(K. Scheel 8/24/09) Per MRC on 8/24/09: Review of the RCR revision was put on hold by MRC. Re-open RCR for additional changes.
*

(A. Kinzler 8/6/09) Per SOC Re-opened Root cause to updates based on AR 949547.
*

(A. Kinzler 8/3/09) MRC Comments: Addressed LOW Returned to MRC date.
*

(K. Scheel 6/23/09) Per MRC on 6/23/09: Root Cause update provided. Extend Root Cause due date to **7/24/09**, due to magnitude of issue and just identifying preliminary cause on 6/18/09, per Plant Manager.
*

TI Leffler 06/22/09: Per SOC: Add Clean Demin contaminated, determine EOC, from IRs **932740 & 933610**: What Normally Tritium free systems are impacted by the Clean Demin Tank being contaminated by the leak(s)/cross-tie.

Tom Mohr 7/17/09, Update on 932740 & 933610, 932740 WGE performed the extent of condition and actions required to disposition 932740 & 933610. The actions are outside the charter of the root cause and cannot be included in the root cause actions and as issues were addressed in 932740 WGE, they are not included in the root cause associated with 928304.

TI Leffler 07/15/09: Per SOC add IR **941485 & 941182** to RCR 928304.

ATI reopened to provide additional information. Will be closed after completed. Per Rich Sisk by B. Carnahan 07/28/09----------

Title: ELEVATED TRITIUM VALUES IDENTIFIED IN 2 STORM DRAINS DUE TO THROUGH-WALL LEAKS IN UNDERGROUND PIPING

Unit(s): Dresden Station Units 2/3

Event Date: 06/05/09

Event Time: 0700

Action Tracking Item Number: 00928304

Report Date: 07/24/09

Sponsoring Manager: Joe Sipek, Engineering Director

Investigators: Team Lead: Richard Sisk, Programs Engineering
Members: Frank Polak, System Engineering (RCR Qualified)
Greg Lupia, Corporate Engineering
Scott Akerman, System Engineering
Jack Lazowski, Design Engineering
Ken Rach, Structural Integrity Inc.
Larry Weigel, Structural Integrity Inc.

Executive Summary: On 6/5/09 at 07:54 Operations begins transferring water to the Unit 1 Condensate Storage Tank. Evolution is completed at 10:53. Tritium sampling identifies a tritium concentration of 455,000 pCi/L from sewer DSP-140, which is the storm drain just North of the 2/3 A Condensate Storage Tank. On 6/6/09 Sample results from sample well DN-MW-107-S reveals tritium concentrations of 3,200,000 pCi/L. This sample well is located West of the Unit 1 Condensate Storage Tank.

The source of the elevated tritium levels identified in the storm sewer system was two through-wall leaks in two different underground pipelines as well as a degraded standpipe located in the Unit 1 Condensate Storage tank. The root cause of the two through-wall leaks was determined to be the degradation of the protective moisture barrier wrap, which allowed moisture to come in contact with the piping resulting in external corrosion. The cause of the standpipe failure is damage from freezing as determined through interviews with Operations department first line supervisors. It is suspected that the tank was left empty prior to 2001 with no heating during weather conditions that were cold enough to freeze the residual water in the pipe causing the indications noted when the pipe was inspected. The Corrective actions generated from this event will be to perform G-scan inspections on 100% of all piping located in the area of the Condensate Storage tanks. Repair all identified degraded piping, identify all piping containing contaminated water on site, generate a Portfolio Director entry for a

project to rehabilitate all piping containing contaminated water and prepare a project plan for the rehabilitation of this piping. The Corrective Actions to Prevent Reoccurrence (CAPR) will be to rehabilitate all identified degraded buried piping located in the Condensate Storage tank area that contains contaminated water.

The extent of condition will be determined by performing Long-range Guided Wave inspections (G-Scan) of all piping containing tritium located near the Condensate Storage tanks. A large portion of these exams is completed but further inspections will be required to achieve 100% coverage.

The risk to the plant from a PRA perspective, The Unit 1A Condensate Storage Tank provides inventory make-up water for long-term accident conditions that are modeled in the Dresden PRA. The CST water was available to the units prior to repair activities. The decrease in available water with the 1A CST unavailable is judged to have a negligible impact to the Dresden Unit 2 and Unit 3 Core Damage Frequency. This event was reportable due to the fact that the release contained tritium at quantities greater than 0.002 curies.

Previous events associated with underground piping leaks include Oyster Creek; underground Condensate Transfer piping through-wall leaks (4/15/2009) and Indian Point, underground Condensate Return Line developed a through-wall leak (2/15/2009).

Per discussion with the Plant Operations Review Committee (PORC) coordinator it was determined that a PORC review was not required.

