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DRAFT LICENSE RENEWAL INTERIM STAFF GUIDANCE
LR-ISG-2011-03

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

INTRODUCTION

This license renewal interim staff guidance (LR-ISG) LR-ISG-2011-03, "Changes to the Generic Aging Lessons Learned (GALL) Report Revision 2 Aging Management Program (AMP) XI.M41, 'Buried and Underground Piping and Tanks'," provides changes to GALL Report AMP XI.M41 as described below. The AMP, as modified herein, provides one acceptable approach for managing the effects of aging of buried and underground piping and tanks within the scope of the License Renewal Rule (Title 10 of the *Code of Federal Regulations*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" (10 CFR Part 54)). This LR-ISG also changes Table 3.0-1, "FSAR Supplement for Aging Management of Applicable Systems," in the Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR). A licensee may reference this ISG in its license renewal application (LRA) to demonstrate that its buried and underground piping and tanks program is acceptable to the staff until the guidance in this LR-ISG is implemented into the next update of the license renewal guidance documents.

DISCUSSION

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

- include inspection recommendations for plants not utilizing a cathodic protection system during the period of extended operation;
- remove the recommendation to volumetrically inspect underground piping to detect internal corrosion;
- recommend that further increases in inspection sample size should be based on an analysis of extent of cause and extent of condition when adverse conditions are detected in the initial and subsequent doubled sample size, rather than continuing to double the sample size;

- add a recommendation that, where damage to the coating is significant and the damage was caused by non-conforming backfill, an extent of condition evaluation should be conducted to ensure that the as-left condition of backfill in the vicinity of observed damage will not lead to further degradation;
- add specific acceptance criteria for cathodic protection surveys;
- add the specific preventive and mitigative actions utilized by the AMP in the FSAR Supplement description of the program; and
- insert editorial changes or clarifications.

Appendix A of this LR-ISG contains the revised AMP XI.M41. Appendix B contains the changes to SRP-LR Table 3.0-1.

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

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

- Demonstrate through the submission of a study that external corrosion control (i.e., cathodic protection and coatings) is not needed. This could be accomplished by conducting soil samples in the vicinity of buried in-scope piping and demonstrating that the soil is not corrosive and conducting pipe-to-soil potential measurements demonstrating that the potentials are acceptable. Soil testing should consist of multiple samples. Each sample should test for soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, and redox potential. The potential soil corrosivity should be determined for each material type of buried in-scope piping. In addition to evaluating each individual parameter, the overall soil corrosivity should be determined. The initial testing should be conducted prior to submitting the application, and a summary of the results and conclusions should be submitted with the LRA. The AMP and Updated Final Safety Analysis Report (UFSAR) Supplement should reflect that testing will continue to be conducted once in each 10-year period starting 10 years prior to the period of extended operation. The basis for soil sample locations, soil sample results, the methodology and results of how the overall soil corrosivity was determined, pipe-to-soil potential measurements, and overall conclusion demonstrating that a corrosive condition does not exist should be included in the application.

- Demonstrate through the submission of a study the impracticality of installing or operating a cathodic protection system. This study should be conducted by a competent person as defined in NACE SP 0169-2007, Section 1.3, Introduction, who is knowledgeable in the design, installation, and operation of cathodic protection systems. The study should be submitted with the LRA.

Given the importance of plant-specific operating experience when cathodic protection is not utilized, the applicant must conduct a 20-year search of operating experience for evidence of adverse conditions as described in Section 4.f., Adverse Indications, of Appendix A of this ISG. This search should include components that are not in-scope for license renewal if they are constructed of the same materials and buried in a similar soil environment as in-scope components, because given the similarity in materials and soil environment they represent a reasonable predictor of potential corrosion issues for in-scope piping. The results of this expanded plant-specific operating experience search should be included in the LRA.

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

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

- Given that licensees risk rank their inspection locations based on the potential for and consequence of failure, the code class safety-related and hazardous material piping inspection columns were combined into one inspection category, thus providing greater flexibility in selecting inspection locations with the highest potential risk;

- Given that the potential for piping degradation increases with time, the inspection quantities for some materials increase throughout the 30-year period starting 10 years prior to entering the period of extended operation;

- Minimum and not to exceed inspections quantities were added to the percentage-based inspections quantities. The staff utilized data provided during the review of several license renewal applications to determine an average amount of buried in-scope piping.

