

LICENSE RENEWAL INTERIM STAFF GUIDANCE

LR-ISG-2015-01

CHANGES TO BURIED AND UNDERGROUND PIPING AND TANK RECOMMENDATIONS

INTRODUCTION

This draft license renewal interim staff guidance (LR-ISG) LR-ISG-2015-01, "Changes to Buried and Underground Piping and Tank Recommendations," provides changes to NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," Revision 2 (December 2010), and NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," (SRP-LR), Revision 2 (December 2012), as described below. LR-ISG-2015-01 replaces aging management program (AMP) XI.M41, "Buried and Underground Piping and Tanks," and the associated Updated Final Safety Analysis Report Summary Description in 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'." These changes provide one acceptable approach for managing the associated aging effects for components within the scope of the License Renewal Rule (Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants"). A licensee may cite LR-ISG-2015-01 in its license renewal application (LRA) until the guidance in this LR-ISG is incorporated into the license renewal guidance documents (i.e., GALL Report, SRP-LR).

DISCUSSION

Based on industry operating experience, and the staff's review of LRAs and plant-specific buried and underground piping and tanks inspection reports, since issuance of AMP XI.M41, the staff has determined that the GALL Report and SRP-LR should be revised to reflect new recommendations associated with AMP XI.M41. LR-ISG-2015-01 includes technical and editorial changes to AMP XI.M41. Based on changes to the extent of inspections of buried piping, the "detection of aging effects" inspection tables have been consolidated, resulting in elimination of duplicate recommendations. In addition, some details have been deleted because they have been deemed not necessary for an understanding of the recommendations for managing aging effects associated with buried and underground piping and tanks.

Given the extensive reorganization of AMP XI.M41, a marked up version has not been provided.

Description of Changes

- **Program Description Changes:** the paragraph referencing the programs used to manage internal surfaces of buried and underground piping was deleted. The first paragraph of the Program Description states that AMP XI.M41 manages aging effects associated with the external surfaces of buried and underground components. The staff concluded that there was no need to direct the user to other AMPs that are used to manage the internal surfaces of the components. The wording "of the external surfaces of," was added to the "scope of program" program element for clarity.
- **Changes in Aging Effects:** the "scope of program" and "parameters monitored or inspected" elements were revised to clarify that the changes in material properties aging effect is only applicable to cementitious materials. GALL Report Revision 2 stated that a change in material properties was associated with polymeric materials. The "parameters monitored or inspected" program element was revised to state that loss of material due to wear can occur in polymeric materials. Loss of material due to wear can occur in polymeric components buried in soil containing deleterious materials (e.g., rocks, debris)

that move over time due to seasonal change effects on the soil. The staff has concluded that for the polymeric materials addressed in the GALL Report (i.e., fiberglass, high-density polyethylene (HDPE), polyvinyl chloride (PVC)), there is reasonable assurance that changes in material properties will not occur as a result of contact with typical soil environments. However, the soil environment, as a result of deleterious materials (e.g., sharp rocks, foreign material that can cause loss of material) and potential groundwater exposure can result in change in material properties of cementitious materials.

- **Upper Limit on Cathodic Protection Criterion:** the maximum negative 1200 millivolt (mV) cathodic protection criterion was relocated from the “acceptance criteria” program element to the “preventive actions” program element. NACE International [formerly the National Association of Corrosion Engineers] SP [Standard Practice] 0169-2007, “Control of External Corrosion on Underground or Submerged Metallic Piping Systems,” states that the use of excessive polarized potentials should be avoided; however, it does not establish a specific upper limit as an acceptance criterion for the performance of cathodic protection systems. The standard specifically states: (a) 6.2.2.3.3, “[t]he use of excessive polarized potentials on externally coated pipelines should be avoided to minimize cathodic disbondment of the coating;” and (b) 6.2.2.3.4, “[p]olarized potentials that result in excessive generation of hydrogen should be avoided on all metals, particularly higher strength steel, certain grades of stainless steel, titanium alloy, aluminum alloys, and prestressed concrete pipe.” Based on these statements, the staff relocated the negative 1200 mV cathodic protection criterion to a recommendation within the “preventive actions” program element. This change allows licensees flexibility in balancing the performance of their cathodic protection systems.
- **Coatings on Underground Components:** the recommended preventive actions for underground steel and copper alloy piping and tanks were changed to recommend that coatings be used. Prior to this change, the recommended preventive actions for coatings on steel and copper alloy piping stated, “when provided, coatings are in accordance with...” As a result of this change, if an applicant’s underground steel or copper alloy piping is not coated, the applicant would state an exception and the basis for the exception. The staff incorporated this change because, based on the review of plant-specific documents during audits, it noted that the typical air conditions in underground vaults have higher moisture content than uncontrolled indoor air conditions in plant spaces within buildings. During walkdowns and review of corrective action documents, the staff noted that loss of material has occurred in the vaults.
- **Fire Water System Leak Rate Tests:** an annual system leak rate test was added to the list of alternatives to preventive actions and to conducting visual examinations of the external surfaces of fire mains installed in accordance with NFPA® [National Fire Protection Association] 24. The staff has concluded that annual system leak rate tests are as effective as annual flow tests (already allowed in AMP XI.M41) to detect degradation of buried fire main piping.
- **Availability of Cathodic Protection:** the term “availability” in relation to cathodic protection was changed to “operated.” The staff concluded that the term “available” may result in licensees concluding that as long as cathodic protection equipment was installed, it is available. However, the intent of the staff was that the cathodic protection system should be providing protection.

