FINAL LICENSE RENEWAL INTERIM STAFF GUIDANCE

LR-ISG-2011-03

CHANGES TO THE GENERIC AGING LESSONS LEARNED (GALL) REPORT REVISION 2 AGING MANAGEMENT PROGRAM XI.M41, "BURIED AND UNDERGROUND PIPING AND TANKS"

INTRODUCTION

This final license renewal interim staff guidance (LR-ISG) 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'," provides changes to GALL Report AMP XI.M41 as described below. The AMP, as modified herein, provides one acceptable approach for managing the effects of aging of buried and underground piping and tanks within the scope of the License Renewal Rule (Title 10 of the *Code of Federal Regulations*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" (10 CFR Part 54)). This LR-ISG also changes Table 3.0-1, "FSAR Supplement for Aging Management of Applicable Systems," in the Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR). A licensee may reference this ISG in its license renewal application (LRA) to demonstrate that its buried and underground piping and tanks program is acceptable to the staff until the guidance in this LR-ISG is implemented into the next update of the license renewal guidance documents.

DISCUSSION

GALL Report AMP XI.M41 was a new AMP released in the GALL Report Revision 2. It replaced GALL Report AMP XI.M28, "Buried Piping and Tanks Surveillance," and GALL Report AMP XI.M34, "Buried Piping and Tanks Inspection." GALL Report AMP XI.M41 was developed based on industry operating experience (OE) that occurred prior to and during the development of the GALL Report Revision 2. The new AMP reinforced the importance of preventive actions including cathodic protection, coatings, and backfill quality. The inspection quantities cited in AMP XI.M41 were increased from those recommended in AMPs XI.M28 and XI.M34 and linked to the material type, system function, and degree to which the preventive actions were met. Additionally, AMP XI.M41 addressed unique requirements based on whether the piping and tanks were buried (direct contact with soil or concrete) or underground (below grade, located in a limited access area, and exposed to air). Based on the staff's review of fifteen license renewal applications and stakeholder input, the staff has determined that existing guidance in the SRP-LR and GALL Report should be revised, as follows, to:

- include inspection recommendations for plants not utilizing a cathodic protection system during the period of extended operation;
- remove the recommendation to volumetrically inspect underground piping to detect internal corrosion;
- recommend that further increases in inspection sample size should be based on an analysis of extent of cause and extent of condition when adverse conditions are detected in the initial and subsequent doubled sample size, rather than continuing to double the sample size;
- add a recommendation that, where damage to the coating is significant and the damage was caused by non-conforming backfill, an extent of condition evaluation should be conducted to ensure that the as-left condition of backfill in the vicinity of observed damage will not lead to further degradation;

- add specific acceptance criteria for cathodic protection surveys;
- add the specific preventive and mitigative actions utilized by the AMP in the Final Safety Analysis Report (FSAR) Supplement description of the program;
- insert editorial or miscellaneous changes, or clarifications; and
- correct an internal conflict between AMP XI.M41 and AMP XI.M36, "External Surfaces Monitoring of Mechanical Components."

Inspection Recommendations for Plants Not Utilizing Cathodic Protection during the Period of Extended Operation

The "preventive actions" and "detection of aging effects" program elements were revised to address plants that will not utilize cathodic protection during the period of extended operation for systems or portions of systems within the scope of license renewal. The revised "preventive actions," Section 2.a.iii., states that the failure to provide cathodic protection in accordance with Table 2a, "Preventive Actions for Buried Piping and Tanks," must be justified in the LRA. It further states that an exception must be stated and justified if the basis for not providing cathodic protection is other than demonstrating that external corrosion control (i.e., cathodic protection and coatings) is not required or demonstrating that installation, operation, or surveillance of a cathodic protection system is not practical. Demonstrating that cathodic protection is either not required or not practical should consist of one of the following methodologies:

- Demonstrate through the submission of an analysis that external corrosion control (i.e., cathodic protection and coatings) is not needed. This could be accomplished by conducting soil samples in the vicinity of buried in-scope piping and demonstrating that the soil is not corrosive and conducting pipe-to-soil potential measurements demonstrating that the potentials are acceptable. Soil testing should consist of multiple samples. Each sample should test for soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, sulfates, and redox potential. The potential soil corrosivity should be determined for each material type of buried in-scope piping. In addition to evaluating each individual parameter, the overall soil corrosivity should be determined. The initial testing should be conducted prior to submitting the application, and a summary of the results and conclusions should be submitted with the LRA. The AMP and Updated Final Safety Analysis Report (UFSAR) Supplement should reflect that testing will continue to be conducted once in each 10-year period starting 10 years prior to the period of extended operation. The basis for soil sample locations, soil sample results, the methodology and results of how the overall soil corrosivity was determined, pipe-to-soil potential measurements, and overall conclusion demonstrating that a corrosive condition does not exist should be included in the application.
- Demonstrate through the submission of a study the impracticality of installing or operating a cathodic protection system. This study should be conducted by a competent person as defined in NACE SP0169-2007, Standard Practice Control of External Corrosion on Underground or Submerged Metallic Piping System, Section 1.3, Introduction, who is knowledgeable in the design, installation, and operation of cathodic protection systems. The study should be submitted with the LRA.

Given the importance of plant-specific OE when cathodic protection is not utilized, the applicant must conduct a search of 10 years of OE for evidence of adverse conditions as described in Section 4.f., Adverse Indications, of Appendix A, "Revised GALL Report AMP XI.M41,"of this ISG. This search should include components that are not in-scope for license renewal if they are constructed of the same materials and buried in a similar soil environment as in-scope components, because given the similarity in materials and soil environment, they represent a reasonable predictor of potential corrosion issues for in-scope piping. The results of this expanded plant-specific OE search should be included in the LRA.

Table 4a, "Inspections of Buried Pipe," was revised to reflect the recommended number of inspections when cathodic protection will not be provided during the period of extended operation for systems or portions of systems within the scope of license renewal. The basis for the number of inspections in the original issuance of AMP XI.M41 was the availability of cathodic protection, quality of backfill, and the presence of coatings. For plants without cathodic protection in use during the period of extended operation, the factors that form the basis for the number of inspections were changed to reflect additional emphasis on plant-specific OE related to backfill, coatings, inspection results, emergent conditions, and soil sampling. These factors were established because, absent cathodic protection, the coatings are the only barrier to corrosion. The staff recognized that non-corrosive soil will result in lower corrosion rates, but not necessarily eliminate corrosion. Backfill that contains objects that can damage the coating can result in a direct challenge to the integrity of the piping system. The inspection quantities were increased because without the preventive action of a cathodic protection system and the ability to trend cathodic protection currents (an indicator of coating degradation), increased inspections were necessary to provide reasonable assurance that the components will meet their current licensing basis (CLB) functions throughout the period of extended operation. These inspection quantities are the minimum recommended and possibly need to be higher based on factors such as the plant-specific soil conditions, ground-to-structure potentials and OE.

In conjunction with revising Table 4a to address plants when cathodic protection is not utilized during the period of extended operation for specific systems or all systems, the following changes were made:

- Given that licensees risk rank their inspection locations based on the potential for and consequence of failure, the code class safety-related and hazardous material piping inspection columns were combined into one inspection category, thus providing greater flexibility in selecting inspection locations with the highest potential risk;
- Given that the potential for piping degradation increases with time, the inspection quantities for some materials increase throughout the 30-year period starting 10 years prior to entering the period of extended operation;
- Minimum and not to exceed (NTE) inspection quantities were added to the percentage-based inspection quantities. The staff utilized data provided during the review of several license renewal applications to determine an average amount of buried in-scope piping. The inspection quantities were derived from this average. Minimum and NTE values were included to address plants that differ significantly from the average values;
- Due to the elimination of the distinction between Code Class safety-related and hazardous material piping inspection recommendations, the inspection categories for steel, copper, and aluminum were combined. The high density polyethylene (HDPE)

and other polymeric materials inspection categories were also combined. Given the potential for in-scope nonsafety-related copper (e.g., instrument air), aluminum (e.g., demineralized water), and polymeric (e.g., drains, potable water) piping, the staff recognized that many more inspections could end up being conducted if the material categories were separate. The basis for the merging of the material categories was that they are treated in a common manner by NACE SP0169 (i.e., cathodic protection, coatings, backfill requirements). The number of inspections for each merged material group (e.g., 29 inspections of steel/copper/aluminum piping in preventive action category E, 60 inspections of steel/copper/aluminum piping in preventive action category F, 12 inspections of HDPE/Polymeric in preventive action category B) over the 30-year period starting 10 years prior to the period of extended operation is sufficient to establish a reasonable assurance that the CLB function(s) of in-scope piping will be met;

- The recommendation for availability of the cathodic protection system was changed from 90 percent to 85 percent. This unavailability was derived from allowing three maintenance cycles (most plants are on a quarterly maintenance scheduling frequency) in any given 5-year period to implement repairs to a cathodic protection circuit. The industry had pointed out that the 90 percent availability only allowed two maintenance cycles which would often be too restrictive given the need for planning, parts procurement, and scheduling of the maintenance activities.

  The ISG also recommends an 80 percent as-found effectiveness factor based on the results of annual cathodic protection surveys. In order to remain in preventive action category C, annual cathodic protection surveys must demonstrate that each survey point met the acceptance criteria of Table 6a, “Cathodic Protection Acceptance Criteria,” 85 percent of the time period stated in Table 4a.

  Coupling the 85 percent availability with an 80 percent as-found effectiveness factor will provide reasonable assurance that local areas with coating degradation will receive adequate cathodic protection to prevent loss of function of the piping because cathodic protection will be available and effective for the majority of the operating period, thus the potential for corrosion is minimized.

  Portions of buried in-scope piping that do not meet the 85 percent availability or 80 percent effectiveness threshold are added together to determine the total length of piping that is subject to the inspection quantities of preventive action categories E and F. An example is as follows:

  Consider a piping population which consists of a combination of steel, copper, and aluminum pipe and is 1000 feet in length. The entire length of piping is cathodically protected by a system which has been installed in excess of 5 years. Of these 1000 feet of piping, 600 feet has met the cathodic protection acceptance criteria during 9 of the past 10 surveys. The remaining 400 feet failed to meet the acceptance criteria in 3 of the past 10 inspections. Of the 400 feet which failed to meet the acceptance criteria, 100 feet has acceptable coatings and backfill and plant-specific OE is acceptable. The remaining 300 feet has bad backfill. It is the intention of the staff that the above piping system be addressed as follows:

  – The 600 feet of cathodically protected piping which failed to meet the acceptance criteria only once in the past 10 years may be inspected as category C piping. For inspection years 30-40, Table 4a recommends the inspection of 0.5 percent of 600 feet of piping, NTE 1 inspection. Since 0.5 percent of 600 feet is less than 10 feet (the length of one inspection), one inspection is recommended.

– The 100 feet of cathodically protected piping which failed to meet the cathodic protection acceptance criteria on 3 of the past 10 surveys failed to meet the 80 percent effectiveness recommendation of category C piping. Because this piping meets all the criteria of category E piping, it may be inspected as such. For inspection years 30-40, Table 4a recommends the inspection of 5 percent of the 100 feet of piping, NTE 7 inspections. Since 5 percent of 100 feet is less than 10 feet (the length of one inspection), one inspection of a 10-foot piping segment is recommended.

– The remaining 300 feet of piping fails to meet the criteria for piping categories C-E. It is therefore considered to be category F. For inspection years 30-40, Table 4a recommends the inspection of 10 percent of the 300 feet of piping, NTE 15 inspections. Given that 10 percent of 300 feet is 30 feet and each inspection is recommended to examine 10 feet of pipe, 3 inspections are recommended.

– During the 30-40 year inspection interval, a total of 5 inspections are recommended for this 1000-foot piping system. These inspections need not be conducted in the location which created the inspection requirement, i.e., 1 in the 600 feet of category C piping, one in the 100 feet of category E piping, and 3 in the 300 feet of category E piping; rather, inspections should be based on risk. The risk ranking may indicate that all 5 inspections be conducted in the 300 feet of category E piping.

When recommended by Table 4c, “Inspections of Buried Tanks for all Inspection Periods,” and Table 4d, “Inspections of Underground Tanks for all Inspection Periods,” respectively, all in-scope buried and underground tanks are inspected.