The inspections quantities were derived from this average. Minimum and not to exceed values were included to address plants that differ significantly from the average values; and

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

Removal of the Recommendation to Volumetrically Inspect Underground Piping to Detect Internal Corrosion

The staff recognizes that AMP XI.M41 is a program designed to detect and manage the effects of aging on the external surfaces of buried and underground piping and tanks and that aging of internal surfaces is addressed in other GALL Report AMPs. As such, AMP XI.M41, Program Element 4.c.iv is being revised to delete the recommendation to perform volumetric inspections of external surfaces of underground pipe to detect internal corrosion. This is consistent with the staff position stated in NUREG-1950, "Disposition of Public Comments and Technical Basis for Changes in the License Renewal Guidance Documents NUREG-1801 and NUREG-1800," page IV-175, and Comment Number 1070. Due to removing the recommendation to perform volumetric exams of underground piping from AMP XI.M41, the staff is considering ISGs to other more appropriate AMPs to include this concept.

Sample Size Increase Changes when Adverse Conditions are Identified

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

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

When inspections are halted because of the planned replacement of piping, the completion of the replacement of the piping system, or portion of the system, would be based upon either the station's need to return the system to service for non-Technical Specification-related systems (e.g., demineralized water, circulating water) or the allowed outage time for Technical

Specification-related systems (e.g., diesel fuel oil, auxiliary feedwater, essential service water). For example, a leaking circulating water line could prevent the station from operating until it was replaced if it impacted multiple condenser water boxes. The Technical Specification allowed outage time results in a defined time period based on the safety significance of the system in which the system must be replaced, tested and returned to operable status.

Recommendation Related to Coating Damage Caused by Inappropriate Backfill

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

Cathodic Protection Survey Acceptance Criteria

Based on staff findings during AMP audits, multiple sites do not have an upper limit on cathodic protection pipe-to-soil potential. If the cathodic protection pipe-to-soil values are too high, coating damage can occur. The staff deleted the general reference to the NACE standards for the acceptance criteria and incorporated the NACE SP0169-2007 specific cathodic protection survey acceptance criteria into the AMP. The instant off and -100mV minimum polarization testing criteria listed in NACE SP0169-2007 were selected because proper correction for voltage drops can be difficult given the typical configuration of buried piping in nuclear power plant yard structure areas.

Changes to the FSAR Supplement Description of the Program

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

Key Miscellaneous or Editorial Changes

- Table 2a, NACE RP0285-2002 references were added where recommendations were related to piping and tanks.
- Table 2a, footnote 6, deleted reference to damage to coatings because this footnote only applied to polymer materials, and AMP XI.M41 does not recommend coatings for this material.
- Program Element 4.b.x.B. changed the inspection frequency for internal inspections from 5 years to 10 years to align with the frequency of excavated direct visual inspections. Program Element 4.b.x.A., an alternative to allow hydrostatic testing in lieu of inspections, was not revised to a frequency of every 10 years given that rather than

obtaining quantitative data, this test method represents a “go, no go” methodology that the staff believes should be repeated at the recommended interval versus 10 years.

- Program Elements 4.c.vii. and 4.e.vi. deleted the words, “[w]hen access permits,” from the instruction to conduct visual inspections for polymeric materials that are augmented with manual examinations to maintain consistency with Program Elements 4.b.vii. and 4.d.v.

ACTIONS

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

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

The U.S. Nuclear Regulatory Commission (NRC) is not proposing to treat buried piping and underground piping and tanks as “newly identified” systems, structures, and components (SSCs) under 10 CFR 54.37(b). Therefore, any additional action on such materials which the NRC may impose upon current holders of renewed operating licenses under 10 CFR Part 54 would not fall within the scope of 10 CFR 54.37(b).

