LICENSE RENEWAL INTERIM STAFF GUIDANCE

LR-ISG-2015-01

CHANGES TO BURIED AND UNDERGROUND PIPING AND TANK RECOMMENDATIONS

INTRODUCTION

This 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 2010), 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'." In addition, recommendations contained within AMP XI.M41 related to reductions in the extent of inspections to manage selective leaching in buried components were relocated to AMP XI.M33, "Selective Leaching." 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.

<u>Description of Major Changes</u>

- **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 (cement-based substance) 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) can cause loss of material and potential groundwater exposure can result in change in material properties of cementitious materials.

- **Upper Limits 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) Section 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) Section 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 cylinder pipe.” Based on these statements, the staff relocated the negative 1200 mV cathodic protection criterion to a recommendation within the “preventive actions” program element. Likewise, the recommended upper polarization potentials of no more negative than negative 1,000 mV relative to a copper/copper sulfate reference electrode (CSE) for cementitious containing high-strength prestressing wire was relocated. It is the staff’s intent that if an applicant chooses to use an alternative limit, the applicant would state an exception and a basis for the alternative value. This approach is the same for any of the other recommendations in the “preventive action” program element. However, if a survey data point is more negative than the upper negative limit during periodic cathodic protection surveys, the data point would no longer be considered as failing cathodic protection acceptance criteria (i.e., those recommended in the “acceptance criteria” program element). The exceedance of the upper limit would be addressed in the licensee’s corrective action or preventive maintenance program. This change allows licensees flexibility in balancing the performance of its cathodic protection systems.

  The staff also added a recommendation related to the potential for stress corrosion cracking of steel and stainless steel components. Because this cracking is dependent on plant-specific characteristics (e.g., the cathodic protection polarization level, temperature, pH), the staff did not incorporate specific recommendations. If these conditions are applicable, the applicant describes the conditions and alternative cathodic protection levels in the LRA.

- **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 technical basis for the acceptability of the exception (e.g., demonstrate that the condition should not require additional inspections or other actions). 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 its review of corrective action documents, the staff noted that loss of material has occurred in the vaults.
- **Parameters Monitored or Inspected**: based on public comment, the staff added descriptive detail to this program element.
- **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 pressure boundary applications, and therefore, manual examinations do not add value.
- **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.
- **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. Two changes were incorporated.

  The first 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.

  Based on its review of an extensive number of buried pipe inspection results, the staff also recognizes that there are instances where minor coating or base material damage is noted. However, the depth or extent of the damage to the base material would not warrant an increase in the sample size. The intended function of typical buried piping and tanks is to ensure that sufficient flow at adequate pressure can be delivered to downstream in-scope components. This function could be met even though leakage is occurring. The staff revised the sample size increase recommendation to those instances where degradation in base material (extrapolated to the end of the period of extended operation), regardless of cause, results in a potential challenge to the pressure boundary.

- **Extent of Inspections**: Table XI.M41-2 (previously Table 4a), “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 XI.M41-2, 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 CSE instant off where soil resistivity is greater than 10,000 ohm-centimeters (ohm-cm) to less than 100,000 ohm-cm; (b) negative 650 mV relative to a CSE, instant off where soil resistivity is greater than 100,000 ohm-cm, and (c) verifying less than 1 mil per year (mpy) loss of material.

  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 acceptability (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.

The staff added the loss of material rate based on NACE International Publication 05107, "Report on Corrosion Probes in Soil or Concrete," which states that 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. Based on public comments, the staff expanded the 1 mpy criterion to allow higher loss of material rates in instances where the higher rate would not result in a loss of intended function prior to the end of the period of extended operation. The staff concluded that loss of material rates that exceed 1 mpy are acceptable when plant-specific configurations (e.g., thicker wall pipe) enable a demonstration that adequate wall thickness will be maintained throughout the period of extended operation.

- **Use of Electrical Resistance Corrosion Rate Probes and Associated Acceptance Criterion**: When alternative cathodic protection criteria are used, the AMP incorporates verification of the effectiveness of the protection of the most anodic metal. An acceptable method for this verification is to measure that external loss of material rate using electrical resistance corrosion rate probes to measure that external loss of material rate. When using electrical resistance probes, the applicant states (a) the qualifications of the individuals who will determine the installation locations of the probes and the methods of use (e.g., NACE CP4, "Cathodic Protection Specialist"); and (b) 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. The AMP confirms the external loss of material rate on a specified periodicity.
- **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. See Appendix C.
- **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” systems, structures, components (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 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 LR-ISG 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 AMPs. 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 does 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 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). Current holders of renewed licenses could treat the information presented in this LR-ISG as “operating experience” information and consider 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 is not 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 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, 2015.

10 CFR Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, 2015.

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

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	This 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. For steel components, where the acceptance criteria for the effectiveness of the cathodic protection is other than -850 mV instant off, loss of material rates are measured. Inspections are conducted by qualified individuals. Where the coatings, backfill or the condition of exposed piping does not meet acceptance criteria such that the depth or extent of degradation of the base metal could have resulted in a loss of pressure boundary function when the loss of material rate is extrapolated to the end of the period of extended operation, an increase in the sample size is conducted. If a reduction in the number of inspections recommended in GALL Report, AMP XI.M41, Table XI.M41-2 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.	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 B

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

Program Description

The program 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, nondestructive evaluation of pipe or tank wall thicknesses, pressure 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 pressure boundary 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. 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.

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 XI.M41-1 and the following:

Table XI.M41-1. 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

APPENDIX B

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

Table XI.M41-1. Preventive Actions for Buried and Underground Piping and Tanks C: Coatings; CP: Cathodic Protection; B: Backfill		
Material	**Buried**	**Underground**
Cementitious	C, CP, B	None
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 as well as the following coating types: asphalt/coal tar enamel, concrete, elastomeric polychloroprene, mastic (asphaltic), epoxy polyethylene, polypropylene, polyurethane, and zinc.

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 for which cathodic protection is credited. 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.

d. Cathodic protection is supplied for reinforced concrete pipe and prestressed concrete cylinder pipe. Applicants provide justification when cathodic protection is not provided.

e. Critical potentials for cathodic protection:

   i. To prevent damage to the coating or base metal (e.g., aluminum), the limiting critical potential should not be more negative than -1200 mV.

   ii. Where an impressed current cathodic protection system is utilized with prestressed concrete cylinder 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.

   iii. Depending on the environment, steel and stainless steel components can experience stress corrosion cracking dependent on the cathodic protection polarization level, temperature, pH, etc. If these conditions are applicable, the applicant describes the conditions and alternative cathodic protection levels in the LRA.

   iv. Any further over-protection limits are defined by the applicant and managed during surveillance activities. The use of excessive polarized potentials on externally coated pipelines should be avoided.

f. 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.

g. **Alternatives to the preventive actions in Table XI.M41-1 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 XI.M41-1 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.

   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. 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 are 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: (a) the external surface condition of buried or underground piping or tanks; (b) the external surface condition of associated coatings; or (c) external surfaces of controlled low strength material backfill are performed. Monitoring of the surface condition of the component is conducted to ensure that the aging effects under 3.b are not present or have not progressed to such a degree where a loss of intended function could occur. Monitoring of the surface condition of coatings is conducted to ensure that the coatings are intact, well-adhered, and otherwise sound; such that aging effects would not be expected for the base material of the component. Monitoring of the external surfaces of controlled low strength material backfill is conducted to ensure that there are no cracks present that could admit groundwater to the surface of the component.

b. Visual inspections of the external surface condition of the component should detect:

   i. loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion (MIC) for aluminum alloy (MIC is not applicable for aluminum alloys), copper alloy, steel, stainless steel, super austenitic, and titanium alloy components;

ii. loss of material due to wear for polymeric materials;

iii. cracking, spalling, and corrosion or exposure of rebar for cementitious pipe;

iv. cracking, blistering, change in color due to water absorption for high-density polyethylene (HDPE) and fiberglass components;

v. cracking due to aggressive chemical attack and leaching for cementitious piping; and

vi. changes in material properties due to aggressive chemical attack for cementitious piping as evidenced by visual indications such as cracking, exfoliation, spalling, scaling, or residue or deposits from leaching of the concrete.

c. Volumetric nondestructive examination techniques as well as pit depth gages or calipers may be used for measuring wall thickness as long as: (a) they have been demonstrated to be effective for the material, environment, and conditions (e.g., remote methods) during the examination; and (b) they are capable of quantifying general wall thickness and the depth of pits. Wall thickness measurements are conducted to ensure that minimum wall thickness requirements are met.

d. Inspections for cracking due to stress corrosion cracking for steel, stainless steel and susceptible aluminum alloy materials utilize a method that has been demonstrated to be capable of detecting cracking. Coatings that: (a) are intact, well-adhered, and otherwise sound for the remaining inspection interval; and (b) exhibit small blisters that are few in number and completely surrounded by sound coating bonded to the substrate do not have to be removed. Inspections for cracking are conducted to assess the impact of cracks on the pressure boundary function of the component.

e. 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.

f. When using alternatives to excavated direct visual examination of fire mains, appropriate inspection parameters are used in order to detect indications of fire main leakage. For example:

i. During periodic flow test, a reduction in available flow rate.

ii. For jockey pump monitoring, an increase in the number of pump starts or run time of the pump.

iii. During annual system leakage rate testing an increase in unaccounted flow leak rates (i.e., the leakage path could be through a valve disc and seat, which is not pertinent to this AMP).

