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 and to augment other programs which manage the aging of internal 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 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 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.

With, in some cases, the assistance of this program, 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 (AMP XI.M20), Treated Water (AMP XI.M21A), Internal Inspection of Miscellaneous Piping and Ducts (AMP XI.M38), Fuel Oil Chemistry (AMP XI.M30), Fire Water System (AMP XI.M27) or Water Chemistry (AMP XI.M2). Additionally, this program does not address selective leaching. The selective leaching program (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. 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 (air, soil, or 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

ii. Fire mains are installed in accordance with National Fire Protection Association (NFPA) Standard 24. Preventive actions for fire mains beyond those in NFPA 24 need not be provided if the system undergoes a periodic flow test in accordance with NFPA 25 as described in program element 4 of this AMP.

Table 2a, Preventive Actions for **Buried** Piping and Tanks

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

1. Materials classifications are meant to be broadly interpreted; e.g., all alloys of titanium which 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. When provided, coatings are in accordance with Table 1 of NACE SP0169-2007 or Section 3.4 of NACE RP0285-2002.

3. Coatings are provided based on environmental conditions (e.g., stainless steel in chloride containing environments). If coatings are not provided, a justification is provided in the LRA.

4. Cathodic protection is in accordance with NACE SP0169-2007 or NACE RP0285-2002. 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 10 CFR 50 Appendix B qualified. Cathodic protection need not be provided if:

   a. Soil resistivities > 20,000 ohm cm. If this condition is met, inspections in Table 4a are conducted in accordance with Table 4a footnote 2 item C.

   b. Corrosion rates, based on at least 5 years of data, which indicate that minimum design wall thickness for the buried pipe or tank will not be reached within the period of extended operation. The corrosion rates may be based on measurements taken from actual uncoated pipe or may be approximated for coated piping, which is assumed to contain flaws in the coating, from bare metal coupons of similar material exposed, on site, to soil of similar conditions (e.g., resistivity, ionic content, moisture content, etc). Multiple corrosion measurements are necessary when a length of pipe passes through varying soil types. If this condition is met, inspections in Table 4a are conducted in accordance with Table 4a footnote 2 item D.

5. Backfill is consistent with SP0169-2007 section 5.2.3. The staff considers backfill which is located within 6 inches of the pipe that meets ASTM D 448-08 size number 67 to meet the objectives of SP0169-2007. Backfill quality may be demonstrated by plant records or by examining the backfill while conducting the inspections conducted in program element 4 of this AMP. Backfill not meeting this standard is acceptable if the inspections conducted in program element 4 of this AMP do not reveal evidence of mechanical damage to pipe coatings due to the backfill.

6. Aggregate size for backfill within 6 inches of the pipe must meet ASTM D 448-08 size number 10.

7. Backfill limits apply only if piping is coated.

8. Super austenitic stainless steel, e.g., Al6XN or 254 SMO.

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[4]	
Stainless Steel	X[3]
Steel	X
Copper	X
Aluminum	X[3]
Cementitious or Concrete	
Polymer	

1. Materials classifications are meant to be broadly interpreted; e.g., all alloys of titanium which 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. 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. Coatings are provided based on environmental conditions (e.g., stainless steel in chloride containing environments). If coatings are not provided, a justification is provided in the LRA.

4. 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 cracking. Changes in material properties are monitored by manual examinations. Loss of material is monitored by visual appearance 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 material of construction 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.

ii. Unless otherwise indicated, directed inspections as indicated in Table 4a will be conducted during each 10 year period beginning 10 years prior to the entry into the period of extended operation.

iii. Inspection locations are selected based on susceptibility to degradation. Characteristics such as coating type, coating condition, cathodic protection efficacy, backfill characteristics and soil resistivity are considered.

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

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. For the purpose of this program element, fire mains will be considered to be code class/safety related piping and inspected as such unless they are subjected to a flow test as described in section 7.3 of NFPA 25 at an frequency of at least one test in each six month period.

x. Inspection as indicated in (A), and (B) below may be performed in lieu of the inspections contained in Table 4a for either code class/safety significant or hazmat piping or both:

A. At least 25% of the code class/safety related or hazmat piping or both constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR 195 subpart E on an interval not to exceed 5 years.

B. At least 25% of the code class/safety related or hazmat piping or both constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet this paragraph. Internal inspections are to be conducted at an interval not to exceed 5 years. Consideration should be given to NACE SP0169-2007 sections 6.1.2 and 6.3.3

Table 4a, Inspections of **Buried Pipe**

Material[1]	Preventive Actions[2]	Inspections[3]	
		Code Class Safety Related[4]	Hazmat[5]
Titanium			
Super Austenitic Stainless[7]			
Stainless Steel		1[6]	1[6]
HDPE[8]	A B	1[6] 2	1[6] 1%
Other Polymer[9]	A B	1[6] 2	1[6] 1%
Cementitious or Concrete		1[6]	1[6]
Steel	C D	1[6] 1	1[6] 2%

	E	4	5%
	F	8	10%
Copper	C	1[6]	1[6]
	D	1	1%
	E	1	2%
	F	2	5%
Aluminum	C	1[6]	1[6]
	D	1	2%
	E	1	5%
	F	2	10%

1. Materials classifications are meant to be broadly interpreted; e.g., all alloys of titanium which 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 NACE SP0169-2007 and Table 2a.