<u>Removal of the Recommendation to Volumetrically Inspect Underground Piping to Detect Internal Corrosion</u>

The staff recognizes that AMP XI.M41 is a program designed to detect and manage the effects of aging on the external surfaces of buried and underground piping and tanks and that aging of internal surfaces is addressed in other GALL Report AMPs. As such, AMP XI.M41, program element 4, “detection of aging effects,” part c.iv is being revised to delete the recommendation to perform volumetric inspections of underground piping to detect internal corrosion. This is consistent with the staff position stated in NUREG-1950, “Disposition of Public Comments and Technical Basis for Changes in the License Renewal Guidance Documents NUREG-1801 and NUREG-1800,” page IV-175, and Comment Number 1070.

<u>Sample Size Increase Changes when Adverse Conditions are Identified</u>

In the original issuance of AMP XI.M41, Section 4.f.iv recommended that, upon discovery of adverse conditions during inspections, the inspection sample sizes within the affected piping categories be doubled and if adverse conditions are discovered in the expanded sample, the sample size be doubled again, with doubling continuing as necessary. The staff recognizes that continuous doubling of the sample size could result in a significant portion of the piping being excavated with a potentially minimal increase in the level of understanding of the condition of the piping or its coatings. As a result, the recommendation was revised to recommend an initial doubling of the sample size with the size of the follow-on inspections determined by establishing the extent of condition and extent of cause, consistent with the corrective action program. In addition, the recommendations were revised to address timing of the follow-on inspections so that the scheduling of additional examinations is based on the severity of the degradation identified and commensurate with the consequences of a leak or loss of function.

The staff clarified that if adverse conditions are extensive, inspections may be halted in a piping system, or portion of system, that is planned for replacement. If the initial doubling of the sample size has not been conducted, or the determination of extent of condition or extent of cause requires further inspections, these inspections should be conducted in locations with similar materials and environment.

When inspections are halted because of the planned replacement of piping, the completion of the replacement of the piping system, or portion of the system, would be based upon either the station’s need to return the system to service for non-Technical Specification-related systems (e.g., demineralized water, circulating water) or the allowed outage time for Technical Specification-related systems (e.g., diesel fuel oil, auxiliary feedwater, essential service water). For example, a leaking circulating water line could prevent the station from operating until it was replaced if it impacted multiple condenser water boxes. The Technical Specification allowed outage time results in a defined time period, based on the safety significance of the system, during which the system must be replaced, tested and returned to operable status.

Recommendation Related to Coating Damage Caused by Inappropriate Backfill

The quality of backfill can directly impact the integrity of coatings. Gaps in cathodic protection coverage result in the coating system being the key preventive measure to protect the piping or tank from damage. Therefore, the staff revised program element 6, “acceptance criteria,” part b. to recommend that, where damage to the coating is significant and the damage was caused by non-conforming backfill, an extent of condition evaluation should be conducted to ensure that the as-left condition of backfill in the vicinity of observed damage will not lead to further degradation.

Cathodic Protection Survey Acceptance Criteria

Based on staff reviews during AMP audits, multiple sites do not have an upper limit on cathodic protection pipe-to-soil potential. If the cathodic protection pipe-to-soil values are too high, coating damage can occur to certain types of coatings. The staff deleted the general reference to the NACE standards for the acceptance criteria and incorporated the NACE SP0169-2007 specific cathodic protection survey acceptance criteria into the AMP. The instant off -850 mV (millivolts) relative to a copper/copper sulfate reference electrode (CSE) and 100 mV minimum polarization testing criteria listed in NACE SP0169-2007 were selected because proper correction for voltage drops can be difficult given the typical configuration of buried piping in nuclear power plant yard structure areas. The 100 mV polarization criterion is limited to electrically isolated piping sections or areas of grounded piping where the effects of mixed potentials are shown to be minimal. When the 100 mV polarization criterion is utilized, applicants must explain in the application why the effects of mixed potentials are minimal and why the most anodic metal in the system is adequately protected.

Changes to the FSAR Supplement Description of the Program

Given that coatings, backfill quality, and cathodic protection are the key preventive or mitigative actions, SRP-LR Table 3.0-1XI.M41," was revised to include these by name, see Appendix B, "Revised SRP-LR Table 3.0-1, FSAR Supplement for Aging Management of Applicable Systems." This revision ensures that these features, as applicable, are maintained as part of the licensing basis. In addition, the implementation schedule was revised to state that the program should be implemented before the period of extended operation begins. This change clarifies the need to implement all portions of the program (e.g., preventive actions) prior to commencing the period of extended operation.

Key Miscellaneous or Editorial Changes

- In recognizing that cathodic protection and coatings can prevent or mitigate selective leaching in buried components, the Program Description was revised and Section 4.b.xi. was added to provide an adjustment to the number of selective leaching inspections conducted in accordance with AMP XI.M33, "Selective Leaching." It is commonly recognized that cathodic protection can prevent selective leaching except in the case of certain multi-phase copper alloy based components. Therefore, no selective leaching inspections are required of the external surface of the components for gray cast iron applications which meet the following: (a) the components have been cathodically protected since installation, (b) the cathodic protection system has had 80 percent availability for the 10-year period prior to the period of extended operation, and (c) the as-found measured soil-to-pipe potential readings during periodic cathodic protection surveys meets the acceptance criteria of program element 6, "acceptance criteria," of this AMP. The AMP was also revised to allow the applicant to provide a technical justification for copper alloys depending on the specific phase composition of its components.

  Given that coatings isolate the component from the electrolyte, for buried components which are coated in accordance with Table 2a, and where excavated direct, visual examinations of in-scope buried piping have not revealed any coating damage, no selective leaching inspections are required of the external surface of the components. The inspection sample size may be reduced to 5 percent of the population with a maximum sample of six components when minor through-wall coating damage has been identified in plant-specific operating experience such that: (a) there were no more than two instances of damage identified in the 10-year period prior to the period of extended operation, and (b) if the pipe surface area affected by the coating damage is assumed to have been a through-wall hole, the pipe could be shown to meet unreinforced opening criteria of the applicable piping code.

  The "detection of aging effects" program element of AMP XI.M33 was revised to point to the recommendations in AMP XI.M41. See Appendix F, "Changes to the 'detection of aging effects' Program Element of AMP XI.M33, 'Selective Leaching'."

- Nickel alloy materials were added to Table 2a, Table 2b, "Preventive Actions for Underground Piping and Tanks," and Tables 4a through 4d. Appropriate aging management review (AMR) items were revised to reflect necessary changes to the GALL Report and SRP-LR.

- In AMP XI.M41, the Table 2a reference to NACE RP0285-2002, "Standard Recommended Practice Corrosion Control of Underground Storage Tank Systems by

Cathodic Protection," was added where recommendations were related to piping and tanks.

- In AMP XI.M41, Table 2a, footnote 6 was deleted. This footnote was in reference to damage to coatings for polymeric materials; however, AMP XI.M41 does not recommend coatings for this material.
- Jockey pump monitoring in AMP XI.M41, Section 2.a.ii., was clarified by providing number of pump starts and run time as examples. Given the ambiguity associated with "or equivalent equipment or parameter," this wording was deleted. Applicants without jockey pumps can submit an exception which will describe the alternative monitoring method.
- AMP XI.M41 program element 3, "parameters monitored/inspected," was revised to clarify that cracking is only addressed when excavated direct, visual examinations result in the removal of coatings for reasons other than to inspect for cracking. Although carbonate cracking has been detected in buried piping carrying gas and oil, the staff is not aware of any instances of such cracking in buried piping of commercial nuclear plants. Therefore, there are no AMR items listing cracking as an aging effect requiring management (AERM); however, when the opportunity for examination of bare metal piping becomes available, the surface should be inspected for cracking using an inspection method that has been demonstrated to be capable of detecting cracking.
- With the development of the inspection quantities for plants without cathodic protection or for those where it is available but it does not meet availability or effectiveness criteria, it is recognized that the quantity of inspections required to yield an understanding of the condition of buried piping would be sufficient without doubling the number of inspections for a two-unit site or tripling at a three-unit site. Therefore, the AMP was changed to recommend that the NTE number of inspections at a two unit site be 150 percent of those for preventive action categories E and F for steel, copper, and aluminum piping and preventive action category B for HDPE and other polymeric materials. For a three-unit plant, the inspection numbers would be doubled from that in Table 4a.
- The Table 4a categories "HDPE" and "Other Polymers" were combined, as discussed above. As a result, footnotes 5 and 6 related to approved and not approved HDPE piping materials were deleted, and the remainder of the footnotes renumbered.
- The extent of inspections of controlled, low-strength material was clarified to state that the excavation should include the top surfaces and at least 50 percent of the side surface to visually inspect for cracks in the backfill that could admit groundwater to the external surfaces of the piping components. Excavating under the controlled low strength material could result in damage to the fill material. The conduct of inspections was also clarified to state that when backfill inspections are based on the NTE value, 10 linear feet of the backfill should be exposed for each inspection.
- AMP XI.M41 Section 4.b.x.B. changed the inspection frequency for internal inspections from 5 years to 10 years to align with the frequency of excavated, direct visual inspections. Section 4.b.x.A., an alternative to allow hydrostatic testing in lieu of inspections, was not revised to a frequency of every 10 years given that rather than obtaining quantitative data, this test method represents a "go, no go" methodology that the staff believes should be repeated at the recommended interval versus 10 years. For ease of use, specific criteria from 49 CFR Part 195 Subpart E was incorporated into the

ISG (i.e., test pressure, hold time, acceptance criteria), and the reference to 49 CFR Part 195 was deleted.

- In AMP XI.M41, Sections 4.c.vii. and 4.e.vi., the words, “[w]hen access permits,” were deleted from the instruction to conduct visual inspections for polymeric materials that are augmented with manual examinations to maintain consistency with Sections 4.b.vii. and 4.d.v.
- AMP XI.M41, Table 4c was revised to eliminate unnecessary information and to match the format of Table 4b, “Inspections of Underground Pipe,” and Table 4d.
- The “monitoring and trending” program element of AMP XI.M41 was revised to recommend that where wall thickness measurements are conducted, the results should be trended if follow-up examinations are conducted.
- The “acceptance criteria” program element of AMP XI.M41 was revised to allow coatings inspectors to be qualified by either qualifying as a NACE Coating Inspector Program Level 2 or 3 inspector, or attending the Electric Power Research Institute (EPRI) Comprehensive Coatings Course and completing the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course. The staff recognizes that there are other coatings training programs available. Therefore, an applicant could submit an exception in order to utilize an alternative training program (e.g., Society for Protective Coatings). The references to the general training requirements of 10 CFR Part 192 and 10 CFR Part 195 were deleted because the AMP recommendation for qualification includes two industry-wide training programs (i.e., NACE, EPRI).
- This ISG corrects a difference between the GALL Report and the SRP-LR. SRP-LR, Table 3.3-1, item 107, which references GALL Report Item AP-137, states that stainless steel piping, piping components, and piping elements exposed to soil or concrete are managed for loss of material due to pitting and crevice corrosion by AMP XI.M41. Four of the five referenced GALL Report items associated with AP-137 only list soil as an applicable environment (i.e., VII.C3. AP-137, VII.G. AP-137, VII.H1. AP-137, and VII.H2. AP-137. Item VII.C1.AP-137 lists soil or concrete as the applicable environment. In a like manner, SRP-LR Table 3.3-1, item 106, which references GALL Report Item AP-198, states that steel (with coating or wrapping) piping, piping components, and piping elements exposed to soil or concrete are managed for loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion by AMP XI.M41. Three of the four referenced GALL Report items associated with AP-198 only list soil as an applicable environment (i.e., VII.C3. AP-198, VII.G. AP-198, VII.H1. AP-198. Item VII.C1.AP-198 lists soil or concrete as the applicable environment. As shown in Appendix C, “GALL Report AMR Item Changes,” the seven GALL Report items were corrected to list soil or concrete as the applicable environment.