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 XI.M41-2 and the following. There are no inspection recommendations for titanium alloy, super austenitic, or nickel alloy materials.
Table XI.M41-2 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. Additional inspections, beyond those in Table XI.M41-2 may be appropriate if exceptions are taken to program element 2, “preventive actions,” or in response to plant-specific operating experience.

APPENDIX B

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

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 nondestructive testing if evidence of wall loss beyond minor surface scale is observed.

Table XI.M41-2. 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

Table XI.M41-2. Inspection of Buried and Underground Piping and Tanks		
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

Table XI.M41-2. 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

The Preventive Action Categories are used as follows:

A: Category A no longer used

B: Category B no longer used

C: Category C applies when:

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 nonoperating hours; and

c. Cathodic protection has provided effective protection for buried piping as evidenced by meeting the acceptance criteria of Table XI.M41-3 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 it has been demonstrated, in accordance with the "preventive actions" program element 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 population of buried piping where:

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:

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 not be corrosive for the material type (e.g., AWWA C105, "Polyethylene Encasement for Ductile-Iron Pipe Systems,"

Table XI.M41-2. Inspection of Buried and Underground Piping and Tanks
Table A.1, "Soil-Test Evaluation"). In order to demonstrate that the soil is not corrosive, the applicant: 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. 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 once in each 10-year period starting 10 years prior to the period of extended operation. **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 protection 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 during the four years following the end of an inspection interval cannot also be credited towards the number of inspections stated in Table XI.M41-2 for the following 10-year interval.

b. **Exceptions to Table XI.M41-2 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 XI.M41-2 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 (e.g., where three inspections are recommended in Table XI.M41-2, two inspections are conducted). 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 component. When conducting 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. No inspections are necessary if all the piping constructed from a specific material type is fully backfilled using controlled low strength material for: (a) polymeric and cementitious materials; (b) steel and copper alloy materials when Preventive Action Category C is met; and (c) stainless steel materials.

iv. If all of the in-scope polymeric material is nonsafety-related, no more than one inspection need be conducted.

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.

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. Opportunistic examinations of nonleaking pipes may be credited toward examinations if the location selection criteria are met. The use of guided wave ultrasonic examinations may not be substituted for the inspections listed in the table.

e. **Alternatives to visual examination of piping are as follows**:

i. Aging effects associated with fire mains may be managed by either: (a) 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) monitoring the activity of the jockey pump (e.g., pump starts, run time) on an interval not to exceed one month; or (c) an annual system leak rate test. If the aging effects are not managed by one of these alternatives, and the extent of inspections is not based on the percentage of piping for that material type, then two additional inspections are added to the inspection quantity for that material type.

ii. At least 25 percent of the in-scope piping constructed from the material under consideration is pressure 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 (not to exceed the maximum allowable test pressure of any nonisolated components) with test pressure being held for a continuous eight hour interval.

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 on the external surface of the piping and is qualified by the applicant to identify loss of material that does not meet acceptance criteria. Ultrasonic (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 to identify loss of material that does not meet acceptance criteria. 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: (a) possessing a NACE Coating Inspector Program Level 2 or 3 inspector qualification; (b) who has completed the Electric Power Research Institute (EPRI) Comprehensive Coatings Course and completed the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course; or (c) a coatings specialist qualified in accordance with an ASTM standard endorsed in Regulatory Guide 1.54, Rev. 2, “Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants.”

b. Cracking is absent in rigid polymeric components. Blistering, gouges, or wear of nonmetallic piping is evaluated.

c. The measured wall thickness projected to the end of the period of extended operation meets minimum wall thickness requirements.

d. Indications of cracking in metallic pipe are managed in accordance with the “corrective actions” program element.

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

f. 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).

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

h. For pressure 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.

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

j. When fire water system leak rate testing is conducted, leak rates are within acceptance limits of plant-specific documents.

k. Cracks in controlled low strength material backfill that could admit groundwater to the surface of the component are not acceptable.

l. Criteria for pipe-to-soil potential when using a saturated CSE reference electrode is as stated in Table XI.M41-3, or acceptable alternatives as stated below.

Table XI.M41-3. 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

[1] Plants with sacrificial anode systems state the test method and acceptance criteria and the basis for the method and criteria in the application.

[2] For steel piping, when: (a) active MIC has been identified or is probable; (b) temperatures greater than 60°C (140°F); or (c) in weak acid environments, a polarized potential of -950 mV or more negative is recommended.

m. **Alternatives to the -850 mV criterion for steel piping in Table XI.M41-3 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 mpy loss of material. Loss of material rates in excess of 1 mpy may be acceptable if an engineering evaluation demonstrates that the corrosion rate would not result in a loss of intended function prior to the end of the period of extended operation. The engineering evaluation is cited and summarized in the LRA.

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 loss of material rate is acceptable, is to use installed electrical resistance corrosion rate probes. The external loss of material rate is verified:

- Every year when verifying the effectiveness of the cathodic protection system by measuring the loss of material rate.
- 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.

  As an alternative to verifying the effectiveness of the cathodic protection system every 5 years, soil resistivity testing is conducted annually during a period of time when the soil resistivity would be expected to be at its lowest value (e.g., maximum rainfall periods). Upon completion of 10 annual consecutive soil samples, soil resistivity testing can be extended to every 5 years if the results of the soil sample tests consistently verified that the resistivity did not fall outside of the range being credited (e.g., for the -750 mV relative to a CSE, instant off criterion, all soil resistivity values were greater than 10,000 ohm-cm).

When electrical resistance corrosion rate probes will be used, the application identifies:

- The qualifications of the individuals that will determine the installation locations of the probes and the methods of use (e.g., NACE CP4, “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 nonconforming backfill, an extent of condition evaluation is conducted to determine the extent of degraded backfill in the vicinity of the observed damage.

   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 extrapolated to the end of the period of extended operation meets minimum wall thickness requirements, recommendations for expansion of sample size, below 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, where the depth or extent of degradation of the base metal could have resulted in a loss of pressure boundary function when the loss of material is extrapolated to the end of the period of extended operation, 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 follow-on inspections is determined based on the extent of condition and extent of cause.

   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. These additional inspections conducted during the four years following the end of an inspection interval cannot also be credited towards the number of inspections in Table XI.M41-2 for the following 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 option of monitoring the activity of a jockey pump instead of inspecting buried fire water system piping, 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.

g. Indications of cracking are evaluated in accordance with applicable codes and plant-specific design criteria.

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 an applicant 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:

- 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 No. 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 No. ML093160004).
- In April 2010, while performing inspections as part of its buried pipe program, a licensee discovered that major portions of its 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 No. 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 No. 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.

AWWA C105, "Polyethylene Encasement for Ductile-Iron Pipe Systems," American Water Works Association, 2010.

EPRI 1021175, *Recommendations for an Effective Program to Control the Degradation of Buried and Underground Piping and Tanks, (1016456 Revision 1)*, December 23, 2010.

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

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.

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

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

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 pipe-to-soil 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 XI.M41-1 of AMP XI.M41, 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.

APPENDIX D

RESOLUTION OF PUBLIC COMMENTS

The staff received comments from:

- NEI, dated August 6, 2015, [ADAMS Accession No. ML15225A076]; Comment Nos. 1 - 67
- Hank Kleinfelder, dated August 6, 2015, [ADAMS Accession No. ML15225A077]; Comment Nos. 68 and 69
- Anonymous, dated August 7, 2015, [ADAMS Accession No. ML15225A078]; Comment No. 70
- Kevin Anstee for Entergy – River Bend Station, dated August 10, 2015, [ADAMS Accession No. ML15244A392]; Comment No. 71
- Steven Daily, dated August 10, 2015, [ADAMS Accession No. ML15244A391]; Comment Nos. 72 through 76

Comments were copied from the letters with minimal minor edits. NEI utilized underlining and cross outs to indicate industry recommended wording revisions or additions.

APPENDIX D

RESOLUTION OF PUBLIC COMMENTS

<table>
<tr><th>#</th><th>Comment</th><th>Staff Resolution</th></tr>
<tr><td>1</td><td>P1 / Discussion

Editorial – Incorrect comma usage in initial sentence.

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.</td><td>Editorial change incorporated.</td></tr>
<tr><td>2</td><td>Introduction, page 1 and Discussion "Description of Changes", page 5

Neither the introduction nor the discussion mentions that AMP XI.M33 is also modified by the ISG, yet changes are included as Appendix C. The discussion of selective leaching inspections on page 5 says that the recommendations in AMP XI.M41 have been moved to AMP XI.M33 with no technical changes. However, this is in the context of the changes to AMP XI.M41 and the description does not make it clear that the changes to AMP XI.M33 are provided in this ISG.

The introduction should be revised to indicate that changes to AMP XI.M33 are also included in the ISG. The discussion of selective leaching on page 5 could also be revised to refer to Appendix C for the changes to AMP XI.M33.</td><td>Editorial changes incorporated.</td></tr>
<tr><td>3</td><td>Discussion "Description of Changes", page 2

Appendix B "Preventive Actions", page B-2

Page 2 states that the maximum negative 1200 mv CP criterion was relocated from the "acceptance criteria" program element to a recommendation within the "preventive actions" program element, to allow licensees flexibility in balancing the performance of their CP systems. Page 2 describes this upper limit as a "recommendation." The new description in the "preventive actions" program element says that "the limiting critical potential should not be more negative than -1200 mV." The use of "should not" implies that negative 1200 mv is a recommendation not a requirement, but the wording is not completely clear.

In addition to moving from one program element to another, it may be beneficial to refer to the 1200 mV criterion as a recommendation, such as <u>it is recommended that the limiting critical potential should not be more negative than -1200 mV.</u></td><td>The staff does not agree with this comment. All of the AMP program elements are recommendations. Although the term "recommendation" is used in many GALL Report AMPs, it is predominantly associated with citing documents published by EPRI, ASME and other staff issued documents (e.g., NUREG, generic letter) and not individual provisions of AMPs. It is still the staff's intent that if an applicant chooses to use an alternative limit, it would state an exception and a basis for the alternative value. This approach is the same for any of the other recommendations in the "preventive action" program element. However, if a reading is more negative than the upper negative limit during periodic cathodic protection surveys the reading would no longer be considered as failing cathodic protection acceptance criteria (i.e., those recommended in the "acceptance criteria" program element)</td></tr>
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4	Description of Changes pdf Page 2, 2nd Bullet "Coating on Underground Components" 3rd Sentence The 3rd sentence reads, "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 of an exception." It seems like most stations would be taking an exception, except a very few. As a result of this change, if an applicant's underground steel or copper alloy piping is not coated <u>and there are no indications of corrosion that could challenge the structural integrity or pressure boundary</u>, the applicant would state an exception and the basis of an exception.	The staff does not agree with this comment. As stated in the discussion associated with the change, the staff has observed loss of material during walkdowns of vaults or reviewed plant-specific operating experience demonstrating the same during several audits. The staff has concluded that given the environmental conditions in the vaults, it is appropriate that steel and copper piping be coated. As stated in the comment, this is a recommendation and an exception can be proposed and justified if appropriate.
5	Discussion "Description of Changes", page 4 Appendix B "Acceptance Criteria", page B-11 When discussing electrical resistance probes (ERPs), both page 4 and page B-11 state that the application will specify the qualifications of the individuals who will determine the installation locations of the probes and the methods of use. It then gives an example of NACE CP-4, "Cathodic Protection Specialist". It is not clear whether this is just an example of the type of qualification or the level of qualification. For example, elsewhere in the ISG (page B-9) discusses that evaluations are performed by NACE Level 2 or 3. So would that level of qualification (i.e. Level 2 or 3) be adequate for determining the installation locations of the ERPs? If CP-4 is required, then "e.g." should not be used. If CP-4 is just an example of a type of qualification, then the discussion should indicate that other levels are also acceptable.	The staff has made no changes based on the comment. The staff cited CP4, Cathodic Protection Specialist, as an example of the recommended qualification level for personnel associated with the design and installation of electrical resistance probes due to the complexity of specifying the correct type, location, number, etc. of probes to install. Based on a review of the NACE website, a CP4 qualified individual should be capable of designing complete cathodic protection systems and applying new technologies to an existing cathodic protection program. In contrast, a CP3, Cathodic Protection Technologist, would be capable of designing and installing simplistic forms of galvanic and impressed current cathodic protection systems. In that regard, the staff has concluded that when using NACE to qualify individuals, the CP4 level of qualification, not lower levels, is appropriate for the design and installation of electrical resistance probes. Therefore, the example was not provided to imply that a CP3 would be adequate. The example was provided because there could be other means to qualify an individual to a similar knowledge level as that obtained for CP4. In regard to the "NACE Level 2 or 3" cited on page B-9, these certification levels are associated with coating inspector qualifications. Therefore they are not applicable to cathodic protection qualifications.
6	P6 / Backfitting Revision of typo in 2nd sentence under Licensees that already hold a renewed license. …and consider ~~to~~ this information to ensure that relevant AMPs are, and will remain, effective.	Editorial change incorporated.
7	P7 / 1st paragraph Editorial – Incorrect comma usage. …do not extend to the nuclear safety issues of license renewal and the NRC need not address…	Editorial change incorporated.

8	P7 / 2nd paragraph Editorial – Incorrect comma usage. …do not extend to the nuclear safety issues of license renewal and the NRC need not address…	Editorial change incorporated.
9	A-1 / 1st paragraph …actions (i.e., coatings, backfill quality, and cathodic protection). Editorial – Incorrect comma usage.	Editorial change incorporated.
10	Page A-1 Description of program, 6th sentence. Actions required when cathodic protection does not meet acceptance criteria are inconsistent with the XI.M41 element 6. Alternate acceptance criteria are allowed under NACE SP0169. Recommend revising the 6th sentence as follows: Where the acceptance criteria for the effectiveness of the cathodic protection is other than -850 mV instant off or 100 mV shift, ~~actual~~ loss of material rates are measured from in-situ coupons or installed electrical resistance corrosion rate probes.	The staff agrees with this comment in part. The staff does not agree that a 100 mV shift can be used as an acceptance criterion in the absence of a means to verify the effectiveness of the cathodic protection system. The only acceptance criterion for an impressed cathodic protection system is -850 mV relative to a CSE, instant off. Alternative acceptance criteria are provided; however, in each case, the loss of material rate is measured to confirm the effectiveness of the cathodic protection system. The term “actual” was deleted because the staff recognizes that whenever coupons or probes are used, they might not measure the exact loss of material rate of the protected piping. In addition, the term, “from in-situ coupons” was deleted because AMP XI.M41 currently only contains recommendations for measuring loss of material rates by electrical resistance corrosion rate probes.
11	Appendix B, Program Description, end of 1st paragraph The revised AMP uses the term “cementitious” in places and the term “reinforced cement and asbestos concrete pipe”. Recommend “cementitious” be defined; further, it should be consistently used with concrete materials.	The staff agrees with this comment. Terms such as “cement,” “reinforced concrete,” and “asbestos cement” were replaced with “cementitious.” The only use of the term “concrete” is: (a) when it refers to the environment in which the buried piping or tank is embedded (to remain consistent with the GALL Report AMR line items); (b) when it is included in a title; and (c) when it is included in a quote. The term “cementitious” was clarified by adding a parenthetical phrase after its first use, “cement-based substance.”
12	Element 1 / Page B-1 Editorial – Incorrect comma usage. … refers to plastics or other polymers…	Editorial change incorporated.
13	Scope of Program / App B Added sentence "The term “polymeric” material refers to plastics, or other polymers that comprise the structural element of the component" has the potential to imply something other than intended. Since the function of mechanical components managed by this program is either pressure boundary or leakage boundary, consider replacing the words "structural element" with “pressure” or “leakage boundary.”	The staff agrees with this comment. The term “structural element” was revised to “pressure boundary.” This is consistent with the SRP-LR, Table 2.1-4(b), “Typical ‘Passive’ Component-Intended Functions,” use of term, “[p]rovide pressure-retaining boundary so that sufficient flow at adequate pressure is delivered.”

14	Element 2, Table 2 / Page B-1 Reinforcement in cementitious materials is protected by CP for Reinforced Concrete Pipe & PCCP. Coatings are a less common mitigation for RCP. Reinforcement in cementitious materials is protected by CP for Reinforced Concrete Pipe & PCCP. Coatings are a less common mitigation for RCP.	The staff agrees with this comment in part. Table XI.M41-1 (previously Table 2) was revised to include a recommendation for cathodic protection for reinforced concrete pipe and prestressed concrete cylinder pipe. The staff has concluded that protective coatings should be recommended for cementitious materials to minimize the potential for aging effects such as cracking or changes in material properties due to aggressive chemical attack, or leaching.
15	Page B-1 Element 1 & program description The program description was revised to remove the discussion of the applicability with the Selective Leaching Program. Recommend that the discussion of the applicability of the Selective Leaching program be added to Element 1 similar to the discussion of the Bolting Integrity Program in Element 1. Page 5 of the ISG notes that the recommendations related to reductions in the extent of inspections for AMP XI.M33 have been moved to AMP XI.M33 with no technical changes. When will these AMP XI.M33 changes be issued for industry use and reference? Recommend the following be added to element 1: 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.	The staff agrees with this comment. The recommended sentence was added to the “scope of program” program element of AMP XI.M41. The changes to AMP XI.M33 were provided in Appendix C of the draft and final version of this LR-ISG.

16	Preventive Actions / App B Omission of the "When provided…" wording for underground coating recommendation will likely result in the need for exception by most applicants. The justification for this action in discussion on page 2 indicated that "typical air conditions in underground vaults have higher moisture content than uncontrolled indoor air conditions in plant spaces within buildings." There is no discussion of what documentation exists to support this statement, but the definition of air-indoor, uncontrolled in NUREG-1801 only assumes that system temperatures are expected to be above the dewpoint. Where system temperatures are expected to be below dewpoint, they are normally insulated to mitigate condensation. For other piping, there is no OE cited that indicates that normal film coatings (i.e., paint) is ineffective at controlling surface corrosion. The presence of coatings in pipe trenches is likely to be an unusual condition, as trenches are (were) generally considered to be a sheltered environment for which coatings are (were) unnecessary. Installation of coatings on underground piping if they don't already exist would likely be impractical... as such, this "preventive" action is more of a design or installation consideration than it is a preventive action. A recommendation made today to use coatings in these locations will likely not result in installation of coatings. Rather, it will result in exceptions to the program recommendations. If the existing industry population of piping/tanks in underground (not buried) locations is predominantly not coated, it would be more beneficial to provide guidance that does not require applicants to take an exception. Recommend providing an allowance that underground (not buried) piping / tanks may be uncoated, or may have standard protective film coatings (paint). Specify that an increase in number or frequency of inspections is warranted if wetted conditions or evidence of more than minor surface corrosion is noted during initial inspections.	The staff does not agree with this comment. The basis for the staff's statement that, "typical air conditions in underground vaults have higher moisture content than uncontrolled indoor air conditions in plant spaces within buildings," is its review of plant-specific operating experience and walkdowns of underground vaults during AMP audits. The staff's review included instances of extensive general corrosion and submergence of piping components in underground vaults. Examples include: (a) Safety Evaluation Report With Open Items Related to the License Renewal of Limerick Generating Station, Units 1 and 2 (ADAMS Accession No. ML12213A721), Section 3.0.3.2.12, Enhancement No. 2; and (b) Safety Evaluation Report Related to the License Renewal of Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 (ADAMS Accession No. ML15182A051), Section 3.0.3.2.15, Operating Experience. The staff has concluded that "normal film coatings" may not be effective in preventing loss of material in high humidity or immersion environments. The staff does not agree with the implication of the statement, "installation of coatings on underground piping if they don't already exist would likely be impractical... as such, this 'preventive' action is more of a design or installation consideration than it is a preventive action." Coatings share a similar characteristic as backfill in that their use as preventive actions is better accomplished during the design phase rather than a backfit. The staff recognizes that backfitting coatings on underground piping could be costly and it does not expect that applicants would coat underground piping simply based on AMP XI.M41 recommending coatings as a preventive action. However, the basis for the inspections of underground piping cited in Table XI.M41-2 is that the piping is coated. Should an applicant state an exception to having coated underground piping, it would be expected that there would be an increase in the number or frequency of inspections of the piping or of the vault conditions (e.g., due to in-leakage) to justify the exception.

