to fouling was deleted as an aging effect requiring management from the stated AMR items.
36	Editorial: For the following LR-SRP tables and GALL AMR tables, the Aging Effect/Mechanism column calls out zinc as "Zn" and "zinc". Recommend using Zn to be consistent with existing GALL Rev 2 AMR lines LR-SRP Rev 2 Tables: LR-SRP Table 3.2-1 item 69 LR-SRP Table 3.3-1 item 132 LR-SRP Table 3.4-1 item 63 GALL V.A.E-403 series GALL VII.A2.A-405 series GALL VIII.A.S-400 series	The staff agrees with this editorial comment. The changes were incorporated as requested.
37	Add a new AMR line for HDPE in an underground environment to SRP-LR Table 3.3-1 and GALL section VII.I. See Attachment 3 section 2.2 for recommended additions to SRP-LR Table 3.3-1 and GALL section VII.I. and a discussion of the changes. Adds Underground environment for HDPE components.	The staff agrees with this comment. The LR-ISG was revised to add HDPE piping exposed to an underground environment, SRP-LR Table 3.3-1, Item 3.3.1-133 and GALL Report Item VII.I.A-406.

#	Location, Comment, Discussion	Staff Resolution
38	Add a new AMR line for gray iron and copper alloy (>15% Zn or >8% Al) in a waste water environment to SRP-LR Table 3.3-1 and GALL section VII.E5. See Attachment 3 section 2.3 for recommended additions to SRP-LR Table 3.3-1 and GALL section VII.E5. and a discussion of the changes. Adds selective leaching AMR lines for waste water environments.	The staff agrees with this comment. The LR-ISG was revised to add the waste water environment to SRP-LR Table 3.3-1, Item 3.3.1-72. GALL Report Item VII.I.A-407 was added. Selective leaching can occur in this material and environment combination. This change could reduce the number of nonconsistent items in an LRA because the environment will now be addressed in the GALL Report AMR tables for this material aging effect and AMP combination.
39	Add new AMR lines for aging management of non-safety related OCCW components to SRP-LR Table 3.3-1 and GALL section VII.C1. See Attachment 3 section 2.4 for recommended additions to SRP-LR Table 3.3-1 and GALL section VII.C1. and a discussion of the changes. Allows non-safety related OCCW components to be managed by XI.M38.	The staff agrees with this comment. The “scope of program” program element of GALL Report AMP XI.M20 states that it includes, “the service water system and any other cooling system exposed to raw water that transfers heat from safety-related SSCs to the [ultimate heat sink] UHS.” Based on a review of GALL Report AMR line items for copper alloy, stainless steel and steel materials exposed to raw water, with the exception of 3 items that cite GALL Report AMP XI.M27 and 1 item that cites GALL Report AMP XI.M38, all other items cite GALL Report AMP XI.M20. The staff concluded that there is value added in including AMR line items for nonsafety-related components not covered by Generic Letter 89-13. Inclusion of these new AMR line items could reduce the number of AMR line items in an LRA that cite generic note E. The LR-ISG was revised to add copper alloy, stainless steel and steel materials exposed to raw water (nonsafety related components not covered by NRC GL 89-13) being managed for loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically influenced corrosion and fouling that leads to corrosion by GALL Report AMP XI.M38. Based on its review of the GALL Report, the staff also added heat exchanger components to the new AMR line items because the only existing program for copper alloy, stainless steel and steel exposed to raw water was GALL Report AMP XI.M20. New items Item 3.3.1-134 was added to SRP-LR Table 3.3-1, and Items VII.C1.A-408 and VII.C1.A-409 were added to the GALL Report.

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#	Location, Comment, Discussion	Staff Resolution
40	Add new AMR lines for aging management of pumps submerged in a waste water environment to SRP-LR Table 3.3-1 and GALL section VII.E5. See Attachment 3 section 2.5 for recommended additions to SRP-LR Table 3.3-1 and GALL section VII.E5. and a discussion of the changes. Adds submerged pump AMR lines for waste water environments.	The staff agrees in part with this comment. The staff does not agree that the closure bolting for the pump should be managed by GALL Report AMP XI.M36. The LR-ISG was revised to add "pump casings" in lieu of "pumps" exposed to a submerged waste water environment. If the term "pumps" had been used, it could have been inferred that the associated closure bolting of the pump would have been included. The aging effects associated with bolting are managed by GALL Report AMP XI.M18, "Bolting Integrity." The inspection method for GALL Report AMP XI.M18 is to visually inspect for leakage at the bolted joint. This would not be possible for submerged bolting. Given that the proposed AMP for the new items is GALL Report AMP XI.M36, it would not be appropriate to manage bolting with this program unless the applicant justified an exception. The "scope of program" program element of GALL Report AMP XI.M36 allows the use of GALL Report AMP XI.M36 for managing internal aging effects for metallic components as long as material and environment combinations are the same for the internal and external surfaces. With a submerged pump, this would be the case. The new items are SRP-LR Table 3.3-1, Item 3.3.1-135, and GALL Report Items VII.E5.A-410 and VII.E5.A-411. This change could reduce the number of nonconsistent items in an LRA because the material and environment will now be addressed in the GALL Report AMR tables.
41	Editorial: Table 3.4-1 Item 12 lists the following (in part) in the Aging Effect/Mechanism column: "cracking due to stress corrosion cracking (stainless steel only and fatigue)." The entry should be revised to state: "cracking due to stress corrosion cracking (stainless steel only) and fatigue." Editorial: The parentheses appear to be misplaced and should be revised to indicate "(stainless steel)".	The staff agrees with this change.

#	Location, Comment, Discussion	Staff Resolution
42	App. B Table 3.4-1 item 12 App. C.VIII.E.SP-75VII.G.SP-75 Change the environment from "Water" to "Treated Water" to be consistent with GALL Chapter XI.D environment definitions and other condensate system water environments noted in GALL section VIII.E. Also revise the component name to "Tanks within the scope of Chapter XI.M29, Aboveground Metallic Tanks only" to be consistent with other tank AMR lines revised by this ISG. For the treated water lines delete the aging effect of cracking due to stress corrosion cracking (stainless steel) and fatigue. Create a separate line for treated water greater than 140F for stainless steel tank that manages the aging effect of cracking due to stress corrosion cracking. The program specified in the line item is the Water Chemistry AMP which manages treated water. The change would also revise the environment consistent with GALL Chapter XI.D environment definitions and other condensate system water environments noted in GALL section VIII.E. Revision of the component name to "Tanks within the scope of Chapter XI.M29, Aboveground Metallic Tanks only" is required to be consistent with other tank AMR lines revised by this ISG. A separate line should be created to manage cracking of stainless steel tanks with treated water internal environments greater than 140F. GALL section IX.D identifies a temperature threshold of 140F for cracking of stainless steels in treated water systems that manage halogens. There is no industry operating experience associated with cracking due to fatigue in large volume storage tanks.	The staff agrees with this comment, but has changed the LR-ISG in a different manner. In the draft version of this LR-ISG, SRP-LR Table 3.4-1 item 3.4-1 item 12 and the corresponding GALL Report items, VIII.E.SP-75 and VIII.G.SP-75 addressed SCC and fatigue in tanks. As a result of comments received, the staff recognizes that stress corrosion cracking in tanks exposed to treated water has originated on the outside of the tanks because of contaminants. Therefore, there is no need to revise the GALL Report AMR line items to address cracking for internal treated water environments. The changes to SRP-LR Table 3.4-1 item 3.4-1 item 12 and the corresponding GALL Report items, VIII.E.SP-75 and VIII.G.SP-75 were deleted from the LR-ISG. The LR-ISG had addressed SCC caused by external contaminants in the changes to SRP-LR Table 3.4-1 items 30 and 31, and the corresponding GALL Report items. However, given the deletion of the changes to the above items, items 3.4-1 item 30 and 3.4-1 item 31 were revised to include the following external environments: air-outdoor, air-indoor controlled, air-indoor uncontrolled, dry air, moist air. This ensures that tanks will be externally inspected for cracks due to SCC in all applicable environments. With regard to fatigue cracking, see the response to Comment No. 33. Cracking due to fatigue has been eliminated from this LR-ISG.

#	Location, Comment, Discussion	Staff Resolution
43	Add new AMR lines for insulation in an indoor air environment and Foamglass insulation in an outdoor air environment to SRP-LR Table 3.4-1 and GALL section VIII.I. See Attachment 3 section 2.1 for recommended additions to SRP-LR Table 3.4-1 and GALL section VIII.I. and a discussion of the changes. Adds AMR lines for insulation.	The staff agrees that adding thermal insulation to the GALL Report is appropriate; however, it does not agree that there is no AERM and no recommended AMP as suggested by the comment. Insulation is susceptible to age-related degradation due to leaks from bolted joints and condensation dripping (during high humidity conditions) from piping in its vicinity. Although leaks in piping systems that could affect the insulation could be viewed as event-driven, SRP-LR Section A.1.2.1, item 7, states, However, leakage from bolted connections should not be considered as abnormal events. Although bolted connections are not supposed to leak, experience shows that leaks do occur, and the leakage could cause corrosion. Thus, the aging effects from leakage of bolted connections should be evaluated for license renewal. Based on the staff's research associated with a recent LRA, foamglas® insulation, unless jacketed, is susceptible to age-related degradation by water intrusion, which will break down the insulation's structure during alternate freeze/thaw cycles. The staff concludes that where jacketing has been installed in accordance with plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc., external visual inspections of the jacketing that occur under the scope of GALL Report AMP XI.M36 are sufficient to ensure that the insulation's intended function will be met. The staff revised GALL Report AMP XI.M36 to state that walkdowns of jacketing installed on in-scope insulation is acceptable as long as plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc. were used to install the jacketing. Alternatively, the applicant would need to propose an inspection methodology. A definition for a new term, "reduced thermal insulation resistance," was added to GALL Report Section IX.E and the following new items were included in the LR-ISG: SRP-LR Table 34-1, items 3.4.1-64 and 3.4.1-65, and GALL Report items VIII.I.S-403 and VIII.I.S-404. Based on a review of several LRAs, the staff also added fiberglass insulation.
44	The environments for insulated components should be: "air-outdoor, or condensation (external)". The phrase "insulated and operated below the dew point" should be deleted from the environment column. Recommend revising the component column to read: "insulated piping, piping components and tanks". Environments should be described consistent with the environments identified in GALL Section IX.D. The GALL condensation environment requires evaluation of systems at temperature below the dew point. It appears that with the reference to insulation in the environment column, the environment is describing the component types vs. the actual environment. Recommend revising the component column to read: "insulated piping, piping components and tanks".	The staff agrees with this comment. The term "insulated" was moved to the lead-in term in the component column. The environments were revised to condensation and outdoor air without reference to being operated below the dew point. The GALL Report definition of condensation was revised to include the following: "[b]ecause of air in-leakage through minor gaps in insulation, condensation can occur underneath the insulation on components when the operating temperature of the component is below the dew point of the air on the external surfaces of the insulation."