<u>Correct an Internal Conflict between AMP XI.M41 and AMP XI.M36</u>

GALL Report AMP XI.M36, “External Surfaces Monitoring of Mechanical Components,” was revised by this ISG. Program element 4 of this AMP states in part that, “This frequency accommodates inspections of components that may be in locations that are normally only accessible during outages or access is physically restricted (underground).” It also states that, “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." These statements create a conflict between AMPs XI.M41 and XI.M36, because the scope of AMP XI.M41 addresses all buried and underground components, while the quoted statements result in underground piping also being included in AMP XI.M36. Some applicants have cited AMP XI.M36 in lieu of AMP XI.M41 for underground components. This is not appropriate because AMP XI.M41 contains preventive action features and specificity in inspection scope that are not contained in AMP XI.M36. Therefore, Appendix E, "Changes to the 'scope of program' and 'detection of aging effects' Program Elements of AMP XI.M36, 'External Surfaces Monitoring of Mechanical Components'," provides clarifying words in the "scope of program" program element and deletes the conflicting words in the "detection of aging effects" program element of AMP XI.M36.

ACTIONS

Applicants should use Appendices A through E in preparing their LRA to be consistent with the GALL Report.

On March 9, 2012 (77 FR 14446), the NRC requested public comments on draft LR-ISG-2011-03 (ADAMS Accession No. ML11244A058). As noticed on April 11, 2012 (77 FR 21813), given that the comment period had closed on April 9, 2012, the comment period was reopened until April 20, 2012, in response to a March 27, 2012 (ADAMS Accession No. ML12089A02), request from the Nuclear Energy Institute (NEI).

The NRC received external stakeholder comments from Mr. Jon Cavello on April 1, 2012 (ADAMS Accession No. ML12094A367), Mears Group on April 9, 2012 (ADAMS Accession No. ML12103A207), Det Norske Veritas (USA) Inc. on April 13, 2012 (ADAMS Accession No. ML12108A049), and NEI by letter dated April 20, 2012 (ADAMS Accession No. ML12114A214). The NRC considered these comments, as well as those from the NRC staff, in developing the final LR-ISG-2011-03. Responses to these comments are in Appendix G, "Resolution of Public Comments," of this LR-ISG. The guidance described in this final LR-ISG supersedes the affected sections of the SRP-LR and GALL Report and is approved for use by the NRC staff and stakeholders.

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

The U.S. Nuclear Regulatory Commission (NRC) is not proposing to treat buried piping and underground piping and tanks 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).

BACKFITTING DISCUSSION

This LR-ISG contains guidance as to one acceptable approach for managing the effects of aging during the period of extended operation for buried and underground piping and tanks within the scope of license renewal. Set forth below is the staff's discussion on compliance with the requirements of the Backfit Rule, 10 CFR 50.109.

Compliance with the Backfit Rule

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 upon the status of the nuclear power plant licensee.

Licensees who are currently in the license renewal process – This LR-ISG is directed to current applicants for license renewal. However, this LR-ISG is not backfitting as defined in 10 CFR 50.109(a)(1). This guidance is non-binding and provides one approach acceptable to the NRC staff for managing the effects of aging in buried and underground piping and tanks in accordance with the requirements of 10 CFR Part 54. License renewal applicants are not required to use this guidance. Applicants may elect to propose an alternative approach for managing the aging of buried and underground piping and tanks during the period of extended operation. In addition, the Backfit Rule does not protect license renewal applicants voluntarily requesting renewed licenses from changes in NRC requirements or guidance on license renewal prior to or during the pendency of their renewal application (NRC, 2008). Therefore, issuance of this LR-ISG does not constitute backfitting as applied to current applicants for license renewal.

Licensees who already hold a renewed license – This guidance is non-binding and the LR-ISG does not require current holders of renewed licenses to take any action (i.e., programmatic or plant hardware changes for managing the aging of buried and underground piping and tanks). However, current holders of renewed licenses should treat this guidance as operating experience 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 management of buried and underground piping and tanks, then the NRC will follow the requirements of the Backfit Rule.

Current operating license or combined license holders who have not yet applied for renewed licenses – This LR-ISG is not directed at holders of (original) operating licenses or combined licenses until they apply for license renewal. As such, this LR-ISG does not constitute backfitting as applied to holders of (original) operating licenses and is not otherwise inconsistent with the applicable issue finality provisions in 10 CFR Part 52 as applied to holders of combined licenses.

CONGRESSIONAL REVIEW ACT

This interim staff guidance is a rule as designated in the Congressional Review Act (5 U.S.C. 801–808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

APPENDICES

Appendix A, Revised GALL Report AMP XI.M41

Appendix B, Revised SRP-LR Table 3.0-1, FSAR Supplement for Aging Management of Applicable Systems

Appendix C, GALL Report AMR Item Changes

Appendix D, SRP-LR AMR Item Changes

Appendix E, Changes to the “scope of program” and “detection of aging effects” Program Elements of AMP XI.M36, “External Surfaces Monitoring of Mechanical Components”

Appendix F, Changes to the “detection of aging effects” Program Element of AMP XI.M33, “Selective Leaching”

Appendix G, Resolution of Public Comments

REFERENCES

10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities, Office of the

Federal Register, National Archives and Records Administration, 2010.

10 CFR Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants,

Office of the Federal Register, National Archives and Records Administration, 2011.

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

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

NUREG-1950, Disposition of Public Comments and Technical Basis for Changes in the License Renewal Guidance Documents NUREG-1801 and NUREG-1800. Washington, D.C., April 2011.

ISO 15589-1, Petroleum and natural gas industries – Cathodic protection of pipeline transportation systems – Part 1: On-land pipelines, 11/15/2003.

Principles and Prevention of Corrosion, Denny A. Jones, Pearson Prentice Hall, 2nd Edition, 2005.

ASM Handbook, Volume 13B, Corrosion: Materials, Corrosion of Copper and Copper Alloys, 2005.

U.S. Nuclear Regulatory Commission (NRC). 2008. Memorandum from Dale E. Klein, Chairman, to Hubert T. Bell, Office of the Inspector General, “Response to Recommendation 8 of 9/6/07 Audit Report on NRC’s License Renewal Program.” (April 1, 2008). ADAMS No. ML080870286.

Appendix A

Revised GALL Report AMP XI.M41

XI.M41 BURIED AND UNDERGROUND PIPING AND TANKS

Program Description

This is a comprehensive program designed to manage the aging of the external surfaces of buried and underground piping and tanks. It addresses piping and tanks composed of any material, including metallic, polymeric, cementitious, and concrete materials. This program manages aging through preventive, mitigative, and inspection activities. It manages applicable aging effects such as loss of material, cracking, and changes in material properties.

Depending on the material, preventive and mitigative techniques may include the material itself, external coatings for external corrosion control, the application of cathodic protection, and the quality of backfill utilized. Also, depending on the material, inspection activities may include electrochemical verification of the effectiveness of cathodic protection, non-destructive evaluation of pipe or tank wall thicknesses, hydrotesting of the pipe, and visual inspections of the pipe or tank from the exterior as permitted by opportunistic or directed excavations.

Management of aging of the internal surfaces of buried and underground piping and tanks is accomplished through the use of other aging management programs (e.g., “Open Cycle Cooling Water System” (AMP XI.M20), “Closed Treated Water System” (AMP XI.M21A), “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components” (AMP XI.M38), “Fuel Oil Chemistry” (AMP XI.M30), “Fire Water System” (AMP XI.M27), or “Water Chemistry” (AMP XI.M2)).

This program does not provide aging management of selective leaching. The Selective Leaching of Materials (AMP XI.M33) is applied in addition to this program for applicable materials and environments. However, based on the preventive actions of this AMP, the number of inspections of buried in-scope components susceptible to selective leaching may be adjusted as discussed in program element 4, “detection of aging effects,” of this AMP.

The terms “buried” and “underground” are fully defined in Chapter IX of the GALL Report. Briefly, buried piping and tanks are in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks 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.

Evaluation and Technical Basis

1. ***Scope of Program:*** This program manages the effects of aging for buried and underground piping and tanks constructed of any material including metallic, polymeric, cementitious, and concrete materials. The program addresses aging effects such as loss of material, cracking, and changes in material properties. The program also manages loss of material due to corrosion of piping system bolting within the scope of this program. The Bolting Integrity Program (AMP XI.M18) manages other aging effects associated with piping system bolting.

2. ***Preventive Actions:*** Preventive actions utilized by this program vary with the material of the tank or pipe and the environment (e.g., air, soil, concrete) to which it is exposed. These actions are outlined below:

a. Preventive Actions – **Buried Piping and Tanks**

i. Preventive actions for buried piping and tanks are conducted in accordance with Table 2a and its accompanying footnotes.

Table 2a. Preventive Actions for Buried Piping and Tanks

Material[1]	Coating	Cathodic Protection[4]	Backfill Quality
Titanium			
Super Austenitic Stainless[8]			
Nickel Alloy			
Stainless Steel	X[2]		X[5, 7]
Steel	X[3]	X	X[5]
Copper	X[3]	X	X[5]
Aluminum	X[3]	X	X[5]
Cementitious or Concrete	X[2]		X[5, 7]
Polymer			X[6]

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Coatings are provided based on environmental conditions (e.g., stainless steel in chloride containing environments). Applicants should provide justification when coatings are not provided. When provided, coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002.
3. Coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002. A broader range of coatings may be used if justification is provided in the LRA.
4. Cathodic protection is in accordance with NACE SP0169-2007 or NACE RP0285-2002. The system should be operated so that the cathodic protection criteria and other considerations described in the standards are met at every location in the system. The system monitoring interval discussed in Section 10.3 of NACE SP0169-2007 may not be extended beyond one year. The equipment used to implement cathodic protection need not be qualified in accordance with 10 CFR Part 50, Appendix B.
5. Backfill is consistent with SP0169-2007 Section 5.2.3 or NACE RP0285-2002 Section 3.6. The staff considers backfill that is located within 6 inches of the component that meets ASTM D 448-08 size number 67 to meet the objectives of NACE SP0169-2007 and NACE RP0285-2002. For materials other than aluminum, the staff also considers the use of controlled low strength materials (flowable backfill) acceptable to meet the objectives of SP0169-2007. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections described in program element 4 of this AMP. Backfill is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's coatings or the surface of the component (if not coated) due to the backfill.
6. Backfill is consistent with SP0169-2007 Section 5.2.3. The staff considers backfill that is located within 6 inches of the component that meets ASTM D 448-08 size number 10 to meet the objectives of SP0169-2007. The staff also considers the use of controlled low strength materials (flowable backfill) to meet the objectives of SP0169-2007. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections described in program element 4 of this AMP. Backfill not meeting this standard, in either the initial or subsequent inspections, is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's surface due to the backfill.
7. Backfill limits apply only if piping is coated.
8. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).

ii. For fire mains installed in accordance with National Fire Protection Association (NFPA) Standard 24, preventive actions beyond those in NFPA 24 need not be provided if the system undergoes either a periodic flow test in accordance with NFPA 25 or the activity of the jockey pump (e.g., number of pump starts, run time) is monitored as described in program element 4 of this AMP.

iii. Failure to provide cathodic protection in accordance with Table 2a must be justified in the LRA. The justification should include sufficient detail (e.g., soil sample locations, soil sample results, the methodology and results of how the overall soil corrosivity was determined, pipe-to-soil potential measurements) for the staff to independently reach the same conclusion as the applicant. An exception must be stated and justified if the basis for not providing cathodic protection is other than demonstrating that external corrosion control (i.e., cathodic protection and coatings) is not required or demonstrating that installation, operation, or surveillance of a cathodic protection system is not practical. Inspections in excess of those recommended in program element 4 of this AMP may be required based on plant-specific operating experience.

iv. If cathodic protection is not provided for any reason, the applicant should review 10 years of plant-specific operating experience to determine if adverse conditions as described in Section 4.f., Adverse Indications, of this AMP have occurred at the station. This search should include components that are not in-scope for license renewal if, when compared to in-scope piping, they are buried in a similar soil environment. The results of this expanded plant-specific operating experience search should be included in the LRA.

b. Preventive Actions – **Underground Piping and Tanks**

i. Preventive actions for underground piping and tanks are conducted in accordance with Table 2b and its accompanying footnotes.

Table 2b. Preventive Actions for Underground Piping and Tanks

Material[1]	**Coating Provided**[2]
Titanium	
Super Austenitic Stainless[3]	
Nickel Alloy	
Stainless Steel	
Steel	X
Copper	X
Aluminum	
Cementitious or Concrete	
Polymer	

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for underground piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. When provided, coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002. A broader range of coatings may be used if justification is provided in the LRA.
3. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).