17	Element 2, Sub-paragraph a / Page B-2 Editorial – Incorrect comma usage. … copper alloy, and aluminum alloy piping and tanks and underground steel and copper alloy piping and tanks, coatings are	Editorial change incorporated.
18	Page B-2 Element 2.c last sentence As noted by prior industry comments and NACE International SP0169-2007, use of excessive polarized potentials should be avoided on all metals particularly those metals that could result in excessive generation of hydrogen (e.g. aluminum, titanium, or selected grades of stainless steel). In addition NACE International SP0169 does not provide a limiting critical potential to prevent damage of coatings. Consistent with SP0169, the use of excessive polarized potentials on externally coated pipelines should be avoided to minimize cathodic disbondment of the coating. Recommend the last sentence be revised to read: To prevent damage to the ~~coating~~ metallic components, the limiting critical potential should not be more negative than -1200 mV. A further over-protection limit shall be defined by the applicant and managed during surveillance activities. The use of excessive polarized potentials on externally coated pipelines should be avoided.	The staff agrees with the concept of this comment in principal; however, the changes to the AMP are different than those proposed in the comment. A new section was included in reference to Table XI.M41-1 in AMP XI.M41, "Critical potentials for cathodic protection." It includes the following. IAEA NE Series No. NP-T-3.20, "Buried and Underground Piping and Tank Ageing Management for Nuclear Power Plants," Section 4.3.14.5, "Blistering," states that excessive amounts of cathodic protection current (i.e., greater than -1200 mV) can cause coating disbondment and blistering. Therefore, the staff revised the first sentence to cite coatings and base metal. The upper limit for prestressed concrete cylinder pipe in Table XI.M41-3, footnote 2, was moved to the "preventive actions" program element for the same reason that the upper limit of -1200 mV was moved from Table XI.M41-3. These upper limits are important as preventive actions; however, the intent of the acceptance criteria in Table XI.M41-3 was to establish criteria that are used to transition to different preventive action categories in Table XI.M41-2 (i.e., increased or decreased number of inspections). When the upper limits are not met, the variance should be considered as a condition adverse to quality that is addressed by the corrective action program. Increased inspections, if conducted, would be as a result of the licensee's evaluation of the condition adverse to quality in lieu of recommended increased inspections stated in Table XI.M41-2. In addition, the staff included a new bullet under this note describing the potential for SCC of steel and stainless steel buried components depending on the environment. The staff included, with slight edits, the second proposed sentence as an additional caution under this note.

19	Element 2, Sub-paragraphs a – d / Page B-2 References to NACE SP0169-2007 should be replaced or supplemented by reference to latest edition, SP0169-2013, particularly with respect to Table 1a/1b for coatings. Recommended change: NACE SP0169-~~2007~~2013	The staff agrees with this comment in part. The staff has concluded that it will not adopt the 2013 edition of SP0169 in its entirety. The staff does not agree with Section 6, "Criteria and Other Considerations for Cathodic Protection," for several reasons. Some examples include: • The staff disagrees with the use of the 100 mV cathodic polarization acceptance criterion (in the mixed metal environment) without confirmatory testing to verify that all metals are adequately protected. The staff's position is supported by ISO 15589-1, Section 5.3.2.2 which states, "[f]urthermore, the criteria shall not be used in case of pipelines connected to or consisting of mixed metal components." • The staff disagrees with the language in Section 6.2.1.1, which allows criteria that have been documented through empirical evidence to indicate corrosion control effectiveness on specific piping systems. Given that the staff has not reviewed this "empirical evidence," it can not endorse this option. • The staff does not agree with the use of a potential of –850 mV instant-on without measurement or calculation of voltage drops. However, the staff reviewed SP0169-2013, Section 5, "External Coatings," and has concluded that the expanded list of coating materials in the cited tables are acceptable for use and provide for a more efficient review of LRAs. Table XI.M41-1 was revised to cite the specific materials that were added in SP0169-2013, Section 5, Table 1a, "Generic External Coating Systems for Carbon Steel Pipe with Material Requirements and Recommended Practices for Application) for Underground and Submerged Pipe (Field- and Shop-Applied)" and Table 1b, "Generic External Coating Systems for Ductile Iron Pipe with Material Requirements and Recommended Practices for Application." The staff has concluded that the coating types cited in the 2013 Edition can be capable of restricting moisture penetration and/or electrically isolating the base metal of the buried component and are therefore acceptable as coatings for buried and underground components. References: (a) Corrosion, LL Shreir, 3rd Edition, Chapter 14.8, "Protective Coatings for Underground Use;" and (b) "CP Shielding and Pipeline Coatings," Greg Ruschau, CC Technologies.

20	Element 3.a.i / Page B-3 Corrosion nomenclature change. Recommended change: microbiologically-influenced corrosion.	Editorial change incorporated. The staff also revised this section to reflect that aluminum alloy components are not susceptible to MIC. Aluminum components are susceptible to pitting and crevice corrosion; however, they are not susceptible to microbiologically-influenced corrosion in buried environments. The staff reached the conclusion that aluminum is not susceptible to microbiologically-influenced corrosion based on a review of the following: • Corrosion of Aluminum, Christian Vargel, Elsevier, 2004, Chapter 2.11, “Microbiological Corrosion,” which states, “[t]here is no specific microbiological corrosion of aluminum in aqueous media, especially in seawater, which contains a wide range of bacteria.” • A Practical Manual on Microbiologically Influenced Corrosion, Volume 2 (2nd Edition), John G Stoecker, NACE International, 2001, Chapter 7, “MIC in the Power Industry,” and Chapter 8, “MIC in the Waste Treatment Industries,” which state, “[m]icrobial influences can cause localized corrosion, often at rates one or more orders of magnitude greater than the expected general corrosion rates, for copper-based alloys, carbon steels, and stainless steels.” There was no mention of aluminum alloys. • ASM Handbook, Volume 13A, “Corrosion: Fundamentals, Testing, and Protection,” Stephen D Cramer, 2003, Section 58, “Microbiologically Influenced Corrosion,” Stephen C Dexter, University of Delaware, page 407 MIC of aluminum alloys is only cited for aircraft fuel tanks.
21	Element 3.a.iii. / Page B-3 Recommend deletion of loss of material due to wear for polymeric materials, or cite relevant OE showing this to be an applicable AE of concern. Is the OE definitive in concluding that the wear was a result of objects slowly migrating over time due to seasonal changes, versus damage incurred during original backfilling? Recommended change provided in comment.	The staff does not agree with this comment. The staff has not seen any specific OE associated with ground movement of deleterious material in backfill damaging polymeric components. However, it is well known that objects such as concrete block and rebar can move based on seasonal changes in backfill. This movement could damage polymeric materials.
22	Element 3.a.iv / Page B-3 Editorial – Incorrect comma usage. … asbestos cement pipe and concrete pipe;	Editorial change incorporated.

23	Element 3.a.vi / Page B-3 Editorial – Semicolon between aging effects implies another bullet based upon the preceding structure in this section. Recommend a comma. Recommended change: 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.	The staff editorially realigned the bullets to address this comment.
24	Element 3.b / Page B-3 Suggest addition of other NDE technologies and potentially cross-referencing EPRI Buried Pipe NDE Guide. Ultrasonic testing (UT), Magnetic Flux Leakage (MFL), Pulsed Eddy Current (PEC), Saturated Low Frequency Eddy Current (SLOFEC), and other non-destructive means may be used to measure wall thickness… Applicants must ensure that evaluation technologies are fit for purpose and comply with governing codes, where applicable.	The staff agrees with this comment, but rather than listing specific NDE techniques, it provided two conditions for the use of wall thickness measurement techniques: (a) the method has been demonstrated to be effective for the material, environment, and conditions (e.g., remote methods) during the examination; and (b) the method is capable of quantifying general wall thickness and the depth of pits.
25	Element 3.c / Page B-3 Coatings may be intact, but could be disbonded. Replace the following sentence: Intact coatings do not have to be removed to inspect for potential cracking." Recommended wording: Coatings that are intact, well-adhered, and otherwise sound for the remaining inspection interval do not have to be removed.	The staff concluded that the proposed sentence accurately describes the staff's intent. The change was incorporated. The staff also addressed coatings exhibiting blisters that are small in size and few in number.
26	Element 4, 1st paragraph, bottom of page / Page B-3 Editorial – Incorrect comma usage. For multi-unit sites, the inspections are…	Editorial change incorporated.

27	Appendix B / page B-3 The section for parameters monitored or inspected fails to identify the appropriate parameters to monitor. Item d. is the only item that identifies any parameters to monitor, that is, “pipe-to-soil potential and cathodic protection current.” Parameters monitored or inspected must be things that you can monitor and inspect even when there are no signs of aging effects. They must match the detection methods. For visual inspections and surface examinations, the only parameter that can be monitored is surface condition. Wall thickness should be the parameter monitored for the UT examinations. The AMP does not provide parameters to monitor for flow testing, jockey pump activity monitoring, or annual system leak test. Listing the applicable aging effects under parameters monitored and inspected is not consistent with the SRP description of the ten program elements. Recommend adding appropriate parameters to monitor.	The staff revised the “parameters monitored or inspected” program element as follows. For conditioning monitoring aspects, a link was provided between the aging effect and the parameter or parameters that will be monitored. For performance monitoring aspects (e.g., jockey pump monitoring) specific examples were provided for each test method or trended parameter.
28	Appendix B, Element #4, Page B-4, top paragraph 2nd sentence The sentence reads, “Piping inspections are typically conducted by visual examination of the external surfaces of pipe or coatings.” It does not address the scenario where much of the buried piping is encased in concrete, which industry sees as controlled low strength material backfill). Recommended change: Piping inspections are typically conducted by visual examination of the external surfaces of pipe, encasement if encased in controlled low strength material backfill or coatings.	The staff revised the “parameters monitored or inspected” program element to address inspection of the external surfaces of controlled low strength material backfill. In conjunction with resolving this comment, the staff recognized that there was not an acceptance criterion for controlled low strength material backfill. A new acceptance criterion was added stating that cracks in controlled low strength material backfill that could admit groundwater to the surface of the component are not acceptable.

29	Element 4, Table 4, Preventive Action Categories D & E / Page B-6 Eliminate the need to perform soil testing and confirm non-corrosive soil as part of Category E, and reverse the number of inspections between Categories D & E. Preventive Action Category D prerequisites are that soil has been proven non-corrosive per Element 2 Section e.iv (i.e., soil tests performed; locations, results, methodology submitted in the LRA). No cathodic protection is required. Preventive Action Category E prerequisites are that coatings and backfill meet preventive measure criteria, as-found coatings have been found in satisfactory condition, and soil has been demonstrated non-corrosion by performing soil test results prior to LRA submittal, and every 10-year period during PEO. Cathodic protection is provided, but not performing at desired level. A station should perform fewer inspections when it has demonstrated it has coatings and backfill meeting preventive measures, a history of satisfactory as-found coating conditions, demonstrated non-corrosive soil, and some level of cathodic protection, than a station which has also demonstrated non-corrosive soil but has no cathodic protection at all. Alternatively, the existing numbers would be sufficient for stations which do not need to provide evidence of non-corrosive soil as many northern plants (where roadways are salted) would meet the definition of "mildly" or "moderately" corrosive soil per existing guidelines such as AWWA Standard C105 and Table 20.1 of C.P. Dillon Corrosion Control in the Chemical Process Industries. Effectively, this would prevent many/most northern plants from meeting definition of "non-corrosive" and ever meeting Preventive Action Category E. Recommended changes: Switch the number of inspections between categories D&E. Remove requirement to perform soil testing and demonstrate non-corrosive soil for category E.	The staff does not agree with this comment. Preventive Action Category D is for those portions of in-scope buried piping where it has been demonstrated that external corrosion control is not necessary. The staff has concluded that the number of inspections for Preventive Action Category D is appropriate. If the applicant has presented sufficient evidence to demonstrate that external corrosion control is not required (i.e., soil analyses, pipe to soil potential measurements, other relevant parameters) periodic confirmation inspections should be conducted. However, the quantity of inspections does not need to be as high as for Preventive Action Category E. Preventive Action Categories C and E are used when it was not possible (or evidence was not presented in the LRA) to demonstrate that cathodic protection is not needed. Where cathodic protection is needed to protect the buried components, Preventive Action Category C represents the ideal condition. A cathodic protection system has been installed and the system is meeting operating and effectiveness goals. In contrast, for Preventive Action Category E, cathodic protection system is not meeting operating and effectiveness criteria, or it is impractical to install cathodic protection even though it is necessary to provide adequate protection for buried components. The AMP recommends that coatings and backfill are provided in accordance with the "preventive actions" program element for Preventive Action Category E. In order to meet this provision, it is presumed that there are plant-specific specifications or records that would demonstrate that the coatings and backfill are consistent with the "preventive actions" program element. Alternatively for backfill, if there are no plant-specific records, the AMP allows the backfill to be confirmed with each excavation. However, these plant-specific specifications, records, or excavations do not demonstrate that all of the coatings and backfill are acceptable. It is possible that local areas may have deleterious materials in the backfill or coating holidays might exist in some locations. In fact, based on the staff's review of plant-specific OE, it is likely that most stations have some locations where the backfill and coatings are not completely effective. As a result, Preventive Action Category E recommends soil sampling to determine the corrosivity of the soil as a defense in depth for the coatings and backfill for those locations where cathodic protection is not meeting operating and effectiveness criteria, or it is impractical to install cathodic protection. The recommendation to conduct periodic soil testing for Preventive Action Category E will not be removed; however, an applicant can elect to not perform soil sampling by conducting inspections to Preventive Action Category F. In regard to the portion of the comment associated with northern plants, the staff has concluded that it is appropriate to use the term "demonstrated to be not corrosive." The staff recognizes that when measuring only soil resistivity, terms such as "mildly" or "moderately" corrosive are used. However, as recommended in Table XI.M41-2, soil tests include multiple parameters including, soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, sulfates, and redox potential. Given the values for each of these, an overall soil corrosivity characteristic can be determined. For example, AWWA C105, "Polyethylene Encasement for Ductile-Iron Pipe Systems," Table A.1, "Soil-Test Evaluation," states that a ten point or higher rating indicates that the soil is corrosive to ductile iron pipe.

30	Element 4, Table 4, Preventive Action Category E / Page B-6 If the previous comment is not incorporated, Table 4, Category E, part b.iii.5 should be deleted. Item 5 precludes any station from meeting preventive action category E if soil samples are not performed prior to LRA submittal. If a definition or standard of what constitutes acceptable soil conditions was defined in the table, this would allow stations flexibility to perform soil sampling, testing, and evaluation at any time following issuance of a renewed license and meet the same intent as submitting the results with the LRA. As a result, stations could then adhere to Preventive Action category E should their cathodic protection underperform during any 10-year period and fail to meet category C criteria, and not have to default to category F instead. Recommended changes: Delete Table 4, Category E, part b.iii.5: 5) Provides a summary of the results and conclusions of the soil testing in the LRA.	The staff agrees with this comment. This wording was deleted from the AMP. The decision to conduct inspections to Preventive Action Categories C, E or F (although not D) is appropriately made when inspections are being conducted and not upon submittal of the LRA. Table XI.M41-2 was revised to provide AWWA C105, Table A.1 as one acceptable method to demonstrate that the soil is not corrosive.
31	Element 4, Table 4, subpart E.a / Page B-6 Suggest clarifying whether sites with excessive cementitious backfill are included. Recommended change: 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, apart from areas affected by cementitious backfill; or…”	The staff does not agree with this comment. If it is impractical to install cathodic protection due to the amount of cementitious backfill that was used, Preventive Action Category E is still appropriate. For those portions of piping that are encased in controlled low strength material backfill, the inspections can consist of inspecting the external surfaces of the backfill for cracking.

32	Page B-6 and B-7, Table 4 Category E.b.iii As written, these criteria could be extremely difficult to meet. 1). Criterion E.b.iii should be revised to indicate that mildly corrosive soil environment may be acceptable. As written the soil environment must be demonstrated to be not corrosive. All soil environments have some corrosive tendencies. The analysis should demonstrate that an aggressive environment does not exist that would result in loss of intended function prior to the end of the PEO. Plants in northern environments typically have mildly aggressive soil environments next to roads that are heavily salted in winter. 2.) Criterion E.b.iii.4) should be revised to delete or reword the reference to submitting the application. This would allow plants with renewed license to use Category E rather than Category F. 3.) Criterion E.B.iii.5 prevents the use of Category E if soil samples are performed prior to LRA submittal. Recommend revising the following portions of Category E.B.iii as follows: E.b.iii Soil environment has been demonstrated to be not corrosive non-aggressive for the material type and would not result in a loss of intended function prior to the end of the PEO. In order to demonstrate that the soil is not corrosive aggressive, the applicant: E.b.iii.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. E.b.iii.5) Provides a summary of the results and conclusions of the soil testing in the LRA to the NRC.	The staff agrees in part with this comment. The staff's response to this comment and associated changers are discussed in Comment No. 29, last paragraph, and Comment No. 30.
33	Element 4.a, 2nd sentence / Page B-7 Typo. …For example, degraded performance of the cathodic protections system…	Editorial change incorporated.
34	Element 4.a, last sentence / Page B-7 Last sentence of section should be clarified, with regards to the inability to credit inspections performed as part of the transition allowance as also counting as those required during the following interval. These additional inspections conducted <u>during the four years following the end of an</u> inspection interval cannot <u>also</u> be credited towards the number of inspections stated in Table 4 for the <u>following</u> 10-year interval.	Editorial change incorporated.

35	Detection of Aging Effects / App B Page B-8 It's not clear how the section c.iii extent of inspections for fire protection piping must be integrated with other inspections. If the piping is of the same material category as that in other systems, it's not clear that the inspections must include any fire protection piping at all, even if the extent of inspections is expanded as directed. The inspections are still based only on the material (and preventive conditions), not on the system. If the intent is that at least two inspections be performed on Fire Protection piping, then clarification should be provided in this section, or in Table 4. The remainder of the program is written such that no Fire Protection piping need be inspected if the system is monitored via approved alternatives.	The staff agrees that as written, the sentence does not adequately convey the staff's intent. The sentence was revised to clarify the staff's intent. The intent is that if aging effects associated with fire protection piping are not managed by activities such as periodic flow tests, jockey pump monitoring, or annual leak test, then the number of excavated direct visual examinations in its material type is increased. The increase in inspections accounts for the fact that there is generally a considerable amount of buried fire protection piping. If this piping is not being monitored or tested for potential leakage by one of the alternatives, then increased inspections should be conducted for this material. This does not mean that fire protection piping must be excavated for direct visual inspection. For example, assume that the buried fire protection piping is constructed of ductile iron piping and steel piping is being inspected based on Preventive Action Category E. The number of inspections of buried steel piping would be 5 percent of the total of all buried steel piping including the fire protection piping or 5 inspections of buried steel piping would be conducted. If the fire protection piping was being monitored or inspected by one of the above alternatives, 5 percent of the total of steel buried piping without including the fire protection piping or 3 inspections would be conducted.
36	Element 4.d / Page B-8 Suggest advising safe accessibility as well as risk. … selected based on risk (i.e., susceptibility to degradation and consequences of failure) <u>and consider safe accessibility</u>.	The staff has not made any changes to AMP XI.M41 based on this comment. Buried components inspections should be performed on those components with the highest susceptibility to degradation and the highest consequences of failure to plant safety. Industrial safety considerations are managed by the licensee.
37	Page B-8 element 4.b.iii Element 4.b.iii (Exceptions to Table 4 Inspection Quantities) notes that when Preventative Action Category A or C is met for all materials except aluminum alloys, no inspections are necessary if all piping constructed from a specific material type is fully backfilled using controlled low strength material. There is no Preventative Action Category A defined for Table 4. Revise 4.b.iii as follows: For polymeric piping or when Preventative Action Category A or C is met for all materials except aluminum alloys, no inspections are necessary if all piping constructed from a specific material type is fully backfilled using controlled low strength material.	The staff agrees with the need to correct this sentence. The reference to Category A was removed while retaining the alternative for polymeric piping as well as other materials.

38	Detection of Aging Effects App. B, b.iii, Page B-8. Item b.iii has "Category A shown" which no longer exists. Delete Category A.	The staff agrees with this comment. See the response to Comment No. 37
39	Detection of Aging Effects App. B, b.iv, Page B-8. Item b.iv has "Category B shown" which no longer exists. Delete existing text, "Category B shown."	The staff agrees with the need to correct this sentence. The sentence was revised to remove reference to Category B but retain the intent of the exception.
40	Appendix B, Element #4, Page B-8, b.iii What is "Preventive Action Category A?" Please define.	The staff does not agree with this comment; however, an editorial change was incorporated, see the response to related Comment No. 37. There is no need to define Category A because Table XI.M41-2 states that Preventive Action Categories A and B are "no longer used." Based on the staff's attendance of several industry meetings related to buried piping, it recognized that Preventive Action Categories C through F were cited in industry presentations related to inspections of buried piping. As a result, the staff retained Preventive Action Categories C through F rather than re-lettering them as Preventive Action Categories A through D.
41	Appendix B, Element #4, Page B-8, b.iv The sentence states "If all of the in-scope polymeric material is nonsafety-related, the inspection quantities for Preventive Action Category B may be reduced by half." However, there are no inspection quantities in preventive action category B for polymeric materials. Recommend rewording as follows: If all of the in-scope polymeric material is nonsafety-related, the inspection quantities ~~for~~<u>in</u> Preventive Actions Category B may be reduced by half.	The staff agrees with this comment. See the response to Comment No. 39.
42	Appendix B, Page B-8, section point d. "Piping inspection locations are selected based on risk (i.e., susceptibility to degradation and consequences of failure)." Recommend additional sentence=> <u>In general, inspection locations as well as re-inspection intervals should be based on new risk results by re-integrating the monitoring and inspection results into plant's buried piping risk database in order to update determine future re-inspection locations and intervals.</u>	The staff agrees that past inspection results should be used as input in determining the susceptibility to degradation for the selection of future inspection locations. However, inspection results should not be used to increase the interval of inspections beyond 10 years. The proposed wording is ambiguous in regard to inspection intervals. As such, the staff has concluded that no changes will be incorporated into AMP XI.M41 as a result of this comment.

43	Element 4.e.ii / Page B-9 Design pressure testing is only required for ASME structural credit and is not advised as a corrosion evaluation methodology. At a 5-year interval, operating pressure should be sufficient to identify / address vulnerabilities for nonsafety-related segments. Adding continuity and bounding components will compensate for this lesser pressure. This is consistent with NEI 09-14 guidance. Recommended rewording: The piping is pressurized to 110 percent of the design pressure of any <u>bounding</u> component within the boundary with test pressure being held for <u>a continuous</u> eight hours <u>interval</u>.	The staff agrees with this comment in part. Given that the term “bounding” is not defined, the staff adopted wording from ANSI/ASME B31.1, “Power Piping,” 1983 Edition which states, “but shall not exceed the maximum allowable test pressure of any nonisolated components, such as vessels, pumps, or valves.
44	Element 4.e.iii / Page B-9 Inspections must be qualified to address threats. The inspection method has been demonstrated to be capable of detecting both general and pitting corrosion and is qualified by the applicant <u>to identify/evaluate potentially unacceptable flaws.</u>	The staff agrees with this comment; however, alternative wording was used to link the aging effect to the acceptance criterion.
45	Element 4.f. / Page B-9 Inspections must be qualified to address threats. …demonstrated to be capable of detecting both general and pitting corrosion and is qualified by the applicant <u>to identify / evaluate potentially unacceptable flaws.</u>	The staff agrees with this comment; however, alternative wording was used to link the aging affect to the acceptance criteria.

46	Page B-9 Element 6.a. Add a third coating qualification option that requires inspection and evaluation of buried external coating by a coating specialist qualified in accordance with an ASTM standard endorsed in Reg Guide 1.54 including staff limitations associated with a particular standard. Reg Gide 1.54 Rev 2 endorses ASTM D4537-04a and ASTM D7108-05 which establish guidelines to qualify coating inspectors and Nuclear Coating Specialists. Recommend Element 6.a. be revised as follows: 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 NACE Coating Inspector Level 2 or 3 inspection qualification, qualifications in accordance with an ASTM standard endorsed in Regulatory Guide 1.54 including staff limitations associated with a particular standard, or an individual who has attended the EPRI Comprehensive Coating Course and complete the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course.	The staff reviewed the qualification requirements for a coatings specialist during its development of AMP XI.M42, “Internal Coatings/Linings for In-Scope Piping, Piping Components, Heat Exchangers, and Tanks.” The staff has concluded that a coatings specialist qualified in accordance with Regulatory Guide 1.54 (RG 1.54) has undergone sufficiently rigorous qualification program consistent with the other proposed qualification methods cited in AMP XI.M41. The change was incorporated and RG 1.54 was incorporated as a reference into the ISG and AMP XI.M41.
47	Element 6.c / Page B-9 Add rust staining as an indicator of migration without leakage due to insufficient cover. …leakage or exposed or rust staining from rebar or reinforcing “hoop” bands.	The staff agrees with this comment. The change was incorporated as requested.
48	Element 6.f / Page B-9 Hydro testing is overly specific for some piping systems, functions, and conditions. For ~~hydrostatic~~ pressure 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.	The staff agrees with this change. Given that the specific pressurization value is provided in the AMP (I.e. 110 percent), the term “pressure test” is adequately descriptive. The change was incorporated as requested. The change was also incorporated in two other places where the testing is cited in the AMP.
49	Element 6.f / Page B-9 Editorial –Incorrect comma usage. …isolated portion of the piping that is not accounted for…	Editorial change incorporated.
50	Appendix B /page B-9 Acceptance criterion of no pressure drop seems abnormally stringent for a hydrostatic test. Isn’t it normal to have such tests deemed acceptable based only on visual inspections not identifying leakage? N/A	The staff does not agree with this comment. When a pressure test is utilized in lieu of an excavated direct visual examination of buried piping, 25 percent of the particular material type is pressure tested. It is not expected that all of this piping would be excavated and available for visual observation of leakage. Pressure drop is the only viable means to detect leakage in the unexcavated piping.

51	Element 6.g / Page B-10 Editorial –Incorrect comma usage. …leakage from buried piping are, not occurring.	Editorial change incorporated.
52	Element 6, Table 6 / Page B-10 Add -1200mV acceptance criterion for aluminum piping per NACE SP0169-2013. -Similar to relocation of discussion on precautions of overprotection of coated piping, recommend discussion on precautions of overprotection of PCCP pipe be moved to Element 2 as a preventive measure as well. -Add -1200mV acceptance criterion for aluminum. Relocate PCCP overprotection discussion to Element 2.	The staff agrees with this comment. AMP XI.M41 was revised to state that the upper -1200 mV polarization criterion applies to prevent damage to either the coatings or base metal, for example aluminum. The limit for PCCP (prestressed concrete cylinder piping) was moved to the "preventive actions" program element in response to Comment No. 18.
53	Appendix B, Table 6, foot note 2 This table uses -1,000 mV. In other areas -1,200 mVs are used? Need to be consistent in all locations where 1200mV is used such as 2.b that implies 1200 is the criteria for all when it isn't for prestressed concrete piping as discussed in Table 6. Recommend adding to 2.b, <u>For prestressed concrete cylinder piping the potential should be no more than -1000 mV to prevent hydrogen generation or embrittlement of the prestressed wiring.</u>	The staff agrees with this comment. See resolution of Comment Nos. 18 and 52.

54	Appendix B “Acceptance Criteria” Table 6, page B-10 Page B-10, Table 6 provides CP acceptance criteria (-850 mV relative to a CSE instant off for Steel). If acceptance criteria are not met, that test point is not considered "effective" and would result in transitioning into a higher inspection category. However, Note 2 within this table states that "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 -1000 mV relative to a CSE are avoided...". It is not clear whether the -1000 mV for pre-stressed concrete pipe is a criterion that would determine whether the protection is "effective" that would result in transitioning into a higher inspection category if exceeded, or just a level to be avoided. If it is meant to be an acceptance criterion, then include the -1000 mV in the body of the table rather than a footnote. If it is not an acceptance criterion, that should be clarified in the footnote.	The staff agrees with this comment. See response to Comment No. 18.
55	Element 6.k.iv / page B-10 & B-11 The -650mV and -750mV criteria should not need to be confirmed via the 1mpy criterion. If <1mpy corrosion is occurring, as indicated by an ER probe, this is confirmation itself of lack of corrosion, such that a secondary evaluation need not be performed of whether test points are also meeting -650mV and -750mV at locations of high resistivity soils. These alternative values for high resistivity soils are presented in ISO 15589-1 as valid stand-alone acceptance criteria, not requiring confirmation via other means. This is particularly relevant to piping which is backfilled in cementitious material. Cementitious materials often have very high resistivity values, but an ER probe would be unable to provide representative corrosion rates of pipes embedded in concrete backfill. Without breaking apart the cementitious fill and directly examining the embedded pipe, there are few practical means to otherwise confirm absence of on-going corrosion. This requirement to confirm corrosion rates should especially not be applicable to piping embedded in cementitious materials. Recommend only requiring the soil resistivities be verified every 5 years for application of the -650mV and -750mV criteria.	The staff does not agree with this comment. However, based on a further review of NACE Corrosion Expo 2006, Paper No. 06163, the staff has concluded that an alternative to verifying the effectiveness of the cathodic protection system every 5 years will provide equivalent assurance. The paper states, “[l]arge variations in soil resistivity (by an order of magnitude) were observed…” The alternative consists of soil resistivity testing being conducted annually during periods where soil resistivity would be expected to be at its lowest value. In addition, if 10 years of data demonstrate that resistivity is within the expected range (e.g., for the -750 mV relative to a CSE, instant off criterion, all soil resistivity values were greater than 10,000 ohm-cm), the staff has concluded that further soil resistivity testing could be conducted every 5 years. The staff concludes that this alternative provides equivalent assurance of adequate cathodic protection because there is ample evidence (see the basis for the change discussion in the front material of the ISG) to demonstrate that in higher resistivity soils, lower levels of cathodic protection provide adequate protection for the piping.

56	Element 6.k.iv / page B-11 The 100mV criterion should not be required to be proven effective by periodic assessment of a 1mpy criterion. The 100mV criterion can be proved effective in a mixed metal environment for a material that is not the most anodic, through a variety of means. The 100mV shift can be proven effective with 3 basic components; reference cell, non-cathodically protected metal object that is electrically isolated from a mixed-metal environment, and a cathodically protected protect metal object of the same material that is interconnected with the mixed metal-environment. So long as the instant-off polarization potential difference between the non-cathodically protected object and cathodically protected object is >100mV, this is demonstration of 100mV of polarization. While certain sophisticated ER probe assemblies (i.e., “smart-stacks”) prove this with ER probes, which also are able to provide information on corrosion rates, ER probes are not exclusively required to perform this assessment. As such, validation of <1mpy corrosion rates in all applications is not possible, nor should it be required. Demonstration of this 100mV shift is in accordance with NACE SP0169-2013, and numerous international standards, which have long established this as evidence of effective cathodic protection and not requiring validation of material loss rates through other means. Inclusion of the requirement to verify effectiveness of the 100mV shift, as evidence by also monitoring corrosion rate over time, is beyond the scope and requirements of NACE SP0169-2013 and all international CP standards, and thus, should not be included in LR-ISG-2015-01. Recommend removing requirement to validate corrosion rate (<1mpy) when demonstrating the 100mV polarization criteria. Acceptability of 100mV shift as an acceptance criterion could be documented in an engineering evaluation, if necessary.	The staff does not agree with this comment. The 100mV polarization criterion may not be effective in a mixed metal environment. This is reinforced by ISO 15589-1, which states, “[f]urthermore, the criteria [100 mV polarization] shall not be used in case of pipelines connected to or consisting of mixed metal components.” The typical nuclear site contains buried mixed metals. AMP XI.M41states that if the 100mV polarization criterion is used, the applicant verifies the effectiveness of the cathodic protection system. The AMP provides one recommended method to demonstrate that the cathodic protection system is effective. If an applicant selects this method, it can declare its program consistent in regard to using the 100 mV polarization criterion. An applicant can state an exception to the AMP, propose an alternative way to demonstrate the effectiveness of the cathodic protection system, and provide the basis to explain why the method will be effective.

57	Page B-10 and B-11 Element 6.k. ISO 15589-1, an international standard on cathodic protection, cites additional cathodic protection guidance on cathodic protection acceptance criteria that should be incorporated into XI.M41. The acceptance criteria for cathodic protection polarization of steel piping, specifically the -850mV criterion, should be modified to incorporate guidance provided in ISO 15589-1. This ISO standard lists other CP potential values based upon soil resistivity. <100ohm-m -850mV 100-1000 ohm-m -750mV >1000ohm-m -650mV The -650 mV and -750 mV criteria based on soil resistivity should not need to be confirmed by the 1mpy criterion. Recommend revising Table 6 to allow the application of -650 mV and -750 mV acceptance criteria based on soil resistivity and deleting confirmation by the 1mpy criterion and require only soil resistivity be verified every 5 years.	The staff does not agree with this comment; however, a related change was incorporated. See the response to Comment No. 55.
58	Page B-10 and B-11 Element 6.k The 1 mpy acceptance criterion should be revised to note that corrosion rates in excess of 1 mpy may also be acceptable if the corrosion rate would not result in a loss of intended function prior to the end of the PEO. Recommend adding the following to the first paragraph on page B-11 just prior to the last sentence: <u>Corrosions rates in excess of 1mpy may be acceptable if an engineering evaluation demonstrates that the corrosion rate would not result in a loss of intended function prior to the end of the PEO.</u>	The 1 mpy criterion is an industry-accepted standard. For example, it is cited in NACE SP-0169-2013, Section 6.1, “Criteria and Other Considerations for Cathodic Protection, Introduction.” However, the staff agrees with this comment. The staff recognizes that some buried pipe systems, depending on the pipe design pressure and wall thickness, may have adequate margin to allow a higher annual corrosion rate. AMP XI.M41 was revised to include a recommendation that the engineering evaluation be cited and summarized in the LRA. The purpose of the summary in the LRA is for the staff to effectively determine the adequacy of the evaluation or to formulate followup questions.
59	Element 7.a / Page B-11 Nonconforming fill requires guidance on corrective actions to focus results. …observed damage will not lead to further degradation (e.g., indirect assessments of coatings / CP integrity or CP performance within specifications to address risks to damaged areas).	The staff does not agree with this comment. The recommendations in the comment are not related to mitigating the potential impact of damage to the coatings. The AMP recommendation is to assess the extent of the nonconforming backfill. The staff revised the wording to more clearly align with the extent of the degraded backfill. The wording, “in the vicinity of the observed damage” is intended to communicate that the extent of condition is not meant to encompass the entire site, but rather the degraded backfill in the vicinity where the deleterious materials were detected. However, if repeated instances of detecting deleterious material in the backfill that caused damage to coatings occur, it would be expected that a licensee would appropriately respond via its corrective action program.

60	Element 7.b / Page B-11 Editorial – Incorrect comma usage. …large area minimum wall thickness and local area wall thickness…	Editorial change incorporated.
61	Element 7.c / Page B-11 Where the coatings, backfill, or the condition of exposed piping reveals piping integrity results that do not meet acceptance criteria, the degraded component is repaired or replaced. In addition, an expansion of sample size is conducted to evaluate the at-risk condition identified (e.g., damaged coatings due to nonconforming fill and poor CP). The number of inspections within the affected piping categories are doubled or increased by 5, whichever is smaller. If nonconforming piping integrity conditions are identified 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. Recommend restricting corrective actions to integrity-driving risks and not merely nonconforming controls.	The staff agrees with this comment. Based on its review of an extensive number of buried pipe inspection results, there are instances where minor coating or base material damage is noted. However, the depth or extent of the damage to the base material would not warrant an extent of condition inspection plan. The intended function of typical buried piping and tanks is to ensure that sufficient flow at adequate pressure can be delivered to downstream in-scope components. This function could be met even though leakage is occurring. The staff revised the recommendation to conduct extent of condition inspections to those instances where degradation in base material, regardless of cause, could result in a potential challenge to the pressure boundary.
62	Element 7.f. / page B-12 This recommended corrective action does not seem necessary. Alternatives to the -850mV criterion are intended to demonstrate, through other means, whether the CP system is effective. If, through these other means, CP is still found to be ineffective, the consequence should be no different than if the -850mV criterion was used and not met…specifically, it would count against the Effectiveness criteria contained in Table 4 and result in changes in preventive action categories (e.g., drop from Category C to E or F). If corrosion rates consistently came back >1mpy, indicative of on-going corrosion, the piping segment would thereby meet category E or F, and require inspection. If corrosion rates came back >1mpy once or twice over 10 years, this would not be indicative of significant corrosion and cause for concern. Recommended change: ~~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.~~	The staff agrees with the logic of this comment. The purpose of establishing acceptance criteria for the cathodic protection system is to establish reasonable assurance that loss of material will not challenge the intended function of a buried component. The outcome of assessing the effectiveness of the cathodic protection system should be the same regardless of the criteria or means to assess the effectiveness. The staff deleted the sentence as recommended.