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#	Location, Comment, Discussion	Staff Resolution
45	A separate GALL AMR line is required for steel fire water storage tanks in an air-outdoor environment that manage loss of material with AMP XI.M27 Fire Water Systems. AMP XI.M27 in Appendix D of this LR-ISG recommends inspection and testing of Fire Water storage tanks consistent with NFPA 25 guidance.	The staff agrees with this comment. SRP-LR item 3.3.1-136 and GALL Report item VII.G.A-412 were added to address steel, stainless steel and aluminum fire water storage tanks exposed to air-indoor uncontrolled, air-outdoor, condensation, moist air, raw water, treated water being managed for loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion; and cracking due to stress corrosion cracking by GALL Report AMP XI.M27.
46	Delete the definition of flow blockage as an aging effect. The aging mechanism definition of fouling is a more appropriate consideration to use. Fouling is defined in GALL Section IX.E as an accumulation of deposits on the surface of a component or structure. As revised by this ISG fouling includes eroded coatings and delaminated coatings that result in a reduction of heat transfer, flow or pressure, or loss of material. Section IX.E contains definitions of Aging Effects. Flow blockage, reduction of flow and lower system pressure are not typically considered aging effects, but they may be consequences of aging effects. Flow blockage is a consequence of loss of coating integrity (or of corrosion - fouling) as pipe leakage is a consequence of loss of material (or cracking).	The staff does not agree with this comment. Fouling is an aging mechanism, not an aging effect, as defined in GALL Report Table IX.F, "Selected Definitions & Use of Terms for Describing and Standardizing Aging Mechanisms." The aging mechanism of fouling can result in two effects: fouling that leads to corrosion and flow blockage. Fouling that leads to corrosion is not addressed in this LR-ISG because it is already addressed in the GALL Report. Flow blockage is an aging effect because the mechanism, fouling, occurs and increases in severity over time. Some fouling could be event driven and as such is not the result of aging degradation (e.g., a sudden die-off of biological forms because of environmental changes that results in flow blockage or complete delamination of a newly installed internal coating (because of improper installation methods) during the initial startup of a system after a modification). However, fouling can lead to flow blockage over time (i.e., aging) through mechanisms such as erosion of coatings caused by flow turbulence in a piping system, accumulation of corrosion products that leads to flow blockage in a fire sprinkler system, or growth of tubercles due to MIC. No changes were made to the LR-ISG.
47	The condensation environment definition in GALL Chapter IX.D should be revised to include applicability of a condensation or indoor air environment. Recommend that the condensation environment apply to systems that operate more than 50% of the time at temperatures below the dew point. If a system normally operates above the dew point and only rarely operates below the dew point, then condensation on the external surface of the insulated piping would likely occur infrequently. Since AMP XI.M36 has been revised to take a sampling approach for corrosion under insulation, potentially including components where condensation occurs infrequently, the sample could be diluted and provide non-representative results. Revising the definition for condensation to apply to systems that are normally operated below the dew point (more than 50% of the time) would provide a representative sample that bounds other insulated material groups in other indoor air environments that operate with a condensation environment for less than 50% of the time.	The staff does not agree with the proposed change; however, as discussed below, a change to the LR-ISG was incorporated related to selection of the inspection locations. SRP-LR Section A.1.2.1 (7) states that aging is considered during all modes of operation, and "[t]he applicable aging effects to be considered for license renewal include those that could result from normal plant operation, including plant/system operating transients and plant shutdown." Therefore, an exclusion from inspection scope based on the amount of time a system is operated below the dew point is not appropriate. The staff agrees with the statement, "the sample could be diluted and provide nonrepresentative results." As a result, the LR-ISG was revised to include a recommendation that inspection locations be selected based on the potential for CUI to be occurring. Appropriate examples for consideration were included such as: (a) alternate wetting and drying in environments where trace contaminants could be present, and (b) length of time the system operates below the dew point. If an applicant has a plant-specific configuration in which seasonal condensation only affects a limited portion of its in-scope components, an exception to the program can be stated and justified.

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48	Revise the definition of recurring internal corrosion to quantify repetitive occurrences (i.e., three or four consecutive cycles) over which a frequency of one event per cycle is considered to be recurring degradation. Recommend revising the second sentence to read: "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 cycle <u>over a minimum of three refueling cycles</u>) of aging effects with similar aging mechanisms. Also clarify "internal aging effects with similar aging mechanisms" consistent with the following. Recurring internal corrosion is evaluated based on the aging mechanisms observed. For example, multiple occurrences of loss of material (LOM) due to MIC, LOM due to pitting, or LOM due to galvanic corrosion would be considered three separate occurrences of recurring internal corrosion that would be evaluated separately. A minimum of three repetitive occurrences is required to establish a trend. It may be excessively conservative to consider two events occurring in consecutive cycles as a qualification to require these actions. In addition, a minimum of two cycles after the first occurrence may be required to complete corrective action associated with the first occurrence. Aging effects with similar aging mechanisms requires additional clarification.	The staff evaluated the two proposed changes in this comment as follows. The staff agrees that clarification is warranted for the frequency of occurrence. The wording of the LR-ISG and new FE item was revised to read, "(e.g., one per refueling outage cycle that has occurred over 3 or more sequential or nonsequential cycles for a 10-year OE search, or 2 or more sequential or nonsequential cycles for a 5-year OE search). Three or more cycles for a 10-year OE search (and 2 for a 5-year OE search) were selected because the FE item has two criteria: frequency and whether the degree of degradation is significant. Given that the degree of degradation is significant, the occurrence of two or three examples should warrant increased attention during the period of extended operation. The staff concludes that "sequential <u>or</u> nonsequential cycles" is appropriate. Plotting various scenarios makes this point. For example, for a 10-year search with 18-month refueling outage intervals, one occurrence in each of the oldest two intervals, followed by an interval with no occurrence, which is then followed by two intervals with one occurrence in each would result in the further evaluation threshold not being met when, enhanced program requirements would be appropriate because a continuing aging effect is occurring. In instances in which, "a minimum of two cycles after the first occurrence might be required to complete corrective action associated with the first occurrence," an applicant could include a plant-specific discussion to justify not meeting the FE item recommendations. In this instance, a justification could include description of the corrective actions, what inspections will be conducted to demonstrate that the corrective actions were effective, and what enhanced program requirements will be implemented if the corrective actions were not effective. The staff considers MIC, pitting, and galvanic corrosion to be different aging mechanisms and therefore agrees with that part of this comment. The current wording was clarified by replacing the term "similar" with the term "same" in the further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6.
49	Revise the third sentence of element 4 to read: Flow tests confirm the system is functional by verifying the capability of the system to deliver water to fire suppression systems at required pressures and flow rates. Flow tests do not "maintain required pressures and flow rates" but rather verify that the system is capable of delivering water at required pressures and flow rates.	The staff agrees with this clarifying change. The change was incorporated as requested.

#	Location, Comment, Discussion	Staff Resolution
50	Delete flushes in the fourth sentence of element 3 in AMP XI.M27 as indicated by the strikethrough in the following markup. "Periodic flow testing, flushes, and internal and external visual inspections are performed to ensure that the system maintains its intended function." LR-ISG-2012-02 deleted periodic flushes from element 2 of AMP XI.M27. Element 3 requires revision to be consistent with the changes made by LR-ISG-2012-02.	The staff does not agree with the proposed change. Flushes were deleted from the "preventive actions" program element of GALL Report AMP XI.M27 because they can result in introducing new nutrients to the stagnant fire water systems when raw water is used as the source of makeup. Therefore flushes do not consistently serve as a preventive action for many of the systems in the industry. Flushes provide valuable insights related to flow blockage as described in the "detection of aging effects" program element. For example, Table 4a, hydrant testing, in Section 7.3.2 of NFPA 25 consists of annual flushing until all foreign material has cleared. This program element also permits flushing as a means to confirm that wetted portions of the fire water system that are normally dry but not configured to drain are clear of corrosion buildup.
51	Revise the fourth sentence of AMP XI.M27 element 4 to as follows to identify that fire hydrants and fire water storage tanks are the only fire protection system components that require visual inspections of their external surfaces. "The visual inspections are capable of evaluating the (a) conditions of external surfaces of components (i.e. fire hydrants and fire water storage tanks), (b) conditions on the internal surfaces of components that could be indicative of wall loss, and (c)...." LR-ISG-2012-02 limits the visual inspections of external surfaces of fire protection system components to fire hydrants and fire water storage tanks. This clarification is required to defined the limited scope of external surface inspections.	The staff does not agree with the proposed change. There are several external visual inspections contained in NFPA 25, and included in the new Table 4a, (see the response to Comment No. 12), that consist of external visual inspections not related to fire hydrants and storage tanks. Examples include: • Sprinkler inspections, Section 5.2.1.1.1 • Piping inspections, Section 6.2.1
52	Delete Part (b) of Element 6 which states: "indications of degradation or fouling are evaluated by engineering." This isn't an acceptance criterion. Element 7 notes that the applicant's 10 CFR 50 Appendix B program is to be used for corrective actions. Part (b) of Element 6 isn't an acceptance criterion and is not consistent with NUREG-1800 Appendix A (RLSB-1) section A.1.2.3.6. Consistent with Element 7, the plant's corrective action program should be used to address the documented degradation or fouling.	The staff does not agree with the requested change because it is not consistent with SRP-LR Section A.1.2.3.6. Excerpts from this section are as follows: • The quantitative or qualitative acceptance criteria of the program and its basis should be described. • The program should include a methodology for analyzing the results against applicable acceptance criteria. • Acceptance criteria could be specific numerical values, or could consist of a discussion of the process for calculating specific numerical values of conditional acceptance criteria to ensure that the structure- and component-intended function(s) will be maintained under all CLB design conditions. • Information from available references may be cited. A generic reference to the corrective action program, as proposed by the comment, does not provide the specificity recommended in SRP-LR Section A.1.2.3.6. The staff recognizes that specific acceptance criteria are not always available for the industrywide guidance provided in the GALL Report. However, the staff determined that the following wording is sufficient to replace the generic reference to engineering evaluations, "[a]dditionally, if the presence of sufficient foreign organic or inorganic material to obstruct pipe or sprinklers is detected during pipe inspections, the material is removed and its source is determined and corrected." This phrase replaced part (b).