3. ***Parameters Monitored/Inspected:*** The aging effects addressed by this AMP are changes in material properties of polymeric materials, loss of material due to all forms of

corrosion and, potentially, cracking due to stress corrosion. Changes in material properties are monitored by manual examinations. Loss of material is monitored by visual inspection of the exterior of the piping or tank and wall thickness of the piping or tank. Wall thickness is determined by a non-destructive examination technique such as ultrasonic testing (UT). Inspections for cracking are only addressed when excavated, direct visual examinations result in the removal of coatings for reasons other than to inspect for cracking. Inspections for cracking should utilize a method that has been demonstrated to be capable of detecting cracking.

Pipe-to-soil potential and the cathodic protection current, are monitored for steel, copper, and aluminum piping and tanks in contact with soil to determine the effectiveness of cathodic protection systems and, thereby, the effectiveness of corrosion mitigation.

4. ***Detection of Aging Effects:*** Methods and frequencies used for the detection of aging effects vary with the material and environment of the buried and underground piping and tanks. These methods and frequencies are outlined below.

a. Opportunistic Inspections

i. All buried and underground piping and tanks, regardless of their construction material, are inspected by visual means whenever they become accessible for any reason. The information in paragraph f of this program element is applied in the event deterioration of piping or tanks is observed.

b. Directed Inspections – **Buried Pipe**

i. Directed inspections of buried piping are conducted in accordance with Table 4a and its accompanying footnotes. Modifications to this table may be appropriate if exceptions to program element 2, “preventive actions,” are taken or in response to plant-specific operating experience.

ii. Directed inspections as indicated in Table 4a will be conducted during each 10-year period beginning 10 years prior to commencing the period of extended operation.

iii. Inspection locations are selected based on risk (i.e., based on susceptibility to degradation and consequences of failure). Characteristics such as coating type, coating condition, cathodic protection efficacy, backfill characteristics, soil resistivity, pipe contents, and pipe function are considered. Piping systems that are backfilled using controlled low strength material generally experience lower corrosion rates and may be more difficult to excavate than piping systems backfilled using compacted aggregate fill. As a result, systems backfilled using aggregate fill should generally be given a higher inspection priority than comparable systems that are completely backfilled using controlled low strength material. For many piping systems, External Corrosion Direct Assessment (ECDA), as described in NACE SP0502-2010, Pipeline External Corrosion Direct Assessment Methodology, has been demonstrated effective in identifying pipe locations that merit further inspection.

iv. Visual inspections are supplemented with surface and/or volumetric non-destructive testing (NDT) if significant indications are observed.

v. Opportunistic examinations of non-leaking pipes may be credited toward these direct examinations if the location selection criteria in item iii, above, are met.

vi. Table 4a inspection quantities are for a single unit plant. For two-unit sites, the NTE inspection quantities are increased by 50 percent. For a three-unit site, the NTE inspection quantities are doubled.

vii. Visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other changes in material properties.

viii. The use of guided wave ultrasonic or other advanced inspection techniques is encouraged for the purpose of determining those piping locations that should be inspected but may not be substituted for the inspections listed in the table.

ix. Fire mains are inspected in accordance with Table 4a unless they are subjected to either a flow test as described in Section 7.3 of NFPA 25 at a frequency of at least one test in each one-year period or the activity of the jockey pump (e.g., pump starts, run time) is monitored on an interval not to exceed one month. At a minimum, a flow test is conducted by the end of the next refueling outage or as directed by the current licensing basis, whichever is shorter, when unexplained changes in jockey pump activity (or equivalent equipment or parameter) are observed.

x. Inspection as indicated in either (A), or (B) below may be performed in lieu of the inspections contained in Table 4a:

A. At least 25 percent of the in-scope piping constructed from the material under consideration is hydrostatically tested to 110 percent of the design pressure of any component within the boundary with test pressure being held for eight hours on an interval not to exceed five years.

B. At least 25 percent of the in-scope piping constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. UT examinations can be considered approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet the intent of this paragraph. Internal inspections are to be conducted at an interval not to exceed 10 years.

xi. Dependent on plant-specific operating experience and implementation of preventive actions, the number of one-time selective leaching inspections for the external surfaces of buried components which are susceptible to selective leaching, as recommended in AMP XI.M33, may be adjusted as follows:

A. No selective leaching inspections are required of the external surface of gray cast iron buried components which meet the following: (a) the components have been cathodically protected since installation, (b) for the 10-year period prior to the period of extended operation the cathodic protection system has had 80 percent availability, and (c) the as-found measured soil-to-pipe potential readings during periodic cathodic protection surveys meets the acceptance criteria of program element 6, “acceptance criteria,” of this AMP. Where only portions of the population of components have met this criterion, those portions may be deducted from the population size for purposes of determining the number of inspections; however, the maximum sample size of AMP XI.M33 is still applicable. The same adjustments may be utilized for copper alloy based components; however, technical justification must be provided that demonstrates the effectiveness of cathodic protection in the prevention of selective leaching for those alloys. Absent such a justification, the AMP XI.M33 sample size recommendations cannot be adjusted.

B. No selective leaching inspections are required of the external surface of buried components which are coated in accordance with Table 2a, and where excavated, direct visual examinations of in-scope buried piping has not revealed any coating damage. The inspection sample size may be reduced to 5 percent of the population with a maximum sample of six components when minor through-wall coating damage has been identified in plant-specific operating experience such that: (a) there were no more than two instances of damage identified in the 10-year period prior to the period of extended operation, and (b) if the pipe surface area affected by the coating damage is assumed to have been a through-wall hole, the pipe could be shown to meet unreinforced opening criteria of the applicable piping code.

Table 4a. Inspections of Buried Pipe

Material[1]	**Preventive Actions[2,7]**	**Inspections[3,5] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]**		
		Years 30 – 40	Years 40 – 50	Years 50 - 60
Titanium				
Super Austenitic Stainless[4]				
Nickel Alloy				
Stainless Steel		1[6]	1[6]	1[6]
Polymeric[8]	A	1[6]	1[6]	1[6]
	B	1%, NTE 2	2%, NTE 4	3%, NTE 6

Table 4a. Inspections of Buried Pipe				
Material[1]	**Preventive Actions[2,7]**	**Inspections[3,5] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]**		
		Years 30 – 40	Years 40 – 50	Years 50 - 60
Cementitious or Concrete		1[6]	1[6]	1[6]
Steel Copper Aluminum	C	0.5%, NTE 1[6]	0.5%, NTE 1[6]	0.5%, NTE 1[6]
	D	1%, NTE 2	1%, NTE 2	1%, NTE 2
	E	5%, NTE 7	6%, NTE 10	7.5%, NTE 12
	F	10%, NTE 15	12%, NTE 20	15%, NTE 25

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Preventive actions are categorized as follows:
   - A. Backfill is in accordance with Table 2a of this AMP.
   - B. Backfill is not in accordance with Table 2a of this AMP.
   - C. Inspection criteria provided for category C piping may be used for in-scope buried piping where::
     - i. Cathodic protection was installed or refurbished 5 years prior to the end of the inspection period of interest (i.e., prior to 35, 45, or 55 years); and
     - ii. Cathodic protection has been operational (available) at least 85 percent of the time since either 10 years prior to the period of extended operation or since installation/refurbishment, whichever is shorter. Time periods in which the cathodic protection system is off-line for testing do not have to be included in the total unavailability hours; and
     - iii. Cathodic protection has provided effective protection for buried piping as evidenced by meeting the acceptance criteria of paragraph Table 6a of this AMP at least 80 percent of the time since either 10 years prior to the period of extended operation or since installation/refurbishment, whichever is shorter. As found results of annual surveys are to be used to demonstrate locations within the plant's population of buried pipe where cathodic protection acceptance criteria have, or have not, been met.
   - D. Inspection criteria provided for category D piping may be used for those portions of in-scope buried piping where the plant has demonstrated, in accordance with Section 2.a.iii. of this AMP, that external corrosion control is not required.
   - E. Inspection criteria provided for category E piping may be used for those portions of the plant's population of buried piping where:
     - i. An analysis, conducted in accordance with Section 2.a.iii. of this AMP, has demonstrated that installation or operation of a cathodic protection system is impractical; or
     - ii. A cathodic protection system has been installed but all or portions of the piping covered by that system fail to meet any of the criteria of category C piping above, provided
       - a. Coatings and backfill are provided in accordance with Table 2a of this AMP; and
       - b. Plant-specific operating experience is acceptable (i.e., no leaks in buried piping due to external corrosion, no significant coating degradation or metal loss in more than 10 percent of inspections conducted); and
       - c. Soil has been demonstrated to be not corrosive for the material type.

Table 4a. Inspections of Buried Pipe				
Material[1]	Preventive Actions[2,7]	Inspections[3,5] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]		
		Years 30 – 40	Years 40 – 50	Years 50 - 60

F. Inspection criteria provided for category F piping may be used for those portions of in-scope buried piping which cannot be classified as category C, D, or E

3. Guidance related to the extent of inspections:
   i. Table 4a lists the recommended inspections based on a percent of the total length of piping of a material type, or a maximum number of discrete inspections (i.e., the not to exceed number of inspections).
   ii. When the percentage of inspections for a given material type results in an inspection quantity less than 10 feet, then 10 feet of piping should be inspected. If the entire run of piping of that material type is less than 10 feet in total length, then the entire run of piping should be inspected.
   iii. When a not to exceed inspection quantity or number of inspections is used to determine the extent of inspections for a material type, a minimum of 10 feet of piping should be inspected during each inspection. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected and only one inspection is required in that interval.
   iv. If fire protection piping will be inspected by excavations in lieu of alternative testing (e.g., flow test, jockey pump monitoring) and the extent of inspections is not based on the percentage of piping in the material group, then additional inspections should be added to the NTE value for that material type. If the NTE value for that material type is less than 10, add 1 inspection, otherwise add 2 inspections.
4. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).
5. Inspections may be reduced to one-half (when 2 or more inspections are listed) the level indicated in the table when performing the indicated inspections necessitates excavation of piping that has been fully backfilled using controlled low strength material. In conducting these inspections, the backfill may be excavated and the pipe examined, or the soil around the backfill may be excavated and the controlled low strength material backfill examined. The backfill inspection should include excavation of the top surfaces and at least 50 percent of the side surface to visually inspect for cracks in the backfill that could admit groundwater to the external surfaces of the piping components. When conducting inspection of backfill based on the NTE value, ten linear feet of the backfill should be exposed for each inspection.
6. With the exception of aluminum components, no inspections are necessary if all the piping constructed from a specific material type is fully backfilled using controlled low strength material.
7. In order to demonstrate that soil is not corrosive, the applicant should:
   i. Obtain a minimum of three sets of soil samples in each soil environment (e.g., moisture content, soil composition) in the vicinity in which in-scope components are buried.
   ii. The soil should be tested for soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, sulfates, and redox potential.
   iii. The potential soil corrosivity should be determined for each material type of buried in-scope piping. In addition to evaluating each individual parameter, the overall soil corrosivity should be determined.
   iv. Soil testing should be conducted prior to submitting the application and once in each 10-year period starting 10 years prior to the period of extended operation.
   v. A summary of the results and conclusions of the soil testing should be provided in the LRA.
8. If all of the in-scope polymeric material is non safety-related, the inspection quantities for preventive action category B may be reduced by half.

c. Directed Inspections – **Underground Pipe**

   i. Directed inspections for underground piping are conducted in accordance with Table 4b and its accompanying footnotes.

   ii. Directed inspections as indicated in Table 4b will be conducted during each 10-year period beginning 10 years prior to entry into the period of extended operation.

iii. Inspection locations are selected based on risk (i.e., based on susceptibility to degradation and consequences of failure). Characteristics such as coating type, coating condition, external environment, pipe contents, and pipe function, are considered.

iv. Underground pipes are inspected visually to detect external corrosion.

v. Opportunistic examinations may be credited toward these direct examinations if the location selection criteria in item iii, above, are met.

vi. At multi-unit sites, individual inspections of shared piping may be credited for only one unit.

vii. Visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other changes in material properties.

viii. The use of guided wave ultrasonic or other advanced inspection techniques is encouraged for the purpose of determining those piping locations that should be inspected but may not be substituted for the inspections listed in the table.

ix. Fire mains are inspected in accordance with Table 4b unless they are subjected to either a flow test as described in Section 7.3 of NFPA 25 at a frequency of at least one test in each one-year period or the activity of the jockey pump (or equivalent equipment or parameter) is monitored on an interval not to exceed one month. At a minimum, a flow test is conducted by the end of the next refueling outage or as directed by current licensing basis, whichever is shorter, when unexplained changes in jockey pump activity (or equivalent equipment or parameter) are observed.

Table 4b. Inspections of Underground Pipe for all Inspection Periods

Material[1]	**Inspections[2] of In-Scope Piping [(NTE) Not to Exceed Number of Inspections]**
Titanium	
Super Austenitic Stainless[3]	
Nickel Alloy	
Stainless Steel	1
Polymeric	1
Cementitious or Concrete	1
Steel	2%, NTE 2
Copper	1%, NTE1
Aluminum	1%, NTE 1

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for underground piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is as defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Guidance related to the extent of inspections:
   i. Table 4b lists the recommended inspections based on a percent of the total length of piping of a material type, or a maximum number of discrete inspections (i.e., the not to exceed number of inspections).

Table 4b. Inspections of Underground Pipe for all Inspection Periods	
Material[1]	**Inspections[2] of In-Scope Piping [(NTE) Not to Exceed Number of Inspections]**
ii. When the percentage of inspections for a given material type results in an inspection quantity less than 10 feet, then 10 feet of piping should be inspected. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected. iii. When a not to exceed inspection quantity or number of inspections is used to determine the extent of inspections for a material type, a minimum of 10 feet of piping should be inspected during each inspection. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected and only one inspection is required in that interval. iv. If fire protection piping will be inspected in lieu of alternative testing (e.g., flow test, jockey pump monitoring) and the extent of inspections is not based on the percentage of piping in the material group, then 1 additional inspection should be added to the NTE value for that material type. 3. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).	

x. Inspection as indicated in (A), and (B) below may be performed in lieu of the inspections contained in Table 4b:

A. At least 25 percent of the in-scope piping constructed from the material under consideration is hydrostatically tested to 110 percent of the design pressure of any component within the boundary with test pressure being held for eight hours on an interval not to exceed five years.

B. At least 25 percent of the in-scope piping constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet this criteria. UT examinations can be considered approved by the staff.

d. Directed Inspections – **Buried Tanks**

i. Directed inspections for buried tanks are conducted in accordance with Table 4c and its accompanying footnotes. Modifications to this table may be appropriate if exceptions to program element 2, “preventive actions,” are taken or in response to plant-specific operating experience.

ii. Directed inspections as indicated in Table 4c will be conducted during each 10-year period beginning 10 years prior to entry into the period of extended operation.

iii. Each in-scope buried tank is examined if it is constructed from a material for which an examination is indicated in Table 4c.

iv. Examinations may be conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. If the tank is inspected from the external surface, a minimum 25 percent coverage is required. This area must include at least some of both the top and bottom of the tank. If the tank is inspected internally by UT, at least one measurement is required per square foot of tank surface. UT measurements are distributed uniformly over the surface of the tank. If the tank is inspected internally by another volumetric technique, at least 90 percent of the surface of the tank must be inspected. Double wall tanks may be examined by monitoring the annular space for leakage.

v. Visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other changes in material properties.

vi. Opportunistic examinations may be credited toward these direct examinations.

Table 4c. Inspections of Buried Tanks for all Inspection Periods		
Material[1]		**Inspections**
Titanium		
Super Austenitic Stainless		
Nickel Alloy		
Stainless Steel		
Polymeric[2]		X
Other Polymer[2]		X
Cementitious or Concrete		X
Steel[3] Copper[3] Aluminum[3]		X

1. Materials classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried tanks are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Polymeric tanks are inspected if backfill is not in accordance with Table 2a of this AMP.
3. Steel, copper, and aluminum tanks are inspected if cathodic protection was
   i. installed or refurbished 5 years prior to the end of the inspection period of interest (i.e., prior to 35, 45, or 55 years); and
   ii. has been operational (available) at least 85 percent of the time since either 10 years prior to the period of extended operation or since installation/refurbishment, whichever is shorter. Time periods in which the cathodic protection system is off-line for testing do not have to be included in the total unavailability hours; and
   iii. has provided effective protection for buried piping as evidenced by meeting the acceptance criteria of paragraph Table 6a of this AMP at least 80 percent of the time since either 10 years prior to the period of extended operation or since installation/refurbishment, whichever is shorter. As found results of annual surveys are to be used to demonstrate locations within the plant's population of buried piping where cathodic protection acceptance criteria have, or have not, been met.

e. Directed Inspections – **Underground Tanks**

i. Directed inspections for underground tanks are conducted in accordance with Table 4d and its accompanying footnotes.

ii. Directed inspections as indicated in Table 4d will be conducted during each 10-year period beginning 10 years prior to the entry into the period of extended operation.

Table 4d. Inspections of Underground Tanks for all Inspection Periods	
Material[1]	**Inspections**
Titanium	
Super Austenitic Stainless[2]	
Nickel Alloy	
Stainless Steel	
Polymeric	
Cementitious or concrete	
Steel Copper Aluminum	X

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for underground tanks are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is as defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).

iii. Each in-scope underground tank is examined if it is constructed from a material for which an examination is indicated in Table 4d.

iv. Examinations may be conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. If the tank is inspected from the external surface, a minimum of 25 percent coverage is required. This area must include at least some of both the top and bottom of the tank. If the tank is inspected internally by UT, at least one measurement is required per square foot of tank surface. If the tank is inspected internally by another volumetric technique, at least 90 percent of the surface of the tank must be inspected. Double wall tanks may be examined by monitoring the annular space for leakage.

v. Tanks that cannot be examined using volumetric examination techniques are examined visually from the outside.

vi. Opportunistic examinations may be credited toward these direct examinations.

f. Adverse Indications

i. Adverse indications observed during monitoring of cathodic protection systems or during inspections are entered into the plant corrective action program. Adverse indications that are the result of inspections will result in an expansion of sample size as described in item iii, below. Examples of adverse indications resulting from inspections include leaks, material thickness less than minimum, coarse backfill within 6 inches of a coated pipe or tank (see Table 2a footnotes 5 and 6) with accompanying coating degradation, and general or local degradation of coatings so as to expose the base material.

ii Adverse indications that fail to meet the acceptance criteria described in program element 6, “acceptance criteria,” will result in the repair or replacement of the affected component.

iii. If adverse indications are detected, inspection sample sizes within the affected piping categories are doubled. If adverse indications are found in the expanded sample, an analysis is conducted to determine the extent of condition and extent of cause. The size of the follow-on inspections will be determined based on the extent of condition and extent of cause. The timing of the additional examinations should be based on the severity of the degradation identified and should be commensurate with the consequences of a leak or loss of function, but in all cases, the expanded sample inspections should be completed within the 10-year interval in which the original adverse indication was identified. Expansion of sample size may be limited by the extent of piping or tanks subject to the observed degradation mechanism.

iv. If adverse conditions are extensive, inspections may be halted in a piping system, or portion of system that is planned for replacement. If the initial doubling of the sample size has not been conducted, or the determination of extent of condition or extent of cause requires further inspections, these inspections should be conducted in locations with similar materials and environment.

5. ***Monitoring and Trending:*** For piping and tanks protected by cathodic protection systems, potential difference and current measurements are trended to identify changes in the effectiveness of the systems and/or coatings. If aging of fire mains is managed through monitoring jockey pump activity (or similar parameter), the jockey pump activity (or similar parameter) is trended to identify changes in pump activity that may be the result of increased leakage from buried fire main piping. Where wall thickness measurements are conducted, the results should be trended if follow-up examinations are conducted.

6. ***Acceptance Criteria:*** The principal acceptance criteria associated with the inspections contained with this AMP follow:

a. Criteria for soil-to-pipe potential when using a saturated copper/copper sulfate reference electrode are as follows:

Table 6a. Cathodic Protection Acceptance Criteria	
Material	Criteria[1, 3, 4]
Steel	-850 mV relative to a CSE, instant off, or 100 mV minimum polarization[2]
Copper	100 mV minimum polarization
Aluminum	100 mV minimum polarization
1. To prevent damage to the coating, the limiting critical potential should not be more negative than -1200 mV.	

2. The 100 mV polarization criterion is limited to electrically isolated piping sections or areas of grounded piping where the effects of mixed potentials are shown to be minimal. When the 100 mV criterion is utilized in lieu of the -850 mV CSE criterion for steel piping, or where copper or aluminum components are protected, applicants must explain in the application why the effects of mixed potentials are minimal and why the most anodic metal in the system is adequately protected.
3. Plants with sacrificial anode systems shall state the test method and acceptance criteria and the basis for the method and criteria in the application.
4. Where an impressed current cathodic protection system is utilized with pre-stressed concrete pipe, steps should be taken to avoid an excessive level of potential that could damage the prestressing wire. Therefore, polarized potentials more negative than -1,000 mV relative to a CSE should be avoided to prevent hydrogen generation and possible hydrogen embrittlement of the high-strength prestressing wire.

b. For coated piping or tanks, there should be either no evidence of coating degradation or the type and extent of coating degradation should be insignificant as evaluated by an individual possessing a NACE Coating Inspector Program Level 2 or 3 inspector qualification, or an individual has attended the Electric Power Research Institute (EPRI) Comprehensive Coatings Course and completed the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course. Where damage to the coating has been evaluated as significant and the damage was caused by non-conforming backfill, an extent of condition evaluation should be conducted to ensure that the as-left condition of backfill in the vicinity of observed damage will not lead to further degradation.

c. If coated or uncoated metallic piping or tanks show evidence of corrosion, the remaining wall thickness in the affected area is determined to ensure that the minimum wall thickness is maintained. This may include different values for large area minimum wall thickness, and local area wall thickness.

d. Cracking or blistering of nonmetallic piping is evaluated.

e. Cementitious or concrete piping may exhibit minor cracking and spalling provided there is no evidence of leakage or exposed rebar or reinforcing “hoop” bands.

f. Backfill is in accordance with specifications described in program element 2, “preventive actions.”

g. Flow test results for fire mains are in accordance with NFPA 25 Section 7.3.

h. For hydrostatic tests, the test acceptance criteria is no visible indications of leakage and no drop in pressure within the isolated portion of the piping that is not accounted for by a temperature change in the test media or quantified leakage across test boundary valves.

i. Changes in jockey pump activity (or similar parameter) that cannot be attributed to causes other than leakage from buried piping are not occurring.

7. ***Corrective Actions:*** The site corrective actions program, quality assurance (QA) procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. 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:*** The confirmation process ensures that preventive actions are adequate to manage the aging effects and that appropriate corrective actions have been completed and are effective. The confirmation process for this program is implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.

9. ***Administrative Controls:*** The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.

10. ***Operating Experience:*** Operating experience shows that buried and underground piping and tanks are subject to corrosion. Corrosion of buried oil, gas, and hazardous materials pipelines have been adequately managed through a combination of inspections and mitigative techniques, such as those prescribed in NACE SP0169-2007 and NACE RP0285-2002. Given the differences in piping and tank configurations between transmission pipelines and those in nuclear facilities, it is necessary for applicants to evaluate both plant-specific and nuclear industry operating experience and to modify its aging management program accordingly. The following examples of industry experience may be of significance to an applicant's program:

a. In February 2005, a leak was detected in a 4-inch condensate storage supply line. The cause of the leak was microbiologically influenced corrosion or under deposit corrosion. The leak was repaired in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI, "Repair/Replacement Plan."

b. In September 2005, a service water leak was discovered in a buried service water header. The header had been in service for 38 years. The cause of the leak was either failure of the external coating or damage to the coating caused by improper backfill. The service water header was relocated above ground.

c. In October 2007, degradation of essential service water piping was reported. The riser pipe leak was caused by a loss of pipe wall thickness due to external corrosion induced by the wet environment surrounding the unprotected carbon steel pipe. The corrosion processes that caused this leak affected all eight similar locations on the essential service water riser pipes within vault enclosures and had occurred over many years.

d. In February 2009, a leak was discovered on the return line to the condensate storage tank. The cause of the leak was coating degradation probably due to the installation specification not containing restrictions on the type of backfill allowing rocks in the backfill. The leaking piping was also located close to water table.

e. In April 2009, a leak was discovered in a portion of buried aluminum pipe where it went through a concrete wall. The piping was for the condensate transfer system. The failure was caused by vibration of the pipe within its steel support system. This vibration led to coating failure and eventual galvanic corrosion between the aluminum pipe and the steel supports.

f. In June 2009, an active leak was discovered in buried piping associated with the condensate storage tank. The leak was discovered because elevated levels of tritium were detected. The cause of the through-wall leaks was determined to be the degradation of the protective moisture barrier wrap that allowed moisture to come in contact with the piping resulting in external corrosion.

References

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

ASTM Standard D 448-08, *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*, 2008.

NACE Recommended Practice RP0285-2002, *Standard Recommended Practice Corrosion Control of Underground Storage Tank Systems by Cathodic Protection,* revised April 2002.

NACE Standard Practice SP0169-2007, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*, 2007.

NFPA Standard 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2010 edition.

NFPA Standard 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2008 edition.

ISO 15589-1, Petroleum and natural gas industries – Cathodic protection of pipeline transportation systems – Part 1: On-land pipelines, 11/15/2003

NACE Standard RP0100-2004, *Standard Recommended Practice, Cathodic Protection of Prestressed Concrete Cylinder Pipelines*, 2004

APPENDIX B

Revised 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.M41	Buried and Underground Piping and Tanks	This comprehensive program is designed to manage the aging of the external surfaces of buried and underground piping and tanks. It addresses piping and tanks composed of any material, including metallic, polymeric, concrete, and cementitious materials. The program manages aging through preventive, mitigative, (i.e., coatings, backfill quality and cathodic protection) and inspection activities. It manages applicable aging effects, such as loss of material, cracking, and changes in material properties. If a reduction in the number of inspections recommended in Table 4a is claimed based on a lack of soil corrosivity as determined by soil testing, the UFSAR program description should state that soil testing should be conducted once in each 10-year period starting 10 years prior to the period of extended operation.	Program should be implemented before the period of extended operation	GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4

APPENDIX C - GALL REPORT AMR ITEM CHANGES

V ENGINEERED SAFETY FEATURES
D1 Emergency Core Cooling System (PWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
V.D1.EP-72	V.D1-26(EP-31)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

V ENGINEERED SAFETY FEATURES
D2 Emergency Core Cooling System (BWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
V.D2.EP-72	V.D2-27(EP-31)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

V ENGINEERED SAFETY FEATURES
E External Surfaces of Components and Miscellaneous Bolting

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
V.E.EP-123		Underground piping, piping components, and piping elements	Steel, stainless steel, nickel alloy	Air-indoor, uncontrolled (external) or condensation (external)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No

APPENDIX C - GALL REPORT AMR ITEM CHANGES

VII AUXILIARY SYSTEMS
C1 Open-Cycle Cooling Water System (Service Water System)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.C1.AP-137	VII.C1-16(AP-56)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

VII AUXILIARY SYSTEMS
C3 Ultimate Heat Sink

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.C3.AP-137	VII.C3-8(AP-56)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.C3.AP-198	VII.C3-9(A-01)	Piping, piping components, and piping elements	Steel (with coating or wrapping)	Soil or concrete	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

APPENDIX C - GALL REPORT AMR ITEM CHANGES

VII G	AUXILIARY SYSTEMS Fire Protection						
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.G.AP-137	VII.G-20(AP-56)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.G.AP-198	VII.G-25(A-01)	Piping, piping components, and piping elements	Steel (with coating or wrapping)	Soil or concrete	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

VII H1	AUXILIARY SYSTEMS Diesel Fuel Oil System						
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H1.AP-137	VII.H1-7(AP-56)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.H1.AP-198	VII.H1-9(A-01)	Piping, piping components, and piping elements	Steel (with coating or wrapping)	Soil or concrete	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

APPENDIX C - GALL REPORT AMR ITEM CHANGES

VII AUXILIARY SYSTEMS
H2 Emergency Diesel Generator System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H2.AP-137	VII.H2-19(AP-56)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil <u>or concrete</u>	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

VII AUXILIARY SYSTEMS
I External Surfaces of Components and Miscellaneous Bolting

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.I.AP-243		Bolting	Stainless steel, nickel alloy	Soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.I.AP-284		Underground piping, piping components, and piping elements	Steel, stainless steel, nickel alloy, copper alloy, aluminum	Air-indoor uncontrolled or condensation (external)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No

APPENDIX C - GALL REPORT AMR ITEM CHANGES

VIII E	STEAM AND POWER CONVERSION SYSTEM Condensate System						
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.E.SP-94	VIII.E-28(SP-37)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.E.SP-145	VIII.E-1(S-01)	Piping, piping components, and piping elements; tanks	Steel (with coating or wrapping), <u>stainless steel, nickel alloy</u>	Soil or concrete	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.G.SP-94	VIII.G-31(SP-37)	Piping, piping components, and piping elements	Stainless steel, nickel alloy	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.G.SP-145	VIII.G-1(S-01)	Piping, piping components, and piping elements; tanks	Steel (with coating or wrapping), <u>stainless steel, nickel alloy</u>	Soil or concrete	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

APPENDIX C - GALL REPORT AMR ITEM CHANGES

VIII STEAM AND POWER CONVERSION SYSTEM H External Surfaces of Components and Miscellaneous Bolting							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.H.SP-143		Bolting	Stainless steel, nickel alloy	Soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.H.SP-161		Underground piping, piping components, and piping elements	Steel, stainless steel, nickel alloy copper alloy, aluminum	Air-indoor uncontrolled or condensation (external)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No

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
53	BWR/PWR	Stainless steel, nickel alloy piping, piping components, and piping elements exposed to soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	V.D1.EP-72 V.D2.EP-72	V.D1-26(EP-31) V.D2-27(EP-31)
53x	BWR/PWR	Steel, stainless steel, nickel alloy underground piping, piping components, and piping elements exposed to air-indoor uncontrolled or condensation (external)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	V.E.EP-123	

APPENDIX D – SRP-LR AMR ITEM CHANGES

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
107	BWR/ PWR	Stainless steel, nickel alloy piping, piping components, and piping elements exposed to Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VII.C1.AP-137 VII.C3.AP-137 VII.G.AP-137 VII.H1.AP-137 VII.H2.AP-137	VII.C1-16(AP-56) VII.C3-8(AP-56) VII.G-20(AP-56) VII.H1-7(AP-56) VII.H2-19(AP-56)
108	BWR/ PWR	Titanium, super austenitic, aluminum, copper alloy, stainless steel, nickel alloy piping, piping components, and piping elements, bolting exposed to soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VII.C1.AP-171 VII.C1.AP-172 VII.C1.AP-173 VII.C1.AP-174 VII.I.AP-243	N/A N/A N/A N/A N/A
109x	BWR/ PWR	Underground aluminum, copper alloy, stainless steel, nickel alloy steel piping, piping components, and piping elements	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VII.I.AP-284	N/A

APPENDIX D – SRP-LR AMR ITEM CHANGES

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
47	BWR/PWR	Steel (with coating or wrapping), stainless steel, nickel-alloy piping, piping components, and piping elements; tanks exposed to Soil or Concrete	Loss of material due to general (steel only), pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VIII.E.SP-145 VIII.G.SP-145	VIII.E-1(S-01) VIII.G-1(S-01)
48	BWR/PWR	Stainless steel, nickel alloy bolting exposed to soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VIII.H.SP-143	N/A
49	BWR/PWR	Stainless steel, nickel alloy piping, piping components, and piping elements exposed to soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VIII.E.SP-94 VIII.G.SP-94	VIII.E-28(SP-37) VIII.G-31(SP-37)
50x	BWR/PWR	Underground stainless steel, nickel alloy, steel piping, piping components, and piping elements	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No	VIII.H.SP-161	N/A

Appendix E - Changes to the “scope of program” and “detection of aging effects” Program Elements of AMP XI.M36, “External Surfaces Monitoring of Mechanical Components”

Changes to the “scope of program” and “detection of aging effects” program elements of AMP XI.M36 have been shown below as underlined (additions) and crossed-out (deletions).

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

The program may also 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 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 describe the component internal environment and the credited similar external component environment inspected.

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

Detection of Aging Effects: This program manages aging effects of loss of material, cracking, and change 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 requirements, plant-specific visual inspections are performed of metallic and polymeric component surfaces using plant-specific procedures implemented by inspectors qualified through plant-specific programs. The inspections are capable of detecting age-related degradation and are performed at a frequency not to exceed one refueling cycle. This frequency accommodates inspections of components that may be in locations that are normally only accessible during outages ~~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.~~ Surfaces that are insulated 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.

Visual inspection will identify indirect indicators of flexible polymer hardening and loss of strength and include the presence of surface cracking, crazing, discoloration, and, for elastomers with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Visual inspection should be 100 percent of accessible components. 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 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 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

Appendix F - Changes to the “detection of aging effects” Program Element of AMP XI.M33, “Selective Leaching”

Changes to the “detection of aging effects” program element of AMP XI.M33 have been shown below as underlined (additions) and crossed-out (deletions)

Detection of Aging Effects: The visual inspection and hardness measurement or other mechanical examination techniques, such as destructive testing (when the opportunity arises), chipping, or scraping, is a one-time inspection conducted within the last 5 years prior to entering the period of extended operation. Because selective leaching is a slow acting corrosion process, this measurement is performed just prior to the period of extended operation. Follow-up of unacceptable inspection findings includes an evaluation using the corrective action program and a possible expansion of the inspection sample size and location.

Where practical, the inspection includes a representative sample of the system population and focuses on the bounding or lead components most susceptible to aging due to time in service, severity of operating conditions, and lowest design margin. Twenty percent of the population with a maximum sample of 25 constitutes a representative sample size. Otherwise, a technical justification of the methodology and sample size used for selecting components for one-time inspection should be included as part of the program’s documentation. Each group of components with different material/environment combinations is considered a separate population. In recognizing that cathodic protection and coatings can prevent or mitigate selective leaching on the external surfaces of buried components, the “detection of aging effects” program element of AMP XI.M41, in some instances, provides for a reduced sample size.