- **Manual Manipulation of Polymeric Materials:** the recommendation to augment polymeric material inspections with manual examinations was eliminated. The staff has concluded that flexible polymeric materials are not typically used in buried or underground piping or tank applications, and therefore, manual examinations do not add value.
- **Timing of Additional Inspections:** a provision was added to the “detection of aging effects” program element to address the timing of additional inspections when plant-specific conditions result in transitioning to a higher inspection category during a current 10-year inspection interval. The staff recognizes that the complexity of conducting visual examinations of buried piping requires extensive planning and scheduling. The staff concluded that deferring additional examinations to no later than the end of two refueling cycles in the next interval would not present an unacceptable level of uncertainty regarding the condition of buried piping components.
- **Adverse Indications and Conditions:** the terms, “adverse indications” and “adverse conditions” referring to unacceptable inspection findings were replaced with “coatings, backfill or the condition of exposed piping that does not meet acceptance criteria.” This change ensures that follow-on actions as a result of unacceptable inspection findings are appropriate for the magnitude of the degradation. In addition, this change makes the AMP more consistent with other GALL Report AMPs, which refer to acceptance criteria rather than terms such as “adverse indications” and “adverse conditions.”
- **Sample Size Increase:** the sample size increase previously stated in the “acceptance criteria” program element was revised and moved to the “corrective actions” program element. The change was to set a maximum limit of five additional inspections. The recommendation in LR-ISG-2011-03 was to double the number of inspections from a specific category. The staff recognizes that for some material types, depending on the effectiveness of the preventive actions, the previous sample size increase would result in significantly more inspections. The maximum of five additional inspections is based on the guidance provided in Generic Letter 90-05, “Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping.” The staff has concluded that doubling the number of inspections or conducting five additional inspections, whichever is less, will provide adequate insights to the licensee in regard to the condition of buried components.
- **Use of Electrical Resistance Corrosion Rate Probes and Associated Acceptance Criterion:** a 1 mil/year (mpy) loss of material criterion was added for cathodic protection. As stated in NACE International Publication 05107, “Report on Corrosion Probes in Soil or Concrete,” an average corrosion rate of less than 1 mpy over a 12-month monitoring period is generally accepted as an indication that cathodic protection is effective.

In conjunction with including the 1 mpy acceptance criterion in AMP XI.M41, the staff added recommendations related to the actions that the applicant will take when using this alternative acceptance criterion. These actions include: (a) verifying that the 1 mpy is consistent with plant-specific design documents or that a lower acceptance criterion (e.g., 0.5 mpy) is stated; (b) verifying the external loss of material rate every year by using electrical resistance corrosion rate probes; (c) stating what actions will be taken if the measured external loss of material acceptance criterion is exceeded; (d) specifying

the qualifications of the individuals who will determine the installation locations of the probes and the methods of use (e.g., NACE CP-4, "Cathodic Protection Specialist"); and (e) stating how the impact of significant site features (e.g., large cathodic protection current collectors, shielding due to large objects located in the vicinity of the protected piping) and local soil conditions will be factored into placement of the probes and use of probe data. Based on these new recommendations, there is reasonable assurance that: (a) the cathodic protection system will be protecting the buried steel piping consistent with the plant-specific corrosion rate bases and (b) the design and use of the buried piping coupons will be sufficient to detect actual corrosion rates.

- **Extent of Inspections:** Table 4, "Inspections of Buried Pipe," was significantly revised. During the development of GALL Report Revision 2, the staff became aware of a number of industry operating experience examples where leakage had occurred. As a result the staff developed AMP XI.M41 Table 4, which resulted in recommendations for buried pipe inspections based on the material type, effectiveness of preventive actions (i.e., coatings, backfill, cathodic protection), soil sampling, and plant-specific operating experience. The number of inspections in each 10-year period for plants with effective preventive actions (i.e., one inspection per 10-year period starting 10 years prior to the period of extended operation) was not significantly changed from that of GALL Report Revision 1. The staff established a new tier of inspections (i.e., Inspection Category D) for plants that could demonstrate that cathodic protection was not required based on plant-specific data (i.e., two inspections per 10-year period starting 10 years prior to the period of extended operation). However, for plants where: (a) the preventive actions, particularly cathodic protection, were not effective, (b) cathodic protection was not used; (c) plant-specific operating experience revealed significant buried piping or coating degradation; or (d) soil sampling revealed that the soil is corrosive, new Inspection Categories E and F were developed in GALL Report Revision 2. Therefore, the number of inspections for these two new categories was substantially increased in each 10-year interval in GALL Report Revision 2.

Based on the staff's continuing review of industry operating experience and plant-specific buried piping inspection results, the staff has noted that: (a) there have been no failures of the intended function of buried piping components (i.e., sufficient flow at adequate pressure is delivered); (b) coating degradation, when found, is generally limited in extent; (c) metal loss outside of the immediate vicinity of degraded coatings is minimal; and (d) as a result of the industry's buried pipe initiative, awareness of the importance of cathodic protection and the condition of coatings has greatly improved. As a result, the staff has reduced the number of inspections recommended for buried piping components for inspection categories E and F. The new extent of inspections is loosely based on NEI [Nuclear Energy Institute] 09-14, "Guideline for the Management of Underground Piping and Tank Integrity," Revision 3. Appendix C, "Guidance for Inspection and Condition Assessment of Buried and Underground Piping and Tanks," of this document established a range of one to three inspections per buried pipe grouping. This document credited indirect inspections. The staff has not credited indirect (e.g., guided wave examinations) inspections as an alternative to direct visual inspections of the external surfaces of buried piping. The staff concluded that three inspections (or 5 percent of the piping length) per 10-year interval commencing 10 years prior to the period of extended operation will provide reasonable assurance that the pressure

boundary function of buried steel, copper alloy, or aluminum alloy piping components will be met during the period of extended operation for Inspection Category E. To conduct inspections for Category E, it is permissible that cathodic protection does not meet performance goals; however, the conditions necessary to meet Category E are: coatings have been provided, backfill meets the recommendations in the “preventive actions” program element, plant-specific operating experience meets expectations, and soil sampling demonstrates that the soil is not corrosive. The number of inspections for Category F, if Category E had not been met, is six inspections (or 10 percent of the piping length) per 10-year interval commencing 10 years prior to the period of extended operation. It should be noted that an expansion of sample size is conducted if coatings, backfill, or the exposed piping condition does not meet acceptance criteria.

- **Alternative Cathodic Protection Acceptance Criteria:** the following alternative cathodic protection acceptance criteria were added: (a) negative 750 mV relative to a copper/copper sulfate reference electrode (CSE), instant off where soil resistivity is greater than 10,000 ohm-centimeters (ohm-cm) to less than 100,000 ohm-cm; and (b) negative 650 mV relative to a CSE, instant off where soil resistivity is greater than 100,000 ohm-cm. The staff added the alternative acceptance criteria for higher resistivity soils based on: (a) its inclusion in international standards; (b) the staff’s review of industry papers on the alternative acceptance criteria; and (c) the recommendation to verify the acceptance (e.g., 1 mpy) of the alternative criteria as described in the above discussion associated with adding the 1 mpy loss of material criterion. ISO [International Organization for Standardization] 15589:2003, “Petroleum and Natural Gas Industries -- Cathodic Protection of Pipeline Transportation Systems -- Part 1: On-land Pipelines,” and British Standard, EN 12954:2001, “Cathodic Protection of Buried or Immersed Metallic Structures - General Principles and Application for Pipelines,” allow use of the alternative cathodic protection criteria in higher resistivity soils. NACE Corrosion Expo 2006, Paper No. 06163, “Cathodic Protection of Pipelines in High Resistivity Soils and the Effects of Seasonal Changes,” and NACE Corrosion Expo 2012, Paper No. C2012-001165, “Evaluation of Global Cathodic Protection Criteria – Part 3: Effectiveness of the -100 mV Polarization Criterion and Various Off-Potentials with Higher Resistivity Soils, Elevated Temperatures, and Soils with Bacteria,” support the use of alternative cathodic protection acceptance criteria in higher resistivity soils. Use of the alternative cathodic protection acceptance criteria for higher resistivity soils is verified by the use of electrical resistance corrosion rate probes and an acceptance criterion of 1 mpy, as described above.
- **Selective Leaching Inspections:** the recommendations in AMP XI.M41 related to reductions in the extent of inspections for AMP XI.M33, “Selective Leaching,” have been moved to AMP XI.M33 with no technical changes.
- **Operating Experience:** industry operating experience examples were updated.

ACTIONS

Applicants should use Appendices A through C in preparing their LRAs to be consistent with the GALL Report and this LR-ISG.

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

The NRC is not proposing to treat the revised recommendations for managing aging effects associated with buried and underground piping and tanks as “newly identified” SSCs under 10 CFR 54.37(b). Therefore, any additional action for such SSCs, which the NRC may impose upon current holders of renewed operating licenses under 10 CFR Part 54, would not fall within the scope of 10 CFR 54.37(b). The NRC would address compliance with the requirements of 10 CFR 50.109, “Backfitting,” before imposing any new aging management requirements on current holders of renewed operating licenses (see discussion below).

BACKFITTING AND ISSUE FINALITY

This draft LR-ISG contains guidance on one acceptable approach for managing the associated aging effects occurring during the period of extended operation for buried and underground piping and tanks. The staff intends to use the guidance in this draft LR-ISG, if finalized, when reviewing current and future license renewal applications. The staff also intends to use the LR-ISG in evaluating voluntary, licensee-initiated changes to previously-approved aging management programs. Existing holders of renewed operating licenses may follow the guidance in this LR-ISG, but would not be required to do so.

Backfitting

Issuance of this LR-ISG in final form would not constitute backfitting as defined in the Backfit Rule for nuclear power plants, 10 CFR 50.109(a)(1), and the NRC staff did not prepare a backfit analysis for issuing this LR-ISG. There are several rationales for this conclusion, depending on the status of the nuclear power plant licensee under 10 CFR Parts 50 and 54.

Licensees currently in the license renewal process - The backfitting provisions in 10 CFR 50.109 are not applicable to an applicant for a renewed license. Therefore, issuance of this LR-ISG in final form would not constitute backfitting as defined in 10 CFR 50.109(a)(1).

Licensees that already hold a renewed license - This guidance would be nonbinding and the LR-ISG would not require current holders of renewed licenses to take any action (i.e., programmatic or plant hardware changes for managing the associated aging effects for components within the scope of this LR-ISG). If the draft LR-ISG is finalized as written, then current holders of renewed licenses could treat the information presented in this LR-ISG as “operating experience” information and consider to this information to ensure that relevant AMPs are, and will remain, effective. If, in the future, the NRC decides to take additional action and impose requirements for managing the associated aging effects for components within the scope of this LR-ISG, then the NRC would follow the requirements of the Backfit Rule.

Current 10 CFR Part 50 operating license holders that have not yet applied for renewed licenses - The backfitting provisions in 10 CFR 50.109 do not apply to any future applicant for license renewal. Therefore, issuance of this LR-ISG would not constitute backfitting as defined in 10 CFR 50.109(a)(1).

Issue Finality under 10 CFR Part 52

Issuance of this LR-ISG in final form would not be inconsistent with the issue finality provision applicable to standard design certifications, 10 CFR 52.63, or the specific issue finality

provisions in each of the approved design certification rules within the appendices of 10 CFR Part 52. The design certification information for the rules in 10 CFR Part 72 does not address compliance with the license renewal requirements in 10 CFR Part 54. Therefore, the issue finality provisions applicable to these design certifications do not extend to the nuclear safety issues of license renewal, and the NRC need not address these issue finality provisions when issuing this LR-ISG.

Issuance of this LR-ISG would not be inconsistent with the issue finality provision, 10 CFR 52.98, which is applicable to the current combined licenses issued under 10 CFR Part 52. The NRC's issuance of those combined licenses was not based upon any consideration of compliance with the license renewal requirements in 10 CFR Part 54. Furthermore, the issue finality provisions of 10 CFR Part 52 do not extend to the aging management matters covered by 10 CFR Part 54, as evidenced by the requirement in 10 CFR 52.107, "Application for Renewal," stating that applications for renewal of a combined license must be in accordance with 10 CFR Part 54. Therefore, the issue finality provisions applicable to the current holders of combined licenses do not extend to the subject of license renewal, and the NRC need not address § 52.98 when issuing this LR-ISG.

Currently no holders of combined licenses are seeking license renewal under 10 CFR Part 54, and the issue finality provisions in 10 CFR Part 52 are not applicable to future applicants seeking a renewed license. Therefore, the changes and new positions presented in the LR-ISG may be made without consideration of the issue finality provisions in 10 CFR Part 52.

CONGRESSIONAL REVIEW ACT

This LR-ISG is a rule as defined in the Congressional Review Act (5 U.S.C. §§ 801-808). However, the Office of Management and Budget has not found it to be a major rule as defined in the Congressional Review Act.

APPENDICES

Appendix A, SRP-LR Table 3.0-1, FSAR Supplement for AMP XI.M41

Appendix B, Revised AMP XI.M41, Buried and Underground Piping and Tanks

Appendix C, Changes to GALL Report AMP XI.M33, Selective Leaching, to the Detection of Aging Effects Program Element

REFERENCES

5 U.S.C. § 801, Congressional Review of Agency Rulemaking, Office of the Law Revision Counsel of the House of Representatives, 2012.

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

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

British Standard EN 12954:2001, Cathodic Protection of Buried or Immersed Metallic Structures - General Principles and Application for Pipelines.

International Organization for Standardization, ISO 15589:2003, Petroleum and Natural Gas Industries -- Cathodic Protection of Pipeline Transportation Systems -- Part 1: On-land Pipelines.

NACE, NACE International Publication 05107, Report on Corrosion Probes in Soil or Concrete.

NACE, NACE Corrosion Expo 2006, Paper No. 06163, Cathodic Protection of Pipelines in High Resistivity Soils and the Effects of Seasonal Changes.

NACE, NACE Corrosion Expo 2012, Paper No. C2012-001165, Evaluation of Global Cathodic Protection Criteria – Part 3: Effectiveness of the -100 mV Polarization Criterion and Various Off-Potentials with Higher Resistivity Soils, Elevated Temperatures, and Soils with Bacteria.

Nuclear Energy Institute, NEI 09-14, "Guideline for the Management of Underground Piping and Tank Integrity," Revision 3.

U.S. Nuclear Regulatory Commission. Generic Letter 90-05, Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping.

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

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

APPENDIX A

SRP-LR TABLE 3.0-1, FSAR SUPPLEMENT for AMP XI.M41

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	<p>The Buried and Underground Piping and Tanks program is a condition monitoring program that manages the aging effects associated with the external surfaces of buried and underground piping and tanks such as loss of material, cracking and changes in material properties (for cementitious piping). It addresses piping and tanks composed of any material, including metallic, polymeric, and cementitious materials. The program also manages aging through preventive and mitigative actions, (i.e., coatings, backfill quality, and cathodic protection). The number of inspections is based on the effectiveness of the preventive and mitigative actions. Annual cathodic protection surveys are conducted. Where the acceptance criteria for the effectiveness of the cathodic protection is other than -850 mV instant off, actual loss of material rates are measured from in-situ coupons. Inspections are conducted by qualified individuals. Where the coatings, backfill or the condition of exposed piping does not meet acceptance criteria, an increase in the sample size is conducted. If a reduction in the number of inspections recommended in GALL Report AMP XI.M41 Table 4 is claimed based on a lack of soil corrosivity as determined by soil testing, then soil testing is conducted once in each 10-year period starting 10 years prior to the period of extended operation.</p>	Program should be implemented before the period of extended operation	<p>GALL V / SRP 3.2 GALL VII / SRP 3.3 GALL VIII / SRP 3.4</p>

APPENDIX B

REVISED AMP XI.M41, BURIED AND UNDERGROUND PIPING AND TANKS

Program Description

This aging management program (AMP) manages 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, and cementitious materials. This program manages aging through preventive, mitigative, inspection, and in some cases, performance monitoring activities. It manages applicable aging effects such as loss of material, cracking, and changes in material properties (for cementitious piping only).

Depending on the material, preventive and mitigative techniques may include external coatings, cathodic protection, and the quality of backfill. 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, hydro testing of the pipe, performance monitoring of fire mains, and visual inspections of the pipe or tank from the exterior.

This program does not provide aging management of selective leaching. The Selective Leaching of Materials program (AMP XI.M33) is applied in addition to this program for applicable materials and environments.