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53	Add NRC IEN/RIS numbers, SER references, LER numbers, or other reference citations so that applicants can review the details of operating experience cited in element 10 of each AMP. Applicants should be able to reference the same operating experience used by the staff when establishing program recommendations. Some sites may have established alternate aging management methods to address the same OE, but are unable to determine whether the staff has identified additional events or not. Alternatively, applicants may determine that the operating experience warrants additional considerations due to a plant-specific condition.	The staff agrees with this comment. References have been added to the LR-ISG.
54	App. E Element 2 See prior comment for Appendix B XI.M29 description. The preventive action of caulking or seals should not apply to indoor tanks in AMP XI.M29, Above Ground Metallic Tanks Program. The preventive actions of caulking and sealants for above ground steel tanks are designed to minimize corrosion between the tank bottom and the foundation by keeping rain water out. Indoor tanks would not be exposed to rain water and do not require caulking or sealants.	See response to Comment No. 24. The change was accepted and incorporated.
55	Revise the NUREG-1801 AMP XI.M29 to be consistent with the AMP XI.M29 program description noted in NUREG-1800 Table 3.0-1	The staff agrees with this comment. The changes to GALL Report AMP XI.M29 and SRP-LR Table 3.0-1 were compared and minor edits were incorporated consisting of the following: • GALL Report AMP XI.M29 Program Description: removed the words “and coated” from the statement allowing the use of GALL Report AMP XI.M36 in lieu of GALL Report AMP XI.M29 when external surfaces of a tank are visible. • GALL Report AMP XI.M29, “preventive actions” program element: inserted the word “steel” in front of tanks to ensure consistency in that only steel tanks need to be coated. • SRP-LR Table 3.0-1: relocated the “surface examination” wording for clarity.

#	Location, Comment, Discussion	Staff Resolution
56	Recommend relaxing the recommendation for periodic thickness measurements of tank bottoms to a one-time inspection (OTI). A OTI combined with ongoing inspections of the condition of the features that exclude water should provide reasonable assurance of the continued tank integrity. If an inspection of the tank bottom has been performed within 5 years of the PEO; when there is 35 plus years of operating experience, and the operating experience indicates unacceptable degradation has not occurred over the 35 plus years, then there is reasonable assurance to suspect that problems will not occur during the PEO. Tanks on concrete bases are generally constructed with features that are intended to exclude water from the external surface of the tank bottom (e.g., oil sand bedding, caulking, flashing, sloped foundations, etc.). As a result, aging of the bottom surface is not expected, but its absence should be confirmed with a OTI. In addition it would be unlikely that an area inside a plant had uncontrolled conditions that would result in loss of material or cracking of large capacity stainless steel tanks exposed to concrete in an indoor air environment. Thickness measurements of tank bottoms is challenging and in addition, there is never a good time to drain or to put foreign objects into the RWST or CST.	The staff agrees with this comment in part, in that a one-time inspection could be acceptable; however, the staff concludes that the environment beneath the tank should be confirmed to be noncorrosive, or the bottom of the tank should be cathodically protected in order to conduct a one-time inspection in lieu of periodic inspections. Based on this comment, the new Table 4a, "Tank Inspection Recommendations," includes a provision to allow a one-time inspection conducted in accordance with GALL Report AMP XI.M32 in lieu of periodic inspections if: (a) an evaluation of environmental impacts is conducted prior to the PEO and during each 10-year period during the PEO and soil sampling is conducted in the vicinity of the tank (soil results are indicative of atmospheric fallout that could be accumulating in the soil) to ensure that chlorides are not present at sufficient levels to cause pitting and crevice corrosion, or (b) the tank bottom is cathodically protected.
57	App E Element 4 2nd paragraph Confirm the intended dimensions of the 1 sq ft inspection location in the following element 4 sentence is intended to inspect a twelve inch long weld segment: "When conducting surface examinations of welds, the 1-square-foot section is oriented along the length of the weld." Confirmation of the inspection requirement is for a twelve inch weld segment length and not a 1 inch x 144 inch strip along the weld, or something in between.	The staff agrees with this clarifying change. The wording was revised to state 1-linear-foot of weld length.

#	Location, Comment, Discussion	Staff Resolution
58	In the 4th paragraph of AMP XI.M29 element 4, modify the description of the first tank inspections from "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." to "however, examinations are conducted at least once every 10 years and at least once with the first inspection to occur before entering the period of extended operation." Other element 4 inspection frequencies should be modified to incorporate a similar inspection frequency. If a ten-year periodic inspection interval is established, with a first inspection performed prior to the PEO, it shouldn't matter if the initial inspection is performed more than 5 years prior to PEO. Some sites may have already performed such inspection at year PEO-6, and there is no added value to performing another exam prior to PEO, provided the ten year interval is maintained.	The staff agrees with this comment. For periodically conducted inspections, the flexibility of conducting the first inspection at any time during the 10 years prior to the period of extended operation provides scheduling flexibility with no reduction in the ability to detect aging effects. The wording, "[e]ach 10-year period starting 10 years before the period of extended operation," was included in the applicable inspection types in the new Table 4a, "Tank Inspection Recommendations."
59	Consider revising the sentence "Visual inspections cover all of the tank's internal surfaces." to provide a minimum percentage of the surface area (such as 20%), or specify that the inspection is intended to cover the wetted surface only. Additionally, please note that "surface exam" is sometimes interpreted to mean mag particle or dye penetrant testing, which may not be possible in tanks that cannot be drained. Inspection of 100% of the internal sides and top of tanks is technically difficult (e.g. scaffold erection, lighting, tank entry, etc.) if not impossible, especially if the tank cannot be drained. Tanks with a floating cover or internal bladder present a different set of challenges.	The staff agrees with this comment. Visual inspections: The staff added the following clarifying wording, "[i]nspections to identify aging of the inside surfaces of tank shell, roof, and bottom should cover all the inside surfaces. Where this is not possible because of tank configuration (e.g., tanks with floating covers or bladders), the LRA should include a justification for why internal aging effects which could cause the tank's intended function not to be met will not remain undetected." This provision allows an applicant to address plant-specific tank configuration details without citing an exception. Surface examinations: The staff understands that "surface exams" are mag particle or dye penetrant exams. However, the comment has been addressed in that the new Table 4a, "Tank Inspection Recommendations," only includes recommendations for surface examinations on the external surfaces of the tanks and therefore there is no conflict with tanks that cannot be drained. For the basis of this change, see the resolution to Comment No. 33.
60	App. E Element #4, Revise the third sentence of the first paragraph to note that visual inspections of the tanks exterior surface are conducted over accessible exterior surfaces rather than over the "entire" exterior surface. There may be obstacles that make it impossible to inspect the entire exterior surface of a tank (e.g., pump house may be located around the circumference of the tank).	The staff agrees with this comment. The LR-ISG was revised by substituting the term "tank's" in place of "entire." The statement now reads, "[w]hen the exterior surface is not coated, visual inspections of the tank's surface are conducted within sufficient proximity (e.g., distance, angle of observation, lighting) to detect loss of material."

#	Location, Comment, Discussion	Staff Resolution
61	App. E elements 1, 3, & 4 Consistent with other mechanical fluid systems, Internal surfaces of tanks that are exposed to treated water should be inspected on as a one-time inspection rather than periodically on a ten year frequency. Revise AMP XI.M29 element 1 to allow internal surface inspections of tanks that are exposed to treated water to be managed by the Water Chemistry program (XI.M2) and One-Time Inspection program (XI.M32) to verify unacceptable degradation is not occurring. Effective control of water chemistry can prevent some aging effects and minimize others. A One-Time Inspection program (XI.M32) verifies system wide effectiveness that unacceptable degradation is not occurring. If unacceptable aging is identified during the one-time inspection, corrective actions and/or a plant specific program would be required. The plant specific program could require periodic inspections.	The staff agrees with the comment. The comment is consistent with the existing GALL Report recommendations. The new Table 4a, "Tank Inspection Recommendations," recommends a one-time inspection in accordance with GALL Report AMP XI.M32 for internal tanks surfaces exposed to treated water.
62	App. E element 10 The NRC Generic Communications referenced in element 10 of this AMP should be deleted as they apply to degradation of steel containments and are more applicable to (and referenced in) AMP XI.S1 and AMP XI.S8. Replace the operating experience (OE) with OE that is applicable to aging in large volume storage tanks managed by this AMP. Extensive changes are being made to this AMP based on "several instances" of operating experience referenced in the LR-ISG background section for XI.M29. Applicable coating degradation and corrosion degradations should be identified in element 10 of the AMP and the associated reference section.	The staff agrees with this comment. The generic communication references were deleted.

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#	Location, Comment, Discussion	Staff Resolution
63	App. F Element 2 Do not delete the strikeout text as indicated in element 2 of AMP XI.M36. Restore the element 2 strikeout text to allow coatings as a preventive measure. With the text that was added ("Components may be coated with a protective paint or coating to mitigate corrosion by protecting the external surface of the component from environmental exposure"), element 2 reads like it's a requirement for this program. This is XI.M36 which covers many different kinds of components, and it's very likely that most are not coated. Therefore applicants would be forced to take an exception.	The staff does not agree with this comment. The draft LR-ISG proposed to delete the wording "[t]he External Surfaces Monitoring of Mechanical Components program is a condition monitoring program that does not include preventive actions" because the statement is not true. This statement is not true in that the staff concludes that external coatings are an important preventive measure for materials that are susceptible to general corrosion (e.g., steel). The staff clarified its position by revising the wording in program element 2, "preventive actions," of GALL Report AMP XI.M36 to state "[d]epending on the material, components may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the component from environmental exposure."
64	App. F Element 4 In the last paragraph on the page, the 2nd sentence has a semi-colon after the word "requirements" that should be a comma: "In the absence of such requirements,…"	The staff agrees with this statement. The editorial change was incorporated.
65	App. F Element 4 Editorial: First paragraph on the page, sentence beginning with "For all outdoor components, except tanks, and any indoor components operated below the dew point inspections are conducted of each material type …, " there needs to be a comma (,) between the words "point" and "inspections".	The staff agrees with this statement. The editorial change was incorporated.
66	In the 3rd paragraph of AMP XI.M36 element 4 modify the description of the component surface inspections from: "…are periodically inspected every 10 years beginning five years before the period of extended operation." to ".. Are periodically inspected during each ten year period beginning 10 years prior to entering the period of extended operation." If a ten-year periodic inspection interval is established, and with a first inspection performed prior to the PEO, it shouldn't matter if the initial inspection is performed more than 5 years prior to PEO. Some sites may have already performed such inspection at year PEO-6, and there is no added value to performing another exam prior to PEO, provided the ten year interval is maintained.	The staff agrees with this comment. However, this section of GALL Report AMP XI.M36 had been modified as a result of the response to Comment No. 23 to begin implementation of CUI inspections during, not before, the PEO operation.