Selective leaching generally does not cause changes in dimensions and is difficult to detect by visual inspection. However, in certain brasses, it causes plug-type dezincification, which can be detected by visual inspection. One acceptable procedure is to visually inspect the susceptible components closely and conduct Brinell hardness testing (where feasible, based on form and configuration or other industry-accepted mechanical inspection techniques) on the inside surfaces of the selected set of components to determine if selective leaching has occurred. If selective leaching is apparent, an engineering evaluation is initiated to determine acceptability of the affected components for further service.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
1	Jon Cavallo ML12094A367	Section 6, "Acceptance Criteria," Paragraph b: The first sentence states that the type and extent of buried pipe coating degradation should be insignificant "...as evaluated by an individual possessing a NACE operator qualification or otherwise meeting the qualifications to evaluate coatings as contained in 49 CFR Parts 192 and 195." These qualifications are for regulated transmission pipelines and cover cathodic protection and not coatings. The correct reference should be **"...** as evaluated by an individual who has successfully completed the EPRI Buried Pipe Condition Assessment and Repair Training Course **1."** This course is available on www.epri.com and is available through EPRI member organizations.	Agree. 10 CFR § 192.805, Qualification program, states that each operator (e.g., coatings inspector) shall have a written qualification program to ensure that through evaluation the individuals can perform their tasks. 10 CFR § 192.803, Definitions, states that written exams, oral exams, or observations during performance on the job meet the evaluation requirement. 10 CFR § 195.505, Qualification program, states that the program should identify covered tasks. The staff reviewed the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course and EPRI Comprehensive Coatings Course Syllabi. The courses include material on corrosion control, coating development, coating: composition, curing mechanisms, calculations, product terms, nuclear qualifications, pre-surface preparation inspections, surface preparation, coating application, coating inspections, condition assessments, and coating failure analysis. Students are evaluated between modules. Based on the review of the syllabi, the staff concludes that the EPRI courses meet the staff intent for coatings inspector knowledge and rigor in a training program. The staff made appropriate changes to the ISG.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
2	Henry Kleinfelder Mears Group ML12103A207	Selecting the instant off and -l00mV minimum polarization testing criteria listed in NACE SP0169-2007 will not provide system operator's reasonable assurance that the CP system is effectively protecting the target buried pipe system. 1. The -100mV criteria refers to a reference to the most noble metal. In most nuclear buried pipe cases the targeted carbon steel system is not the most noble metal. 2. Using the -100mV polarization shift will increase the probability that critical areas will not be adequately protected by CP. Mixed metal couples, such as carbon steel, cast iron, ductile iron and stainless steel coupled to copper grounding components may not be adequately protected when using the 100 millivolt polarization criterion. 3. The -l00mV criterion seems to have been advocated to reduce the probability of damage to existing coatings through over polarization causing cathodic disbondment. We suggest referring to ISO 11589-1 "Petroleum and Natural Gas Industries- Cathodic Protection of Pipeline Transportation Systems- Part 1: On-Land Pipelines" which establishes an upper limit of-1200mV to insure coating integrity maintained. 4. Most coatings found to be in use are bituminous enamels and epoxies Which have proven to be tolerant of high CP currents and not inherently susceptible to cathodic disbondment. 5. NACE Internal policy states that RP or SP must be applied in their entirety. 6. The instant off reference in the draft is missing the correct polarization level. Based on the supporting technical comments above we suggest these clarifications to the **CP** Survey Acceptance Criteria paragraph Cathodic Protection Survey Acceptance Criteria Based on staff findings during AMP audits, multiple sites do not have an upper limit on cathodic protection pipe-to-soil potentials. If the cathodic protection pipe-to-soil values are too high, coating damage can occur to certain types of coating (particularly tape coatings). In plants with coatings susceptible to disbondment from high CP potentials a maximum instant off potential of -1200 mV to CSE (as listed in ISO1 1589-1) The staff deleted the general reference to the NACE standards for the acceptance criteria and incorporated the NACE SP0169-2007 specific cathodic protection survey acceptance criteria into the AMP.	Comment (cont.) The instant off -850mV to CSE and -100mV minimum polarization testing criteria listed in NACE SP0169-2007 were selected because proper correction for voltage drops can be difficult given the typical configuration of buried piping in nuclear power plant yard structure areas. The 100mV polarization criterion is limited to electrically isolated piping sections or areas of grounded piping where the effects of mixed potentials are shown to be minimal. --- Response to comment: Agree. Incorporated comment into the ISG with editorial changes. NACE SP0169-2007,Section 6.2.2.1.3 states, “A minimum of 100 mV of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The formation or decay of polarization can be measured to satisfy this criterion.” ISO 15589-1, “Petroleum and natural gas industries – Cathodic protection of pipeline transportation systems – Part 1: On-land pipelines,” dated 11/15/2003, Section 5.3.2.2 states, “Furthermore, the criteria shall not be used in case of pipelines connected to or consisting of mixed metal components.” The comment is consistent with the position in ISO 15589-1. The staff agrees with the comment, “where the effects of mixed potentials are shown to be minimal.” As long as the applicant is protecting the most anodic buried piping material, the 100 mV polarization can be appropriately utilized.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
3	Steven Daily ML12108A049	DNV offers the following comments and recommendations regarding Section 6, Acceptance Criteria, for cathodic protection (CP) of buried piping and tanks: 1. There has been considerable debate by experts in the CP industry over the use of the 100 mV cathodic protection criterion when applied to structures having different metals interconnected (such as the buried metallic piping and tanks at a nuclear power plant). NACE SP0169-2007 "Control of External Corrosion on Underground or Submerged Metallic Piping Systems" stipulates that for dissimilar metal piping a negative voltage between all pipe surfaces and a stable reference electrode contacting the electrolyte equal to that required for protection of the most anodic metal in the system should be maintained. The major concern is that the difference in potential between the anode and cathode sites in a mixed-metal network can be quite large (e.g. carbon steel-copper, carbon steel-stainless steel, carbon steel-reinforcing steel, etc.). This coupling must be overcome first so that adequate polarization is realized on the most anodic material. Hence, 100 mV of polarization is not always enough to ensure the structure is fully polarized, especially if the mixed native potential that is measured on the pipe or tank is extremely depressed (more noble). 2. Page 25 of NACE International Publication 35108 "One Hundred Millivolt (mV) Cathodic Polarization Criterion" states that the effectiveness of the 100 mV cathodic polarization criterion compared to the -850 mV (CSE) criterion (i.e., a corrosion rate less than 25 pm/y [1 mpy]) relies on corrosion cells operating under cathode control, such that the corrosion potential (Ecorr) is relatively close to the open circuit potential of the anode. However, if the cathode area is large compared to the anode area, as is the case with the coated carbon steel pipe in nuclear power plants, the corrosion cell is operating under mixed or anodic control. The 100 mV cathodic polarization criterion in corrosion cells under mixed or anodic control normally reduces corrosion rate, but not likely to the same degree for structures under cathodic control. Therefore its use should be limited to electrically isolated pipes or areas of grounded piping that are not influenced by the mixed metal couple. 3. As a general note the criteria in Section 6 of the ISG refers to -100 mV minimum polarization. The formation of polarization from a native structure-to-soil potential or the decay of polarization from an instant-off potential may be used to satisfy this criterion, and hence the negative (-) symbol is not required. Therefore this criterion should be referred to as "100 mV minimum polarization".	Agree. See response to comment number 2.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
4	NEI ML12114A214	Discussion Page 1: Significant changes to Element 4 Table 4a and its respective footnotes, has increased the number of inspections. The discussion relative to the changes to Table 4a states that the partial basis for change is to allow applicants greater flexibility in selecting inspection locations of highest risk. However, in the process of eliminating the safety-related and hazmat classifications in the current XI.M41 program, the existing wording leaves open the possibility that non-safety-related piping systems, of low risk, may not only require inspection but could require more inspections than safety-related piping. Discussion Page 2: The element 2 preventive measures criteria leave little margin in regards to their impact on element 4 inspection requirements when inadequate conditions are observed. Coatings, backfill, and cathodic protection are a defense-in-depth approach to protecting piping. The absence, or even less-than-perfect condition, of any one of these preventative measures does not constitute a degree of failure and concern proportional to the element 4 inspection impacts. Engineering evaluations are recommended to assess the adequacy of protection provided to buried component when preventative measure impacts are observed. Discussion on page 2: The intent of the Table 4a inspection numbers appear to be applied on a per unit basis, rather than per station. This results in a quantity that does not consider corrective action extent of condition evaluations that would investigate common conditions on multiple unit sites.	Agree in part. The staff accounted for NEI's concern in its changes to AMP XI.M41. In the current AMP, inspection quantities are based in some instances on a total number of inspections and in others, on a percentage of piping. The staff recognized that by deleting the Code Class safety-related (SR) and hazardous material piping inspection columns, additional piping (i.e., nonsafety-related (NSR)) would be included in the inspection population. As such, each inspection recommendation is expressed as a percentage of piping to be inspected accompanied by a not-to-exceed number of inspections. In addition, the staff combined steel, copper, and aluminum piping into one inspection category, to mitigate the potential for an excess number of inspections while at the same time ensuring that there was an adequate representative sample to demonstrate reasonable assurance that the CLB function of the buried components would be met. In addition, the staff (a) combined the HDPE and other polymeric material category into one, and (b) added footnote 10 to allow the number of inspections for preventive action category B to be reduced by one-half if all the piping was NSR. The staff acknowledges NEI's comment related to differing design specifications between SR and NSR piping (second paragraph of comment); however, during LRA audits, the staff has not found this differentiation within in-scope items which are typically buried in close proximity to each other. If an applicant finds that its configuration is similar to NEI's concern, it would be appropriate to address this as an exception to the AMP. Although the preventive action category descriptions have changed between the ISG and the original version of AMP XI.M41, the not-to-exceed inspection quantities are appropriate. For example, for steel piping: <u>Preventive Action Category C</u>: cathodic protection (CP) is provided and meets all recommendations, no change in the number of inspections despite adding NSR to scope. <u>Preventive Action Category D</u>: external corrosion control is not required. This is a revised preventive action category based on addressing plants without cathodic protection. Although the applicant will have demonstrated that CP is not required, the increase of one inspection in each 10-year period is appropriate to provide reasonable assurance that backfill and coatings are acceptable.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
4,Cont.	NEI ML12114A214	Discussion Page 3: 1st bullet at the bottom of the page claims that combining the code class safety-related and hazardous material piping inspection columns allows for greater flexibility in selecting inspection locations with the highest potential risk, however, Table 4a does not explicitly address risk. By eliminating the safety-related and hazardous material categories, non-safety, non-hazmat, and/or low risk piping populations need to be included when considering Table 4a inspection populations. Based on the inclusion of non-safety, nonhazmat, and/or low risk piping populations, it is possible that Table 4a categories that include only non-safety-related, non-hazmat, and/or low risk piping will be inspected. Furthermore, it is entirely possible that original design specifications could require safety related piping to have better standards on preventive measures, while low risk non-safety piping may not have all the XI.M41 specified preventive measures. As currently written in this ISG, this could create individual subdivisions of a material type where safety-related portions of piping of X material would be inspected by one standard (C & D with fewer inspections) and non-safety piping of the same material would be required to be inspected by a higher standard (F & G with more inspections). It is recommended that the following footnote be included in Table 4a for exclusion of nonsafety related or hazardous material piping be excluded from the Table 4a inspection populations. 10. *Piping that is neither safety-related nor carries hazardous material can be excluded from the inspection populations.*	Response continued, <u>Preventive Action Category E</u>: this is a revised preventive action category based on addressing plants without cathodic protection and addressing comment 2, fourth paragraph, related to unavailability of CP exceeding 90 days. This preventive action category addresses two scenarios. In the first, CP is not installed because it is impractical to install and use. The inspection quantities over the 30-year period, (i.e., 7, 10 and 12) are consistent for a plant without cathodic protection. The inspection quantities are consistent with a similar preventive action category in the original AMP XI.M41, E, which recommended four inspections of Code Class SR piping plus 5 percent of the hazmat piping. In addition, AMP XI.M41 only addressed the lack of cathodic protection for the first 10-year inspection interval. It was expected that CP would be installed during the period of extended operation (PEO). Given that this change allows a plant to not have CP during the PEO, the increase in inspection quantities over the two subsequent 10-year periods is necessary to provide reasonable assurance that coatings and backfill are acceptable because they are the only barriers to aging. In the second, CP has been provided but it does not meet availability or effectiveness recommendations. This is also a revised input based on addressing plants that could range from having an availability of 50 percent to those having 84 percent availability. In the original issuance of AMP XI.M41, these two widely varying levels of performance were addressed with a single inspection recommendation. The total inspections were increased from one for Code Class SR piping plus 2 percent of the hazmat piping to an average of six percent not to exceed 10 inspections per 10-year period. See response for comment 6 to address NEI's comment related to, "inspection numbers appear to be applied on a per unit basis."

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
4, Cont.	NEI ML12114A214		Response continued, Preventive Action Category F: this preventive action category was revised to reflect a plant that does not have CP and one or more of coatings and backfill do not meet recommendations, the soil is corrosive or not tested, and plant-specific operating experience demonstrates that leaks, significant coating degradation, or metal loss in more than 10 percent of inspections has occurred. Given these conditions, where the quality of coatings or backfill has been challenged, or the soil is corrosive or not tested, it is appropriate to inspect a significant quantity of piping to provide reasonable assurance that the CLB function of the piping will be met. This revised preventive action category replaced one where CP was only expected to be not available for the first 10-year period.
5	NEI ML12114A214	Element 3: Stress corrosion cracking is included as an aging effect monitored and inspected by XI.41. However, there are no GALL line items for stress corrosion cracking aligned to this program. Buried stainless steel bolting and piping line GALL AMR lines are needed that reference XI.M41 as the aging management program.	Disagree. The "parameters monitored/inspected" program element was revised to clarify that cracking is only addressed when excavated, direct visual examinations result in the removal of coatings for reasons other than to inspect for cracking. Although carbonate cracking has been detected in buried piping carrying gas and oil, the staff is not aware of any instances of such cracking in buried piping of commercial nuclear plants. Therefore, there are no AMR items listing cracking as an AERM; however, when the opportunity for bare metal piping becomes available, the surface should be inspected for cracking.
6	NEI ML12114A214	Table 4a: NTE values for categories F & G are excessive if Table 4a is meant to apply on a per unit basis. For example, steel piping meeting category G could get as high as 120 inspections over a 30-year period for a two unit site if specified number of inspections are applied to both units. In addition, operating experience from a pipe in one unit should be applicable to the other units at the station based upon buried components of similar materials, coating, cathodic protection, etc. It is recommended that the numbers in Table 4a, specifically categories F and G, be reduced in a manner that can be more reasonability implemented by applicants with multiple units. Recommend that a footnote be added to Table 4a to indicate it is applicable to a single unit site, but increased by 50% for a two unit site, and doubled for a three unit site.	Agree. With the development of the inspection quantities for plants without CP, it is recognized that the quantity of inspections required to yield an understanding of the condition of buried piping would be sufficient without doubling the number of inspections for a two-unit site or tripling at a three-unit site. ISG Section 4.b.vi. was revised to state, "Table 4a inspection quantities are for a single unit plant. For two-unit sites, the NTE inspection quantities are increased by 50 percent. For a three-unit site, the NTE inspection quantities are doubled."