   B Backfill is not in accordance with NACE SP0169-2007 and Table 2a.

   C Cathodic protection, coatings, and backfill have been provided in accordance with NACE SP0169-2007 and Table 2a. Each cathodic protection system has been operated in accordance with NACE SP0169-2007 for at least 90% of the time since the piping under consideration was installed or it was inspected in accordance with this program element.

   D Cathodic protection, coatings, and backfill have been provided in accordance with NACE SP0169-2007 and Table 2a. Each cathodic protection system has been operated in accordance with NACE SP0169-2007 for at less than 90% of the time since the piping under consideration was installed or it was inspected in accordance with this program element.

   E Coatings and backfill are in accordance with NACE SP0169-2007 and Table 2a but cathodic protection is not provided.

   F Preventive actions provided do not meet criteria C, D, or E.

3. Inspections are listed as either a discrete number of visual examinations (excavations) or as a percentage of the linear length of piping under consideration. The following guidance related to the extent of inspections is provided:

   a. Each inspection will examine either the entire length of a run of pipe or a minimum of 10 feet.

   b. If the length of pipe to be inspected based on the number of inspections times the minimum inspection length (10 feet) exceeds 10% of the length of the piping under consideration, only 10% need be inspected.

c. If the length of pipe to be inspected based on the total length of pipe under consideration times percentage to be inspected is less than 10 feet, either 10 feet or the total length of pipe present, whichever is less, will be inspected.

4. Code Class and safety related pipe which also meets the definition of hazmat pipe will be inspected as hazmat pipe.

5. Hazmat pipe is pipe which, during normal operation, contains material which, if released, could be detrimental to the environment. This includes chemical substances such as diesel fuel and radioisotopes. To be considered hazmat, the concentration of radioisotopes within the pipe during normal operation must exceed established standards such as EPA drinking water standard. In the absence of such standards, the concentration of the radioisotope must exceed the greater of background or reliable level of detection. For tritium, the EPA drinking water standard (20,000 pCi/L) is used. (This approach for defining hazmat is consistent with that used in classifying fluid services in ASME B31.3 appendix M.)

6. Only 1 inspection is conducted even if both Code Class/safety related and hazmat pipe are present.

7. Super austenitic stainless steel, e.g., Al6XN or 254 SMO.

8. High Density Polyethylene (HDPE) pipe includes only HDPE pipe approved for use by the NRC for buried applications.

9. Other polymer piping includes some HDPE pipe, and all other polymeric materials including composite materials such as fiberglass.

c. Directed Inspections – **Underground Pipe**

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

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

iii. Inspection locations are selected based on susceptibility to degradation. Characteristics such as coating type, coating condition, exact external environment, and flow characteristics within the pipe, are considered.

iv. Underground pipes are inspected visually to detect external corrosion and by a volumetric technique such as UT to detect internal 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. For the purpose of this program element, fire mains will be considered to be code class/safety related piping and inspected as such unless they are subjected to a flow test as described in section 7.3 of NFPA 25 at an frequency of at least one test in each six month period.

x. Inspection as indicated in (A), and (B) below may be performed in lieu of the inspections contained in Table 4a for either code class/safety significant or hazmat piping or both:

A. At least 25% of the code class/safety related or hazmat piping or both constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR 195 subpart E on an interval not to exceed 5 years.

B. At least 25% of the code class/safety related or hazmat piping or both constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet this paragraph. Internal inspections are to be conducted at an interval not to exceed 5 years. Consideration should be given to SP0169-2007 sections 6.1.2 and 6.3.3

Table 4b, Inspections of **Underground Pipe**

Material[1]	Inspections[2]	
	Code Class Safety Related[3]	Hazmat[4]
Titanium		
Super Austenitic Stainless[6]		
Stainless Steel	1[5]	1[5]
HDPE[7]	1[5]	1[5]
Other Polymer[8]	1[5]	1[5]
Cementitious or Concrete	1[5]	1[5]
Steel	2	5%
Copper	1	2%
Aluminum	1	2%

1. Materials classifications are meant to be broadly interpreted; e.g., all alloys of titanium which 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 as defined in chapter IX of this report. Polymer includes polymeric materials as well as composite materials such as fiberglass.