#	Location, Comment, Discussion	Staff Resolution
67	Revise AMP XI.M36 element 4 identification of sample populations for component surfaces operated below the dew point and insulated outdoor components to allow selection of the component sample based on the most severe environment for the material-environment groupings. Use of a component sample based on the most severe environment for the material-environment groupings is consistent with the LR-ISG-2012-02 approach used in AMP XI.M38. Corrosion of the external surface of external surface of outdoor insulated components can reasonably be expected to bound corrosion of the external surface of indoor insulated components.	The staff does not agree with this comment. The staff is not aware of any data to support that outdoor environments, where precipitation is not constant, are any more severe than an indoor environment where condensation on the external surfaces of components can be present for considerable portions of the operating cycle.
68	App.F. element 1 There is no industry operating experience (OE) referenced in element 10 of this AMP. Add OE that is applicable to corrosion under insulation for aging of external surfaces managed by this AMP. Extensive changes are being made to this AMP based on one instance of operating experience associated with corrosion under insulation referenced in the LR-ISG background section for XI.M36. Applicable operating experience associated with corrosion under insulation should be identified in element 10 of the AMP and the associated reference section.	The staff does not agree with this comment; however, the LR-ISG was revised to include an additional example as follows: In November 1999, an ASME Code Class 2 two-inch unisolable drain line connected to a main steam isolation valve corroded through-wall. The drain line was insulated and located in an outdoor air environment. Sufficient moisture penetrated the insulation to cause corrosion. The degrading condition went undetected until the piping segment failed to meet the containment pressure boundary function. The draft version of the LR-ISG already included examples addressing extensive general corrosion (i.e., corrosion with a wide extent based on its surface area but not its depth of penetration) underneath the insulation removed from an auxiliary feedwater suction line observed during an AMP audit, and gaps in the proposed aging management methods for insulated outdoor tanks and piping surfaces associated with insufficient proposed examination of the surfaces under insulation discovered during the staff's review of AMPs proposed in LRAs.
69	Recommend revising AMP XI.M36 to not require removal of tightly adhering insulation that allows little or no moisture intrusion on mechanical fluid systems.	The staff agrees with this comment and revised the LR-ISG to state that removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. Given that the likelihood of CUI is low for this type of insulation, a walkdown of in-scope piping with tightly adhering insulation to detect damage to the moisture barrier could be an effective means of managing the aging effects associated with this insulation.

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#	Location, Comment, Discussion	Staff Resolution
70	In AMP XI.M36 recommend deleting the last paragraph of element 10. The referenced SRP-LR further evaluation AMR items address recurring internal corrosion and are not applicable to the External Surface Monitoring program. Further evaluation AMR items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6 address loss of material or change in material properties due to recurring internal corrosion. These further evaluation AMR items address recurring internal corrosion and are not applicable to the External Surface Monitoring program that manages aging in primarily non-aggressive external environments associated with ventilation and plant indoor air.	The staff agrees with this comment. The change was incorporated as stated.
71	App. G Element 1 Deleting metallic components with polymer linings from the sentence "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)." It's not clear how polymeric liners of metallic components can be either physically manipulated or expanded by pressurization.	The staff agrees with this comment. The change was incorporated as stated. The inspection of internal coatings will be addressed in LR-ISG-2013-01.

#	Location, Comment, Discussion	Staff Resolution
72	Revise the last sentence of the second paragraph in the program description for XI.M38 to indicate that following failures due to recurring internal corrosion, the program may also be used if corrective actions are taken to prevent or minimize unacceptable aging. The following revision is recommended: Following ~~a failure~~ repetitive failures due to recurring internal corrosion, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest or corrective actions are taken to prevent or minimize unacceptable aging. The current AMP provides an allowance for continued use of the program when recurring internal corrosion is observed and the failed material is replaced by one that is more corrosion-resistant. The proposed further evaluations for recurring internal corrosion allow the AMP to be enhanced or a plant specific program to be completed. A plant specific program should also not be required if corrective actions are taken to prevent or minimize aging due to recurring internal corrosion. For example, other corrective actions could include changing system operating practices to minimize aggressive environments, use of a corrosion resistant coating, etc.	The staff agrees with this comment with the exception of accepting use of the term "minimize unacceptable aging." This portion of GALL Report AMP XI.M38 was revised to incorporate the threshold criteria from the new FE items associated with recurring internal corrosion. Prior to being revised by this LR-ISG, GALL Report AMP XI.M38 used the term, "failure," as the threshold for not allowing use of the AMP. It was not clear whether "failure" referred to a loss of intended function, or sufficient degradation that while the component could still perform its intended function, it would do so only with some level of reduced margin. The revised recommendation allows the use of GALL Report AMP XI.M38 if the program has been augmented to include the necessary changes to manage the recurring aging effect. By extension, this change provides the threshold of degradation for which the program can be used as-is. The staff did not accept the term "minimize unacceptable aging." because the aging management programs should provide reasonable assurance that "unacceptable aging" would be prevented. The term "unacceptable" implies that aging effects could cause an in-scope component to not meet its current licensing basis intended function(s) during the period of extended operation. The staff agrees that there are more ways to correct a degradation mechanism than replacing the material with a more corrosion-resistant material so the text "or corrective actions have been taken to prevent recurrence of the recurring internal corrosion" was added to the end of the paragraph.
73	App. G Element 4 Recommend revising the periodic representative sampling of material-environment groups to an one-time inspection (OTI) verification. If unacceptable degradation is observed in a material-environment group, opportunistic sampling is to be augmented to achieve a representative sample of 20 percent of the population or a maximum of 25 components for that material-environment group during each of the 10 year periodic inspection intervals in the PEO. If an OTI inspection of a material-environment group has been performed within 10 years of the PEO; when there is 30 plus years of operating experience, and the operating experience indicates unacceptable degradation has not occurred over the 30 plus years, then there is reasonable assurance to suspect that problems will not occur during the PEO.	The staff does not agree with this comment. The purpose of GALL Report AMP XI.M32, "One-Time Inspection," is stated as follows: Situations in which additional confirmation is appropriate include: (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected. For these cases, confirmation demonstrates that either the aging effect is not occurring or that the aging effect is occurring very slowly and does not affect the component's or structure's intended function during the period of extended operation based on prior operating experience data. If the in-scope components of interest meet the intent of GALL Report AMP XI.M32 (i.e., an aging effect is not expected to occur, the aging effect progresses slowly) the aging effects for these components should be managed using GALL Report AMP XI.M32, not GALL Report AMP XI.M38. Otherwise, they should be inspected on a periodic basis as recommended in GALL Report AMP XI.M38 and other AMPs.
74 -81		To be addressed in LR-ISG-2013-01

APPENDIX J

REVISIONS 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 manages loss of material due to corrosion, including MIC, 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 the 2011 Edition of NFPA 25. Testing or replacement of sprinklers that have been in place for 50 years is performed in accordance with the 2011 Edition of NFPA 25. In addition to NFPA codes and standards, portions of the water-based fire protection system that are: (a) normally dry but periodically subjected to flow (e.g., dry-pipe or preaction sprinkler system components) and (b) cannot be drained or allow water to collect are to be subjected to augmented testing beyond that specified in NFPA 25, including: (a) periodic full flow tests at the design pressure and flow rate or internal visual inspections and (b) volumetric wall-thickness examinations. Flow testing and visual inspections are performed at intervals specified in the 2011 Edition of NFPA-25. 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.	Program is implemented 5 years before the period of extended operation. Inspections of wetted normally dry piping segments that cannot be drained or that allow water to collect begin 5 years before the period of extended operation. The program's remaining inspections begin during the period of extended operation.	GALL VII / SRP 3.3
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, and with sealant or caulking for outdoor tanks at the concrete-component interface. External visual examinations are sufficient to monitor degradation of the protective paint, coating, and caulking, or sealant (when supplemented with physical manipulation), or uncoated surfaces. Surface exams are conducted to detect cracking when susceptible materials are used (e.g., stainless steel, aluminum). The external surfaces of insulated tanks are sampling-based inspected. Internal visual and surface (when necessary to detect cracking) examinations are conducted as well as 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.	Program is implemented and inspections begin 10 years before the period of extended operation.	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4

APPENDIX J

REVISIONS 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.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. A sample of outdoor component surfaces that are insulated and a sample of indoor insulated components exposed to condensation (due to the in-scope component being operated below the dew point), are periodically inspected every 10 years during the period of extended operation. When appropriate for the component and material, manipulation is used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength.	Program is implemented 6 months before the period of extended operation and inspections begin during the period of extended operation.	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4
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 and piping elements, ducting, heat exchanger components, polymeric and elastomeric components, and other components that are exposed to environments of uncontrolled indoor air; outdoor air; air with borated water leakage, condensation, moist air, diesel exhaust, and any water environment other than open-cycle cooling water, closed treated water, and fire water. 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 during the period of extended operation a representative sample of 20 percent of the population (defined as components having the same combination of material, environment, and aging effect) 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 6 months before the period of extended operation and inspections begin during the period of extended operation.	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4 GALL VI / SRP 3.6

APPENDIX J

REVISIONS TO THE SRP-LR

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

3.2.2.2.9 Loss of Material due to Recurring Internal Corrosion

3.3.2.2.8 Loss of Material due to Recurring Internal Corrosion

3.4.2.2.6 Loss of Material due to Recurring Internal Corrosion

Recurring internal corrosion 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 internal corrosion can be identified by the number of occurrences of aging effects 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 that has occurred over: (a) three or more sequential or nonsequential cycles for a 10-year OE search, or (b) two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism in which the aging effect resulted in the component either not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness.