63	Appendix B “Corrective Actions”, page B-12 Corrective Actions element part “g” discusses the option of monitoring the activity of a jockey pump instead of inspecting buried fire water system piping. It contains a cross reference to “4.d.i”. The cross reference seems incorrect as Section 4 “Detection of Aging Effects” part “d” does not contain an item “i”. It seems that the correct cross reference should be 4.e.i.	An editorial change was incorporated to remove reference to the earlier section of the AMP.
64	Element 10 / Page B-12 SP0169-2013 has relevant guidance for design / application of CP. Such as those prescribed in NACE SP0169-2007, NACE SP0169-2013, and NACE RP0285-2002	The staff does not agree with adopting the 2013 edition of NACE SP0169-2013. See the response to Comment No. 19.
65	Element 10 / Page B-12 Editorial – Incorrect comma usage. …plant-specific and nuclear industry operating experience and to modify its AMP, accordingly.	Editorial change incorporated.
66	References / Page B-13 Suggest adding EPRI guidance, if permissible. Recommendations for Buried Piping / Tanks and the Buried Piping NDE Reference Guide.	The staff added EPRI 1021175, “Recommendations for an Effective Program to Control the Degradation of Buried and Underground Piping and Tanks,” to the reference list. The document contains valuable information about buried piping and tanks (e.g., potential causes of failure, risk ranking considerations) and is publically available at no charge.
67	General We agree with many of the revisions incorporated by this ISG. The revisions are based on industry operating experience and lessons learned consistent with the NEI 09-14 industry initiative for management of underground piping and tank integrity. The revisions provide flexibility for aging management of underground piping and tanks, incorporation of applicable program improvements, and consideration of applicable industry operating experience. Comment – no revision required.	No response required
68	Appendix B, d. ECDA tools have had limited success in nuclear power plants (ASME PVP2012 Session 2.1P). SP0502 tools can be useful with a skilled operator with an understanding of the limitations. Add after has been effective: “under certain conditions with a nuclear power plant experienced technician”	The staff reviewed the AMP recommendations for selecting piping inspection locations and determined that sufficient guidance was provided by the first sentence to not require an example. The sentence associated with ECDA was deleted.

69	Appendix B, i. Soil-to-pipe is incorrect, replace with pipe-to-soil.	Editorial change incorporated.
70	Good	No response required
71	In Appendix B under Section 6 on Page B-9 of draft LR-ISG-2015-01 it states that the qualifications of the individual that is evaluating the coatings for coated piping or tanks. It invokes the NACE Coating Inspector Program Level 2 or 3 inspector qualification. It also allows for an individual who has attended the EPRI Comprehensive Coatings Course and completed the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course. Invoking the EPRI Comprehensive Coatings Course is overly restrictive and not consistent to what is done within the industry. ASTM D-33 developed ASTM D7108 (Standard Guide for Establishing Qualifications for a Nuclear Coatings Specialist) and this standard is invoked by Regulatory Guide *1.54,* Rev. 2. Suggest the sentence be revised to state, or an individual who is a Nuclear Coatings Specialist qualified in accordance with ASTM D7108 and completed the EPRI Buried Pipe Condition Assessment and Repair Training Computer Based Training Course.	The staff agrees with this comment. See the response to Comment No. 46.

72	My questions and comments relate to the "Alternative Cathodic Protection Acceptance Criteria" that are described in LR-ISG-2015-01. The following alternative cathodic protection (CP) acceptance criteria were added for buried piping and tanks going through license renewal: (a) -750 mV (CSE) instant-off structure-to-soil potential where the soil resistivity is greater than: (a) 10,000 ohm-cm to less than 100,000 ohm-cm, and (b) -650 mV (CSE) instant-off structure-to-soil potential where the soil resistivity is greater than 100,000 ohm-cm. We understand that the staff added these criteria for soils with higher resistivity based on its inclusion in international standards, the staff's review of industry papers on alternative acceptance criteria, and a recommendation to verify the alternative acceptance criteria through the use of electrical resistance (ER) probes to verify that the corrosion rate is less than 1 mpy. It would appear that these two alternative criteria are far less restrictive than the minimum -850 mV (CSE) polarized instant-off criteria as referenced in NACE SP0169-2013 or Table 6a "Cathodic Protection Acceptance Criteria" that is referenced in the previous Staff Guidance LR-ISG-2011-03 (i.e., -850 mV instant-off potential or the 100 mV minimum polarization that is limited to electrically isolated sections of pipe). The following are my questions / comments. Based on these questions and comments I believe additional guidance from the NRC should be provided:	No response is required for this portion of the comment. The subparts of the comment are addressed in Comment Nos. 73 – 76.
73	We have a client that has installed coupon test stations for buried piping at their site; however they do not have ER probes installed. We have conducted limited testing on the soil backfill in the lab for various chemical species, pH, % moisture content, soil resistivity (soil box method) and have performed linear polarization resistance (LPR) testing of the soil samples in the lab using a carbon steel coupon. LPR corrosion rate testing could also be performed in the field at the coupon test stations using the Native and CP Coupons. I assume that LPR, corrosion rate test results would also be applicable to qualify use of the Alternative CP Acceptance Criteria?	Based on its review of NACE RP-0502-2002, “Standard Recommended Practice Pipeline External Corrosion Direct Assessment Methodology,” the staff will not revise AMP XI.M41 to incorporate LPR testing in lieu of electrical resistance corrosion probes. The basis for this is that LPR probes measure an instantaneous rate of corrosion. The testing results could under predict the cumulative rate of loss of material over time. In addition, NACE International Publication 05107, “Report on Corrosion Probes in Soil or Concrete,” states that the inputs used for LPRs are not valid under applied CP potentials and some instruments only provide a qualitative indication of corrosion by pitting. In addition, Figure 6, “Range of Operation of LPR Probes in Soil and Concrete,” of this document reveals limited applicability for one type of LPR probe (without solution resistance compensation) in the soil resistivity and loss of material rates of interest. As with all recommendations in an AMP, an applicant can state an exception and provide a basis for using alternative method.

74	Since some of the pipe is backfilled with engineered fill, the Wenner 4-pin method for determining soil resistivity (ASTM G57) would not be applicable, as these measurements are taken in remote areas (typically outside of the plant area) where the readings would not be influenced by buried structures beneath the pins. The Wenner 4-pin readings would therefore be more applicable for measuring the soil resistivity of the native soil at the site, rather than the soil backfill. For measuring the soil backfill resistivity, the soil box method (ASTM G187) using "as-found" and "saturated" soil samples from around the pipe should be performed. Is this a correct assumption?	No changes to the AMP are proposed or necessary. AMP XI.M41 does not provide specific guidance on methods to determine soil resistivity, beyond recommending the periodicity of testing, number and location where the measurement is taken (i.e., in the vicinity in which in-scope components are buried).
75	How often do you collect soil samples for resistivity testing along a piping system and how do you apply these readings to the alternative criteria? Is there a maximum distance from the pipe that the soil samples should be collected and tested? For example are 2 or 3 soil box resistivity readings measured at a plant typically sufficient to prove that the soils have higher resistivity (i.e., >10,000 ohm-cm), or should the use of the alternative criteria be based on assessment of documentation that indicates similar soil backfill conditions exist on any given section of pipe and using the soil box resistivity data from pipe excavations for that system.	No changes to the AMP are proposed or necessary. AMP XI.M41 recommends the: (a) periodicity of measuring soil resistivity; (b) location of samples, in that readings are taken in the vicinity of the buried component of interest; and (c) the minimum number of soil samples, that being, 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. The maximum distance that samples are taken from a component of interest is at the discretion of site or contractor personnel used by the applicant taking into consideration plant-specific configurations
76	How many ER probes (or LPR corrosion rate measurements) are considered necessary to verify that the corrosion rate is less than 1 mpy? ER probes rely on changes in the cross sectional area of a buried electrical resistance conductor that is exposed to the soil environment next to the pipe and typically the probe is furnished with a check element to verify equipment accuracy. For ER probes typically you would measure the corrosion rate with the same instrument on a quarterly basis and then trend the data to determine corrosion rate over several years so the corrosion rate can be determined as a function of environmental conditions such as rain fall and periods of drought. They can be electrically connected to the structure with an external grounding cable so the probe can provide a continuous record of the CP system effectiveness. Are LPR measurements using a carbon steel coupon exposed to the soil sample or LPR measurements from coupon test stations considered acceptable alternatives for determining corrosion rate?	The staff's position regarding the use of LPR probes is addressed in the response to Comment No. 73. The staff has concluded that the number and location of ER probes necessary to verify a corrosion rate of less than 1 mpy is a plant-specific determination. These parameters are derived by individuals meeting the qualification recommendations in AMP XI.M41 (e.g., NACE CP4).