BACKFITTING DISCUSSION

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

<u>Compliance with the Backfit Rule</u>

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

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

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

APPENDICES

Appendix A, "Revised GALL Report AMP XI.M41"

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

REFERENCES

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

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

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

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

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

Appendix A

Revised GALL Report AMP XI.M41

XI.M41 BURIED AND UNDERGROUND PIPING AND TANKS

Program Description

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

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

Management of aging of the internal surfaces of buried and underground piping and tanks is accomplished through the use of other aging management programs (e.g., “Open Cycle Cooling Water System” (AMP XI.M20), “Closed Treated Water System” (AMP XI.M21A), “Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components” (AMP XI.M38), “Fuel Oil Chemistry” (AMP XI.M30), “Fire Water System” (AMP XI.M27), or “Water Chemistry” (AMP XI.M2)). This program does not address selective leaching. The Selective Leaching of Materials (AMP XI.M33) is applied in addition to this program for applicable materials and environments.

The terms “buried” and “underground” are fully defined in Chapter IX of the GALL Report. Briefly, buried piping and tanks are in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks are below grade but are contained within a tunnel or vault such that they are in contact with air and are located where access for inspection is restricted.

Evaluation and Technical Basis

1. ***Scope of Program:*** This program is used to manage the effects of aging for buried and underground piping and tanks constructed of any material including metallic, polymeric, cementitious, and concrete materials. The program addresses aging effects such as loss of material, cracking, and changes in material properties. Typical systems in which buried and underground piping and tanks may be found include service water piping and components, condensate storage transfer lines, fuel oil and lubricating oil lines, fire protection piping and piping components (fire hydrants), and storage tanks. Loss of material due to corrosion of piping system bolting within the scope of this program is managed using this program. Other aging effects associated with piping system bolting are managed through the use of the Bolting Integrity Program (AMP XI.M18).

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

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

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

Table 2a. Preventive Actions for Buried Piping and Tanks

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

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Coatings are provided based on environmental conditions (e.g., stainless steel in chloride containing environments). Provide justification when coatings are not provided. When provided, coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002.
3. Coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002. A broader range of coatings may be used if justification is provided in the LRA.
4. Cathodic protection is in accordance with NACE SP0169-2007 or NACE RP0285-2002. The system should be operated so that the cathodic protection criteria and other considerations described in the standards are met at every location in the system. The duration of deviations from these criteria should not exceed 90 days. When deviations from the criteria are noted during annual surveys, the 90 days commences from the date of the owner being provided the survey results. The system monitoring interval discussed in Section 10.3 of NACE SP0169-2007 may not be extended beyond one year. The equipment used to implement cathodic protection need not be qualified in accordance with 10 CFR Part 50, Appendix B.
5. Backfill is consistent with SP0169-2007 Section 5.2.3 or NACE RP0285-2002 Section 3.6. The staff considers backfill that is located within 6 inches of the component that meets ASTM D 448-08 size number 67 to meet the objectives of SP0169-2007 and NACE RP0285-2002. For materials other than aluminum, the staff also considers the use of controlled low strength materials (flowable backfill) acceptable to meet the objectives of SP0169-2007. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections described in program element 4 of this AMP. Backfill is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's coatings, or the surface of the component, if not coated due to the backfill.
6. Backfill is consistent with SP0169-2007 Section 5.2.3. The staff considers backfill that is located within 6 inches of the component that meets ASTM D 448-08 size number 10 to meet the objectives of SP0169-2007. The staff also considers the use of controlled low strength materials (flowable backfill) to meet the objectives of SP0169-2007. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections described in program element 4 of this AMP. Backfill not meeting this standard, in either the initial or subsequent inspections, is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to the component's surface due to the backfill.
7. Backfill limits apply only if piping is coated.
8. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).

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

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

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

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

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

Table 2b. Preventive Actions for Underground Piping and Tanks

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

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

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

monitored by manual examinations. Loss of material is monitored by visual inspection of the exterior of the piping or tank and wall thickness of the piping or tank. Wall thickness is determined by a non-destructive examination technique such as ultrasonic testing (UT). Two additional parameters, the pipe-to-soil potential and the cathodic protection current, are monitored for steel, copper, and aluminum piping and tanks in contact with soil to determine the effectiveness of cathodic protection systems and, thereby, the effectiveness of corrosion mitigation.