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 adequate management of any recurring aging effect(s). 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), and additional trending parameters and decision points where increased inspections would be implemented. 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 effect 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., the extent of degradation at individual corrosion sites, the rate of degradation change), (d) how inspections of components that are not easily accessed (i.e., buried, underground) will be conducted, and (e) how leaks in any involved buried or underground components will be identified.

Each plant-specific operating experience example should be evaluated to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the operating experience should be evaluated to determine if the AMP that is proposed to manage the aging effect is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the CLB intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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

3.2.3.2.9 Loss of Material due to Recurring Internal Corrosion

3.3.3.2.8 Loss of Material due to Recurring Internal Corrosion

3.4.3.2.6 Loss of Material due to Recurring Internal Corrosion

The GALL Report recommends further evaluation to manage recurring internal corrosion aging effects. The reviewer conducts an independent review of plant-specific OE to determine whether the plant is currently experiencing recurring internal corrosion. The scope of this further evaluation AMR item includes recurring aging effects in which the plant-specific OE review reveals repetitive occurrences (e.g., one per refueling outage that has occurred over: (a) three or more sequential or nonsequential cycles for a 10-year OE search, or (b) two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism as a result of which the component either did not meet plant-specific acceptance criteria or experienced a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness.

The reviewer should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the operating experience should be evaluated to determine if the AMP that is proposed to manage the aging effect is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the CLB intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

The reviewer determines whether a proposed program is adequate to manage recurring internal corrosion by evaluating the proposed AMP against the criteria in SRP-LR Section 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
66	BWR/PWR	Metallic piping, piping components, and tanks exposed to raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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	Stainless steel or aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No	V.D1.E-405 V.D2.E-405	N/A
68	BWR/PWR	Steel, stainless steel, or aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion	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	Insulated steel, stainless steel, copper alloy, or aluminum, piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or 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	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, "Aboveground Metallic Tanks") exposed to treated water, treated borated water	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No	V.A.E-404 V.D1.E-404 V.D2.E-404	N/A N/A N/A
71	BWR/PWR	Insulated stainless steel, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks only)	No	V.A.E-406 V.B.E-406 V.C.E-406 V.D1.E-406 V.D2.E-406 V.E.E-406	N/A N/A N/A N/A N/A 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

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
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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	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	Chapter XI.M27, "Fire Water System"	No	VII.G.A-55	VII.G-19(A-55)
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)

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
72	BWR/PWR	Gray cast iron, Copper alloy (>15% Zn or >8% Al) Piping, piping components, and piping elements, Heat exchanger components exposed to Treated water, Closed-cycle cooling water, Soil, Raw water, Waste water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No	VII.A3.AP-31 VII.A3.AP-43 VII.A4.AP-31 VII.A4.AP-32 VII.A4.AP-43 VII.C1.A-02 VII.C1.A-47 VII.C1.A-51 VII.C1.A-66 VII.C2.A-50 VII.C2.AP-31 VII.C2.AP-32 VII.C2.AP-43 VII.C3.A-02 VII.C3.A-47 VII.C3.A-51 VII.E1.AP-31 VII.E1.AP-43 VII.E1.AP-65 VII.E3.AP-31 VII.E3.AP-32 VII.E3.AP-43 VII.E4.AP-31 VII.E4.AP-32 VII.E4.AP-43 VII.F1.AP-31 VII.F1.AP-43 VII.F1.AP-65 VII.F2.AP-31 VII.F2.AP-43 VII.E5.A-407	VII.A3-7(AP-31) VII.A3-6(AP-43) VII.A4-10(AP-31) VII.A4-9(AP-32) VII.A4-8(AP-43) VII.C1-12(A-02) VII.C1-10(A-47) VII.C1-11(A-51) VII.C1-4(A-66) VII.C2-8(A-50) VII.C2-9(AP-31) VII.C2-7(AP-32) VII.C2-6(AP-43) VII.C3-5(A-02) VII.C3-3(A-47) VII.C3-4(A-51) VII.E1-14(AP-31) VII.E1-13(AP-43) VII.E1-3(AP-65) VII.E3-12(AP-31) VII.E3-11(AP-32) VII.E3-10(AP-43) VII.E4-10(AP-31)

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
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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: 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 raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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	Steel, stainless steel, or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, or crevice corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VII.C3.A-401 VII.E5.A-401 VII.H1.A-401	N/A
129	BWR/PWR	Steel tanks exposed to soil or concrete; air-indoor uncontrolled, raw water, treated water, waste water, condensation	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
130	BWR/PWR	Metallic sprinklers exposed to air-indoor controlled, air-indoor uncontrolled, air-outdoor, moist air, condensation, raw water, treated water	Loss of material due to general (where applicable), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, “Fire Water System”	No	VII.G.A-403	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
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, and copper alloy only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, “Fire Water System”	No	VII.G.A-404	N/A
132	BWR/PWR	Insulated steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components" or 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 3.3-1 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
133	BWR/PWR	Underground HDPE piping, piping components, and piping elements in an air-indoor uncontrolled or condensation (external) environment	Cracking, blistering, change in color due to water absorption	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No	VII.I.A-406	N/A
134	BWR/PWR	Steel, stainless steel, or copper alloy piping, piping components, and piping elements, and heat exchanger components exposed to a raw water environment (for nonsafety-related components not covered by NRC GL 89-13)	Loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components”	No	VII.C1.A-408 VII.C1.A-409	N/A N/A
135	BWR/PWR	Steel or stainless steel pump casings submerged in a waste water (internal and external) environment	Loss of material due to general (steel only), pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, “External Surfaces Monitoring of Mechanical Components”	No	VII.E5.A-410 VII.E5.A-411	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
136	BWR/PWR	Steel, stainless steel or aluminum fire water storage tanks exposed to air-indoor uncontrolled, air-outdoor, condensation, moist air, raw water, treated water	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	Chapter XI.M27, "Fire Water System"	No	VII.G.A-412	N/A
137	BWR/PWR	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to treated water, treated borated water	Loss of material due to general (steel only) pitting and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VII.C3.A-413 VII.E5.A-413 VII.H1.A-413	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
30	BWR/PWR	Steel, Stainless Steel, Aluminum Tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (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 (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VIII.E.SP-137 VIII.E.SP-139	N/A N/A
61	BWR/PWR	Metallic piping, piping components, and tanks exposed to raw water or waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant-specific (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

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
62	BWR/PWR	Steel, stainless steel or aluminum tanks (within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”) exposed to treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No	VIII.E.S-405 VIII.G.S-405	N/A N/A
63	BWR/PWR	Insulated steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn) piping, piping components, and tanks exposed to condensation, air-outdoor	Loss of material due to general (steel, and copper alloy), pitting, or crevice corrosion, and cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) 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
64	BWR/PWR	Jacketed calcium silicate or fiberglass insulation in an air-indoor uncontrolled or air-outdoor environment	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No	VIII.I.S-403	N/A
65	BWR/PWR	Jacketed foamglas ® (glass dust) insulation in an air-indoor uncontrolled or air-outdoor environment	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No	VIII.I.S-404	N/A

APPENDIX K

REVISIONS TO THE GALL REPORT AMR LINE 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-400 V.B.E-400 V.C.E-400 V.D1.E-400 V.D2.E-400		Piping, piping components, and tanks	Metallic	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated to address recurring internal corrosion	Yes, plant specific
V.D1.E-402 V.D2.E-402		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Steel, stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, or aluminum	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, "Aboveground Metallic Tanks," (for tanks)	No
V.A.E-404 V.D1.E-404 V.D2.E-404		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Steel, stainless steel or aluminum	Treated water, treated borated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks,"	No
V.D1.E-405 V.D2.E-405		Tanks within the scope of Chapter XI.M29, "Aboveground Metallic Tanks"	Stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Cracking due to stress corrosion cracking	Chapter XI.M29, "Aboveground Metallic Tanks"	No

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REVISIONS TO THE GALL REPORT AMR LINE 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-406 V.B.E-406 V.C.E-406 V.D1.E-406 V.D2.E-406 V.E.E-406		Insulated piping, piping components, and tanks	Stainless steel, aluminum or copper alloy (> 15% Zn)	Condensation, air-outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, “Aboveground Metallic Tanks,” (for tanks only)	No

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REVISIONS TO THE GALL REPORT AMR LINE ITEMS AND DEFINITIONS

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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: 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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	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 AUXILIARY SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
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	For fire water system components: Chapter XI.M27, "Fire Water System," or for other components: Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
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, fouling that leads to corrosion; flow blockage due to fouling	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, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No

REVISIONS TO THE GALL REPORT AMR LINE 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-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	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
VII.C3.A-401 VII.E5.A-401 VII.H1.A-401		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel; stainless steel, or aluminum	Soil or concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to general (steel only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (stainless steel and aluminum only)	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-402 VII.H1.A-402		Tanks	Steel	Soil or concrete; air-indoor uncontrolled, raw water, treated water, waste water, condensation	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No
VII.G.A-403		Sprinklers	Metallic	Air-indoor controlled, air-indoor uncontrolled, air-outdoor, moist air, condensation, raw water, treated water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No
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-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling	Chapter XI.M27, "Fire Water System"	No

REVISIONS TO THE GALL REPORT AMR LINE 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-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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, aluminum, or copper alloy (> 15% Zn)	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, “Aboveground Metallic Tanks” (for tanks only)	No
VII.I.A-406		Underground piping, piping components, and piping elements	HDPE	Air-indoor uncontrolled or condensation (external) environment	Cracking, blistering, change in color due to water absorption	Chapter XI.M41, “Buried and Underground Piping and Tanks	No
VII.E5.A-407		Piping, piping components, and piping elements, and heat exchanger components	Gray cast iron, copper alloy (>15% Zn or >8% Al)	Waste water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No

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REVISIONS TO THE GALL REPORT AMR LINE ITEMS AND DEFINITIONS

VII AUXILIARY SYSTEMS							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.C1.A-408		Piping, piping components, and piping elements, and heat exchanger components (for nonsafety-related components not covered by NRC GL 89-13)	Steel, copper alloy	Raw water	Loss of material due to general, pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.C1.A-409		Piping, piping components, and piping elements, and heat exchanger components (for nonsafety-related components not covered by NRC GL 89-13)	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion	Chapter XI.MI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.A-410		Pump Casing	Steel	Waste water (internal and external)	Loss of material due to general, pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.E5.A-411		Pump Casing	Stainless steel	Waste water (internal and external)	Loss of material due to pitting, crevice, and microbiologically influenced corrosion	Chapter XI.MI.M36, "External Surfaces Monitoring of Mechanical Components"	No

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REVISIONS TO THE GALL REPORT AMR LINE ITEMS AND DEFINITIONS

VII AUXILIARY SYSTEMS

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.G.A-412		Fire water storage tanks	Steel, stainless steel, or aluminum	Air-indoor uncontrolled, air-outdoor, condensation, moist air, raw water, treated water	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; cracking due to stress corrosion cracking (aluminum and stainless steel only)	Chapter XI.M27, "Fire Water System"	No
VII.C3.A-413 VII.E5.A-413 VII.H1.A-413		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel, or aluminum	Treated water, treated borated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No

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-137		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Stainless steel	Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-138		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Stainless steel	External environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-139		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Aluminum	Soil or Concrete, or the following external environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-140		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Aluminum	External environments air-outdoor, air-indoor uncontrolled, moist air, condensation	Loss of material due to pitting, and crevice corrosion; cracking due to stress corrosion cracking	Chapter XI.M29, “Aboveground Metallic Tanks”	No

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REVISIONS TO THE GALL REPORT AMR LINE 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	Raw water, waste water	Loss of material due to recurring internal corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
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		Insulated piping, piping components, and tanks	Steel, stainless steel, copper alloy, or copper alloy (> 15% Zn), aluminum	Condensation, air-outdoor	Loss of material due to general (steel, and copper alloy only), pitting, and crevice corrosion; cracking due to stress corrosion cracking (aluminum, stainless steel and copper alloy (>15% Zn) only)	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components;" or Chapter XI.M29, “Aboveground Metallic Tanks,” (for tanks only)	No
VIII.I.S-403		Jacketed insulation	Calcium silicate, fiberglass	Air-indoor uncontrolled or air-outdoor	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.I.S-404		Jacketed insulation	Foamglas® (glass dust)	Air-indoor uncontrolled or air-outdoor	Reduced thermal insulation resistance due to moisture intrusion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.E.S-405 VIII.G.S-405		Tanks within the scope of Chapter XI.M29, “Aboveground Metallic Tanks”	Steel, stainless steel, or aluminum	Treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No

APPENDIX K

REVISIONS TO THE GALL REPORT AMR LINE ITEMS AND DEFINITIONS

GALL Report Section	Term	Definition as used in this document
IX.D	Condensation (internal/external)	Condensation on the surfaces of systems at temperatures below the dew point is considered “raw water” due to the potential for internal or external surface contamination. Under certain circumstances, the former terms “moist air” or “warm moist air” are subsumed by the definition of “condensation,” which describes an environment where there is enough moisture for corrosion to occur. Because of air in-leakage through minor gaps in insulation, condensation can occur underneath the insulation on components when the operating temperature of the component is below the dew point of the air on the external surfaces of the insulation.
IX.E	Flow blockage	Flow blockage is the reduction of flow or pressure, or both, in a component due to fouling, which can occur from an accumulation of debris such as particulate fouling (e.g., eroded coatings, corrosion products), biofouling, or macro fouling. Flow blockage can result in a reduction of heat transfer or the inability of a system to meet its intended safety function, or both. This definition is consistent with the definition of the term “pressure boundary” as found in SRP-LR Table 2.1-4(b), “Typical ‘Passive’ Component-Intended Functions.”
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. Degraded elastomers can experience increased hardness, shrinkage, loss of sealing, cracking, and loss of strength.
IX.E	Reduced thermal insulation resistance	Impairment of thermal insulation’s ability to resist the transfer of heat between the ambient environment and the insulated structure or component. This is caused by the degradation of the insulation that typically occurs when insulation is exposed to moisture.

APPENDIX K

REVISIONS TO THE GALL REPORT AMR LINE ITEMS AND DEFINITIONS

GALL Report Section	Term	Definition as used in this document
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). Biofouling, a subset of fouling, can be caused by either macro-organisms (e.g., barnacles, Asian clams, zebra mussels, or others found in fresh and salt water) or micro-organisms (e.g., algae, microfouling tubercles). Fouling also can be categorized as particulate fouling (e.g., sediment, silt, dust, eroded coatings, and corrosion products), biofouling, or macrofouling (e.g., delaminated coatings, debris). 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 a 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, and change in material properties. [Ref. 24, 25]
IX.F	Recurring internal corrosion	Recurring internal corrosion is identified by both the number of occurrences of internal aging effects with the same aging mechanism 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 that has occurred over three or more sequential or nonsequential cycles for a 10-year OE search, or two or more sequential or nonsequential cycles for a 5-year OE search) of aging effects with the same aging mechanism. 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 experiencing a reduction in wall thickness of greater than 50 percent (regardless of the minimum wall thickness). Recurring internal corrosion is evaluated based on the aging mechanisms observed. For example, multiple occurrences of loss of material (LOM) due to MIC, LOM due to pitting, or LOM due to galvanic corrosion would be considered three separate occurrences of aging mechanisms that could be grouped as recurring internal corrosion but that would be evaluated separately.

APPENDIX L

REVISED GALL REPORT AMP XI.M27 "FIRE WATER SYSTEM"

XI.M27 FIRE WATER SYSTEM

Program Description

This AMP applies to water-based fire protection system components, including sprinklers, nozzles, fittings, valve bodies, 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. 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: (a) normally dry but periodically are subject to flow (e.g., dry-pipe or preaction sprinkler system piping and valves) and (b) that cannot be drained or allow water to collect, are subjected to augmented testing or inspections. Also, portions of the system (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.

Either sprinklers are replaced before reaching 50 years inservice or a representative sample of sprinklers from one or more sample areas is tested by using the guidance of the 2011 Edition of NFPA 25, "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.
GALL Report AMP XI.M41, "Buried and Underground Piping and Tanks," is used to monitor the external surfaces of buried and underground water-based fire protection system piping and tanks.

Evaluation and Technical Basis

1. ***Scope of Program:*** Components within the scope of water-based fire protection systems include items such as sprinklers, nozzles, fittings, valve bodies, 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 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:*** 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 could reduce wall thickness of the fire protection piping system components and result in system failure. Flow blockage due to fouling from the buildup of corrosion products or sediment in the system could occur. Therefore, the parameters monitored are the system's ability to maintain required pressure, flow rates, and the system's internal corrosion conditions. Periodic flow testing, flushes, and internal and external visual inspections are performed to ensure that the system maintains its intended function. Testing of sprinklers ensures that degradation is detected in a timely manner. When visual inspections are used to detect loss of material, the inspection technique is capable of detecting surface irregularities that could indicate wall loss to below nominal pipe wall thickness due to corrosion and corrosion product deposition. 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 are normally dry.

4. ***Detection of Aging Effects:*** All water-based fire protection system components are subject to flow testing (except for fire water storage tanks), other testing, and visual inspections. Testing and visual inspections are performed in accordance with Table 4a, "Fire Water System Inspection and Testing Recommendations."

   a. Flow tests confirm the system is functional by verifying the capability of the system to deliver water to fire suppression systems at required pressures and flow rates.

   b. Visual inspections are capable of evaluating: (a) the condition of the external surfaces of components, (b) the conditions of the internal surfaces of components that could indicate wall loss, and (c) the inner diameter of the piping as it applies to the design flow of the fire protection system (i.e., to verify that corrosion product buildup has not resulted in flow blockage due to fouling). Internal visual inspections used to detect loss of material are capable of detecting surface irregularities that could be indicative of wall loss below nominal pipe wall thickness due to corrosion and corrosion product deposition. Where such irregularities are detected, followup volumetric examinations are performed.

   c. Visual inspection of yard fire hydrants ensures timely detection of signs of degradation, such as corrosion. Fire hydrant hose hydrostatic tests, gasket inspections, and fire hydrant flow tests ensure that fire hydrants can perform their intended function and provide opportunities to detect degradation before a loss of intended function can occur.

APPENDIX L

REVISED GALL REPORT AMP XI.M27 "FIRE WATER SYSTEM"

Table 4a Fire Water System Inspection and Testing Recommendations[1, 2, 5]	
Description	NFPA 25 Section
Sprinkler Systems	
Sprinkler inspections[5]	5.2.1.1
Sprinkler testing	5.3.1
Standpipe and Hose Systems	
Flow tests	6.3.1
Private Fire Service Mains	
Underground and exposed piping flow tests	7.3.1
Hydrants	7.3.2
Fire Pumps	
Suction screens	8.3.3.7
Water Storage Tanks	
Exterior inspections	9.2.5.5
Interior inspections	9.2.6[4], 9.2.7
Valves and System-Wide Testing	
Main drain test	13.2.5
Deluge valves[5]	13.4.3.2.2 through 13.4.3.2.5
Water Spray Fixed Systems	
Strainers (refueling outage interval and after each system actuation)	10.2.1.6, 10.2.1.7, 10.2.7
Operation test (refueling outage interval)	10.3.4.3
Foam Water Sprinkler Systems	
Strainers (refueling outage interval and after each system actuation)	11.2.7.1
Operational Test Discharge Patterns (annually)[6]	11.3.2.6
Storage tanks (internal – 10 years)	Visual inspection for internal corrosion
Obstruction Investigation	
Obstruction, internal inspection of piping[3]	14.2 and 14.3

1. All terms and references are to the 2011 Edition of NFPA 25. The staff cites the 2011 Edition of NFPA 25 for the description of the scope and periodicity of specific inspections and tests. This table specifies those inspections and tests that are related to age-managing applicable aging effects associated with loss of material and flow blockage for passive long-lived in-scope components in the fire water system. Inspections and tests not related to the above should continue to be conducted in accordance with the plant's current licensing basis. If the current licensing basis specifies more frequent inspections than required by NFPA 25 or this table, the plant's current licensing basis should continue to be met.
2. A reference to a section includes all sub-bullets unless otherwise noted (e.g., a reference to 5.2.1.1 includes 5.2.1.1.1 through 5.2.1.1.7).
3. The alternative nondestructive examination methods permitted by 14.2.1.1 and 14.3.2.3 are limited to those that can ensure that flow blockage will not occur.
4. In regard to Section 9.2.6.4, the threshold for taking action required in Section 9.2.7 is as follows: pitting and general corrosion to below nominal wall depth and any coating failure in which bare metal is exposed. Blisters should be repaired. Adhesion testing should be performed in the vicinity of blisters even though bare metal might not have been exposed. Regardless of conditions observed on the internal surfaces of the tank, bottom-thickness measurements should be taken on each tank during the first 10-year period of the period of extended operation.
5. Items in areas that are inaccessible because of safety considerations such as those raised by continuous process operations, radiological dose, or energized electrical equipment shall be inspected during each scheduled shutdown but not more often than every refueling outage interval.
6. Where the nature of the protected property is such that foam cannot be discharged, the nozzles or open sprinklers shall be inspected for correct orientation and the system tested with air to ensure that the nozzles are not obstructed.

Portions of water-based fire protection system components that have been wetted but are normally dry, such as dry-pipe or preaction sprinkler system piping and valves, are subjected to augmented testing and inspections beyond those of Table 4a. The augmented tests and inspections are conducted on piping segments that cannot be drained or piping segments that allow water to collect:

- In each 5-year interval, beginning 5 years prior to the period of extended operation, either conduct a flow test or flush sufficient to detect potential flow blockage, or conduct a visual inspection of 100 percent of the internal surface of piping segments that cannot be drained or piping segments that allow water to collect.

- In each 5-year interval of the period of extended operation, 20 percent of the length of piping segments that cannot be drained or piping segments that allow water to collect is subject to volumetric wall thickness inspections. Measurement points are obtained to the extent that each potential degraded condition can be identified (e.g., general corrosion, MIC). The 20 percent of piping that is inspected in each 5-year interval is in different locations than previously inspected piping.

If the results of a 100-percent internal visual inspection are acceptable, and the segment is not subsequently wetted, no further augmented tests or inspections are necessary. 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 Table 4a do not need to be augmented.

The inspections and tests of all water-based fire protection components occur at the intervals specified in the 2011 Edition of NFPA 25.

If the environmental (e.g., type of water, flowrate, temperature) and material that exist on the interior surface of the 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 buried and underground fire protection piping for the purpose of identifying inside diameter loss of material. If not, additional inspection activities are needed to ensure that the intended function of buried and underground 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 in such a way 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.

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 flow testing (e.g., buried and underground piping, fire mains, sprinkler) are monitored and trended. Degradation identified by 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) minimum design wall thickness is maintained, and (c) no fouling exists in the sprinkler systems that could cause corrosion in the sprinklers. Additionally, if the presence of sufficient foreign organic or inorganic material to obstruct pipe or sprinklers is detected during pipe inspections, the material is removed and its source is determined and corrected.

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:*** 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 operating experience may be of significance to an applicant’s program:

d. 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 leak-by.

e. 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.

f. 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, “Loss of Material due to Recurring Internal Corrosion,” address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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*, 2011 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 M

REVISED GALL REPORT AMP XI.M29 "ABOVEGROUND METALLIC TANKS"

XI.M29 ABOVEGROUND METALLIC TANKS

Program Description

The Aboveground Metallic Tanks AMP manages the effects of loss of material and cracking on the outside and inside surfaces of aboveground tanks constructed on concrete or soil. All outdoor tanks (except fire water storage tanks) and certain indoor tanks are included. If the tank exterior is fully visible, the tank's outside surfaces may be inspected under the program for inspection of external surfaces (GALL Report AMP XI.M36) for visual inspections recommended in this AMP; surface examinations are conducted in accordance with the recommendations of this AMP. 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 applicable aging effects.

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***: Tanks within the scope of this program include all outdoor tanks constructed on soil or concrete. Indoor large-volume storage tanks (i.e., those with a capacity greater than 100,000 gallons) designed to internal pressures approximating atmospheric pressure and exposed internally to water are also included. If the tank exterior is fully visible, tank outside surfaces may be inspected under the program for inspection of external surfaces (GALL Report AMP XI.M36). Aging effects for fire water storage tanks are managed using GALL Report AMP XI.M27. Visual inspections are conducted on tank insulation and jacketing when these are installed.
2. ***Preventive Actions:*** In accordance with industry practice, steel tanks may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the tank from environmental exposure. For outdoor tanks, except for cases in which the configuration of the tank bottom and foundation would dictate otherwise (e.g., the foundation is sloped in such a way that water cannot accumulate under the tank bottom), sealant or caulking is 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 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, and bottom and interior surfaces). The AMP 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. Thickness measurements of the bottoms of the tanks are made periodically for the tanks monitored by

this program as an additional way to ensure that loss of material is not occurring at locations 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 periodically removed or inspected to detect the potential for loss of material or cracking underneath the insulation.

4. ***Detection of Aging Effects:*** Tank inspections are conducted in accordance with Table 4a, "Tank Inspection Recommendations." 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. If the exterior surface is not coated, visual inspections of the tank's surface are conducted within sufficient proximity (e.g., distance, angle of observation) to detect loss of material. If the tank is insulated, the inspections include 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.

   If the exterior surface of an outdoor tank or indoor tank exposed to condensation (because the in-scope component being 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 of 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 in such a way 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 could collect such as on top of stiffening rings. In addition, inspection locations should be based on the likelihood of corrosion under insulation occurring (e.g., given how often a potential inspection location is subject to alternate wetting and drying in environments where trace contaminants could be present, how long a system at a potential inspection location operates below the dew point).

   Alternatives to Removing Insulation:

   a. Subsequent inspections may consist of examination of the exterior surface of the insulation for indications of damage to the jacketing or protective outer layer of the insulation when the results of the initial inspection meet the following criteria:

      a. No loss of material due to general, pitting or crevice corrosion, beyond that which could have been present during initial construction is observed, and

      b. no evidence of SCC is observed.

      If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or jacketing, or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as conducted for the initial inspection.

b. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of corrosion under insulation (CUI) is low for tightly adhering insulation. Tightly adhering insulation is considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation is visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections are not credited towards the inspection quantities for other types of insulation.

Potential corrosion of tank bottoms is determined from ultrasonic testing (UT) thickness measurements of the tank bottoms that are taken whenever the tank is drained or at intervals not less than those recommended in Table 4a. 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.

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

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Table 4a Tank Inspection Recommendations[1, 2]				
Material	Environment	AERM	Inspection Technique[3]	Inspection Frequency
Inspections to identify degradation of inside surfaces of tank shell, roof[4], and bottom Inside Surface (IS), Outside Surface (OS)[5, 6]				
Steel	Raw water Waste water	Loss of material	Visual from IS or Volumetric from OS[7]	Each 10-year period starting 10 years before the period of extended operation
Steel	Treated water	Loss of material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Stainless steel	Treated water	Loss of Material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Aluminum	Treated water	Loss of Material	Visual from IS or Volumetric from OS[7]	One-time inspection conducted in accordance with AMP XI.M32[8]
Inspections to identify degradation of external surfaces of tank roof, tank shell, and bottom not exposed to soil or concrete[9]				
Steel	Air – indoor uncontrolled Air – outdoor	Loss of material	Visual from OS	Each refueling outage interval
Stainless steel	Air – indoor uncontrolled	Cracking	Surface [10, 11]	Each 10-year period starting 10 years before the period of extended operation
Stainless steel	Air-outdoor	Loss of material	Visual from OS	Each refueling outage interval
		Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Aluminum	Air – indoor uncontrolled	Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Aluminum	Air-outdoor	Loss of material	Visual from OS	Each refueling outage interval
		Cracking	Surface[10, 11]	Each 10-year period starting 10 years before the period of extended operation
Inspections to identify degradation of external surfaces of tank bottoms and tank shells exposed to soil or concrete				
Steel	Soil or concrete	Loss of material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]
Stainless steel	Soil or concrete	Loss of material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]
Aluminum	Soil or concrete	Loss of Material	Volumetric from IS[12]	Each 10-year period starting 10 years before the period of extended operation[13]

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Table 4a Tank Inspection Recommendations[1, 2]				
Material	Environment	AERM	Inspection Technique[3]	Inspection Frequency

1. GALL Report AMP XI.M30, "Fuel Oil Chemistry," is used to manage loss of material on the internal surfaces of fuel oil storage tanks. However, for outdoor fuel oil storage tanks, inspections to identify aging of the external surfaces of tank bottoms and tank shells exposed to soil or concrete are conducted in accordance with GALL Report AMP XI.M29. GALL Report AMP XI.M41 is used to manage loss of material and cracking for the external surfaces of buried tanks.
2. When one-time internal inspections in accordance with these footnotes are used in lieu of periodic inspections, the one-time inspection must occur within the 5-year period before the start of the PEO.
3. Alternative inspection methods may be used to inspect both surfaces (i.e., internal, external) or the opposite surface (e.g., inspecting the internal surfaces for loss of material from the external surface, inspecting for corrosion under external insulation from the internal surfaces of the tank) as long as the method has been demonstrated to be effective at detecting the AERM and a sufficient amount of the surface is inspected to ensure that localized aging effects are detected. For example, in some cases, subject to being demonstrated effective by the applicant, the low frequency electromagnetic technique (LFET) can be used to scan an entire surface of a tank. If followup ultrasonic examinations are conducted in any areas where the wall thickness is below nominal, an LFET inspection can effectively detect loss of material in the tank shell, roof, or bottom.
4. Nonwetted surfaces on the inside of a tank (e.g., roof, surfaces above the normal waterline) are inspected in the same manner as the wetted surfaces based on the material, environment, and AERM.
5. Visual inspections to identify degradation of the inside surfaces of tank shell, roof, and bottom should cover all the inside surfaces. Where this is not possible because of the tank's configuration (e.g., tanks with floating covers or bladders), the LRA should include a justification for how aging effects will be detected before the loss of the tank's intended function.
6. For tank configurations in which deleterious materials could accumulate on the tank bottom (e.g., sediment, silt), the internal inspections of the tank's bottom should include inspections of the side wall of the tank up to the top of the sludge-affected region.
7. At least 25 percent of the tank's internal surface is to be inspected using a method capable of precisely determining wall thickness. The inspection method should be capable of detecting both general and pitting corrosion and be demonstrated effective by the applicant.
8. At least one tank for each material and environment combination should be inspected at each site. The tank inspection can be credited towards the sample population for GALL Report AMP XI.M32.
9. For insulated tanks, the external inspections of tank surfaces that are insulated are conducted in accordance with the sampling recommendations in this AMP. If the initial inspections meet the criteria described in the preceding "Alternatives to Removing Insulation" portion of this AMP, subsequent inspections may consist of external visual inspections of the jacketing in lieu of surface examinations. Tanks with tightly adhering insulation may use the "Alternatives to Removing Insulation" portion of this AMP for initial and all follow-on inspections.
10. A one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if an evaluation conducted before the PEO and during each 10-year period during the PEO demonstrates the absence of environmental impacts in the vicinity of the plant due to: (a) the plant being located within approximately 5 miles of a saltwater coastline, or within 1/2 mile of a highway that is treated with salt in the wintertime, or in areas in which the soil contains more than trace amounts of chlorides, (b) cooling towers where the water is treated with chlorine or chlorine compounds, and (c) chloride contamination from other agricultural or industrial sources. The evaluation should include soil sampling in the vicinity of the tank (because soil results indicate atmospheric fallout accumulating in the soil and potentially affecting tank surfaces) and sampling of residue on the top and sides of the tank to ensure that chlorides or other deleterious compounds are not present at sufficient levels to cause pitting corrosion, crevice corrosion, or cracking.
11. A minimum of either 25 sections of the tank's surface (e.g., 1-square-foot sections for tank surfaces, 1-linear-foot sections of weld length) or 20 percent of the tank's surface are examined. The sample inspection points are distributed in such a way that inspections occur in those areas most susceptible to degradation (e.g., areas where contaminants could collect, inlet and outlet nozzles, welds).
12. When volumetric examinations of the tank bottom cannot be conducted because the tank is coated, an exception should be stated, and the accompanying justification for not conducting inspections should include the considerations in footnote 13, below, or propose an alternative examination methodology.
13. A one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if an evaluation conducted before the PEO and during each 10-year period during the PEO demonstrates that the soil under the tank is not corrosive using actual soil samples that are analyzed for each individual parameter (e.g., resistivity, pH, redox potential, sulfides, sulfates, moisture) and overall soil corrosivity. The evaluation should include soil sampling from underneath the tank.

    Alternatively, a one-time inspection conducted in accordance with GALL Report AMP XI.M32 may be conducted in lieu of periodic inspections if the bottom of the tank has been cathodically protected in such a way that the availability and effectiveness criteria 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'," Table 4c., "Inspections of Buried Tanks for all Inspection Periods," have been met beginning 5 years prior to the PEO, and the criteria continue to be met throughout the PEO.

5. ***Monitoring and Trending:*** The effects of corrosion of the tank surfaces are detectable by visual and surface (for cracking) examination techniques. Based on operating experience, periodic inspections provide for timely detection of aging effects. The effects of corrosion on the inaccessible external surfaces are detectable by UT thickness measurements of the tank bottom and are monitored and trended if significant material loss is detected 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:*** A review of OE reveals that there have been instances involving defects variously described as wall thinning, pinhole leaks, cracks, and through-wall flaws in tanks. 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, “Loss of Material due to Recurring Internal Corrosion,” address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

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The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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 Information Notice 2013-18, Refueling Water Storage Tank Degradation, September 13, 2013.

APPENDIX N

REVISED GALL REPORT 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) 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 (of polymeric components). When appropriate for the component and material, physical manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength.

Reduced thermal insulation resistance due to moisture intrusion, associated with insulation which is jacketed, is managed by visual inspection of the condition of the jacketing when the insulation has been included in scope to reduce heat transfer from the insulated components. Outdoor insulated components, and indoor components exposed to condensation (because the in-scope component is operated below the dew point), have portions of the insulation inspected or removed to determine whether the exterior surface of the component is degrading or has the potential to degrade. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (GALL Report 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. Visual inspections are conducted on insulation jacketing to ensure that no aging effects are impairing the function of the thermal insulation. Visual inspections are also conducted on outdoor insulated components, and indoor components exposed to condensation (because the in-scope component is operated below the dew point) to determine whether the exterior surface of the component is degrading or has the potential to degrade. 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 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 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 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 GALL Report 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, GALL Report AMP XI.M36.

2. ***Preventive Actions:*** Depending on the material, components may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the component from environmental exposure. Insulation jacketing can limit or prevent water in-leakage for insulation.

3. ***Parameters Monitored/Inspected:*** This program 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, insulation jacketing, 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 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 normally accessible only during outages (e.g., high dose areas). 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.

   In some instances, thermal insulation (e.g., calcium silicate) has been included in scope to reduce heat transfer from components to ensure that functions described in 10 CFR 54.4(a) are successfully accomplished. When metallic jacketing has been used, it is acceptable to conduct external visual inspections of the jacketing to ensure that there is no damage to the jacketing that would permit in-leakage of moisture as long as the jacketing has been installed in accordance with plant-specific procedures that include configuration features such as minimum overlap, location of seams, etc. If plant-specific procedures do not include these features, an alternative inspection methodology should be proposed.

   Component surfaces that are insulated and exposed to condensation (because the in-scope component is operated below the dew point), and insulated outdoor components, (except tanks, which are addressed by GALL Report AMP XI.M29) are periodically inspected every 10 years during the period of extended operation. For all outdoor components (except tanks) and any indoor components exposed to condensation (because the in-scope component is operated below the dew point), inspections are conducted of each material type (e.g., 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, significant moisture can accumulate under insulation during high humidity seasons even with conditioning of air. A minimum of 20 percent of the in-scope piping length, or 20 percent of the surface area for components whose configuration does not conform to a 1-foot axial length determination (e.g., valve, accumulator), 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. Inspection locations should focus on the bounding or lead components most susceptible to aging because of time in service, severity of operating conditions (e.g., amount of time that condensate would be present on the external surfaces of the component), and lowest design margin. The following are alternatives to removing insulation:

      a. Subsequent inspections may consist of examination of the exterior surface of the insulation with sufficient acuity to detect indications of damage to the jacketing or protective outer layer of the insulation when the results of the initial inspection meet the following criteria:

i. No loss of material due to general, pitting, or crevice corrosion, beyond that which could have been present during initial construction is observed, and

ii. no evidence of SCC is observed.

If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or jacketing, or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation should continue as conducted for the initial inspection.

b. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of corrosion under insulation (CUI) is low for tightly adhering insulation. Tightly adhering insulation is considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation is visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections are not credited towards the inspection quantities for other types of insulation.

Visual inspection will identify indirect indicators of flexible polymer hardening and loss of strength, including the presence of surface cracking, crazing, discoloration, and, for elastomers with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Visual inspections cover 100 percent of accessible component surfaces. Visual inspection will identify direct indicators of loss of material due to wear to include dimension 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 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 before any loss of intended function.

5. ***Monitoring and Trending:*** 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 are evaluated. For stainless steel surfaces, a clean, shiny surface is expected. The appearance of discoloration or a mottled appearance 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 affect the component's intended function are evaluated. For flexible polymers, a uniform surface texture and uniform color with no dimension 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) 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, and chalking, are subject to further investigation. Acceptance criteria are specified and may 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.

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 O

REVISED GALL REPORT 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 exposed to uncontrolled indoor air, outdoor air, air with borated water leakage, condensation, moist air, diesel exhaust, and any water system other than open-cycle cooling water system (GALL Report AMP XI.M20), closed treated water system, except elastomers in these systems can be managed by this program (GALL Report AMP XI.M21A), and fire water system (GALL Report 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 loss of a component's intended functions. 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.

This program, as written, is not intended for use on components in which recurring internal corrosion is evident based on a search of plant-specific OE conducted during the LRA development where repetitive occurrences of loss of material have occurred (e.g., one per refueling outage cycle that has occurred over three or more sequential or nonsequential cycles for a 10-year OE search, or two or more sequential or nonsequential cycles for a 5-year OE search) with the same aging mechanism in which the aging effect resulted in the component either not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent (regardless of the minimum wall thickness). If operating experience indicates that there has been recurring internal corrosion, a plant-specific program will be necessary unless this program, or another new or existing program, includes augmented requirements to ensure that any recurring aging effects are adequately managed (e.g., SRP-LR Section 3.2.2.2.9, 3.3.2.2.8, 3.4.2.2.6). Following failure due to recurring internal corrosion, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest, or corrective actions have been taken to prevent recurrence of the recurring internal corrosion.

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 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., the component is sufficiently pressurized to expand the surface of the material in such a way that cracks or crazing would be evident). This program also includes metallic piping with or without polymeric coatings, 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.

For situations in which the material and environment combinations are similar for the internal and external surfaces such that the external surface condition is representative of the internal surface condition, external inspections of components may be credited for managing: (a) loss of material from internal surfaces of metallic components and (b) loss of material, cracking, and change in material properties from the internal surfaces of polymeric components. When credited, the program describes the component's internal environment and the credited external component's environment inspected and provides the basis to justify that the external and internal surface condition and environment are sufficiently 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 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 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., involving manipulation or pressurization 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 would be expected from the normally dry surfaces associated with the latter environment). Alternatively, similar environments (e.g., internal uncontrolled indoor, controlled indoor, dry air environments) can be combined into a larger population provided that the inspections occur on components located in the most severe environment.

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

Visual inspections include all accessible surfaces. Unless otherwise required (e.g., by the ASME code), all inspections are carried out using plant-specific procedures by inspectors qualified through plant-specific programs. The inspection procedures must be capable of detecting the aging effect(s) under consideration. These inspections provide for the detection of aging effects 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 or pressurization 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 accessible 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 before any loss of intended function.

5. ***Monitoring and Trending:*** 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 or a mottled appearance 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 dimension change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. Changes in a flexible material's properties (e.g., hardness, flexibility, physical dimensions, and color) 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. Cracks 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 are specified and may 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. 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 repetitive occurrences of aging effects with the same aging mechanism and determining the trend of its occurrence. Further evaluation AMR line items in SRP-LR Sections 3.2.2.2.9, 3.3.2.2.8, and 3.4.2.2.6, "Loss of Material due to Recurring Internal Corrosion," address recurring internal corrosion. These further evaluation AMR line items are not applicable to 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 it can exhibit 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 line items.

The applicant should evaluate each plant-specific operating experience example to determine if the chosen AMP should be augmented even if the thresholds for significance of aging effect or frequency of occurrence of aging effect have not been exceeded. For example, during a 10-year search of plant-specific operating experience, two instances of 360 degree 30 percent wall loss occurred at copper alloy to steel joints. Neither the significance of the aging effect nor the frequency of occurrence of aging effect threshold has been exceeded. Nevertheless, the applicant should evaluate this operating experience to determine if its proposed AMP is sufficient (e.g., method of inspection, frequency of inspection, number of inspections) to provide reasonable assurance that the current licensing basis intended functions of the component will be met throughout the period of extended operation. Likewise, the GALL Report AMR items associated with the new FE items only cite raw water and waste water environments because OE indicates that these are the predominant environments associated with recurring internal corrosion; however, if the search of plant-specific OE reveals recurring internal corrosion in other water environments (e.g., treated water), the aging effect should be addressed in a similar manner.

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.