

# **GUIDELINE FOR THE MANAGEMENT OF UNDERGROUND PIPING AND TANK INTEGRITY**

**November 2012**



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**Nuclear Energy Institute**

**Guideline for the  
Management of  
Underground Piping and  
Tank Integrity**

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## **REVISION SUMMARY**

<b>Revision</b>	<b>Description of Changes</b>
0	Initial issue
1	<p>Extensive revision. Most significant changes:</p> <ul style="list-style-type: none"><li>• Included text and intent of the Underground Piping and Tank Integrity Initiative</li><li>• Included “shall” statements to designate expectations that must be met or deviations from them justified</li><li>• Added “Definitions” (Section 4)</li><li>• Added an expectation that significant inspection findings and new operating experience related to underground piping and tanks be communicated to NEI (Section 5.1)</li><li>• Expanded the explanation of the intent of the Initiative and included clarifications of the Initiative scope (Section 6)</li><li>• Expanded guidance for justifying deviations from the Initiative (Section 6.2.6)</li><li>• Added Appendix B, a summary of the Initiative requirements in NEI 09-14</li></ul>
2	<ul style="list-style-type: none"><li>• Incorporated the response to inquiries received on revision 1</li><li>• Added appendix C: Guidance for Inspection Planning</li><li>• Made editorial changes as appropriate</li></ul>

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# **GUIDELINE FOR THE MANAGEMENT OF UNDERGROUND PIPING AND TANK INTEGRITY**

## **1 BACKGROUND**

This Guideline for the Management of Underground Piping and Tank Integrity describes the policy and practices that the industry commits to follow in managing underground piping and tanks. The Underground Piping and Tanks Integrity Initiative supersedes the Buried Piping Integrity Initiative; it incorporates all of its elements and adds additional scope and milestones.

The Buried Piping Integrity Initiative was approved by NSIAC (Nuclear Strategic Issues Advisory Committee) in November 2009. When the Buried Piping Integrity Initiative was approved, the scope was limited to piping that was in direct contact with the soil due to the inability to directly inspect this piping and due to the potential impact on the environment and public confidence if leakage occurred. However additional operating experience has shown that piping that is below grade and is not in direct contact with the soil and underground tanks can also degrade with potential adverse consequences. As a result, the Underground Piping and Tanks Integrity Initiative was developed to incorporate and expand upon the Buried Piping Integrity Initiative: its scope also includes selected underground piping that is not in direct contact with the soil and specified underground tanks. The key milestone implementation dates in the Underground Piping and Tanks Integrity Initiative were established to reflect the added initiative scope and its effect on the station resources that will be required to add these items into existing programs. The Underground Piping and Tanks Integrity Initiative was approved by NSIAC in September 2010.

Utility implementation of the Initiative will be verified as directed by the NSIAC.

This guideline contains the following information:

- The text and scope of the Underground Piping and Tanks Integrity Initiative (the “Initiative”).
- The goals that drive the Initiative.
- Key definitions.
- Roles and responsibilities established to ensure implementation of the Initiative.
- Explanation of the intent of the Initiative.
- Insights for effective and consistent implementation within the industry.
- The content of the report to NSIAC on progress of implementing the Initiative.

The approach to addressing underground piping and tank issues embodied in this Initiative compliments the expectations in place under the Ground Water Protection Initiative, which was approved by NSIAC in 2006 and which remains in effect (guidance on implementation of the

Ground Water Protection Initiative is provided in NEI 07-07, *Industry Ground Water Protection Initiative, Final Guidance Document* (Reference 3). The Underground Piping and Tanks Integrity Initiative focuses on assessing in-scope components in order to provide reasonable assurance of their continued structural and leakage integrity with special emphasis on licensed materials. The focus of the Ground Water Protection Initiative (GPI) is on improving the management of situations involving inadvertent radiological releases that get into ground water and the communications with external stakeholders about those events. Integral to the Ground Water Protection Initiative is an evaluation of the potential for unintended leaks of licensed materials resulting from work activities and components that contain or could contain licensed material, including some components that are within the Underground Piping and Tanks Integrity Initiative scoping. In addition, under the GPI, early detection measures are established. If licensed material is detected by early detection measures, plant personnel are expected to appropriately investigate, remediate and communicate with external stakeholders. Utilities should establish governance to ensure that the activities under the two Initiatives are communicated and coordinated.

## 2 INTRODUCTION

Underground piping and tanks are used in several applications at plants with different governing requirements:

- safety related pipe and tanks
  - governed by plant Technical Specifications and ASME Code,
- non-safety related pipe and tanks containing licensed material in liquids or gases
  - governed by NRC regulations and within the scope of NEI's Ground Water Protection Initiative
- other pipes and tanks in non-safety related systems containing water, fuel oils, gases or other media
  - may be governed by local, State and EPA regulations.

The material condition of underground piping and tanks may not be fully characterized, and one of the means of protecting buried components, cathodic protection, may not have been properly maintained at some stations. In recent years, some self revealing leaks have occurred that could impact public confidence, regulatory margin, and, in some cases, plant operation. Additional impacts that could occur if performance is not improved could be:

- safety and operational challenges
- environmental impacts
- increased regulatory requirements for new and existing plants
- EPA violations with stakeholder or media interest
- license renewal delays
- heightened public opposition to new plant construction

As noted in the executive endorsement of the Underground Piping and Tanks Integrity Initiative, the leaders in the nuclear industry recognize that additional industry action directed at assessing the condition of underground piping and tanks within the nuclear fleet is warranted.

Implementation of an assessment program is designed to limit the potential for unintended leaks or integrity breaches. The industry's goal is to proactively address the integrity of underground piping and tanks and where possible, prevent leakage before it occurs using available technologies and other control and evaluative processes. To assure consistent and measured progress in this area an NSIAC Initiative addressing underground piping and tank integrity was approved to commit commercial nuclear power plants to specific program elements. The scope of the Underground Piping and Tanks Integrity Initiative includes selected piping and tanks on the site that are below grade and outside of buildings.

The EPRI Document “*Recommendations for an Effective Program to Control the Degradation of Buried Pipe*” (Reference 1) provides important additional considerations for successful implementation of the buried piping aspect of the Initiative.

NSIAC provides oversight of industry implementation of the Underground Piping and Tanks Integrity Initiative. Periodic reports will be prepared for NSIAC addressing:

- Progress on implementation of the elements of this initiative and any deviations.
- Industry experience and lessons learned.
- Progress of technology development.

Specific guidance on the periodic report is included in Appendix A.

### **3 INDUSTRY INITIATIVE ON UNDERGROUND PIPING AND TANK INTEGRITY**

The Buried Piping Integrity Initiative was approved by NSIAC in November 2009. An extension of the Buried Piping Integrity Initiative that addresses selected underground piping and tanks was approved in September, 2010. The revised Initiative is known as the Underground Piping and Tanks Integrity Initiative.

The expected actions and milestone dates relevant to a given component depend upon whether the component was in the original scope of the Buried Piping Integrity Initiative or in the scope of the revised and renamed Underground Piping and Tanks Integrity Initiative. The scope, goal, and text of the two Initiatives is provided in the following sections.

#### **3.1 SCOPE**

The scope of the Underground Piping and Tanks Integrity Initiative includes the following.

##### **A. Those within the scope of the original Buried Piping Integrity Initiative:**

- All piping that is below grade and
  - Contains any fluid and
  - Is in direct contact with the soil

##### **B. And the following additional components:**

- Underground piping and tanks that are outside of a building and below grade (whether or not they are in direct contact with the soil) if they
  - Are safety related
    - Or -
  - Contain licensed material or are known to be contaminated with licensed material.

#### **3.2 INITIATIVE GOAL**

The goal of the Underground Piping and Tanks Integrity Initiative is to provide reasonable assurance of structural and leakage integrity of in-scope underground piping and tanks with special emphasis on piping and tanks that contain licensed materials.

The Underground Piping and Tanks Integrity Initiative will:

- Drive proactive assessment and management of the condition of piping and tanks that fall within the Initiative scope.
- Ensure sharing of industry experience.
- Drive technology development to improve available techniques for inspecting and analyzing underground piping and tanks.

- Improve regulatory and public confidence in the industry's management of the material condition of its underground tanks and piping systems.

### **3.3 INITIATIVE ACTIONS**

In order to meet these goals, every utility shall implement measures or program(s) to satisfy the elements and associated key attributes in Sections 3.3.A and B. The language in Sections 3.3.A and B below documents the text of the Underground Piping and Tanks Initiative as approved by NSIAC.

#### **A. Original Buried Piping Integrity Initiative Elements**

The components governed by the original Buried Piping Integrity Initiative are described in Part A of Section 3.1 (Scope). The following elements, attributes, and milestones were established by the original Buried Piping Integrity Initiative when it was approved in November 2009. The EPRI document "*Recommendations for an Effective Program to Control the Degradation of Buried Pipe*" provides additional details on these elements and attributes.

Some changes are included in the Initiative description below (as compared to the version approved in November 2009) to clarify meaning, but their intent is unchanged and they remain in effect under the Underground Piping and Tanks Integrity Initiative.

##### **1. Procedures and Oversight – By June, 30, 2010:**

- Ensure clear roles and responsibilities including senior level accountability for the Buried Pipe Integrity Program.
- Develop a Buried Pipe Integrity Program document and implementing procedures.

##### **2. Risk Ranking – Risk Rank buried piping segments by December 31, 2010. Risk Ranking shall incorporate the following attributes:**

- Pipe function
- Pipe locations and layout
- Pipe materials and design
- Health of cathodic protection systems, if applicable
- Based on the above data and other information, determine:
  - The likelihood of failure of each piping segment
  - The consequences of failure of each piping segment
- A means to update the risk ranking as necessary
- A database to track key program data, inspection results, and trends

3. **Inspection Plan** – By June 30, 2011, develop an inspection plan to provide reasonable assurance of integrity of buried piping. This plan shall include the following key attributes:
  - Identification of piping segments to be inspected
  - Potential inspection techniques
  - Inspection schedule for buried piping segments based on risk ranking
  - Assessment of cathodic protection, if applicable
4. **Plan Implementation** – Implementation of the Inspection Plan shall start no later than June 30, 2012. The condition assessment of buried piping containing radioactive material shall be completed by June 30, 2013.
5. **Asset Management Plan** – Inspection results shall be used as input to the development of an asset management plan for buried piping. This plan shall receive a high level of review and approval and will be in place by December 31, 2013.

## **B. Underground Piping and Tanks Integrity Initiative Elements**

The components falling within the scope of the Underground Piping and Tanks Integrity Initiative are described in Part B of Section 3.1 (Scope). The elements, attributes, and milestones described below are established for the additional scope of the Underground Piping and Tanks Integrity Initiative.

1. **Procedures and Oversight** – By December 31, 2011
  - Identify the plant programs or measures that manage the material condition of components within the scope of the Underground Piping and Tanks Integrity Initiative.
  - Establish the necessary controls and implementing process to coordinate the applicable programs and measures and ensure they meet the intent of the Initiative.
  - Establish clear roles and responsibilities including senior level accountability for implementation of the Underground Piping and Tanks Integrity Initiative.
2. **Prioritization** – Prioritize underground piping and tanks by June 30, 2012. Prioritization shall consider the following attributes:
  - Function
  - Locations and layout
  - Materials and design
  - Process fluid
  - Health of cathodic protection systems, if applicable

- Based on the above data and other information, determine:
    - The likelihood of failure of each component
    - The consequences of failure of each component
  - A means to update the prioritization scheme as necessary
  - Process(es) to allow retrieval of key program data
3. **Condition Assessment Plan(s)** – By December 31, 2012 develop or identify existing condition assessment plans that will provide reasonable assurance of integrity of components within the additional scope of the Underground Piping and Tanks Integrity Initiative. These plans shall include the following key attributes:
- Identification of underground piping and tanks to be assessed
  - Potential assessment techniques
  - Assessment schedules that take into account the relative priority of components. This schedule should be coordinated with the schedule developed for the original Buried Piping Integrity Initiative to ensure that the components with the highest overall priority are addressed first.
  - Assessment of cathodic protection, if applicable
4. **Plan Implementation** – Implementation of the Condition Assessment Plan for underground piping and tanks shall start no later than June 30, 2013. The condition assessment of underground piping and tanks containing radioactive material shall be completed by June 30, 2014.
5. **Asset Management Plan** – Inspection results shall be used as input to the development of asset management plans for components within the scope of the Underground Piping and Tanks Integrity Initiative. These plans shall receive a high level of review and approval and will be in place by December 31, 2014.

### 3.4 EXPECTATIONS

The expected outcome of the Underground Piping and Tanks Integrity Initiative is improved regulatory and public confidence in:

- the Industry's management of the material condition of its underground tanks and piping systems.
- the appropriateness of actions taken to establish reasonable assurance of their structural and leakage integrity.

Significant leaks from underground piping and tanks across the industry will be trended as a means of determining the Initiative's affect on the condition of these components.



In order to meet the goals of the Initiative, every utility should engage in industry activities (such as the Buried Piping Integrity Group) that support implementation of the Underground Piping and Tanks Integrity Initiative.

Industry organizations (EPRI, ANI, INPO, and NEI) cooperate in the manner described in this guideline and provide the information necessary to prepare periodic updates to NSIAC.

### **3.5 REQUIREMENTS**

Every utility shall ensure that activities associated with the Underground Piping and Tanks Integrity Initiative and this document are implemented at its nuclear power plants in accordance with the intent of the Initiative and the implementation dates specified therein. Whenever the word “shall” is used in this document it indicates an action that is required under the Underground Piping and Tanks Integrity Initiative. If a plant cannot or will not implement any part of the Initiative (Sections 3.3.A and B) or a “shall” statement in this document, a justification for deviation from the Initiative shall be developed and processed in accordance with Sections 6.2.1 and 6.2.6.

Appendix B captures all the required elements of this document. Users should not rely on this appendix alone, but should read the document to ensure that the context of the requirements is fully understood.

## **4 DEFINITIONS**

### **4.1 ACCESSIBLE**

Piping and tanks that can be routinely observed without the required support of special tools or other assistance. Activities that would indicate inaccessibility include removal of security devices or manways, use of lifting rigs, and performance of excavation, or modification of building structures, armored embedments or encasements.

### **4.2 ADVERSE INSPECTION FINDINGS**

Results from an inspection that has been determined to require an immediate repair or a repair within one operating cycle.

### **4.3 BELOW GRADE**

Locations below standard ground elevation as defined at the station.

### **4.4 BURIED PIPING**

Piping that is below grade and in direct contact with the soil.

### **4.5 ENVIRONMENTALLY HAZARDOUS MATERIALS**

Materials that are subject to EPA or EPA-authorized State regulations or that are specifically addressed in a plant's environmental program(s).

### **4.6 FAILURE**

A breach in the structural or leakage integrity of a piping system or a tank.

### **4.7 FLUIDS**

Fluids include both liquids and gases (including instrument air).

### **4.8 LICENSED MATERIAL**

Licensed material (from 10 CFR 20.1003) (or licensed radioactive material as used in this document) means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission. Components containing licensed material covered under NEI 09-14 should be

consistent with those identified in NEI 07-07 (Reference 3). This definition does not associate a specific level of radioactivity with licensed material because it is not possible to do so. A determination of what is licensed material in any situation must be made by radiation health personnel at each utility – see the discussion under scope for additional clarification.

#### **4.9 OUTSIDE OF A BUILDING**

A component is outside of a building if it is beyond the outside surface of all exterior walls and floors in the building.

#### **4.10 PIPING SEGMENT**

Portions of buried piping systems that are grouped together for risk ranking purposes based on similarities such as installation, manufacture, or environmental conditions. Some risk ranking methods may use other terms to refer to piping segments, such as zones.

#### **4.11 PRIORITIZATION**

The process of assigning relative importance of scoped components as determined by a set of parameters that reflect design and in situ conditions. The intent of the word “prioritization” as used in this document is to imply a process that is less formal than risk ranking.

#### **4.12 RUN TO FAILURE**

A strategy focused on repairing piping or tanks after leakage is discovered as opposed to assessing these items over time with the goal of preventing leakage.

#### **4.13 SAFETY RELATED**

Structures, systems, and components that are relied upon to remain functional during and following design basis events to ensure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the guidelines in 10CFR50 section 34(a)(1), 67(b)(2) or 10CFR100.11.

#### **4.14 SIGNIFICANT LEAKAGE**

Leaks which meet any of the following criteria

- Result in concentrations that could exceed the regulatory concentrations or limits established by the NRC or EPA, or
- Result in voluntary communication under the industry Ground Water Protection Initiative, or

- Result in the system or component being out of service

#### **4.15 TANK**

A fully enclosed stationary vessel used to hold or store fluids for distribution. Tanks are constructed primarily of non-earthen materials (e.g., wood, concrete, steel, or plastic) which provide structural support. Tanks do not include basins, ponds or reservoirs.

#### **4.16 TUNNEL**

A structure that is outside of a building, below grade, designed to accommodate personnel, and not routinely accessible.

#### **4.17 UNDERGROUND TANK**

All tanks that are outside of buildings and sufficiently below grade such that there is a reasonable possibility that leakage from inaccessible portions of the tank may not be detected. Detection can be accomplished by direct observation or by instrumentation that is capable of reliably detecting leakage before it becomes significant (see definition of Significant Leakage). The tanks may be in direct contact with concrete or located in trenches, underground vaults or tunnels. Within the context of this Initiative, underground tanks include abandoned tanks connected to active systems. *(Note that the word “underground” has a different meaning when used within the context of the Underground Piping and Tanks Integrity Initiative as compared to its meaning when used within the NRC’s Generic Aging Lessons Learned report (GALL, NUREG 1801). Chapter IX of GALL defines underground as below grade and not in direct contact with the soil. NEI 09-14 defines underground as including both components that are buried (in direct contact with the soil) plus those that are not indirect contact with the soil.)*

#### **4.18 UNDERGROUND PIPING**

All piping that is below grade, not accessible, and outside of buildings. Buried piping (below grade and in direct contact with the soil) is considered to be a subset of underground piping. *(Note that the word “underground” has a different meaning when used within the context of the Underground Piping and Tanks Integrity Initiative as compared to its meaning when used within the NRC’s Generic Aging Lessons Learned report (GALL, NUREG 1801). Chapter IX of GALL defines underground as below grade and not in direct contact with the soil.)*

#### **4.19 VAULT**

A structure that is outside of a building, below grade, not designed to accommodate personnel and not routinely accessible.

## 5 INDUSTRY ROLES AND RESPONSIBILITIES

This guideline will be implemented through the activities outlined below. These activities have the following intended purpose:

- Implementing the Underground Piping and Tanks Integrity Initiative
- Supporting the intent of the Initiative
- Verifying implementation of the Initiative through maintenance and monitoring of a set of metrics described in the report to NSIAC (Appendix A)
- Ensuring that operating experience related to underground piping and tank integrity is communicated
- Continuing research to identify and develop new techniques for inspection and maintenance/replacement of buried piping and tanks

### 5.1 UTILITIES

Utilities shall perform the following actions in support of the Initiative:

- Implement the actions required by the Initiative (Section 3.3 and all “shall” statements in this document).
- Process a justification for deviation (Section 6.2.6) whenever an action required by the Initiative or a “shall” statement in this document cannot be met.
- Report all results from inspections performed in accordance with the Initiative in the manner proscribed by the EPRI project manager responsible for the Buried Piping Integrity Group.
- Report to NEI the status of meeting the Initiative Implementation dates and any active deviations that do not meet the intent of the Initiative as required for the report to NSIAC (Appendix A)
- Report to INPO (EPIX/ICES) occurrences of leakage or adverse inspection findings in piping, and tanks within the scope of this Initiative as required for the report to NSIAC (Appendix A)

In order to meet the intent of the Initiative, utilities should:

- Participate in the industry programs that support the Initiative
- Contribute technical resources and executive leadership to industry efforts
- Communicate questions regarding the intent of the Initiative or the interpretation of this guideline to the Buried Piping Integrity Initiative Task Force. If a question relates to the text of the Initiative or a “shall” statement in this guideline, task force feedback on the questions would typically precede the development of a justification for deviation.

- Communicate instances of significant leakage or adverse inspection findings of piping and tanks within the scope of the Initiative to the NEI and the EPRI Buried Piping Integrity Group Project Managers in a timely manner for the purpose of rapid dissemination of preliminary operating experience and to request immediate assistance as needed.

## **5.2 EPRI**

EPRI performs the following functions in support of the Initiative:

- Support the real time assessment of operating experience as reported by utilities.
- Collect underground piping and tank inspection data obtained from utilities and evaluate its implications annually.
- Manage the research necessary to improve inspection technology for underground piping and tanks
- Support repair/replacement technology as appropriate
- Provide a venue for identifying research and development needs, sharing operating experience, and other issues that have the potential for impact on the industry
- Compile and report to NEI the information necessary to make periodic reports to NSIAC (Appendix A) on progress in the development of inspection technology

## **5.3 INPO**

INPO performs the following functions in support of the Initiative:

- Incorporate within their plant evaluations a review of buried/underground piping and tank programs as applicable. The review should include piping and tanks that may not be safety related but are important to safety or contain potentially radiologically contaminated fluids.
- Communicate operating experience relative to underground piping and tank integrity issues and other relevant information to the industry.
- Compile and report to NEI the operating experience information necessary to make periodic reports to NSIAC (Appendix A).

## **5.4 ANI**

ANI performs the following function in support of the Initiative:

- Report significant recommendations from inspections related to underground piping and tank integrity and observations on Initiative implementation to NEI in support of the periodic report to NSIAC (Appendix A).

## 5.5 NEI

NEI performs the following functions in support of the Initiative:

- Manage the industry's regulatory interface on underground piping and tank issues of generic regulatory significance.
- Manage the operation of the Buried Piping Integrity Working Group and Task Force. Task Force responsibilities include:
  - Addressing questions regarding the interpretation of the Initiative
  - Judging whether deviations from Initiative requirements meet the intent of the Initiative
  - Evaluating important operating experience
  - Evaluating the overall status of Initiative implementation as part of the report to NSIAC
- Communicate information relative to the Underground Piping and Tanks Integrity Initiative to the industry.
- Compile the information necessary to make periodic reports to NSIAC (Appendix A) on implementation of the Initiative.
- Communicate the periodic report to NSIAC on implementation of the Underground Piping and Tanks Integrity Initiative, industry operating experience, and inspection technology developments (Appendix A).
- Coordinate activities with utilities, EPRI, ANI, and INPO.

## **6 INTENT OF THE UNDERGROUND PIPING AND TANKS INTEGRITY INITIATIVE**

The following sections describe the activities and commitments that implement the Initiative actions presented in Section 3.3 of this document. Additional activities may also be necessary as industry experience and technology evolves.

Additional information on the intent of the Initiative is provided by EPRI document, “Recommendations for an Effective Program to Control the Degradation of Buried Pipe” (Reference 1). Although verbatim compliance with the EPRI guideline is not a commitment under the Initiative, the EPRI guidance forms the basis for the Initiative and provides additional details on the Initiative’s attributes and elements. References to the applicable sections of the EPRI document, where applicable, are provided in the descriptions in Section 6.2.

### **6.1 UNDERGROUND PIPING AND TANKS INTEGRITY INITIATIVE SCOPE**

The following are clarifications and explanations of the intent of the scope of the Initiative:

- In general, the piping and tanks that are subject to the Underground Piping and Tanks Integrity Initiative are determined by starting with the total population of utility owned piping and tanks within the site boundaries and adjusting this population using the scope statement in section 3.1 and the clarifications in this section. This will result in some low consequence components such as those associated with water and sewage treatment facilities and storm drains to be subject to the Initiative, but the components may not need to be inspected. Appendix C provides guidance on inspection of in-scope components.
- Abandoned piping and tanks that are drained, not connected to an active system, and that are not known to be contaminated with licensed material are not within the scope of the Initiative.
- Piping and tanks that are below grade are excluded from the scope of the Initiative if they are accessible for direct inspection (see definition of Accessible).
- Portions of piping systems that are contained within building walls or basemats are not considered “underground” and are not within the scope of the Initiative.
- Underground piping includes buried piping, and piping in vaults, trenches, tunnels, beneath buildings, or encased in concrete.
- Piping owned by others that runs inside of the owner controlled area is not within the scope of the Initiative.
- If a vault is not accessible from inside a building, piping or tanks within the vault are considered outside of the building and within the scope of the Initiative even if the vault shares a wall with the building.



- Owner's piping located outside of the owner controlled area is not within the scope of the Initiative unless it is safety related or contains licensed material.
- Pump casings (the column or pipe that surrounds the actual pump) that penetrate the floors of buildings are not within the scope of the Initiative even if the casing is in contact with the soil.
- Some tanks that are safety related or contain licensed material sit at grade on a concrete donut shaped foundation with a center filled with compacted sand. The key factor that determines if such a tank is within the scope of the Initiative is the position of the bottom of the tank with respect to grade and the capability of detecting leaks by monitoring the tank level. If the tank contains licensed material, it is incumbent on the licensee to ensure that the tank is covered by either the Underground Piping and Tanks Integrity Initiative or the Ground Water Protection Initiative.
- Licensed material (from 10 CFR 20.1003) means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission. 10 CFR 20.1003 . The term "licensed material" as used in this document is intended to be consistent with its meaning in the Ground Water Protection Initiative (NEI 07-07, Reference 3, Objective 2.2, Source Containing Licensed Material). Consistent with Regulatory Issue Summary RIS 2008-03 "Return/Re-use of Previously Discharged Licensed Material" "licensed material" as applied in the Underground Piping and Tank Integrity Initiative does not include the concentration(s) of radioactive material previously released as a controlled, planned airborne or liquid radioactive effluent when it is returned to the facility in concentrations below the exempt concentration limits in 10 CFR 30. See the definition of licensed material (section 4.8) for more information.

## **6.2 UNDERGROUND PIPING AND TANKS INTEGRITY INITIATIVE IMPLEMENTATION**

The goal of the Underground Piping and Tanks Integrity Initiative is to provide reasonable assurance of structural and leakage integrity of in-scope underground piping and tanks with special emphasis on components that contain licensed materials. The concept of reasonable assurance within the context of the Initiative means establishing and maintaining confidence in underground piping and tank integrity based on engineering judgment supported by facts, actions, knowledge, experience, and/or observations. It defines a level of confidence which is deemed to be adequate to support a particular position.

The approach used to establish reasonable assurance should include leakage prevention by means of inspection as a key part of its process. It should be systematic and based on defined programs and processes that produce consistent results. The approach should be documented and supported by engineering evaluation, governing procedures, and risk ranking. It should be continuously validated by the results of examinations and fitness-for-service evaluations, and by the experience gained from required repairs and applied mitigation methods.

Although the Underground Piping and Tanks Integrity Initiative will provide a high level of confidence in the integrity of underground piping and tanks, it is not possible to guarantee that

there will be no leakage or no structural degradation in these components. This initiative is intended to reduce the probability and consequences of underground piping and tank issues as low as reasonably achievable.

Some utilities include tanks in the same program as buried piping and some have separate programs for tanks. The objective of the Underground Piping and Tanks Integrity Initiative is not to dictate a specific approach; rather it is to ensure that by whatever means utilities manage these components, the applicable guidance in the programs meet the intent of the Initiative as explained in this document.

## **A. Activities within the Buried Piping Integrity Initiative Scope**

### **6.2.1 Procedures and Oversight**

The necessary governance and oversight responsibilities shall be in place by June 30, 2010. These include the procedures and oversight elements in section 3.3 and the following items.

- Clear lines of responsibility  
The Buried Piping Integrity Program shall be established including the identification of a responsible executive who will carry out the senior level functions specified in the Initiative and this guideline.
- Process for justifying and approving exceptions to the Initiative  
When a utility determines that a required element of the Initiative cannot be met, a technical justification for deviation shall be developed and retained with the utility's program documentation. The technical justification should provide the basis for determining that the proposed deviation meets the same objective, or level of conservatism exhibited by the original work product, and should clearly state how long the deviation will be in effect. Justifications for deviation shall be reviewed and approved in accordance with the applicable plant procedures with concurrence from the responsible utility executive.

Each utility shall report all approved justifications for deviation that are currently active at each of its plants to NEI semi-annually as part of the utility's input to the NSIAC report.

Note that the entire process for justifying deviations is described in Section 6.2.6.

- Program Documents and Implementing Procedures  
A Program Plan and associated procedures shall be developed to implement the Underground Piping and Tanks Integrity Initiative. The program documents and implementing procedures shall implement, as a minimum, the elements of the Underground Piping and Tanks Integrity Initiative (Section 3.3) and requirements in this document. Guidance for the specific content of the program document may be obtained from Sections 1.4.1 and 1.4.2 in the EPRI document on buried piping, "Recommendations for an Effective Program to Control the Degradation of Buried Pipe (Reference 1)."

### **6.2.2 Risk Ranking**

A risk ranking process shall be used to understand site vulnerabilities and to help prioritize the selection of inspection locations. Risk ranking is performed by determining the likelihood of failure of each segment of applicable piping and combining that failure probability with the consequences of failure of that item. Components with high likelihood of failure and high consequences of failure should receive more attention than low ranked components. A description of a risk ranking process for buried piping is provided in Reference 1.

The risk ranking process shall incorporate the attributes listed in Section 3.3.A.2 of this document as augmented by the “shall” statement below as a minimum.

- The risk ranking shall be periodically reviewed and updated as necessary to reflect inspection results, changes in operating conditions, and design modifications.

The risk ranking process shall also determine the likelihood and consequence of failure for each piping segment in order to prioritize inspections or other actions and should consider the following:

- Soil analysis data, when available to assess the likelihood of OD corrosion
- The potential for ID (fluid-side) corrosion and fouling
- The “health” of the cathodic protection system. “Health” should be interpreted in the context of whether the system is performing its function as designed.
- Over the line survey results. These results help assess the likelihood of OD corrosion.
- Whether piping and tanks contain fluids with licensed material. The risk ranking process should place sufficient priority on these components such that the intent of the Initiative is met.
- The results of the Ground Water Protection Initiative risk ranking process. The NEI Ground Water Protection Initiative also contains a risk ranking process for systems, structures, and components, including underground piping and tanks, containing radioactive materials. The results of the Ground Water Protection risk ranking process should also be used as an input in inspection plan development.

Risk Ranking may be performed using software tools; several different software tools are available for this application. This guideline does not recommend or discourage any software system; but, regardless of the tool that is used, utilities should review the risk ranking results to ensure they reflect relative system priorities and are appropriate from an engineering judgment perspective.

The initial risk ranking process shall be complete by December 31, 2010.

### **6.2.3 Inspection Plan**

The goal of the inspection plan is to support an assessment of the pipe’s structural and leakage integrity and provide reasonable assurance that a piping segment will maintain this integrity between successive inspections. The results of risk ranking along with plant and industry experience, plant licensing commitments, and trending of past inspection data should be considered to define inspection locations, inspection methods, and inspection schedules (see reference 1). Other considerations such as access may also be considered when the relative risk rankings are similar. More guidance on inspection planning is provided in Appendix C.

The inspection plan shall incorporate the attributes listed in Section 3.3.A.3 of this document as augmented by the “shall” statement below.

- Where buried pipes are protected by a cathodic protection (CP) system, the CP system shall be periodically inspected and tested to assess its continued adequacy.

Development of an inspection plan should consider the following:

- The capabilities of the inspection techniques used
- Industry and internal operating experience
- Piping design characteristics
- The condition of the piping inspected (if inspected previously)
- The results of risk ranking performed for the Ground Water Protection Initiative
- Contingency plans that include
  - Methods and criteria to assess the significance of inspection results considering the damage mechanism and licensing commitments.
  - Repair and replacement options
- Input from a coating specialist
- Whether a CP system should be added to systems containing materials susceptible to degradation.

Sampling techniques and engineering evaluations based on known conditions of piping are an acceptable means of achieving reasonable assurance.

The inspection plan shall be in place by June 30, 2011.

#### **6.2.4 Plan Implementation**

Plan implementation should consist of performing a condition assessment based on both inspection results and engineering evaluations. The inspections should be conducted at the most vulnerable locations determined using methods such as the risk ranking, results of cathodic protection and coating surveys, plant experience, etc. The combination of evaluations and inspections performed should provide reasonable assurance that the piping segment will maintain structural and leakage integrity until the next planned inspection. The inspection results should be documented and relevant photographs or video, when taken, should be filed to support inspection results. All inspection results (whether degradation exists or not) shall be reported to EPRI in the manner prescribed by the Buried Piping Integrity Group project manager.

Buried piping segments whose failures are inconsequential, and would cause no direct or collateral damage (such as potable water), may be considered “run to failure” and dispositioned accordingly. Safety related lines and those containing licensed materials should never be characterized as “run to failure”. Reference 1 provides more guidance on this categorization. Consider benchmarking piping segments characterized as “run to failure” against programs at

other utilities to check for consistent application. Note that segments categorized as “run to failure” are still considered within the scope of the Initiative and leaks and adverse inspection findings in these segments shall be reported in accordance with Appendix A.

Inspections should consider the following:

- Inspecting the coating when a buried pipe is uncovered
- Performing a visual inspection of buried pipe when it is uncovered or entered for any reason in order to look for evidence of corrosion or damage.
- In situations where system operability or functionality is in question due to wall or weld degradation, examining the piping to determine remaining thickness.
- Estimating a projection of future damage based on current inspection results and the time to the next planned inspection or repair.
- Categorizing the inspection results in support of a remaining life calculation.
- Using the knowledge gained through the inspection and integrity assessment process to review and adjust as necessary the risk-informed ranking and the inspection plan.

The results of condition assessments should be an input to the Asset Management Plan.

Implementation of the inspection plan shall start no later than June 30, 2012 and the condition assessment of buried piping containing licensed materials shall be completed by June 30, 2013.

Notes:

1. This milestone refers to inspection plans; it does not refer to reactor units or stations. Therefore, the start of implementation is defined as the completion of at least one direct examination of piping included in the inspection plan for a site.
2. The start of inspections applies to all in-scope lines and not just those that contain licensed material.
3. Implementation of the inspection plan should include at least one direct examination of piping included in the inspection plan. It is not sufficient that the direct examination has been planned; it also must also be completed. Previous inspections that meet the intent of a direct examination as defined in the industry’s inspection planning document qualify as starting even if they were performed prior to the approval of the Initiative or the formal development of the inspection plan.
4. In accordance with Appendix C, the condition assessment does not require an actual examination of the component for other than high risk lines, but it should involve an engineering evaluation and associated documentation of the condition of the lines.

### 6.2.5 Asset Management Plan

An asset management plan or plans addressing buried piping shall be developed and maintained. An asset management plan is a long range plan for managing the structural and leakage integrity of buried piping. Where the risk of failure is unacceptable, preventive and mitigative options should be implemented as part of the long range strategy.

The asset management plan for buried piping may be part of the overall site or fleet asset management plan.

The asset management plan should be a living document that is periodically reviewed and updated as more plant data becomes available through physical assessments and other means and as industry knowledge and technology evolve.

The asset management plan shall be reviewed and approved by an appropriate high level organization within the utility (such as the plant health committee).

Key elements of an Assessment Management Plan should include:

- Inspection plans
- Planned maintenance activities
- Plans for repair
- Anticipated replacement

One method to develop an asset management plan would be to categorize each buried line based on its risk rank, contents (licensed material, diesel oil, raw or minimally treated water, hazardous chemicals, off gas, etc), importance to power generation, results of cathodic protection testing, and coating surveys, plant experience, etc. For example, each line would then be placed into categories such as:

- Components to be repaired or replaced with a planned schedule within an implementation plan.
- Components that need to be periodically inspected or monitored with a planned schedule.
- Components that are acceptable to run to leak and then repaired as needed (e.g., piping with low risk or low environmental impact. Plants should also consider public confidence concerns in applying this categorization.).

The plan should consider additional actions for a line such as:

- Inspect to determine the need to repair or replace.
- Add or enhance the cathodic protection.
- Add or enhance coating protection.

- Actions to minimize the degradation of the inner surface of the piping.
- Add protection against heavy surface loads.

The Asset Management Plan for buried piping shall be in place by December 31, 2013.

## **B. Activities within the Underground Piping and Tanks Integrity Initiative Scope**

The expectations described in Section 6.2.A above (regarding procedures and oversight, risk ranking, inspection plans, plan implementation, and asset management) are applicable to the components added by the Underground Piping and Tanks Integrity Initiative unless specifically stated otherwise below. The following sections (6.2.6 through 6.2.10) explain the intent of the Underground Piping and Tanks Initiative and provide additional guidance where appropriate. Note that the activities and milestones in sections 6.2.6 through 6.2.10 apply only to the additional components that were added by the Underground Piping and Tank Integrity Initiative when it extended the Buried Piping Integrity Initiative.



## 6.2.6 Procedure and oversight

Procedure and oversight responsibilities applicable to the Underground Piping and Tanks Integrity Initiative, including associated plant programs, shall be revised to include in-scope tanks and piping by December 31, 2011. The following steps are one method of approaching this process.

- Identify the piping and tanks that fall within the scope added by the Underground Piping and Tanks Integrity Initiative.
- Identify the programs or processes in place, or develop new ones if necessary, to manage the leakage and structural integrity of these components.
- Develop or amend existing overarching program or process documents to ensure that all the relevant programs are associated with the Underground Piping and Tanks Integrity Initiative and coordinated to control changes so that Initiative intent is managed and not inadvertently compromised.
- Identify roles and responsibilities for the new program/process
- Develop a process for justifying any deviations to the Initiative elements documented in this guideline. Ensure the process meets the intent of Section A.6.2.1 and this section.

Procedures and oversight shall incorporate the attributes listed in Section 3.3.B.1 plus the “shall” statements in the following paragraphs.

- Process for obtaining review of Initiative and NEI 09-14 interpretations  
Questions regarding the intent of the Initiative or the guidance in this document should be communicated to NEI. The Buried Piping Integrity Task Force will review the question and reply in a timely manner. The task force will also communicate interpretations of significant generic applicability to the industry as a means of facilitating consistent implementation of the Initiative.

If a utility proceeds with an activity that does not meet the language of the Initiative or a “shall” statement in this document, a justification for deviation shall be processed in accordance with the remainder of this section. Note that a deviation may still meet the intent of the Initiative (see below) even if it does not meet the exact language of the Initiative. For example, it may be possible to risk rank buried piping without addressing every parameter in Section 3.3.A.2.

- Process for justifying and approving exceptions to the Initiative  
When a utility determines that a required element of the Initiative or a “shall” statement in this document will not or cannot be met, a justification for deviation shall be developed and retained with the utility’s corrective action program. If a utility finds itself outside of a required Initiative element and takes immediate action to meet the element, a deviation justification is not required, but the condition should be entered into the corrective action program and the Buried Piping Integrity Task Force should be notified. Required

elements of the Initiative include the entire text of the Initiative (Sections 3.3.A and 3.3.B) and all “shall” statements in this document (summarized in Appendix B).

The justification shall provide the basis for determining that the proposed deviation meets the same objective, or level of conservatism exhibited by the original requirement, and should clearly state how long the deviation will be in effect. Justifications for deviation shall be approved by the responsible utility executive.

To maintain the integrity of the deviation process and ensure a consistent approach to guideline implementation (or inability to implement), it is important for utilities to share deviations with the industry in an open and timely manner. Timely notification of deviations allows the industry to systematically review the issue for potential generic implications and take appropriate actions to facilitate consistent and appropriate implementation of guidance. The following guidance applies:

- Approved deviations shall be sent to NEI in a timely manner for review by the Buried Piping Integrity Task Force (BPITF).
  - The BPITF review is not an independent review or an approval. Their assessment is based on engineering judgment and experience.
- The BPITF will review the justification for deviation for the following items.
  - Effect on guidance.
  - Whether the deviation meets the intent of the Initiative.
  - Generic applicability.
- Generically applicable information relative to the justifications will be communicated to the industry.
- When the BPITF finds that the deviation does not meet the intent of the Initiative, the applicable utility and the Buried Piping Integrity Working Group will be informed. Semi-annually each utility shall report to NEI all active justifications for deviation at each of its plants that are judged to not meet the intent of the Initiative. This report is made as part of the utility’s input to the NSIAC report (Appendix A).
- If the BPITF finds that the deviation does meet the intent of the Initiative, the utility will be informed but the deviation will not be reported to NSIAC. The justification should be retained with utility program documentation.

All requirements described in Section A. 6.2.1 are relevant to this section of the Underground Piping and Tanks Integrity Initiative except for implementation schedules.

#### **6.2.7 Prioritization**

The risk ranking process for buried piping will have been established as part of the Buried Piping Integrity Initiative. This process may not be able to incorporate underground piping or tanks because of the different parameters of concern. The process of risk ranking is referred to as “prioritization” within the Underground Piping and Tanks Integrity Initiative in recognition of this situation and the possibility that a risk ranking tool may not be in place when utilities start

the process. Greater use of engineering judgment is expected in the development of prioritization results.

Prioritization shall incorporate the attributes listed in Section 3.3.B.2. Attributes that should also be considered when prioritizing components include:

- Age
- Relevant industry operating experience
- Piping flow rate
- Tank volume
- Contents
- Soil condition and chemistry
- Plant operating history
- Leakage history
- Internal corrosion consideration (such as flow accelerated corrosion for piping only, and microbiologically induced corrosion)
- Coating and lining
- Wet or alternately dry

Prioritization should be adjusted as appropriate to apply engineering judgment to the results.

All requirements described in Section A. 6.2.2 are relevant to the Underground Piping and Tanks Integrity Initiative, except for implementation schedules. Prioritization of components that fall within the scope of the Underground Piping and Tanks Integrity Initiative shall be complete by June 30, 2012.

#### **6.2.8 Condition Assessment Plan**

The results of prioritization along with plant and industry experience, plant licensing commitments, and trending of past inspection data should be used to define inspection locations, inspection methods, and inspection schedules. Condition assessment plans shall incorporate the attributes listed in Section 3.3.B.3. The Condition Assessment Plan shall be in place by December 31, 2012. All requirements described in Section A. 6.2.3 are relevant to the Underground Piping and Tanks Integrity Initiative, except for implementation schedules. Guidance on inspection planning is provided in Appendix C.

#### **6.2.9 Plan Implementation**

Implementation of the Condition Assessment plan for components included within the scope added by the Underground Piping and Tanks Integrity Initiative shall start no later than June 30, 2013. The condition assessment of underground piping and tanks containing licensed material shall be completed by June 30, 2014.

After prioritization is performed, the inspection process should address all piping and tanks within the scope of both the initial Buried Piping Integrity Initiative and the Underground Piping and Tanks Integrity Initiative in order to ensure the relative importance of the components are recognized and the more important components are inspected first when possible.

All requirements described in Section A. 6.2.4 are relevant to the Underground Piping and Tanks Integrity Initiative, except for implementation schedules.

#### **6.2.10 Asset Management Plan**

The Asset Management Plan for underground piping and tanks shall be in place by December 31, 2014. All requirements described in Section A. 6.2.5 are relevant to the Underground Piping and Tanks Integrity Initiative, except for implementation schedule.

## 7 REFERENCES

1. EPRI document, *Recommendations for an Effective Program to Control the Degradation of Buried Pipe*, December 2008
2. NACE (National Association of Corrosion Engineers) documents
  - a. SP0502-2008 (formerly RP0502), Pipeline External Corrosion Direct Assessment Methodology
  - b. SP0169-2007 (formerly RP0169), Control of External Corrosion on Underground or Submerged Metallic Piping Systems
  - c. RP0102-2002, In-Line Inspection of Pipelines
  - d. SP0207-2007, Performing Close-Interval Potential Surveys and DC Surface Potential Gradient Surveys on Buried or Submerged Metallic Pipelines
  - e. RP0288, "Standard Recommended Practice: Inspection of Linings on Steel and Concrete Tanks"
3. NEI 07-07, *Industry Ground Water Protection Initiative – Final Guidance Document*, August 2007
4. INPO 12-009, ICES Reporting Requirements and Standards
5. NUREG 1801, Volume 2 Section X1.M34, Generic Aging Lessons Learned (GALL) Report, Buried Piping and Tanks Inspection
6. ASTM G 158, "Standard Guide for Three Methods of Assessing Buried Steel Tanks"
7. ASTM E 1990, "Standard Guide for Performing Evaluations of Underground Storage Tank Systems for Operational Conformance with 40 CFR, Part 280 Regulations"
8. NLPA Standard 631, "Entry, Cleaning, Interior Inspection, Repair, and Lining of Underground Storage Tanks"



## **APPENDIX A**

### **REPORT TO NSIAC**

#### **REPORT CONTENT**

A report to NSIAC will be prepared semi-annually addressing the following four items:

1. Overview – developed by NEI semi-annually on the following topics as appropriate:
  - Notable information:
    - Incidents that attract media or industry stakeholder attention
    - INPO feedback from plant evaluations
    - Important ANI feedback from plant evaluations
    - Major piping or tank replacements and repairs as determined by NEI Buried Piping Integrity Task Force. Examples are major piping improvement projects where portions of service water systems were replaced with high density polyethylene piping or 6% molybdenum stainless steel)
  - Assessment of availability of technology to support inspections
  - Overall status of Initiative implementation, including the effect of active approved deviations to Initiative elements.
2. Progress on Initiative implementation and exceptions – utilities will report to NEI the status of implementation of each Initiative element at each of their plants using the approach described below. The report will be made semiannually (by January 31 and July 31) to NEI. NEI will collect and assemble the information.
  - Report implementation status for each Initiative element and for each plant. The elements and the expected implementation dates are repeated below:
    - Buried piping procedures and oversight in place by 6/30/10
    - Buried piping risk ranking complete by 12/31/10
    - Buried piping inspection plan in place by 6/30/11
    - Underground piping and tanks procedures and oversight in place by 12/31/11
    - Buried piping inspection start by 6/30/12
    - Underground piping and tanks prioritization complete by 6/30/12
    - Underground piping and tanks condition assessment plan in place by 12/31/12
    - Condition assessment of buried piping containing radioactive materials complete by 6/30/13
    - Underground piping and tanks inspection start by 6/30/13
    - Buried piping asset management plan in place by 12/31/13

- Condition assessment of underground piping and tanks containing radioactive materials complete by 6/30/14
  - Underground piping and tanks asset management plan in place by 12/31/14
  - Document the status for each implementation date as follows:
    - Will extend the implementation date or have extended
    - Implementation by the due date is at risk
    - On schedule to meet date
    - Complete
  - Describe each active deviation that does not meet the intent of the Underground Piping and Tanks Integrity Initiative. Note that the existence of an approved deviation to an implementation date does not change the fact that the date will not be met. If an implementation date is not going to be met, it shall be reported as such until the implementation is completed.
3. Industry experience and learning – Utilities will report the information below to INPO. INPO will collect the information and report the results to NEI.
- Utilities will enter operating experience related to the items below into the INPO EPIX/ICES database when instances occur. Entries should be made in a timeframe consistent with EPIX/ICES timing requirements (Reference 4).
    - Every leak from underground piping and tanks within the scope of this Initiative
    - Significant leaks from underground piping and tanks that are within the scope of this Initiative: Significant leaks are defined as those which meet either of the following criteria
      - Result in concentrations that could exceed the regulatory concentrations or limits established by the NRC or EPA., or
      - Result in voluntary communication under the industry Ground Water Protection Initiative, or
      - Result in the system or component being out of service
    - Adverse inspection findings: defined as indications from inspections that require immediate repair or repair within one cycle
  - Each instance will be categorized into one of the following five areas depending upon the piping segment or tank affected (where more than one area applies, use the one that appears highest in the list below).
    - Safety related
    - Contains licensed material
    - Contains environmentally hazardous fluids (e.g., oils, chemicals, non-radioactive fluids)
    - Components categorized as not “run to failure”
    - Components categorized as “run to failure”
4. Progress on inspection technology development – EPRI will assemble the information below and report the results to NEI.



- Identify each technology that is being researched for possible use in inspections
- Describe the development and implementation status of each identified inspection technology.

### **GENERAL**

Information on leakage from applicable buried/underground piping and tanks using the above criteria will be collected beginning for events that occurred in 2009. Information on Initiative implementation and inspection technology will be collected beginning in 2010.

Information will be collected from utilities, INPO, ANI, and EPRI and sent to NEI semi-annually. NEI will assemble a report for Buried Piping Integrity Task Force review and assessment. The objective is to:

- Prepare an NSIAC presentation.
- Share implementation status and operating experience with the industry as appropriate.



## APPENDIX B

### NEI 09-14 REQUIREMENTS

Section	Requirement
3.3	<p>In order to meet these goals, every utility shall implement measures or program(s) to satisfy the elements and associated key attributes in Sections 3.3.A and B. The language in sections 3.3.A and B below documents the text of the Underground Piping and Tanks Initiative as approved by NSIAC...</p> <p><i><u>Note that the entire text of sections 3.3.A.1 thru 3.3.A.5 and 3.3.B.1 thru 3.3.B.10 is a requirement under the Underground Piping and Tanks Integrity Initiative since these sections constitute the text of the Initiative as approved by NSIAC. In the interest of brevity, the text from these sections is not captured in this table.</u></i></p>
3.5	Every utility shall ensure that activities associated with the Underground Piping and Tanks Integrity Initiative and this document are implemented at its nuclear power plants in accordance with the intent of the Initiative and the implementation dates specified therein.
3.5	If a plant cannot or will not implement any part of the Initiative (Sections 3.3.A and B) or a “shall” statement in this document, a justification for deviation from the Initiative shall be developed and processed in accordance with Section 6.1.
5.1	<p>Utilities shall perform the following actions in support of the Initiative:</p> <ul style="list-style-type: none"> <li>• Implement the actions required by the Initiative (Section 3.3 and all “shall” statements in this document).</li> <li>• Process a justification for deviation (Section 6.1.1) whenever an action required by the Initiative or a “shall” statement in this document cannot be met.</li> <li>• Report all results from inspections performed in accordance with the Initiative in the manner proscribed by the EPRI project manager responsible for the Buried Piping Integrity Group.</li> <li>• Report to NEI the status of meeting the Initiative Implementation dates and any active deviations that do not meet the intent of the Initiative as required for the report to NSIAC (Appendix A)</li> <li>• Report to INPO (EPIX/ICES) occurrences of leakage or adverse inspection findings in piping, and tanks within the scope of this Initiative as required for the report to NSIAC (Appendix A)</li> </ul>
6.2.1	The necessary governance and oversight responsibilities shall be in place by June 30, 2010.
6.2.1	The Buried Piping Integrity Program shall be established including the identification of a responsible executive who will carry out the senior level functions specified in the Initiative and this guideline.

Section	Requirement
6.2.1	When a utility determines that a required element of the Initiative cannot be met, a technical justification for deviation shall be developed and retained with the utility's program documentation.
6.2.1	Justifications for deviation shall be reviewed and approved in accordance with the applicable plant procedures with concurrence from the responsible utility executive.
6.2.1	Each utility shall report all approved justifications for deviation that are currently active at each of its plants to NEI semi-annually as part of the utility's input to the NSIAC report.
6.2.1	A Program Plan and associated procedures shall be developed to implement the Underground Piping and Tanks Integrity Initiative.
6.2.1	The program documents and implementing procedures shall implement, as a minimum, the elements of the Underground Piping and Tanks Integrity Initiative (Section 3.3) and requirements in this document.
6.2.2	A risk ranking process shall be used to understand site vulnerabilities and to help prioritize the selection of inspection locations.
6.2.2	<p>The risk ranking process shall incorporate the attributes listed in Section 3.3.A.2 of this document as augmented by the "shall" statement below as a minimum.</p> <ul style="list-style-type: none"> <li>• The risk ranking shall be periodically reviewed and updated as necessary to reflect inspection results, changes in operating conditions, and design modifications.</li> </ul>
6.2.2	The initial risk ranking process shall be complete by December 31, 2010.
6.2.2	The risk ranking process shall determine the likelihood and consequence of failure for each piping segment in order to prioritize inspections or other actions
6.2.3	<p>The inspection plan shall incorporate the attributes listed in Section 3.3.A.3 of this document as augmented by the "shall" statement below.</p> <ul style="list-style-type: none"> <li>• Where buried pipes are protected by a cathodic protection (CP) system, the CP system shall be periodically inspected and tested to assess its continued adequacy.</li> </ul>
6.2.3	The inspection plan shall be in place by June 30, 2011.
6.2.4	Note that segments categorized as "run to failure" are still considered within the scope of the Initiative and leaks and adverse inspection findings in these segments shall be reported in accordance with Appendix A.
6.2.4	All inspection results (whether degradation exists or not) shall be reported to EPRI in the manner proscribed by the Buried Piping Integrity Group project manager.
6.2.4	Implementation of the inspection plan shall start no later than June 30, 2012 and the condition assessment of buried piping containing licensed materials shall be completed by June 30, 2013.
6.2.5	An asset management plan or plans addressing buried piping shall be developed and maintained.
6.2.5	The asset management plan shall be reviewed and approved by an appropriate high level organization within the utility (such as the plant health committee).
6.2.5	The Asset Management Plan for buried piping shall be in place by December 31, 2013.
6.2.6	Procedure and oversight responsibilities applicable to the Underground Piping and Tanks Integrity Initiative, including associated plant programs, shall be revised to

Section	Requirement
	include in-scope tanks and piping by December 31, 2011.
6.2.6	Procedures and oversight shall incorporate the attributes listed in Section 3.3.B.1 plus the “shall” statements in the following paragraphs.
6.2.6	If a utility proceeds with an activity that does not meet the language of the Initiative or a “shall” statement in this document, a justification for deviation shall be processed in accordance with the remainder of this section.
6.2.6	When a utility determines that a required element of the Initiative will not or cannot be met, a justification for deviation shall be developed and retained with the utility’s corrective action program.
6.2.6	The justification shall provide the basis for determining that the proposed deviation meets the same objective, or level of conservatism exhibited by the original requirement, and should clearly state how long the deviation will be in effect.
6.2.6	Justifications for deviation shall be approved by the responsible utility executive.
6.2.6	Approved deviations shall be sent to NEI in a timely manner for review by the Buried Piping Integrity Task Force (BPITF).
6.2.6	Semi-annually each utility shall report to NEI all active justifications for deviation at each of its plants that are judged to not meet the intent of the Initiative.
6.2.7	Prioritization shall incorporate the attributes listed in Section 3.3.B.2.
6.2.7	Prioritization of components that fall within the scope of the Underground Piping and Tanks Integrity Initiative shall be complete by June 30, 2012.
6.2.8	Condition assessment plans shall incorporate the attributes listed in Section 3.3.B.3.
6.2.8	The Condition Assessment Plan shall be in place by December 31, 2012.
6.2.9	Implementation of the Condition Assessment plan for components included within the scope added by the Underground Piping and Tanks Integrity Initiative shall start no later than June 30, 2013.
6.2.9	The condition assessment of underground piping and tanks containing licensed material shall be completed by June 30, 2014.
6.2.10	The Asset Management Plan for underground piping and tanks shall be in place by December 31, 2014.
App A	If an implementation date is not going to be met, it shall be reported as such until the implementation is completed.



**APPENDIX C**

**GUIDANCE FOR INSPECTION AND CONDITION ASSESSMENT OF  
BURIED AND UNDERGROUND PIPING AND TANKS**

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## **1. Preface**

This document provides industry guidance for the determination of reasonable assurance for structural and/or leakage integrity for buried and underground piping and tanks. The criteria and guidelines presented in this document were developed as a consistent basis for establishment of what is necessary to provide “reasonable assurance of integrity”.

## **2. Purpose**

The purpose of this document is to provide a technically based approach for development of inspection and condition assessment plans that establish reasonable assurance of structural and/or leakage integrity of buried and underground piping and tanks through the application of the results of both indirect inspections and direct examinations. The approach is programmatically founded in the precepts established in the “Recommendations for an Effective Program to Control the Degradation of Buried and Underground Piping and Tanks (1016456, Revision 1-EPRI Product ID: 1021175) and utility site specific program documents. This document is intended to establish reasonable assurance for scoped buried and underground piping systems and tanks; optimizing the inspection scope, while not requiring 100% inspection.

## **3. Background**

Reasonable assurance is an industry concept used to achieve increased confidence in the capability of a structure, system or component (SSC) to perform its intended function. Reasonable assurance does not equate to absolute assurance or confidence. Rather, reasonable assurance collects appropriate data/insights/information to support the establishment of increased confidence. Situations may occur where sufficient data cannot be easily collected; in these cases, the available data may be supplemented with additional insights to bolster a technical foundation of reasonable assurance. If available information (even with supplemental insights) is insufficient to support a conclusion of reasonable assurance, then additional actions must be taken to achieve reasonable assurance. Ultimately, the establishment of reasonable assurance is the obligation of the owner. This guideline provides insights to achieve consistency among industry users to identify what actions are generally necessary to establish reasonable assurance for structural and/or leakage integrity for buried and underground piping and tanks.

Reasonable assurance of integrity in buried and underground piping systems and tanks containing licensed material or non-licensed material is obtained when activities such as an engineering evaluation (including a Fitness-for-Service evaluation), indirect inspections of underground components, direct examination and remediation (if necessary), are performed. Such a combination of activities will provide a high level of confidence that the structural and leak integrity of the buried and underground piping systems and tanks, will be managed and effectively maintained.

A reasonable assurance of integrity process is based on defining systems that are in scope, risk ranking these systems, and then identifying a sample of locations in these systems for inspections. It relies on engineering analyses, expert judgment, operating experience, and groundwater protection program data to determine what regions of the buried and underground pipes or tanks are most vulnerable to degradation and adequately characterizing the vulnerability

so that appropriate preventive, mitigating or corrective actions may be taken. This process is based on risk identification and inspection sampling intended to greatly reduce the potential for unacceptable leakage or failures in the most susceptible systems.

Engineering evaluation is an important part of the “reasonable assurance of integrity” process. The engineering evaluation will consider but is not limited to items such as high consequence and/or likelihood areas, previous inspection results, fabrication practices, material type, backfill, coating, soil condition, water levels, water and soil chemistry, cathodic protection, connection to the grounding grid, operational history, industry operating experience, site operating experience and groundwater protection program data. For underground pipe, exterior environments that should be considered in the engineering evaluation include presence and type of insulation, potential for water intrusion, humidity, temperature, coating, condition of the tunnel or vault (e.g., heavily cracked or spalled concrete, etc), and condition of the pipe supports (corroded rollers, loose pipe supports, loose or corroded anchor bolts, etc). This engineering evaluation will identify the risk of potential leakage, the most probable locations, and/or areas of likely susceptibility. The evaluation will also identify the potential consequences that could result if a leak occurred. With this information, an inspection plan can be developed and implemented that provides information regarding the condition of the structure, system or component. The inspections can be indirect in that they will provide information on the condition of the pipe remotely – from ground level or from an exposed section of pipe that is distant or remote from the pipe location of interest. Inspections include a direct examination of the pipe wall and a visual inspection of the outer surface coating to determine coating integrity. Direct examination can also be achieved using an in-line vehicle (or Pipeline Inspection Gauge “PIG”) deployed with demonstrated direct examination equipment that is capable of detecting both OD and ID degradation at the location of interest that may challenge structural or leakage integrity.

The specific inspections and examinations that are performed will be based on the type of degradation observed or expected, the susceptibility of the pipe to leakage or breaks, the consequences of a leak or break, and the location of the pipe. The scheduling of re-inspection and re-examination is also dependent on the engineering determination of susceptibility, consequences, and the results of the initial inspection or examination.

#### **4. Scope**

The scope of this guidance includes all piping and tanks covered by the NSIAC Underground Piping and Tanks Integrity Initiative. The Industry Initiative encompasses:

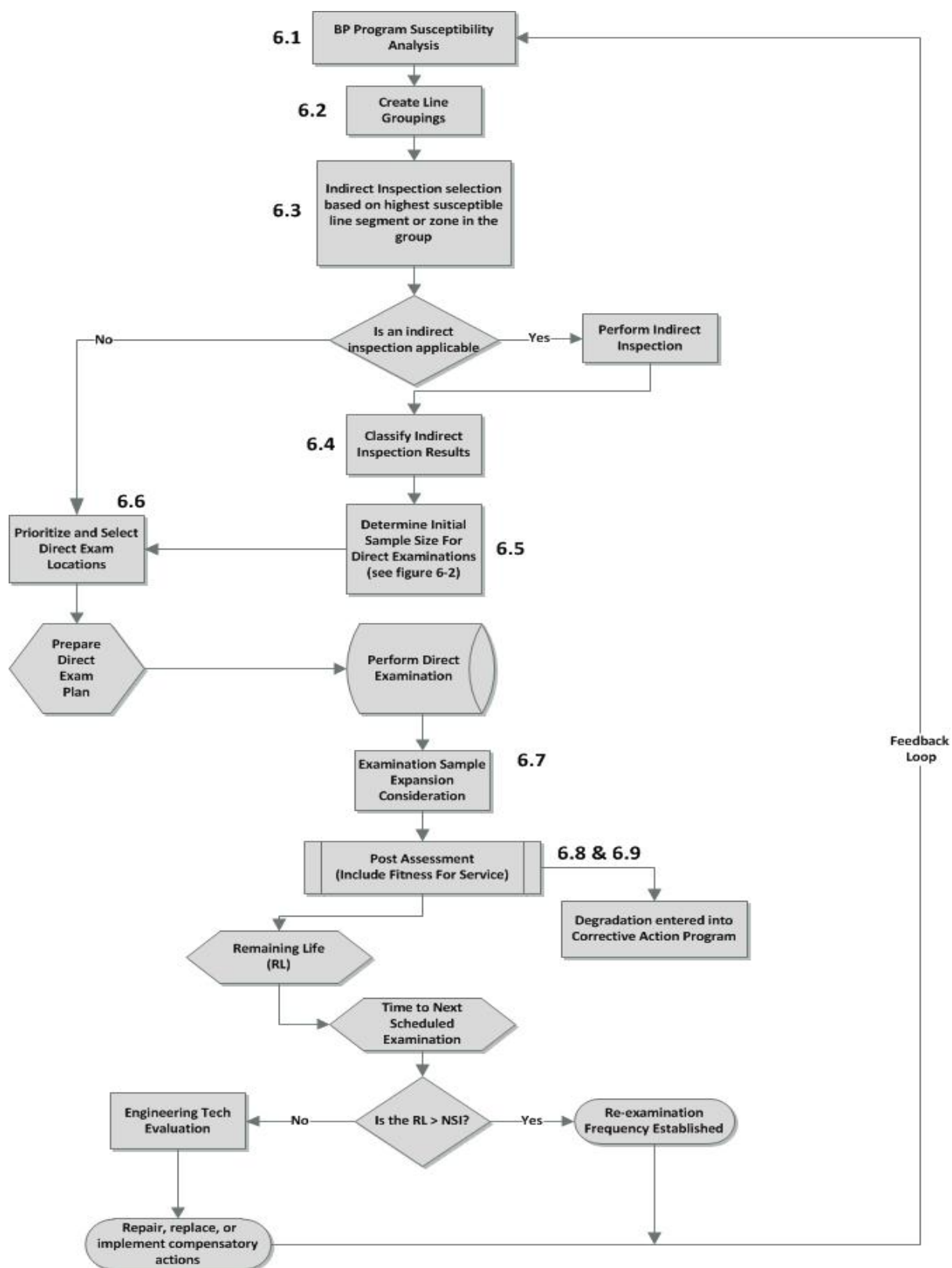
- all piping that is below grade, in direct contact with the soil and contains any fluid
- underground piping and tanks that are outside of buildings and below grade (whether or not they are in direct contact with the soil) and safety related or contain licensed material or are known to be contaminated with licensed material.

## 5. Terms and Definitions

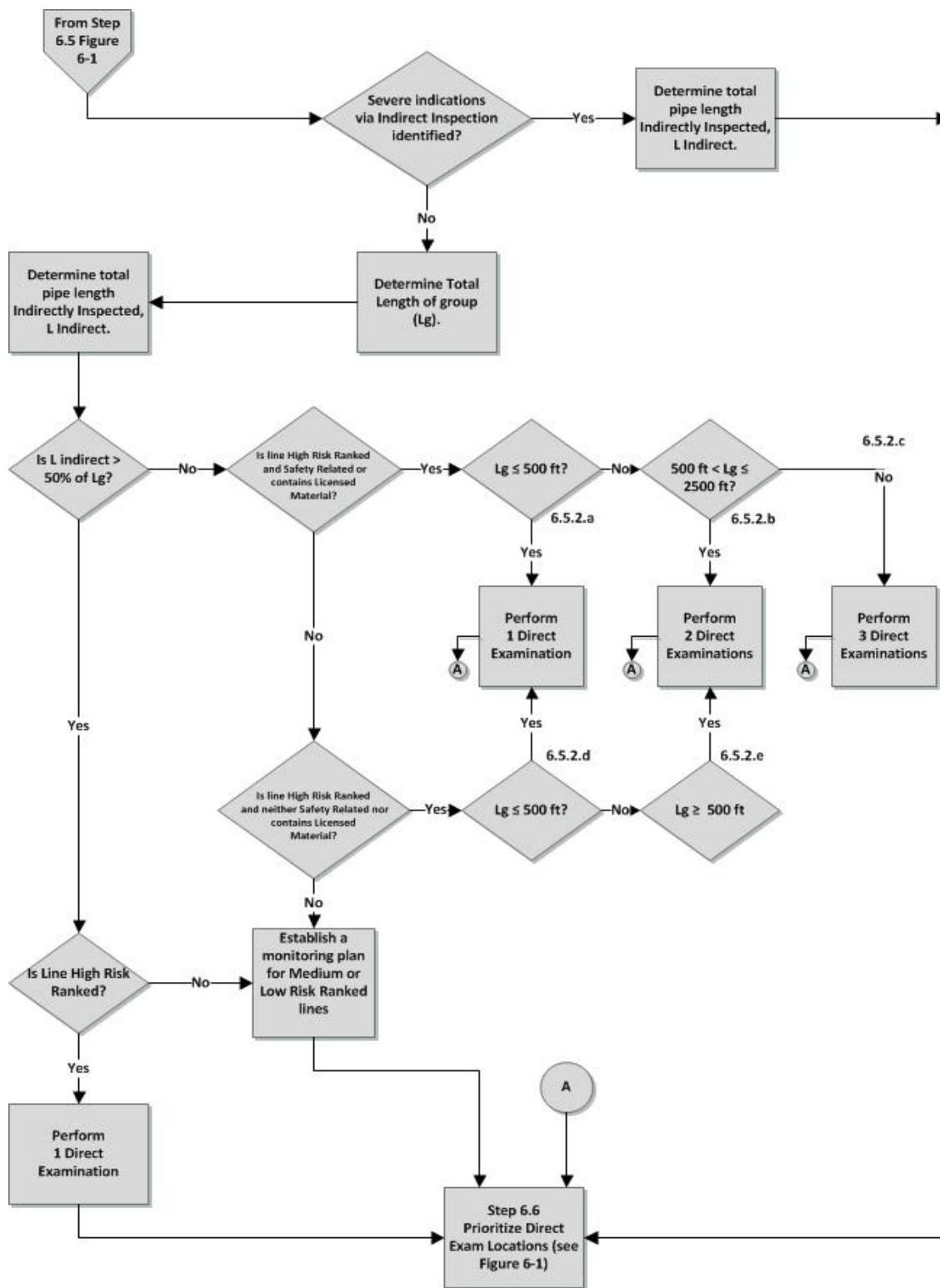
- 5.1. **Baseline Inspections** - Inspection of new or replaced pipe or components that have not previously been involved in plant operations.
- 5.2. **Corrosion Rate (CR)** - The rate of corrosion occurring over a defined period of time.
- 5.3. **Direct Examination** - A Nondestructive Evaluation (NDE) examination where the NDE sensor(s) is in immediate contact with or in close proximity to the section of the component being examined. Results provide some degree of quantitative measurement of wall thickness or discontinuity size. Direct examinations can be performed from the interior or exterior surface. Detection and characterization capabilities vary by NDE method as well as by specific NDE technique. Examples of NDE methods include ultrasonics, eddy current, radiography, visual and various electromagnetic techniques. Visual examinations should be supplemented with NDE or engineering judgment that addresses the condition of the pipe wall.
- 5.4. **Fitness-for-Service (FFS)** - A technical evaluation of direct examination data to determine acceptable flaw size, degradation rate, remaining life, and the time to the next inspection or repair/replacement/mitigation.
- 5.5. **Highest Susceptible Locations** - The highest likelihood and consequence risk ranked segments or zones as defined in the buried piping susceptibility analysis and risk ranking database.
- 5.6. **Indirect Inspection** – Survey techniques used to assess the likelihood of degradation without having direct access to the section of the component being examined. These inspections typically measure surrounding conditions that may be indicative of corrosion or damage. Results are typically qualitative and less accurate than direct examinations. Examples of indirect inspection methods include over-the-line surveys and for the purpose of this document, long range guided wave.
- 5.7. **Initial Inspection** - The inspection of pipe or components that have been in service but have not been previously inspected.
- 5.8. **Inspection Program** - A systematic evaluation of in-scope components using various techniques (e.g., ultrasonic testing (UT), radiographic testing (RT), visual testing (VT), leak testing (LT), eddy current testing (ET)).
- 5.9. **L<sub>g</sub>** –The total length of piping associated with a group of lines.
- 5.10. **L<sub>indirect</sub>** –The total length of pipe associated with a group of pipe lines that have been indirectly inspected.
- 5.11. **Line Grouping** - A process that may be used to optimize inspection scope and schedule duration. Lines/segments/zones are grouped based on various attributes,

- such as but not limited to process fluid, pipe material, coatings, depth, age, soil/backfill, etc.
- 5.12. Next Scheduled Inspection (NSI)** - The time duration until another inspection of the pipe line group is required.
- 5.13. Opportunistic Inspection** – An inspection performed when buried or underground components are exposed or excavated due to another activity providing an opportunity to inspect and document the results for a program component.
- 5.14. Piping Segment** - Portions of buried piping systems that are grouped together for risk ranking purposes based on similarities such as installation, manufacture, or environmental conditions. Some risk ranking methods may use other terms to refer to piping segments, such as zones.
- 5.15. Post Assessment** - An assessment of all indirect and direct examination results including a FFS evaluation that will determine the projected structural and leakage integrity of a pipe.
- 5.16. Remaining Life (RL)** - The time period until the pipe wall thickness is no longer acceptable.
- 5.17. Visual Inspections** - Direct observation by inspectors or by the use of remote visual inspection devices. Visual inspections may include the use of pit gauges to assess the extent of any degradation noted.

**Figure 6-1**  
**Buried and Underground Piping Inspection/Condition Assessment Reasonable Assurance (RA) Flow Chart**



**Figure 6-2**  
**Buried and Underground Piping Inspection/Condition Assessment Reasonable Assurance (RA) Flow Chart**



## **6. Buried and Underground Piping Inspection/Condition Assessment RA Flow Chart-Description**

### **6.1. Buried Piping Program Susceptibility Analysis and Risk Ranking**

1. Susceptibility Analysis and Risk Ranking are used to determine the overall likelihood and consequence of a line, segment or zone failure.
2. This evaluation is based on detailed site specific information and provides a risk assessment of all piping within the program scope.
3. The following potential exclusions or exceptions from the inspection scope may be considered based on the susceptibility and risk ranking process. The basis for the exclusion should be documented:
  - a. Segments or zones constructed of materials of minimal susceptibility to the associated ID and OD degradation mechanisms like titanium and super austenitic stainless (e.g., AL6XN or 254 SMO).
  - b. Piping sections that are hydrostatically tested in accordance with 49 CFR 195 subpart E on an interval not to exceed 5 years.
  - c. Segments or Zones of Stainless Steel, HDPE, other Polymer, or Cementitious or Concrete materials in Controlled Low Strength Materials (flowable fill) or Higher Long Term Compressive Strength Materials (Concrete).
  - d. Required Inspections for Segments or Zones of Carbon Steel materials may be reduced by 50% if in Controlled Low Strength Materials (flowable fill) or Higher Long Term Compressive Strength Materials (Concrete). The remaining inspection may be performed by excavating the backfill and examining the pipe or by excavating the soil around the backfill and examining the backfill materials. The corrosion rate of piping that is fully encased in Controlled Low Strength Materials (flowable fill) or Higher Long Term Compressive Strength Materials (Concrete) that is not degraded is expected to be minimal.
  - e. Lines or segments with no consequence of failure.

### **6.2. Create Line Groupings**

1. The purpose for the grouping of lines is to be able to extrapolate inspection results from one or more examinations to the rest of the group, optimizing the number of excavations.
2. Separate segments or zones by process fluid (e.g., Tritiated, Service Water, & Oil lines would be grouped separately; Corrosive vs. non-corrosive fluid, for instance chemical feed would be grouped separately from condensate and separately from tritiated circulating water piping)

3. Further separate or create groups of lines with similar physical attributes based on the following :
  - a. Material (e.g., Carbon Steel, Stainless Steel, Plastic, Fiberglass, and Aluminum would be grouped separately) Note: Consideration should be given to the corrosion resistance of specific materials like the different grades of stainless steels.
  - b. Coating type/age/condition
    - i. ID coating, type/age/condition
    - ii. OD coating, type/age/condition
  - c. Line depth (the basis for this grouping is the effect of live loads, and overburden):
    - i. < 10ft below grade -- Can see the effects of live loads
    - ii. > 10ft below grade
  - d. Pipe Age (e.g., Inspections on newer lines should not be used to justify reasonable assurance on older lines).
  - e. Location in similar soil conditions (e.g., Lines in close proximity to one another in the same underground path/fill trench, backfill)
  - f. Level of Cathodic protection, availability and operating history
  - g. Operating Conditions
    - i. Temperature (e.g., lines that undergo cyclic temperature changes and/or are >100F would not be grouped with ambient temperature lines).
    - ii. Operating frequency, and durations (e.g., continuous flow,, infrequent/outage only, stagnant or dead leg)
  - h. Pipe joining methods (e.g., socket vs butt welds or threaded connections & could be a consideration for the adequacy of the external coating application)
4. For underground piping additional considerations for line group includes:
  - a. Presence and type of insulation
  - b. Potential for ground or rain water intrusion
  - c. Tunnel or vault temperature and humidity
  - d. Condition of the tunnel or vault structure
  - e. Type of deadweight support (e.g., pipe hangers versus continuous)
  - f. Condition of the pipe supports (rollers, anchor bolts, hangers, etc)
5. It is not required to separate or create new groups for each category listed in 6.2.3 and/or 6.2.4 above.
6. Each segment or zone should be included in a Line Group.



7. Documentation is required to support the basis for each line grouping.
8. Inspections would be performed on the highest susceptible locations in each group.

### **6.3. Indirect Inspection**

1. Indirect inspections, when feasible, are an available option for determining the number and location of direct examinations that are required.
2. Indirect inspections are not required and the owner can go straight to the maximum direct examinations per the respective category of that line group. The number of required direct examinations can be determined using figure 6.2 or section 6.5.2 below.
3. Indirect Inspection Selection is based on the highest susceptible locations in a line group.
4. Review each of the Indirect Inspection techniques per station or industry examination guidelines for determining applicable or optimum methods for each grouping or individual segments/zones.
5. Review historical cathodic protection survey data and segment or zone location accessibility in order to refine the inspection selection areas.
6. Review the Groundwater Protection Program data.
7. Indirect inspection measurements should be referenced to precise geographic locations and documented so that inspection results can be used for excavation and direct examinations. Indications from inspections should be aligned with other results, drawings and structures.
8. Verification of the indirect inspections indications should be done using the direct examination results. At least one direct examination will be performed in each high risk line grouping.

### **6.4. Classify Indirect Inspection Results**

1. Criteria for classifying indirect inspection results should be established.
2. The criteria for classifying the severity of indications should take into account the indirect inspection techniques used and the conditions surrounding the pipe segment. The following general classifications may be used:
  - a. Severe – indications having the highest likelihood of active corrosion activity
  - b. Moderate – possible pipeline corrosion activity
  - c. Minor – the lowest likelihood of active corrosion activity.
3. The capability and accuracy of the inspection method used must be considered as part of the engineering evaluation.

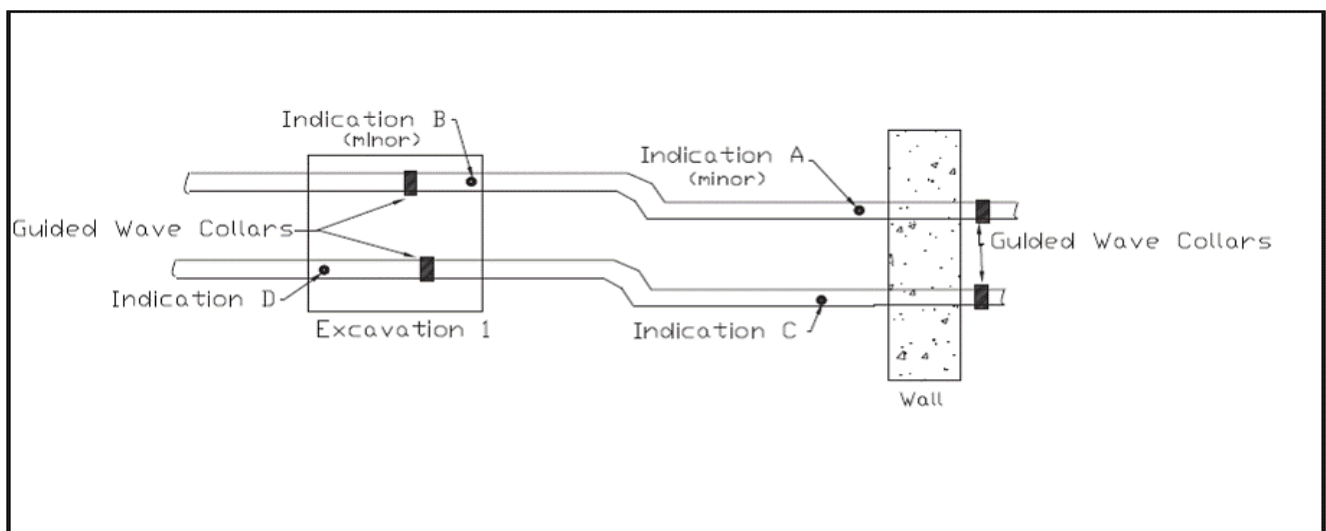
## 6.5. Direct Examination Initial Sample Size

1. When indirect inspections (for example a combination of Guided Wave and Above Ground Coating Surveys), covered greater than 50% of total (group) length including the highest susceptibility locations and where **no severe indication** (Section 6.4) is identified; one direct examination of the highest susceptible location to confirm the indirect inspection results would be required for each high risk line grouping, irrespective of the total line length. If an acceptable direct examination was achieved (i.e., Post Examination Assessment), then reasonable assurance could be demonstrated.
2. When indirect inspections covered less than 50% of total length of a pipe group and where **no severe indication** is identified:
  - a. For those High Risk Ranked lines that are safety related or contain Licensed Material or are known to be contaminated, that have pipe groups with total lengths of piping less than approximately 500' (ft.), then one direct examination of the highest susceptible location, with acceptable results, may be sufficient to demonstrate reasonable assurance. In selecting the location of the direct examination, consideration can be given to the accessibility of examination locations.
  - b. For those High Risk Ranked lines that are safety related or contain Licensed Material or are known to be contaminated, that have pipe groups with total lengths of piping greater than approximately 500' (ft.), but less than 2500' (ft.), two direct examinations of the highest susceptible locations, with acceptable results, may be sufficient to demonstrate reasonable assurance. In selecting the location of the direct examination, consideration can be given to the accessibility of examination locations.
  - c. For those High Risk Ranked lines that are safety related or contain Licensed Material or are known to be contaminated, that have pipe groups with total lengths of piping greater than approximately 2500' (ft.), three direct examinations of the highest susceptible locations, with acceptable results, may be sufficient to demonstrate reasonable assurance. In selecting the location of the direct examination, consideration can be given to the accessibility of examination locations.
  - d. For those lines that are High Risk Ranked and are not safety related, do not contain Licensed Material or are not known to be contaminated that have pipe groups with total lengths less than approximately 500' (ft.), one direct examination of the highest susceptible location, with acceptable results, may be sufficient to demonstrate reasonable assurance. In selecting the location of the direct examination, consideration can be given to the accessibility of examination locations.
  - e. For those lines that are High Risk Ranked and are not safety related, do not contain Licensed Material or are not known to be contaminated that have pipe groups with total lengths greater than approximately 500' (ft.), two direct examinations of the highest susceptible locations, with acceptable results, may

be sufficient to demonstrate reasonable assurance. In selecting the location of the direct examination, consideration can be given to the accessibility of examination locations. .

- f. For those lines that are Medium and Low Risk Ranked, a monitoring plan should be established and direct examinations performed on an opportunistic basis to determine reasonable assurance.
3. For indirect inspections that indicate severe levels of corrosion activity, categorize locations for direct examination and proceed to section 6.6.
4. For indirect inspections that indicate moderate and minor levels of corrosion activity the direct examination or examinations in section 6.5.2 would be focused on the highest area of indicated degradation.
5. Where indirect inspections that evaluate wall thickness are performed at the most susceptible locations in a group, and the results of such inspections indicate NO or MINOR likelihood of corrosion activity, then confirmation of the indirect inspection results may be obtained from a direct examination of another indirect inspection location in the same group (where the same inspection technique was used). This can be allowed when accessibility issues exist for conducting a direct examination.

Using the figure below to illustrate this concept; a guided wave shot is taken in Excavation 1 showing only “minor” indications at “B” and “D”. A direct exam is performed that validates these results, and the remaining life is acceptable. A second set of guided wave shots is taken through a wall penetration (highest susceptible location), showing minor indications at “A” and “C”. The pipe condition and indications at “A” and “C” would be considered validated by the direct examination completed in Excavation 1 with an acceptable remaining life. A second excavation would not be required to validate indications “A” and “C”. To provide additional assurance of pipe integrity for all of these indications; one or more of the monitoring activities listed in section 6.8-3 should be periodically performed.



## **6.6. Direct Examination Selection**

The objective of direct examination is to assess the extent of corrosion activity for line segments selected for examination based on the risk assessment and indirect inspections, when performed. When no significant degradation is found from a direct examination the remaining service life and next scheduled inspection should be calculated using the guidance in the following sections.

1. Indirect inspections results should be used in determining the priority of direct examinations. Below is an example of criteria used for prioritizing direct examinations based on the severity of indications from the indirect inspections:
  - a. Severe Indications – Initiate Direct Examination Plan with Contingencies for Mitigating Action for:
    - i. Severe indications in close proximity
    - ii. Severe indications in a region with multiple moderate indications
    - iii. Isolated severe indications in a high risk region or area
    - iv. Moderate indications in a region of high risk, prior leaks or severe corrosion
  - b. Moderate Indications – Scheduled Action Required
    - i. Isolated severe indication in a low risk region
    - ii. Groups of moderate indications
    - iii. Groups of minor indications in a medium risk region
    - iv. Groups of minor indications in close proximity
  - c. Minor Indications – Monitor
    - i. All remaining indication scenarios
2. If no Indirect Inspections were performed for a group, then selection of the direct examination locations is based on the highest susceptible location of each high risk line group considering location accessibility. Review historical cathodic protection survey data or other relevant parameters to refine the direct examination area determination.
3. Direct examinations resulting from excavations should include coatings inspections by a person trained and experienced in coating condition assessment.
4. At least one Direct Examination is required for each High Risk Line Group in order to establish reasonable assurance for the Group.
5. A Direct Examination at an individual excavation for one pipe/group will assess a minimum 10' (ft.) length of pipe, if feasible. When there is more than 1 pipe/group in an excavation, each pipe/group that receives an examination accounts for a separate direct examination. If multiple lines of the same pipe grouping are exposed during excavation the direct examination length may be broken up between the pipes in that

group. For example, a length of 5' (ft.) is examined on two lines of the same group would count for one direct examination for that group.

## 6.7. Inspection Sample Expansion Considerations

When a pipe segment or zone has degradation detected by direct examination that exceeds the acceptance criteria in sections 6.8 and 6.9:

1. Determine the extent of the degradation by mapping the axial and transverse lengths and depths of the degraded area.
2. Review the indirect inspection results for the affected segment or zone and determine if additional excavation is required to perform direct examination of other areas with severe or moderate indications.
3. Determine any segments or zones that share the same degradation susceptibility characteristics and schedule additional direct examinations. The timing of the additional examinations should be based on the severity of the degradation identified and should be commensurate with the consequence of a leak or loss of function.
4. Scope expansion must be sufficient to provide confidence that the extent of condition reasonably bounds the degradation.
5. Document the findings and actions in the appropriate corrective action program.

## 6.8. Post Examination Assessment

The purpose of the post assessment process is to define the inspection interval (time to Next Scheduled Inspection or NSI), assess the effectiveness of the program, and then feed the results back to the pre-assessment step to revise the risk ranking of buried and underground pipe segments or zones and tanks as a continuous improvement process. The cumulative goal of the evaluations for a piping group is to complete a post assessment; including a fitness for service evaluation, that determines the remaining life and next scheduled inspection interval to provide quantitative reasonable assurance for that group.

1. The assessment of the examination results should be made using a Fitness-for-Service (FFS) evaluation. Any degradation found during a direct examination should be appropriately documented.
2. The FFS evaluation performed will apply to all lines, segments, or zones in the group.
  - a. When direct wall thickness measurement meets  $t_{min}$  &  $t_{meas}$  is  $>87.5\%$  of  $t_{nom}$  no FFS evaluation is required, unless active degradation is identified.
  - b. When direct wall thickness measurement meets  $t_{min}$  &  $t_{meas}$  is  $<87.5\%$  of  $t_{nom}$ :
    - i. Perform an FFS evaluation
    - ii. Evaluate cause of degradation (consider all variables-material, backfill, coatings, installation, etc.)
    - iii. Evaluate the extent of degradation (localized verses global)

- iv. Evaluate the need for scope expansion
  - v. Enter into the corrective action program
  - c. When direct wall thickness measurement does NOT meet  $t_{\min}$ :
    - i. Evaluate cause and extent of degradation
      - Inspection scope expansion (See section 6.7)
      - Determine the Extent of Condition
      - Repair degraded areas
      - Evaluate potential mitigation strategies
      - Enter into the corrective action program
3. Monitoring activities should be considered as part of the reasonable assurance programmatic or compensatory actions. Examples for the justification of the scheduling/deferral of reasonable assurance direct examinations are:
- Increased Ground Water Initiative related well monitoring frequency
  - Enhanced Cathodic Protection
  - Enhanced over the line or Area Potential Earth Current (APEC) Surveys
  - Soil Analysis
  - Coating Scans
  - Flow/pressure testing
  - Guided Wave inspections
  - Boroscope or robotic inspections of the pipe inside diameter
  - Corrosion Probes
  - Leak Testing (Acoustic monitoring, etc.)
  - Vault conditions for underground piping

## **6.9. Fitness for Service (FFS) Evaluation**

The purpose of the FFS evaluation process is to provide guidelines for evaluating wall thickness degradation in safety and non-safety related components. Engineering should use these guidelines, or other applicable methodologies, when establishing the acceptance criteria or refining the acceptance criteria when warranted. The projected life of the component, based on these calculations, is to be used to establish the interval between examinations.

### **a) Corrosion Rate**

It is recognized that for buried piping, most degradation mechanisms are not linear with time. Any corrosion rate calculated from one inspection is likely to have a large inaccuracy and could be either conservative (for inactive degradation mechanisms) or non-conservative (for recently activated mechanisms). Whenever possible, corrosion

rates should be determined by directly comparing measured wall thickness changes over a known time interval. Therefore, it is recommended to perform at least two inspections before a more accurate corrosion rate can be established.

When previous pipe wall thickness measurements or other data are not available, default external corrosion or pitting rate may be used to determine re-inspection intervals. NACE recommends a default external corrosion/pitting rate of 16 mils/year. NACE further indicates that the default rate may be reduced by 24% (from 16 mils/year), provided that the Cathodic Protection (CP) levels of the pipeline segments being evaluated have had at least 40 mV of polarization, considering the voltage drop, for a significant fraction of the time since installation. If the evaluated line can potentially be subjected to an internal corrosion process, such as Flow Accelerated Corrosion (FAC), Erosion/Corrosion (E/C) or Microbiologic Influenced Corrosion (MIC), effects of internal wall loss should also be simultaneously considered.

For components with multiple examinations the corrosion rate may be more refined, as outlined in equation 1 below:

$$CR = (time_{meas1} - time_{meas2}) \times SF / time \dots \dots \dots \text{Equation 1}$$

Where:

CR = Corrosion rate, also referred to as  $R_{ml}$  in Ref. 14  
 $time_{meas1}$  =  $t_{meas}$  at 1st examination  
 $time_{meas2}$  =  $t_{meas}$  at 2nd or subsequent examination at same location  
 $t_{meas}$  = The minimum measured value  
SF = Safety Factor (recommend at least 10%) = 1.10  
time = The length of time between the ( $time_{meas1}$  and  $time_{meas2}$ ) examinations (years)

#### b) Remaining Life (RL) Calculation

For the examination of a buried and underground pipe component or tank, the remaining life (RL) may be calculated as per Equation 2 below:

$$RL = (t_{meas} - t_{min}) / CR \dots \dots \dots \text{Equation 2}$$

Where:

$t_{meas}$  = The minimum measured value from the most recent examination  
 $t_{min}$  = The minimum acceptable wall thickness for the current inspection required to meet Code requirements.  
CR = Corrosion Rate (mils/year). Whenever possible external corrosion rates should be calculated from direct comparison of changes in wall thickness over time. However, for the initial examination the time period of active corrosion is unknown. In the absence of a known period of time from the

initiation of corrosion, a default corrosion rate (CR) of 16 mils/year may be used.

If the evaluated line can be subjected to FAC, E/C, and/or MIC, then the effects of internal wall loss should be considered.

c) Time to Next Scheduled Inspection (NSI)

When  $t_{meas}$  is found to be less than or equal to 50% of  $t_{nom}$ , the re-examination interval should be taken as one-half the remaining life (RL) calculated in Equation 2. The examination interval may be increased if it can be determined that the corrosion mechanism is inactive, for example a coating repair has been applied. When  $t_{meas}$  is greater than 50% of  $t_{nom}$ , the re-inspection interval may be taken as 75% of RL, as summarized below:

$$t_{meas} \leq 0.5 \times t_{nom}: \quad NSI = 0.50 \times RL \quad \text{.....Equation 3}$$

$$t_{meas} > 0.5 \times t_{nom}: \quad NSI = 0.75 \times RL \quad \text{.....Equation 4}$$

d) Mitigation or Engineering Technical Evaluation

- i. A determination should be made to either mitigate directly or to perform additional engineering technical evaluation/analysis if the remaining life does not support the period of time until the pipe will be available for the next examination (e.g., refueling outage).
- ii. If more than a single line is in the group, the lines with no examination data need to be evaluated based on the examinations performed for determination of condition. Additional examination may be required based on this evaluation.
- iii. A determination should be made to repair, replace or implement compensatory actions.
- iv. All engineering evaluations should be performed and documented as required by station procedures.



## 7. Tanks

The number of buried and underground storage tanks (UST) is minimal compared to the volume of underground / buried piping. Therefore, a unique risk ranking process for these components will not be developed. Buried and underground storage tanks are regulated by several different federal, state and local agencies. For example to determine which agency regulates a specific tank you must look at its use, size and contents.

- Because of their importance to reactor safety, emergency diesel generator systems, including the diesel fuel storage and supply system and associated tanks (including both above and underground tanks) and piping are regulated by the NRC. However if these same tanks leak, the remedial investigation and clean up are regulated by the USEPA.
- If the UST contains a petroleum fuel, such as diesel or gasoline, and is not directly related to reactor safety, these tanks would be regulated by both the USEPA, State environmental agencies and the individual State Fire Marshals.
- If the UST contains hazardous wastes, then the tank system is regulated by the USEPA and State environmental agencies.
- If the UST contains a hazardous chemical, then the tank is regulated by the USEPA and the State environmental agencies along with the State Emergency Management Council (SEMA) and Local Emergency Planning Council (LEPC).

Credit should be taken for the inspection requirements required by the different federal, state and local regulation and different regulating agencies to determine the material condition requirements of the UST.

## 8. References

1. "Recommendations for an Effective Program to Control the Degradation of Buried and Underground Piping and Tanks 1021175 (EPRI 1016456, Revision 1)
2. Radiological SSC Groundwater Initiative Risk Evaluation Criteria
3. A.P. Moser "Buried Pipe Design", McGraw Hill, 2<sup>nd</sup> Edition (Table 2.7 "Live Loads").
4. Section XI, Div. 1 Class 2 and 3 Metallic Piping Buried in a Back-Filled Trench, Inquiry, Draft "What Rules may be used to evaluate Class 2 and Class 3 metallic piping buried in a back-filled trench subjected to metal loss on the internal and external surfaces of the pipe or fitting"
5. ASME B&PV Code, Section XI
6. ASME B&PC Code, Section III
7. ASME B31.1, "Power Piping"
8. ASME Standard B31.3, "Process Piping"
9. ASME B31-G, "Manual for Determining the Remaining Strength of Corroded Pipelines"
10. American Petroleum Institute (API) Standard 510 Pressure Vessel Inspection Code: "Maintenance Inspection, Rating, Repair, and Alteration"
11. API Standard 570 Piping Inspection Code: "In-service Inspection, Rating, Repair, and Alteration of Piping Systems"
12. API Standard 653, "Tank Inspection, Repair, and Reconstruction"
13. ASME Code Case N-597-1, "Requirements for Analytical Evaluation of Pipe Wall Thinning", Section XI Div. 1.
14. ASME Code Case N-513, "Evaluation Criteria for temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping", Section XI, Div. 1.
15. API 579-2/ASME FFS-2, "Fitness-For-Service"
16. NACE Standard Practice SP0169-2007, Control of External Corrosion on Underground or Submerged Metallic Piping Systems, 2007.
17. NACE International Standard Recommended Practice, RP0502, Item No. 21097, "Pipeline External Corrosion Direct Assessment Methodology".
18. NUREG -1801, Rev. 2, Generic Aging Lessons Learned