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

a. Opportunistic Inspections

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

b. Directed Inspections – **Buried Pipe**

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

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

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

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

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

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

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

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

ix. Fire mains are inspected in accordance with Table 4a unless they are subjected to either a flow test as described in Section 7.3 of NFPA 25 at a frequency of at least one test in each 1-year period or the activity of the jockey pump (or equivalent equipment or parameter) is monitored on an interval not to exceed one month. At a minimum, a flow test is conducted by the end of the next refueling outage or as directed by the current licensing basis, whichever is shorter, when unexplained changes in jockey pump activity (or equivalent equipment or parameter) are observed.

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

A. At least 25 percent of the in-scope piping constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR Part 195 Subpart E on an interval not to exceed five years.

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

Table 4a. Inspections of Buried Pipe

Material[1]	**Preventive Actions[2,9]**	**Inspections[3,7] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]**		
		Years 30 – 40	Years 40 – 50	Years 50 - 60
Titanium				
Super Austenitic Stainless[4]				
Stainless Steel		1[8]	1[8]	1[8]

Table 4a. Inspections of Buried Pipe				
Material[1]	Preventive Actions[2,9]	Inspections[3,7] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]		
		Years 30 – 40	Years 40 – 50	Years 50 - 60
HDPE[5]	A	1[8]	1[8]	1[8]
	B	1%, NTE 2	2%, NTE 3	3%, NTE 4
Other Polymer[6]	A	1[8]	1[8]	1[8]
	B	1%, NTE 2	2%, NTE 4	4%, NTE 6
Cementitious or Concrete		1[8]	1[8]	1[8]
Steel	C	0.5%, NTE 1[8]	0.5%, NTE 1[8]	0.5%, NTE 1[8]
	D	1%, NTE 2	1%, NTE 2	1%, NTE 2
	E	1%, NTE 2	1%, NTE 2	1%, NTE 2
	F	5%, NTE 7	6%, NTE 10	7.5%, NTE 12
	G	10%, NTE 15	12%, NTE 20	15%, NTE 25
Copper	C	0.5%, NTE 1[8]	0.5%, NTE 1[8]	0.5%, NTE 1[8]
	D	1%, NTE 2	1%, NTE 2	1%, NTE 2
	E	1%, NTE 2	1%, NTE 2	1%, NTE 2
	F	2.5%, NTE 3	3%, NTE 4	4%, NTE 5
	G	5%, NTE 6	6%, NTE 8	8%, NTE 10
Aluminum	C	0.5%, NTE 1	0.5%, NTE 1	0.5%, NTE 1

Table 4a. Inspections of Buried Pipe

Material[1]	Preventive Actions[2,9]	Inspections[3,7] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]		
		Years 30 – 40	Years 40 – 50	Years 50 - 60
	D	1%, NTE 2	1%, NTE 2	1%, NTE 2
	E	1%, NTE 2	1%, NTE 2	2%, NTE 2
	F	5%, NTE 6	6%, NTE 8	7.5%, NTE 10
	G	10%, NTE 12	12%, NTE 16	15%, NTE 20

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried piping are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Preventive actions are categorized as follows:
   A. Backfill is in accordance with Table 2a of this AMP.
   B. Backfill is not in accordance with Table 2a of this AMP.
   C. Cathodic protection provided:
      i. installed 5 years prior to the end of the inspection period of interest (i.e., prior to 35, 45, 55), and
      ii. operational 90 percent of the time since installation. Time periods in which the cathodic protection system is secured for testing do not count against the 90 percent availability criterion, and
      iii. provides adequate protection for 100 percent of the area for which protection is claimed. Any area for which the as-left protection from annual cathodic protection surveys does not meet the acceptance criteria will, on a proportional basis, be inspected to category F or G as appropriate. For example, if 10 percent of the cathodic protection survey points are left in the under protected range after the annual survey, then 10 percent of the inspections from the applicable F or G category should be conducted in addition to those from the applicable category C row. These additional inspections should be conducted in the vicinity of under protected portions of the piping system.
   D. Cathodic Protection provided:
      i. installed less than 5 years prior to the end of the inspection period of interest, or
      ii. operation less than 90 percent of the time since installation. Time periods in which the cathodic protection system is secured for testing do not count against the 90 percent availability criterion. It should be noted that, Table 2a, "Preventive Actions for Buried Piping and Tanks, footnote 4, states that, "[t]he system [cathodic protection] should be operated so that the cathodic protection criteria and other considerations described in the standards are met at every location in the system. The duration of deviations from these criteria should not exceed 90 days."
   E. External corrosion control is not required.
   F. Cathodic protection not provided. This category should be selected even if the applicant has demonstrated, that cathodic protection is not practical:
      i. cathodic protection not provided in accordance with C – D above; however,
      ii. coatings and backfill are provided in accordance with Table 2a of this AMP, and
      iii. 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
      iv. soil has been demonstrated to be not corrosive for the material type.
   G. Cathodic protection not provided. This category should be selected even if the applicant has demonstrated, that cathodic protection is not practical:

Table 4a. Inspections of Buried Pipe				
Material[1]	Preventive Actions[2,9]	Inspections[3,7] of In-scope Piping [Not to Exceed (NTE) Number of Inspections]		
		Years 30 – 40	Years 40 – 50	Years 50 - 60

i. cathodic protection not provided in accordance with C – E above; and
ii. coatings or backfill are not provided in accordance with Table 2a of this AMP; or
iii. one or more items of adverse plant-specific operating experience (i.e., leaks in buried piping due to external corrosion, or significant coating degradation or metal loss in more than 10 percent of inspections conducted); or
iv. soil testing has not been conducted or the soil is corrosive for the material type.

3. Guidance related to the extent of inspections:
   i. Table 4a lists the recommended inspections based on a percent of the total length of piping of a material type, or a maximum number of discrete inspections (i.e., the not to exceed number of inspections).
   ii. When the percentage of inspections for a given material type results in an inspection quantity less than 10 feet, then 10 feet of piping should be inspected. If the entire run of piping of that material type is less than 10 feet in total length, then the entire run of piping should be inspected.
   iii. When a not to exceed inspection quantity or number of inspections is used to determine the extent of inspections for a material type, a minimum of 10 feet of piping should be inspected during each inspection. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected and only one inspection is required in that interval.
   iv. If fire protection piping will be inspected by excavations in lieu of alternative testing (e.g., flow test, jockey pump monitoring) and the extent of inspections is not based on the percentage of piping in the material group, then additional inspections should be added to the NTE value for that material type. If the NTE value for that material type is less than 10, add 1 inspection, otherwise add 2 inspections.
4. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).
5. High Density Polyethylene (HDPE) pipe includes only HDPE pipe approved for use by the NRC for buried applications.
6. Other polymer piping includes some HDPE pipe and all other polymeric materials including composite materials such as fiberglass.
7. Inspections may be reduced to one-half (when 2 or more inspections are listed) the level indicated in the table when performing the indicated inspections necessitates excavation of piping that has been fully backfilled using controlled low strength material. In conducting these inspections, the backfill may be excavated and the pipe examined, or the soil around the backfill may be excavated and the controlled low strength material backfill examined. The corrosion rate of piping that is fully encased within controlled low strength material backfill that shows no signs of degradation, particularly cracking, is expected to be minimal.
8. No inspections are necessary if all the piping constructed from under consideration is fully backfilled using controlled low strength material.
9. In order to demonstrate that soil is not corrosive, the applicant should:
   i. Obtain a minimum of three sets of soil samples in each soil environment (e.g., moisture content, soil composition) in the vicinity in which in-scope components are buried.
   ii. The soil should be tested for soil resistivity, corrosion accelerating bacteria, pH, moisture, chlorides, and redox potential.
   iii. The potential soil corrosivity should be determined for each material type of buried in-scope piping. In addition to evaluating each individual parameter, the overall soil corrosivity should be determined.
   iv. Soil testing should be conducted prior to submitting the application and once in each ten-year period starting 10 years prior to the period of extended operation.
   v. A summary of the results and conclusions of the soil testing should be provided in the LRA.

c. Directed Inspections – **Underground Pipe**

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

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

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

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

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

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

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

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

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

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

Material[1]	**Inspections[2] of In-Scope Piping [(NTE) Not to Exceed Number of Inspections]**
Titanium	
Super Austenitic Stainless[3]	
Stainless Steel	1
HDPE[4]	1
Other Polymer[5]	1
Cementitious or Concrete	1
Steel	2%, NTE 2
Copper	1%, NTE1
Aluminum	1%, NTE 1

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for underground piping are to be included in the titanium category). Material categories are generally aligned with P numbers

Table 4b. Inspections of Underground Pipe for all Inspection Periods	
Material[1]	**Inspections[2] of In-Scope Piping [(NTE) Not to Exceed Number of Inspections]**

as found in the ASME Code, Section IX. Steel is as defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.

2. Guidance related to the extent of inspections:
   i. Table 4b lists the recommended inspections based on a percent of the total length of piping of a material type, or a maximum number of discrete inspections (i.e., the not to exceed number of inspections).
   ii. When the percentage of inspections for a given material type results in an inspection quantity less than 10 feet, then 10 feet of piping should be inspected. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected.
   iii. When a not to exceed inspection quantity or number of inspections is used to determine the extent of inspections for a material type, a minimum of 10 feet of piping should be inspected during each inspection. If the entire run of piping of that material type is less than10 feet in total length, then the entire run of piping should be inspected and only one inspection is required in that interval.
   iv. If fire protection piping will be inspected in lieu of alternative testing (e.g., flow test, jockey pump monitoring) and the extent of inspections is not based on the percentage of piping in the material group, then 1 additional inspection should be added to the NTE value for that material type.
3. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).
4. HDPE pipe includes only HDPE pipe approved for use by the NRC for buried applications.
5. Other polymer piping includes some HDPE pipe and all other polymeric materials including composite materials such as fiberglass.

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

A. At least 25 percent of the in-scope piping constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR Part 195, Subpart E on an interval not to exceed five years.

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

d. Directed Inspections – **Buried Tanks**

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

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

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

iv. Examinations may be conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. If the tank is inspected from the external surface, a minimum

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

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

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

Table 4c. Inspections of Buried Tanks for all Inspection Periods

Material[1]	Preventive Actions[2]	Inspections
Titanium		
Super Austenitic Stainless[3]		
Stainless Steel		
HDPE[4]	A B	 X
Other Polymer[5]	A B	 X
Cementitious or Concrete		X
Steel	C D E	 X
Copper	C D E	 X
Aluminum	C D E	 X

1. Materials classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for buried tanks are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Preventive actions are categorized as follows:
   A. Backfill is in accordance with Table 2a of this AMP.
   B. Backfill is not in accordance with Table 2a of this AMP.
   C. Cathodic protection provided, or external corrosion control is not required. If cathodic protection is provided:
      i. installed 5 years prior to the end of the inspection period of interest (i.e., prior to 35, 45, 55), and
      ii. operational 90 percent of the time since installation. Time periods in which the cathodic protection system is secured for testing do not count against the 90 percent availability criterion. It should be noted that, Table 2a, “Preventive Actions for Buried Piping and Tanks, footnote 4, states that, “[t]he system [cathodic protection] should be operated so that the cathodic protection criteria and other considerations described in the standards are met at every

Table 4c. Inspections of Buried Tanks for all Inspection Periods		
Material[1]	Preventive Actions[2]	Inspections
location in the system. The duration of deviations from these criteria should not exceed 90 days." D. Cathodic Protection provided: i. installed less than 5 years prior to the end of the inspection period of interest, or ii. operation less than 90 percent of the time since installation. E. Cathodic protection is not provided. 3. Super austenitic stainless steel (e.g., Al6XN or 254 SMO). 4. HDPE includes only HDPE material approved for use by the NRC for buried applications. 5. Other polymer includes some HDPE material and all other polymeric materials including composite materials such as fiberglass.		

e. Directed Inspections – **Underground Tanks**

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

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

Table 4d. Inspections of Underground Tanks for all Inspection Periods	
Material[1]	**Inspections**
Titanium	
Super Austenitic Stainless[2]	
Stainless Steel	
HDPE[3]	
Other Polymer[4]	
Cementitious or concrete	
Steel	X
Copper	
Aluminum	

1. Material classifications are meant to be broadly interpreted (e.g., all alloys of titanium that are commonly used for underground tanks are to be included in the titanium category). Material categories are generally aligned with P numbers as found in the ASME Code, Section IX. Steel is as defined in Chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.
2. Super austenitic stainless steel (e.g., Al6XN or 254 SMO).
3. HDPE includes only HDPE material approved for use by the NRC for buried applications.
4. Other polymer includes some HDPE material and all other polymeric materials including composite materials such as fiberglass.

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

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

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

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

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

f. Adverse Indications

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

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

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

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

5. ***Monitoring and Trending:*** For piping and tanks protected by cathodic protection systems, potential difference and current measurements are trended to identify changes in the effectiveness of the systems and/or coatings. If aging of fire mains is managed through

monitoring jockey pump activity (or similar parameter), the jockey pump activity (or similar parameter) is trended to identify changes in pump activity that may be the result of increased leakage from buried fire main piping.

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

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

Material	Criteria[1]
Steel	-850 mV, instant off, or -100 mV minimum polarization
Copper	-100 mV minimum polarization
Aluminum	-100 mV minimum polarization
1. To prevent damage to the coating, the limiting critical potential should not be more negative than -1200 mV.	

b. For coated piping or tanks, there should be either no evidence of coating degradation or the type and extent of coating degradation should be insignificant as evaluated by an individual possessing a NACE operator qualification or otherwise meeting the qualifications to evaluate coatings as contained in 49 CFR Parts 192 and 195. Where damage to the coating has been evaluated as significant and the damage was caused by non-conforming backfill, an extent of condition evaluation should be conducted to ensure that the as-left condition of backfill in the vicinity of observed damage will not lead to further degradation.

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

d. Cracking or blistering of nonmetallic piping is evaluated.

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

f. Backfill is in accordance with specifications described in program element 2 of this AMP.

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

h. For hydrostatic tests, the condition “without leakage” as required by 49 CFR 195.302 may be met by demonstrating that the test pressure, as adjusted for temperature, does not vary during the test.

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

7. ***Corrective Actions:*** The site corrective actions program, quality assurance (QA) procedures, site review and approval process, and administrative controls are implemented in

accordance with the requirements of 10 CFR Part 50, Appendix B. The staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.

8. ***Confirmation Process:*** The confirmation process ensures that preventive actions are adequate to manage the aging effects and that appropriate corrective actions have been completed and are effective. The confirmation process for this program is implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.

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

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

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

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

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

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

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

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

References

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

49 CFR Part 195 Subpart E, *Transportation of Hazardous Liquids by Pipeline, Pressure Testing*. Office of the Federal Register, National Archives and Records Administration, 2009.

AASHTO R 27, *Standard Practice for Assessment of Corrosion of Steel Piling for Non Marine Applications*, American Association of State Highway and Transportation Officials, Washington DC, 2006.

ASME Boiler and Pressure Vessel Code, Section IX, *Welding and Brazing*, American Society of Mechanical Engineers, 2004.

ASME Standard B31.3, *Process Piping*, Appendix M, American Society of Mechanical Engineers, 2002.

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

J. A. Beavers and C. L. Durr, *Corrosion of Steel Piping in Non Marine Applications*, NCHRP Report 408, Transportation Research Board, National Research Council, Washington DC, 1998.

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

NACE Recommended Practice RP0502-2010, *Pipeline External Corrosion Direct Assessment Methodology*, 2010.

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

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

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

American Water Works Association (AWWA) C105 Polyethylene Encasement for Ductile-Iron Pipe Systems, 2010, Denver, CO.

APPENDIX B

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

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