Significance of Event: Although contaminated water was released to the environment, the safety significance to the public was low due to the fact that the contaminated water was contained within the protected area. The Unit 1A Condensate Storage Tank provides inventory make-up water for long-term accident conditions that are modeled in the Dresden PRA. The CST water was available to the units prior to repair activities. The decrease in available water with the 1A CST unavailable is judged to have a negligible impact to the Dresden Unit 2 and Unit 3 Core Damage Frequency.

Event Description: (refer to attachment D for E&CF Chart)

On 5/29/09 the Maintenance Department was performing a walkdown at the Unit 2/3 Condensate Storage Tanks for work to be performed the following week. A pit under the Fuel Pool reject isolation valve [2/3-3350-A500] was full of water and needed to be pumped out to facilitate the work. Maintenance brought a sample of the pit water, presumed to be rainwater, to the Chemistry department in order to determine if the water could be pumped to the local sewer or, if it contained an elevated tritium concentration, it would be pumped to a radwaste drain in the Turbine Building.

On 6/2/09 the results of the tritium analysis of the containment pit water showed a tritium concentration of 21,000 pCi/L. Chemistry directed Operations to pump this water into a Radwaste drain in the plant. This result was higher than expected but not comparable with the 4,000,000 pCi/L concentration found in the CST.

On 6/4/09 at 17:00 preliminary results from the Radiological Groundwater Protection Program (RGGP) became available. 12 of the 13 results were in line with the expected trends, DSP-132, the sewer at the Unit 1 outfall showed a tritium

concentration of 17,000 pCi/L. Chemistry management decided to re-analyze this sample and retake the sample again the following day.

On 6/5/09 at 07:54 Operations begins transferring water to the Unit 1 Condensate Storage Tank. Evolution is completed at 10:53. Tritium sampling identifies a tritium concentration of 455,000 pCi/L from sewer DSP-140, which is the storm drain just North of the 2/3 A Condensate Storage Tank.

The Outage Control Center (OCC) was activated on 6/5/09 and at this time a trouble shooting team was formed to identify the source of the elevated tritium levels. The troubleshooting consisted of the following tasks:

On 6/5/09 a review of the piping located in the area was conducted to identify piping containing contaminated water. Through this review six buried pipelines were identified as containing contaminated water as well as the Unit 1 Condensate Storage Tank. The pipelines identified were 2/3-3346-24", 2/3-3340-6", 2/3-3329-16", 2/3-3327-12", 2/3-3339-6" and 2/3-3333-6".

On 6/6/09 Sample results from sample well DN-MW-107-S reveals tritium concentrations of 3,200,000 pCi/L. This sample well is located West of the Unit 1 Condensate Storage Tank.

On 6/6/09 Insulation was removed from lines 2/3-3340-6" and 2/3-3346-24" where they exit the Unit 1 Condensate Storage Tank. This was done to perform a Long Range Guided Wave Ultrasonic inspection (G-Scan) of this piping. An inspection was performed on 2/3-3340-6" with inspection results identifying one area with 50% wall loss. Line 2/3-3346-24" could not be inspected due to the fact that there was not a straight piece of pipe above ground to install the G-Scan collar.

Excavation activities began on 6/7/09 to unearth the remaining pipelines that could not be inspected from aboveground.

On 6/8/09 G-Scan inspections were performed on the Condensate lines 2/3-3333-6", 2/3-3339-6" as well as 2/3-4324-4" and 2/3-43220-4", which are Clean Demineralized water pipelines. Inspection results from the Condensate lines revealed minor corrosion on both lines. The Clean Demineralized water pipelines were not analyzed at this time due to the fact that they contained clean water. The remaining Condensate lines 2/3-3346-24", 2/3-3327-12" and 2/3-3329-16" could not be inspected at this time due additional excavating being required to access the piping. Excavation activities continued through the night.

On 6/10/09 G-scan inspections were performed on condensate lines 2/3-3346-24", 2/3-3327-12" and 2/3-3329-16". Inspection results identified one area of 50% wall loss on line 2/3-3327-12", two locations of 40% wall loss on line 2/3-3329-16" and two severe areas of degradation estimated at 75% and 52% wall loss. It was determined at this time to perform additional excavating in order to be able to perform visual inspections for all areas identified by G-scan that were 50% or greater. In order to perform additional excavating, it was decided that the Unit 1 Condensate Storage Tank needed to be drained and a more complex shoring plan needed to be designed due to the close proximity of the storage tanks.