2. Inspections are listed as either a discrete number of visual examinations (excavations) or as a percentage of the linear length of piping under consideration. The following guidance related to the extent of inspections is provided:

   a. Each inspection will examine either the entire length of a run of pipe or a minimum of 10 feet.

   b. If the length of pipe to be inspected based on the number of inspections times the minimum inspection length (10 feet) exceeds 10% of the length of the piping under consideration, only 10% need be inspected.

   c. If the length of pipe to be inspected based on the total length of pipe under consideration times percentage to be inspected is less than 10 feet, either 10 feet or the total length of pipe present, whichever is less, will be inspected.

3. Code Class and safety related pipe which also meets the definition of hazmat pipe will be inspected as hazmat pipe.

4. Hazmat pipe is pipe which, during normal operation, contains material which, if released, could be detrimental to the environment. This includes chemical substances such as diesel fuel and radioisotopes. To be considered hazmat, concentration of radioisotope within the pipe during normal operation must exceed established standards such as EPA drinking water standard. In the absence of such standards, the concentration of the radioisotope must exceed the greater of background or reliable level of detection. For tritium, the EPA drinking water standard (20,000 pCi/L) is used. (This approach for defining hazmat is consistent with that used in classifying fluid services in ASME B31.3 appendix M)

5. Only 1 inspection is conducted even if both Code Class/safety related and hazmat pipe are present.

6. Super austenitic stainless steel, e.g., Al6XN or 254 SMO.

7. HDPE pipe includes only HDPE pipe approved for use by the NRC for buried applications.

8. Other polymer piping includes some HDPE pipe, and all other polymeric materials including composite materials such as fiberglass.

d. Directed Inspections – Buried Tanks

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

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

iii. Each buried tank is examined if it is Code Class/safety related or contains hazardous materials as defined in footnote 5 to Table 4a and 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% 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 1 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.

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**

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 which 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 NACE RP0285-2002 and Table 2a.

B Backfill is not in accordance with NACE RP0285-2002 and Table 2a.

C Cathodic protection, coatings, and backfill have been provided in accordance with NACE RP0285-2002 and Table 2a. Each cathodic protection system has been operated in accordance with NACE RP0285-2002 for at least 90% of the time since the piping under consideration was installed or it was inspected in accordance with this program element.

D Cathodic protection, coatings, and backfill have been provided in accordance with NACE RP0285-2007 and Table 2a. Each cathodic protection system has been operated in accordance with NACE RP0285-2002 for at less than 90% of the time since the piping under consideration was installed or it was inspected in accordance with this program element.

E Cathodic protection is not provided.

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.

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.

iii. Each underground tank which is Code Class/safety related or contains hazardous materials as defined in footnote 5 to Table 4a and 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% 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 1 measurement is required per square foot of tank surface. If the tank is inspected internally by another volumetric technique, at least 90% of the surface of the tank must be inspected.

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.

Table 4d, Inspections of **Underground Tanks**

Material[1]	Inspections
Titanium	
Super Austenitic Stainless[2]	
Stainless Steel	
HDPE[3]	
Other Polymer[4]	
Cementitious or concrete	
Steel	X
Copper	
Aluminum	

1. Materials classifications are meant to be broadly interpreted; e.g., all alloys of titanium which 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 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 pipe includes only HDPE pipe approved for use by the NRC for buried applications.

4. Other polymer piping includes some HDPE pipe, and all other polymeric materials including composite materials such as fiberglass.

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 which are the result of inspections will result in an expansion of sample size as described in item iv, below. Adverse indications which are the result of monitoring of a cathodic protection system may warrant increased monitoring of the cathodic protection system and/or additional inspections. Examples of adverse indications resulting from inspections include leaks, material thickness less than minimum, the presence of coarse backfill with accompanying coating degradation within 6 inches of a coated pipe or tank (see Table 2a Footnotes 5 and 6), and general or local degradation of coatings so as to expose the base material.

ii Adverse indications which 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. An analysis may be conducted to determine the potential extent of the degradation observed. Expansion of sample size may be limited by the extent of piping or tanks subject to the observed degradation mechanism.

iv. If adverse indications are detected, inspection sample sizes within the affected piping categories are doubled. If adverse indications are found in the expanded sample, the inspection sample size is again doubled. This doubling of the inspection sample size continues as necessary.

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 as describe in NACE Standards RP0285-2002 and SP0169-2007.

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

a. Criteria for soil-to-pipe potential are listed in NACE RP0285-2002 and SP0169-2007.

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 a NACE certified inspector.

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.

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 industry experience may be of significance to an applicant's program:

a. On February 21, 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) Section XI, "Repair/Replacement Plan".

b. On September 6, 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 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 which 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.

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

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

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

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

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

49 CFR 195 subpart E, Transportation of Hazardous Liquids by Pipeline, Pressure Testing.

ASME Standard B31.3 – 2002, Process Piping, Appendix M.

ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing.