Instructions and Observations

Instructions for Completion of the Spreadsheet

Utilities were given the following instructions for completing the spreadsheet.

General

- Be as accurate as possible when completing the survey, the information will not be submitted "under oath and affirmation".
- Complete the survey information for the underground portion(s) of systems that meet the definition of "important". "Important" systems are defined as those that are safety related, contain or are contaminated with licensed material, or contain environmentally hazardous material.
- Complete the survey separately for each unit.
- The system names in the table are "standard names" as defined within the INPO EPIX system. Do not change the system names in the table, instead, attempt to apply these names to the plant systems that perform similar functions unless an appropriate EPIX name is not provided.
- If there are buried systems that did not meet any of these descriptions, add the additional system names to the bottom of the list and enter the information for each of the systems added.
- Underground is defined as below grade and outside of a building (see NEI 09-14, rev 1). Piping that is in direct contact with the soil or that is contained in tunnels or vaults is included in this definition.
- Use a "1" (the number one) for all "Yes" answers, and use a "0" (the number zero) or leave the cell blank for all "No" answers.

System Design Information

- Use only one line in the table for each system. If a system has more than one buried segment and if the information for each segment differs, enter the information as follows
  - Enter a "1" if the system has any underground segments. Leave this cell, and all the other cells in the row, blank if the system does not have any underground segments.
  - Enter a "1" for "safety related", "contains licensed material", or "contains environmentally hazardous material" if one or more of the underground segments meet these categories, a "0" (zero) if these do not apply.
  - Enter a "1" for each exterior piping material type that applies to the underground segments in the system. Note that the exterior is the surface of interest.
  - Enter a "1" for each piping class that applies to underground piping segments in the system
  - Enter a "1" if any underground piping segment in the system is subjected to ASME Sec XI quarterly O&M flow tests, a "0" (zero) if this does not apply.
- The materials of fabrication abbreviations that are used in the survey entries are defined below.

- If the piping type is "C" or "O" and if it is SR or contains licensed radioactive or hazardous materials, briefly describe the type of pipe in the comments column

Leakage Event Information

- Obtain leakage information for the "important" systems (as defined above) from 2007 to the present.
- If there had been more than one leak from an underground portion of a system in any one year, enter the total number of leaks and a cause code and point of initiation for each.
- Identify where the leak initiated (ID, OD, or ?) by placing a "1" (one) in the appropriate column. If more than one leak occurred in a system in one year, enter the number of leaks that initiated from each surface.
- Identify the likely cause of leaks using the "Cause Codes" listed (see below). Enter a "1" for the most appropriate cause. Enter only one cause for each leak.
- If the same cause applies to more than one leak, enter the number of times that each appropriate cause code applied.
- Ensure the number of leaks in a year equals the number of initiation points and the number of cause codes.

Abbreviations

Materials of Fabrication

If piping is SR or contains hazardous material, briefly describe the type of pipe in the comments column.

- AL - Aluminum or aluminum alloy
- CU - Copper or copper alloy
- C - Concrete
- FE - Iron: ductile iron, cast iron
- O - Other
- P - Plastic or HDPE
- S - Steel: carbon steel, low alloy steel, cast steel
- SS - Stainless steel, Ni alloy, TI alloy, superaustentic materials or other highly corrosion resistant material

Leakage Cause Codes

- Crk - Cracking (such as SCC, Cl assisted, IGSCC)
- Gal - Galvanic corrosion
- GC - General Corrosion - relatively uniform loss of wall thickness (often due to no cathodic protection (CP) or CP failure and/or general coating failure)
- I - Other internal, such as microbiologically induced corrision, errosion/corrosion
- Lea - Selective leaching
- Mec - Flange, seal, or mechanical joint failure
- Other

- Ov - Mechanical overload (such as settlement, external impact, external loading, water hammer, earthquakes, backhoes)
- Pit - Pitting - small sharp cavities (often caused by local coating failure or damage, or stray current)

Observations

The observations below are provided in two sections: "General" observations related to the "Totals" on the spreadsheets and observations on the charts.

General

The following observations were made on the "Totals" information on each spreadsheet.

- There were 47 instances of class 2 systems that are buried. There were more PWR systems in this category (35) than would be implied by the larger number of PWR designs and most of these systems were RHR (10), make up and purification (6) and high pressure safety injection (5).
- There were 184 instances of buried class 3 systems, and the PWR's accounted for a proportionally larger share of this number (137 versus 47). The majority of these systems for both PWRs and BWRs were essential service water with a significant number of buried emergency diesel fuel oil systems in PWRs.
- There were no reported instances of buried class 1 or class 3 high energy systems.
- 95 PWR systems and 49 BWR systems were reported to be subject to ASME Section XI O&M testing.

Charts

In addition to the "Totals" on each spreadsheet, some of the data has been charted in various ways. Some observations on these charts are discussed below.

Figure 1: Buried Piping by System

- This chart shows the total number of plants that reported buried segments for each important system. If the system is not on the chart, no plant reported it as important and buried. The BWR and PWR totals are shown in different colors on each bar.
- The most frequently buried important systems are diesel fuel oil and essential service water. This is not surprising. A number of important systems are reported to be buried very infrequently such as environmental control systems. This may be due to differences in plant categorization of "importance".

Figure 2: Buried Systems and Leakage

- This chart shows the total number of plants that reported buried segments for each important system plotted next to the number of reported leaks for the same system.
- The "important" system with the largest number of leak events was essential service water, followed by fire protection, condensate, and then liquid waste management. This is not a surprise, but it may be an indication of the relative number of leaks in the fire protection

system since few of the utilities categorized this system as "important" and therefore information on this system was not reported as often as others.

- Caution should be used when applying any conclusions regarding the frequency of leakage in the systems shown; plants categorized the "importance" of similar systems differently and therefore information on many of the systems was not provided by every plant.
- A comparison of the sizes of the bars for each system gives an approximation of how often the given system leaked. This relationship led to Figure 3.

Figure 3: Ratio of Leaks to Buried Systems
- This chart shows the ratio of the number of reported occurrences of leakage in a given important system to the number of times a segment of that system was reported to be buried.
- Superficially, this data might be interpreted to show which systems are more likely to leak, but this conclusion is clouded by the fact that several other parameters are important in reaching this conclusion, including the length of piping buried and its material of fabrication.

Figure 4: Piping Materials
- This chart shows the relative frequency of use of different materials of fabrication in buried piping systems. Data for BWRs and PWRs is shown separately.
- Steel is used most frequently followed by stainless steel and then by iron. Note that plants indicated every material type that was used in a system, so in some cases more than one material was reported for a given system by a single unit.

Figure 5: Importance Category
- This chart shows the relative instance of occurrence of the three reasons for calling a system "important" (safety related, contains licensed material, or contains hazardous material).
- "Contains radioactive material" is the predominant reason reported. "Safety related" and "contains hazardous materials" are both about equally represented. Note that some systems were categorized as "important" for more than one of these reasons.

Figure 6: BWR Leakage Causes
- This chart shows the trend of leakage from "important" BWR systems broken down by cause. Only systems that had reported leaks are shown.
- The trend shows a significant increase in leakage over time. This trend could be misleading due to the increased sensitivity for reporting leakage in the last few years (since the approval of the Ground Water Protection Initiative and since we asked utilities to report <u>all</u> leaks starting in 2009). This trend will need to be observed over a longer time frame before conclusions are drawn. NEI intends to maintain this trend as part of the semi-annual reports required by the Underground Piping and Tanks Initiative.
- The predominant leakage cause reported was "mechanical" followed by "galvanic corrosion".
- The BWRs did not report any "cracking", "general corrosion", "selective leaching", or "microbiologically induced corrosion".

Figure 7: PWR Leakage Causes

- This chart shows the trend of leakage from "important" PWR systems broken down by cause. Only systems that had reported leaks are shown.
- The chart shows an increasing leakage trend over time (but not so large as for BWRs). This trend could be misleading due to the increased sensitivity for reporting leakage in the last few years (since the approval of the Ground Water Protection Initiative and since we asked utilities to report all leaks starting in 2009). This trend will need to be observed over a longer time frame before conclusions are drawn. NEI intends to maintain this trend as part of the semi-annual reports required by the Underground Piping and Tanks Initiative.
- The predominant leakage cause reported was "galvanic corrosion" followed by "pitting" and "mechanical".
- The PWRs did not report any "selective leaching".

Figure 8: Total Leakage Causes

- This chart shows the trend of leakage from "important" BWR and PWR systems broken down by cause. Only systems that had reported leaks are shown.
- As is the case for the BWR and PWR charts, the trend looks like it is increasing over time. The same caution applies to this interpretation as was explained for the BWR and PWR results above.
- The predominant leakage cause reported was "mechanical" followed by "galvanic corrosion" and "pitting".
- Note that "Other" was used relatively frequently for all three leakage trend charts. It is hoped that the use of this "default" cause will decrease due to the current emphasis on reporting.
- The only cause that was never reported was "selective leaching".

Figure 9: BWR-PWR Leakage Events

- This chart shows the total number of reported leaks from all plants and for all years captured by the survey. The data is shown for each important system that had leaks, with the BWR and PWR totals shown in separate colors on each bar.
- The same caution regarding apparent leakage trends applies to this chart as explained for the 3 charts above.
- Other than 2007, the relative number of leaks in BWRs versus PWRs approximates the relative numbers of each plant design.