Evaluation and Technical Basis

- 1. Scope of Program:** This program manages the effects of aging of the external surfaces of buried and underground piping and tanks constructed of any material including metallic, polymeric, and cementitious materials. The term “polymeric” material refers to plastics, or other polymers that comprise the structural element of the component. The program addresses aging effects such as loss of material, cracking, and changes in material properties (for cementitious piping only). 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. There are no recommended preventive actions for titanium alloy, super austenitic stainless steels, and nickel alloy materials. Preventive actions for buried and underground piping and tanks are conducted in accordance with Table 2 and the following:

Table 2. Preventive Actions for Buried and Underground Piping and Tanks		
C: Coatings; CP: Cathodic Protection; B: Backfill		
Material	Buried	Underground
Stainless Steel	C, B	None
Steel	C, CP, B	C
Copper alloy	C, CP, B	C
Aluminum alloy	C, CP, B	None
Cementitious	C, B	None

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Table 2. Preventive Actions for Buried and Underground Piping and Tanks		
C: Coatings; CP: Cathodic Protection; B: Backfill		
Material	Buried	Underground
Polymer	B	None

- a. For buried stainless steel or cementitious piping or tanks, coatings are provided based on the environmental conditions (e.g., stainless steel in chloride containing environments). Applicants provide justification when coatings are not provided. Coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002.
- b. For buried steel, copper alloy, and aluminum alloy piping and tanks, and underground steel and copper alloy piping and tanks, coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002.
- c. Cathodic protection is in accordance with NACE SP0169-2007 or NACE RP0285-2002. The system is 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. To prevent damage to the coating, the limiting critical potential should not be more negative than -1200 mV.
- d. 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 (size number 10 for polymeric materials) to meet the objectives of NACE SP0169-2007 and NACE RP0285-2002. For stainless steel and cementitious materials, backfill limits apply only if the component is coated. For materials other than aluminum alloy, the staff also considers the use of controlled low strength materials (flowable backfill) acceptable to meet the objectives of SP0169-2007.
- e. **Alternatives to the preventive actions in Table 2 are as follows:**
 - i. A broader range of coatings may be used if justification is provided in the LRA.
 - ii. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections described in the “detection of aging effects” program element of this AMP.
 - iii. For fire mains installed in accordance with National Fire Protection Association (NFPA) NFPA® 24, preventive actions beyond those in NFPA® 24 need not be provided if: (a) the system undergoes either a periodic flow test in accordance with NFPA® 25; (b) the activity of the jockey pump (e.g., number of pump starts, run time) is monitored as described in “detection of aging effects” program element of this AMP; or (c) an annual system leakage rate test is conducted.
 - iv. Failure to provide cathodic protection in accordance with Table 2 may be acceptable if justified in the LRA. The justification addresses soil sample locations, soil sample results, the methodology and results of how the overall soil corrosivity was determined, pipe to soil potential measurements and other relevant parameters. Inspections in excess of those recommended in the “detection of aging effects”

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program element of this AMP may be necessary based on plant-specific operating experience.

If cathodic protection is not provided for any reason, the applicant reviews the most recent 10 years of plant specific operating experience to determine if degraded conditions that would not have met the acceptance criteria of this AMP have occurred at the station. This search includes components that are not in-scope for license renewal if, when compared to in-scope piping, they are similar materials and coating systems and buried in a similar soil environment. The results of this expanded plant specific operating experience search are included in the LRA.

3. Parameters Monitored or Inspected:

- a. Visual inspections of buried or underground piping or tanks, or their coatings, are performed to monitor for:
 - i. loss of material due to general, pitting, crevice, and microbiological-induced corrosion for aluminum alloy, copper alloy, steel, stainless steel, super austenitic, and titanium alloy components;
 - ii. cracking due to stress corrosion cracking for stainless steel and susceptible aluminum alloy materials;
 - iii. loss of material due to wear for polymeric materials;
 - iv. cracking, spalling, and corrosion or exposure of rebar for asbestos cement pipe, and concrete pipe;
 - v. cracking, blistering, change in color due to water absorption for high-density polyethylene (HDPE) and fiberglass components; and
 - vi. cracking due to aggressive chemical attack and leaching; changes in material properties due to aggressive chemical attack for reinforced concrete and asbestos cement piping.
- b. Ultrasonic testing (UT) may be performed to monitor wall thickness. Pit depth gages, calipers or other techniques qualified for measuring wall thickness may also be used.
- c. Inspections for cracking utilize a method that has been demonstrated to be capable of detecting cracking. Intact coatings do not have to be removed to inspect for potential cracking.
- d. Pipe-to-soil potential and the cathodic protection current are monitored for steel, copper alloy, and aluminum alloy piping and tanks in contact with soil to determine the effectiveness of cathodic protection systems.

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. Inspections of buried and underground piping and tanks are conducted in accordance with Table 4 and the following. There are no inspection recommendations for titanium alloy, super austenitic, or nickel alloy materials. Table 4 inspection quantities are for a single unit plant. For two-unit sites, the inspection quantities (i.e., not the percentage of pipe length) are increased by 50 percent. For a three-unit site, the inspection quantities are doubled. For multi-unit sites the inspections are distributed evenly among the units. Modifications to Table 4 may be appropriate if exceptions are taken to program element 2, "preventive actions," or in response to plant-specific operating experience.

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Inspections of buried and underground piping and tanks are conducted during each 10-year period, commencing 10 years prior to the period of extended operation. Piping inspections are typically conducted by visual examination of the external surfaces of pipe or coatings. Tank inspections are conducted externally by visual examination of the surfaces of the tank or coating or internally by volumetric methods. Opportunistic inspections are conducted for in-scope piping whenever they become accessible. Visual inspections are supplemented with surface and/or volumetric non-destructive testing if evidence of wall loss beyond minor surface scale is observed.

Table 4. Inspection of Buried and Underground Piping and Tanks		
Inspections of Buried Piping		
Material	Preventive Action Categories	Inspection See section 4.c. for extent of inspections
Stainless Steel		1 inspection
Polymeric	Backfill is in accordance with preventive actions program element	1 inspection
	Backfill is not in accordance with preventive actions program element	The smaller of 1% of the length of pipe or 2 inspections
Cementitious		1 inspection
Steel	C	The smaller of 0.5% of the piping length or 1 inspection
	D	The smaller of 1% of the piping length or 2 inspections
	E	The smaller of 5% of the piping length or 3 inspections
	F	The smaller of 10% of the piping length or 6 inspections

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Table 4. Inspection of Buried and Underground Piping and Tanks			
Inspections of Buried Piping			
Copper alloy	C	The smaller of 0.5% of the piping length or 1 inspection	
	D	The smaller of 1% of the piping length or 2 inspections	
	E	The smaller of 5% of the piping length or 3 inspections	
	F	The smaller of 10% of the piping length or 6 inspections	
Aluminum alloy	C	The smaller of 0.5% of the piping length or 1 inspection	
	D	The smaller of 1% of the piping length or 2 inspections	
	E	The smaller of 5% of the piping length or 3 inspections	
	F	The smaller of 10% of the piping length or 6 inspections	
Inspections of Buried Tanks and Underground Piping and Tanks			
Material	Buried Tanks	Underground Piping	Underground Tanks
Stainless Steel	All tanks	1 inspection	All tanks
Polymeric	All tanks	1 inspection	None
Cementitious	All tanks	1 inspection	None
Steel	All tanks	The smaller of 2% of the piping length or 2 inspections	All tanks

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Table 4. Inspection of Buried and Underground Piping and Tanks			
Copper alloy or Aluminum alloy	All tanks	The smaller of 1% of the length of piping or 1 inspection	All tanks
<p align="center">The Preventive Action Categories are used as follows:</p> <p>C: Category C applies when:</p> <ul style="list-style-type: none"> a. Cathodic protection was installed or refurbished 5 years prior to the end of the inspection period of interest; and b. Cathodic protection has operated 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 non-operating hours; and c. Cathodic protection has provided effective protection for buried piping as evidenced by meeting the acceptance criteria of Table 6 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. <p>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 e.iv. of the "preventive actions" program element of this AMP, that external corrosion control is not required.</p> <p>E: Inspection criteria provided for Category E piping may be used for those portions of the plant's population of buried piping where:</p> <ul style="list-style-type: none"> a. An analysis, conducted in accordance with the "preventive actions" program element of this AMP, has demonstrated that installation or operation of a cathodic protection system is impractical; or b. 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: <ul style="list-style-type: none"> i. Coatings and backfill are provided in accordance with the "preventive actions" program element of this AMP; and ii. 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 iii. Soil has been demonstrated to be not corrosive for the material type. In order to demonstrate that the soil is not corrosive, the applicant: <ul style="list-style-type: none"> 1) Obtains 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. 			

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Table 4. Inspection of Buried and Underground Piping and Tanks

The Preventive Action Categories are used as follows, continued:

- 2) Tests the soil for soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, sulfates, and redox potential.
- 3) Determines the potential soil corrosivity for each material type of buried in-scope piping. In addition to evaluating each individual parameter, the overall soil corrosivity is determined.
- 4) Conducts soil testing prior to submitting the application and once in each 10-year period starting 10 years prior to the period of extended operation.
- 5) Provides a summary of the results and conclusions of the soil testing in the LRA.

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

- a. **Transitioning to a Higher Number of Inspections:** Plant-specific conditions can result in transitioning to a higher number of inspections than originally planned at the beginning of a 10-year interval. For example, degraded performance of the cathodic protections system could result in transitioning from Preventive Action Category C to Preventive Action Category E. Coating, backfill, or the condition of exposed piping that do not meet acceptance criteria could result in transitioning from Preventive Action Category E to Preventive Action Category F. If this transition occurs in the latter half of the current 10-year interval, the timing of the additional examinations is based on the severity of the degradation identified and is commensurate with the consequences of a leak or loss of function, but in all cases, the examinations are completed within 4 years after the end of the particular 10-year interval. These additional inspections conducted in an inspection interval cannot be credited towards the number of inspections stated in Table 4 for the 10-year interval.
- b. **Exceptions to Table 4 inspection quantities:**
 - i. Where piping constructed of steel, copper alloy, or aluminum alloy has been coated with the same coating system and the backfill has the same requirements, the total inspections for this piping may be combined to satisfy the recommended inspection quantity. For example, for Preventive Action Category F, 10 percent of the total of the associated steel, copper alloy, or aluminum alloy is inspected; or 6 10-foot segments of steel, copper alloy, or aluminum alloy piping is inspected.
 - ii. For buried piping, inspections may be reduced to one-half the number of inspections indicated in Table 4 when performance of the indicated inspections necessitates excavation of piping that has been fully backfilled using controlled low strength material. The inspection quantity is rounded up. 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 includes 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

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- inspection of backfill based on the number of inspections designated for that material type, 10 linear feet of the backfill is exposed for each inspection.
- iii. When Preventive Action Category A or C is met for all materials except for aluminum alloys, no inspections are necessary if all the piping constructed from a specific material type is fully backfilled using controlled low strength material.
 - iv. If all of the in-scope polymeric material is nonsafety-related, the inspection quantities for Preventive Action Category B may be reduced by half.
 - v. Buried polymeric tanks are only inspected if backfill is not in accordance with the preventive actions.
 - vi. Stainless steel tanks are inspected when they are not coated and the underground environment is potentially exposed to in-leakage of groundwater or rain water.
 - vii. Steel, copper alloy, and aluminum alloy buried tanks are not inspected if the cathodic protection provided for the tank met the criteria for Preventive Action Category C.
- c. **Guidance related to the extent of inspections for piping is as follows:**
- i. When the inspections are based on the number of inspections in lieu of percentage of piping length, 10 feet of piping is exposed for each inspection.
 - ii. When the percentage of inspections for a given material type results in an inspection quantity of less than 10 feet, then 10 feet of piping is 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 is inspected.
 - iii. If fire protection piping is inspected by excavations in lieu of alternative testing (e.g., flow test, jockey pump monitoring, leak rate testing) and the extent of inspections is not based on the percentage of piping in the material group, then two additional inspections are added to the inspection quantity for that material type.
- d. **Piping inspection location selection:** Piping inspection locations are selected based on risk (i.e., 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. For many piping systems, External Corrosion Direct Assessment (ECDA), as described in NACE SP0502-2010, "Pipeline External Corrosion Direct Assessment Methodology," has been effective in identifying pipe locations that merit further inspection. Opportunistic examinations of non-leaking pipes may be credited toward examinations if the location selection criteria are met. The use of guided wave ultrasonic or other advanced inspection techniques is encouraged for the purpose of determining the piping locations that will be inspected. These methods may not be substituted for the inspections listed in the table.
- e. **Alternatives to visual examination of piping are as follows:**
- i. Fire mains are inspected in accordance with Table 4, unless they are either: (a) subjected to 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; (b) the activity of the jockey pump (e.g., pump starts, run time) is monitored on an interval not to exceed one month; or (c) an annual system leak rate test is conducted.

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- ii. At least 25 percent of the in-scope piping constructed from the material under consideration is hydrostatically tested on an interval not to exceed five years. The piping is pressurized to 110 percent of the design pressure of any component within the boundary with test pressure being held for eight hours.
 - iii. 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 has been demonstrated to be capable of detecting both general and pitting corrosion and is qualified by the applicant. UT examinations, in general, satisfy this criterion. As of the effective date of this document, guided wave ultrasonic examinations do not meet the intent of this paragraph. If internal inspections are to be conducted in lieu of direct visual examination, they are conducted at an interval not to exceed 10 years.
 - f. **Guidance related to the extent of inspections for tanks is as follows.** Examinations are conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. A minimum of 25 percent coverage is obtained. This area includes at least some of both the top and bottom of the tank. If the tank is inspected internally by volumetric methods, the method is: capable of determining tank wall thickness, demonstrated to be capable of detecting both general and pitting corrosion, and qualified by the applicant. Double wall tanks may be examined by monitoring the annular space for leakage.
- 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 a 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. Likewise, if leak rate testing is conducted, leak rates are trended. Where wall thickness measurements are conducted, the results are trended when follow up examinations are conducted.
- 6. *Acceptance Criteria:*** The acceptance criteria associated with this AMP are:
- a. For coated piping or tanks, there is either no evidence of coating degradation, or the type and extent of coating degradation is evaluated as insignificant by an individual possessing a NACE Coating Inspector Program Level 2 or 3 inspector qualification, or an individual who 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.
 - b. Cracking, blistering, gouges, or wear of nonmetallic piping is evaluated.
 - c. Cementitious piping may exhibit minor cracking and spalling provided there is no evidence of leakage, exposed rebar, or reinforcing “hoop” bands.
 - d. Backfill is acceptable if the inspections do not reveal evidence that the backfill caused damage to the component’s coatings or the surface of the component (if not coated).
 - e. Flow test results for fire mains are in accordance with NFPA® 25, Section 7.3.
 - f. For hydrostatic tests, the test acceptance criteria are that there are 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 by quantified leakage across test boundary valves.

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- g. Changes in jockey pump activity (or similar parameter) that cannot be attributed to causes other than leakage from buried piping, are not occurring.
- h. When fire water system leak rate testing is conducted, leak rates are within acceptance limits of plant-specific documents.
- i. Criteria for soil-to-pipe potential when using a saturated CSE reference electrode are as stated in Table 6, or acceptable alternatives as stated below.

Table 6. Cathodic Protection Acceptance Criteria	
Material	Criteria^{1,2}
Steel	-850 mV relative to a CSE, instant off
Copper alloy	100 mV minimum polarization
Aluminum alloy	100 mV minimum polarization
<p>¹ Plants with sacrificial anode systems state the test method and acceptance criteria and the basis for the method and criteria in the application.</p> <p>² Where an impressed current cathodic protection system is utilized with pre-stressed concrete pipe, steps are 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 are avoided to prevent hydrogen generation and possible hydrogen embrittlement of the high-strength prestressing wire.</p>	

- k. **Alternatives to the -850 mV criterion for steel piping in Table 6 are as follows.**
 - i. 100 mV minimum polarization
 - ii. -750 mV relative to a CSE, instant off where soil resistivity is greater than 10,000 ohm-cm to less than 100,000 ohm-cm
 - iii. -650 mV relative to a CSE, instant off where soil resistivity is greater than 100,000 ohm-cm
 - iv. Verify less than 1 mil/year (mpy) loss of material

When using the 100 mV, -750 mV, or -650 mV polarization criteria as an alternative to the -850 mV criterion for steel piping, means to verify the effectiveness of the protection of the most anodic metal is incorporated into the program. One acceptable means to verify the effectiveness of the cathodic protection system, or to demonstrate that the corrosion rate is less than 1 mpy, is to use installed electrical resistance corrosion rate probes.

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The acceptance criterion (for external loss of material) to demonstrate that a cathodic protection system is operating in a satisfactory manner is 1 mpy or less. This 1 mpy criterion is related to the performance of the cathodic protection system and has no relationship to available corrosion allowances or to the remaining operational life of the piping system under consideration. Applicants separately evaluate whether a 1 mpy corrosion rate is acceptable from the perspective of the intended function (e.g., pressure boundary) of the piping under consideration. The external loss of material rate is verified:

- Every year when verifying less than 1 mpy loss of material.
- Every 2 years when using the 100 mV minimum polarization.
- Every 5 years when using the -750 or -650 criteria associated with higher resistivity soils. The soil resistivity is verified every 5 years.

If electrical resistance corrosion rate probes will be used, the application states:

- The qualifications of the individuals that will determine the installation locations of the probes and the methods of use (e.g., NACE CP-4, "Cathodic Protection Specialist").
- How the impact of significant site features (e.g., large cathodic protection current collectors, shielding due to large objects located in the vicinity of the protected piping) and local soil conditions will be factored into placement of the probes and use of probe data.

- 7. Corrective Actions:** Results that do not meet the acceptance criteria are addressed as conditions adverse to quality or significant conditions adverse to quality under those specific portions of the quality assurance (QA) program that are used to meet Criterion XVI, "Corrective Action," of 10 CFR Part 50, Appendix B. Appendix A of the GALL-SLR Report describes how an applicant may apply its 10 CFR Part 50, Appendix B, QA program to fulfill the corrective actions element of this AMP for both safety-related and nonsafety-related structures and components within the scope of this program.
- a. Where damage to the coating has been evaluated as significant and the damage was caused by non-conforming backfill, an extent of condition evaluation is conducted to ensure that the as-left condition of backfill in the vicinity of the observed damage will not lead to further degradation.
 - b. 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. If the wall thickness meets minimum wall thickness requirements, recommendations for expansion of sample size (see 7.c.) do not apply.
 - c. Where the coatings, backfill, or the condition of exposed piping does not meet acceptance criteria, the degraded condition is repaired or the affected component is replaced. In addition, an expansion of sample size is conducted. The number of inspections within the affected piping categories are doubled or increased by 5, whichever is smaller. If the acceptance criteria are not met in any of the expanded samples, an analysis is conducted to determine the extent of condition and extent of cause. The number of the follow-on inspections is determined based on the extent of condition and extent of cause.

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The timing of the additional examinations is based on the severity of the degradation identified and is commensurate with the consequences of a leak or loss of function. However, in all cases, the expanded sample inspection is completed within the 10-year interval in which the original inspection was conducted or, if identified in the latter half of the current 10-year interval, within 4 years after the end of the 10-year interval. The number of inspections may be limited by the extent of piping or tanks subject to the observed degradation mechanism.

The expansion of sample inspections may be halted in a piping system or portion of system that will be replaced within the 10-year interval in which the inspections were conducted or, if identified in the latter half of the current 10-year interval, within 4 years after the end of the 10-year interval.

- d. Unacceptable cathodic protection survey results are entered into the plant corrective action program.
 - e. Sources of leakage detected during pressure tests are identified and corrected.
 - f. When using the alternatives to the -850 mV relative to a CSE instant off acceptance criterion for the cathodic protection system, the application states what actions will be taken if the measured external loss of material acceptance criterion, or internal loss of material rates (if opportunistic inspections are conducted by other AMPs) is exceeded.
 - g. When using the option of monitoring the activity of a jockey pump instead of inspecting buried fire water system piping (see 4.d.i.), a flow test or system leak rate 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.
- 8. Confirmation Process:** The confirmation process is addressed through those specific portions of the QA program that are used to meet Criterion XVI, "Corrective Action," of 10 CFR Part 50, Appendix B. Appendix A of the GALL-SLR Report describes how an applicant may apply its 10 CFR Part 50, Appendix B, QA program to fulfill the confirmation process element of this AMP for both safety-related and nonsafety-related structures and components within the scope of this program.
- 9. Administrative Controls:** Administrative controls are addressed through the QA program that is used to meet the requirements of 10 CFR Part 50, Appendix B, associated with managing the effects of aging. Appendix A of the GALL-SLR Report describes how an applicant may apply its 10 CFR Part 50, Appendix B, QA program to fulfill the administrative controls element of this AMP for both safety-related and nonsafety-related structures and components within the scope of this program.
- 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 AMP accordingly. The following examples of industry experience may be of significance to an applicant's program:

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- In August 2009, a leak was discovered in a portion of buried aluminum alloy pipe where it passed through a concrete wall. The piping is in 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 alloy pipe and the steel supports. (ADAMS Accession Number ML093160004).
- 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. (ADAMS Accession Number ML093160004).
- In April 2010, while performing inspections as part of its buried pipe program, a licensee discovered that major portions of their auxiliary feedwater piping were substantially degraded. The licensee's cause determination attributes the cause of the corrosion to the failure to properly coat the piping "as specified" during original construction. The affected piping was replaced during the next refueling outage. (ADAMS Accession Number ML103000405).
- In November 2013, minor weepage was noted in a 10-inch service water supply line to the emergency diesel generators while performing a modification to a main transformer moat. Coating degradation was noted at approximately ten locations along the exposed piping. The leaking and unacceptable portions of the degraded pipe were clamped and recoated until a permanent replacement could be installed. (ADAMS Accession Number ML13329A422).

The program is informed and enhanced when necessary through the systematic and ongoing review of both plant-specific and industry operating experience, as discussed in Appendix B of the GALL Report.

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

NFPA® 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*, November 15, 2003.

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

APPENDIX C

CHANGES to GALL REPORT AMP XI.M33, "SELECTIVE LEACHING," CHANGES to the DETECTION OF AGING EFFECTS PROGRAM ELEMENT

The following recommendations are added to the "detection of aging effects" program element of AMP XI.M33.

For buried components susceptible to selective leaching, dependent on plant-specific operating experience and implementation of preventive actions of AMP XI.M41, the number of one-time selective leaching inspections for the external surfaces of buried components which are susceptible to selective leaching may be adjusted as follows:

No selective leaching inspections are required of the external surface of gray cast iron buried components which meet the following conditions: (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" program element of AMP XI.M41. 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.

No selective leaching inspections are required of the external surface of buried components which are coated in accordance with Table 2, and where 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.