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
7	NEI ML12114A214	As documented in the first bullet at the bottom of page 3 of the Draft ISG discussion, the Staff removed the safety-related and hazmat classification for inspections from XI.M41 to allow applicants to utilize their risk ranking process in selecting pipe segments of greatest concern. Recommend combining the steel, copper, and aluminum inspection groups into one material category called "metals requiring cathodic protection" in tables 4a through 4d to allow flexibility in selecting risk significant locations for inspection. Inspection requirements for the "metals requiring cathodic protection" are assumed to be consistent with the steel inspection requirements. This would allow inspections to be conducted on cathodically protected piping of highest risk, regardless of material type.	Agree. See response to comment 4 above.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
8	NEI ML12114A214	Table 4a, footnote 2.C.iii: "adequate protection" seems to be defined as meeting the NACE standard following annual surveys. How many instances of not meeting the acceptance criteria at a given point in the system constitute being classified as F or G? Cathodic protection values fluctuate between surveys and adjustments are made to "tune" the system to correct for this. Based on the example given in the second sentence of this footnote, it is implied that a single failure results in a category reclassification. As written, the reclassification to a category F or G based on a single survey result can result in 10-20 times more inspections than the original scope. A single survey result to reclassify into those categories represents an undue burden when considering that preventive measures are a defense-in-depth approach to protecting buried piping. Cathodic protection is meant to protect piping following failure of the coatings and backfill. An engineering evaluation to assess the under-protected areas based upon known conditions (e.g., prior inspection results, coating assessments, soil conditions, etc.) is recommended when annual surveys or other conditions indicate that protection may not be adequate. The last sentence of Table 4a, footnote 2.D.ii (also table 2a, footnote 4 and Table 4c, footnote 2Cii) requires that duration of deviations from these criteria should not exceed 90 days appears to require reclassification to a category F or G based on the 91st day. In lieu of inspection category reclassification, an engineering evaluation may be performed justifying not reclassifying the subject population. Furthermore, the second sentence of this footnote is unclear. As written it reads: *For example, if 10 percent of the cathodic protection survey points are left in the under protected range after the annual survey, then 10 percent of the inspections from the applicable F or G category, should be conducted in addition to those from the applicable category C row.* It appears the intent of this sentence is to state that if a portion of a system is under protected, that portion is to become an individual population and inspected separately in accordance with the appropriate F or G category. Proposed revision to Table 4a, footnote 2.C.iii: iii. provides adequate protection for 100% of the area for which protection is claimed. Any portions of a piping system that consistency does not meet acceptance criteria, as identified by annual cathodic protection surveys, will, on a proportional basis, be inspected in accordance with category F or G, as applicable. For example, if 100 feet of a 1000 foot population is not adequately protected, the 900 foot population that meets acceptance criteria will be inspected in accordance with category C or D, as applicable, while the 100 foot population not meeting acceptance criteria will be inspected in accordance with category F or G, as applicable. In lieu of inspection category reclassification, an engineering evaluation may be performed justifying not reclassifying the subject population.	Agree in part. The staff has incorporated changes to the ISG with the exception of the following aspects: • "appears to require reclassification to a category F or G based on the 91st day." The staff revised the ISG to remove any reference to availability of CP related to days of service. However, the ISG retains the concept of availability in regards to the installation timing of the system (i.e., less than or more than five years) and operational percentage since the time of installation. The ISG has been revised to recommend a minimum of 85 percent availability in lieu of 90 percent. The 85 percent was based on allowing three 90-day maintenance cycles in a given five-year period to accomplish repairs to a CP circuit. If either the five-year or 85 percent availability criteria is not met, preventive action category E must be met. This category recommends 29 inspections over the thirty-year period starting ten years prior to the period of extended operation. The staff recognizes that a CP circuit might be available for 84 percent of the period or installation could have missed the five year criteria by one day; however, standard criterion must be set, and the staff believes that the five years and 85 percent are reasonable goals to meet which balance the defense in depth nature of CP and a station's maintenance schedule. • "Any portions of a piping system that consistency does not meet acceptance criteria, as identified by annual cathodic protection surveys, will, on a proportional basis, be inspected in accordance with category F or G, as applicable." The staff believes that the term "consistently" is not well enough defined. The revised conditions to meet the preventive action categories are a blend of availability and effectiveness. • "In lieu of inspection category reclassification, an engineering evaluation may be performed justifying not reclassifying the subject population." The staff believes that this sentence lacks sufficient objective criteria and therefore it was not included in the changes to the ISG.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
9	NEI ML12114A214	Table 4a, footnote 6: Recommend the following revision of Table 4a, footnote 6, to avoid confusion with the HDPE piping approved by staff in footnote 5. "Other polymer piping includes HDPE not approved by the NRC for buried applications and all other polymeric materials including composite materials such as fiberglass."	Agree. The staff deleted footnotes 5 and 6 and renumbered the remaining footnotes.
10	NEI ML12114A214	Element 4.c.x: Typo - Table 4a is listed, should be Table 4b	Agree. The editorial change was incorporated.
11	NEI ML12114A214	Table 4a, Table 4b, Table 4c, and Table 4d: Add a new material row for nickel alloys consistent with the stainless steel row. Nickel alloys and stainless steels have similar aging characteristics in buried and underground environments. Also add associated AMR lines in the external surfaces section of GALL Chapter VII for nickel alloy piping components in underground and buried environments.	Agree. Tables 2a and 2b, and 4a – 4d were revised and appropriate AMR items in the GALL Report and SRP-LR were revised.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
12	NEI ML12114A214	Table 4a, footnote 7: Recommend that inspection requirements for piping backfilled with controlled low strength material be clarified to note that the piping will be excavated to expose the top surfaces and at least 50% of the side surface for inspection. Excavation to expose the entire surface of the controlled low strength material is not practice and would significantly increase the risk of damage to the piping system and the controlled low strength material backfill.	Agree. The ISG was revised accordingly.
13	NEI ML12114A214	Element 4.b.x.A: There appears to be an improper reference to hydrostatic testing per 49CFR PART 195 Subpart E. If the intent is to require the pressure and time requirements in 195.304, they should be reproduced in this AMP. Otherwise, Subpart E may not apply due to the following ambiguities: (1) What is the maximum operating pressure at the nuclear site (MOP has a specific meaning in Part 195) (2) 195.306 requires the evacuation of all buildings within 300ft of the pipe, which would mean evacuating the plant. (3) 195.302 excludes the need for hydrostatically testing pipes whose definition effectively are those in a nuclear plant	Agree. Specific criteria from 49 CFR Part 195 Subpart E were incorporated into the ISG (i.e., test pressure, hold time, acceptance criteria), and the reference to 49 CFR Part 195 was deleted.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
14	NEI ML12114A214	Table 4a, footnote 9: Add "sulfates" to the parameters that each soil sample is tested for to demonstrate the cathodic protection is not required. Although not identified as a parameter in the ISG, the NACE website (http)://events.nace.orq/library/corrosion/SoilCorrosionNariables.asp) identifies sulfate level as another variable that influences corrosion rates in soil. With respect to sulfates, the NACE website states the following: "Compared to the corrosive effect of chloride ion levels, sulfates are generally considered to be more benign in their corrosive action towards metallic materials. However, concrete may be attacked as a result of high sulfate levels. The presence of sulfates does pose a major risk for metallic materials in the sense that sulfates can be converted to highly corrosive sulfides by anaerobic sulfate reducing bacteria." It should also be noted that AWWA C105 is cited as reference for the XI.M41 Program in Appendix A of the ISG. The point system for predicting soil corrosivity in AWWA **C105** (http://events.nace.orc/library/corrosion/SoilCorrosion/Numerical.asp) includes sulfides as a parameter. Since the scope of the program includes both metallic and concrete buried piping, the inclusion of sulfide and sulfates levels as soil test parameters may be warranted in the ISG.	Agree. The comment was incorporated.
15	NEI ML12114A214	Section 2.a.iv requires that if cathodic protect is not installed, twenty years of plant specific operating experience to determine if adverse conditions as described in Section 4.f of the GALL XI.M41. A 10-year period is recommended to be consistent with NEI 95-10 operating experience review requirements.	Agree in part. NEI 95-10, Revision 6, Section 4.4 states, “[a] review of the prior five to ten years of operating and maintenance history should be sufficient.” While the staff does not agree that a five-year search is sufficient in instances where cathodic protection is not applied, a 10-year search should be sufficient to provide an adequate level of knowledge of the current performance of the pipe coating and backfill in the vicinity of buried piping. Thus the recommendation was revised from 20 years to 10 years.

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
16	NEI ML12114A214	Table 2a Note 5 last sentence states: "Backfill is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's coatings, or the surface of the component, if not coated due to the backfill." Subject sentence is not clear. Suggest rewording similar to the following: Backfill is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's coatings or the surface of the component (if not coated) due to the backfill."	Agree. Change was incorporated for clarity.
17	NEI ML12114A214	Section 4.e.vi: This statement is not applicable and should be deleted, since, in accordance with Table 4d, directed inspections of underground polymeric tanks are not required.	Agree. 4.e.vi was deleted.
18	NEI ML12114A214	Element 6 table: A reference for the -1200mV overprotection criteria should be added. In addition, this is not a hard and fast number. This should be a trigger to assess the overall CP system since there are many factors that cause coating disbondment.	Agree in part. The staff added a reference for the -1200 mV over protection criteria. ISO 15589-1, "Petroleum and natural gas industries – Cathodic protection of pipeline transportation systems – Part 1: On-land pipelines," dated 11/15/2003, 5.3.21., states "To prevent damage to the coating, the limiting critical potential should not be more negative than -1200mV referred to CSE, to avoid the detrimental effects of hydrogen production and/or a high pH at the metal surface."

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
19	NEI ML12114A214	Element 6.a: Non-impressed current cathodic protection systems need to be treated differently. Criteria should be provided for plants with sacrificial anodes (that cannot be interrupted to measure an instant off). The ability to collect an "IR free measurement" within the excavation can be used to demonstrate the effect of IR drop by comparing pipe-to- soil measurements next to a pipe in an excavation as compared to surface measurements. Add a note to limit potentials for pretensioned wires in PCCP.	Agree in part. A footnote was added to the acceptance criteria related to sacrificial anode CP systems, “Plants with sacrificial anode systems should state the test method and acceptance criteria and basis in the application.” NACE Standard RP0100-2004, Standard Recommended Practice, Cathodic Protection of Prestressed Concrete Cylinder Pipelines, states a recommended maximum -1000mV relative to a CSE. This value was included in the acceptance criteria.
20	NEI ML12114A214	Element 6.b: Recommend that coating degradation be evaluated by a trained coatings inspector. Training should be consistent with EPRI 1023249, "Buried Pipe Condition Assessment and Repair, Version 1" and EPRI Comprehensive Coating Training Course.	Agree. See response to comment 1.
21	NEI ML12114A214	Element 10.e: Recommend revising this operating experience (OE) example to indicate how it applies to components in an underground or buried environment or deleted the **OE.**	Agree. Example was clarified by including the term “a portion of buried.”

Comment No.	Comment Source (ADAMS Accession No.)	Comment on Draft LR-ISG-2011-01	NRC Staff Response
22	NEI ML12114A214	References: Pipeline External Corrosion Direct Assessment Methodology (ECDA) should be listed as "Standard Practice SP0502-2010 ... " instead of recommended practice RP0502-2010.	Agree in part. Reference was deleted as it is not used in the ISG.