Once shoring and excavating activities were completed on 6/15/09, visual examination was completed of the severe areas identified on line 2/3-3346-24". The visual inspection did not reveal a through-wall leak but areas of pitting were identified that measured approximately 60% wall loss. At approximately 14:19 operations put the

Make-up Demineralized Water system into service to fill the 1B Clean Demin Tank and a through-wall leak was identified on line 2/3-4324-4". A water sample was taken from this leak and the results identified 3,000 pCi/L of tritium. A second sample was taken on 6/16/09 to validate the first sample and it revealed 130,000 pCi/L of tritium. After further investigations to identify flow paths for tritium to enter the Make-up Demineralized Water system it was decided that an internal visual inspection of the Unit 1 Condensate Storage Tank was required.

On 6/17/09 System Engineering performed a visual inspection of the internals of the Unit 1 Condensate Storage Tank. This inspection revealed that the standpipe, which is connected to line 2/3-4324-4", had two areas with fish mouth ruptures as well as another area with a though-wall crack. At this time it was determined that the contaminated tank water got into the standpipe through the defects. The open isolation valve then connected the standpipe to the 4-inch line and due to the head of water in the tank, there was a sufficient pressure differential to leak the contaminated CST water into the ground. Under work order 01241421-41 the through-wall leak on line 2/3-4324-4" was repaired by sectional replacement. The standpipe was also removed and a blind flange was installed under work order 01241421-43.

Daily tritium sampling continued in order to validate that all services of leakage had been identified and on 7/12/09 tritium concentration levels of 3,500,000 were detected in the excavation area. Excavation activities were being performed on 7/13/09 to uncover line 2/3-3346-24" for the preparation for carbon fiber repair. Workers noticed a stream of water coming from the area of the 24" pipe on the South end of the excavation as well as a pool of water that had not been there previously. The area was then excavated enough to see the top of the pipe and a through-wall leak was identified at the 11o'clock position. A review of the previous G-scan inspection was completed and no indication of severe corrosion was identified. The inspection vendor was contacted and requested to reanalyze the inspection shot to determine if anything had been overlooked. They stated after review of the inspection that the indication for the weld was broader than a normal weld indication and that the weld had masked the indication from the leak location. They also stated that if the leak indication had been identified, it would have been called as a medium corrosion area at best which is less than 50% wall loss. During this time, excavation activities continued in order to install a temporary clamp to prevent further contaminated water from entering the environment. The temporary clamp was installed under work order 1241421-24. Prior to installing the temporary clamp, a visual as well as an ultrasonic inspection was completed on the area to determine structural integrity of the pipe. The results of these inspections revealed that the leak was approximately 0.2" in diameter and was located within an external pit 1" in diameter. The nearest circumferential weld was approximately 8" from the leak. The average thickness in the area was 0.360" with the lowest thickness reading being 0.275". Other small pits and external corrosion areas were also identified at various locations around the circumference of the pipe.

It has been determined that both the degraded standpipe within the Unit 1 Condensate Storage tank as well as the through-wall leak on line 2/3-3346-24" are the root causes of the elevated tritium levels identified on 6/2/09. The through-wall leak on line 2/3-4324-4" has been identified as a contributing cause of the elevated tritium

levels. Without these three events occurring the elevated levels would not have occurred.

Extent of Condition: Clearly describe the extent of the condition as it relates to the problem. Identify impact on other plant systems, components, structures, programs, procedures, processes, or organizations in the same manner as the identified apparent cause

Condition being addressed	Extent of Condition
Through-Wall leaks on line 2/3-3346-24"	Complete G-Scan inspections on piping that contains contaminated water within the CST area. To date there is a approximately 200' feet of piping that require inspection. The following lines require inspection to complete 100% coverage: 2/3-3346-24" – 60' within the middle of the Pipe run 2/3-3329-16" – 50' under the Unit 2 interlock 2/3-3327-12" – 50' under the Unit 2 interlock and 30' off of 2/3A CST 2/3-3333-6" – 30' off of the 2/3A CST 2/3-3339-6" – 10' off of the 2/3B CST CA: 00928304-21 will track the completion of these inspections.
Degraded CST Stand-Pipe	Visual inspections were recently performed by divers on the 1B CST, 2/3A CST and 2/3B CST. The system engineer reviewed videos from these inspections and no defects were identified on the standpipes for each CST. No other contaminated tanks were identified having internal standpipes.

Analysis: (Reference Attachment 16 and describe the root cause analysis techniques utilized in the investigation. Provide the basis for using these techniques and describe the analysis results).

Two root cause evaluation techniques were utilized in the analysis of this event: a Failure Modes and Effects Analysis, a Cause and Effect Analysis. The Failure Modes and Effects Analysis provided the failure mode of the piping as well as the ruptured standpipe while the Cause and Effect Analysis was utilized in determining the actual root cause of the event.

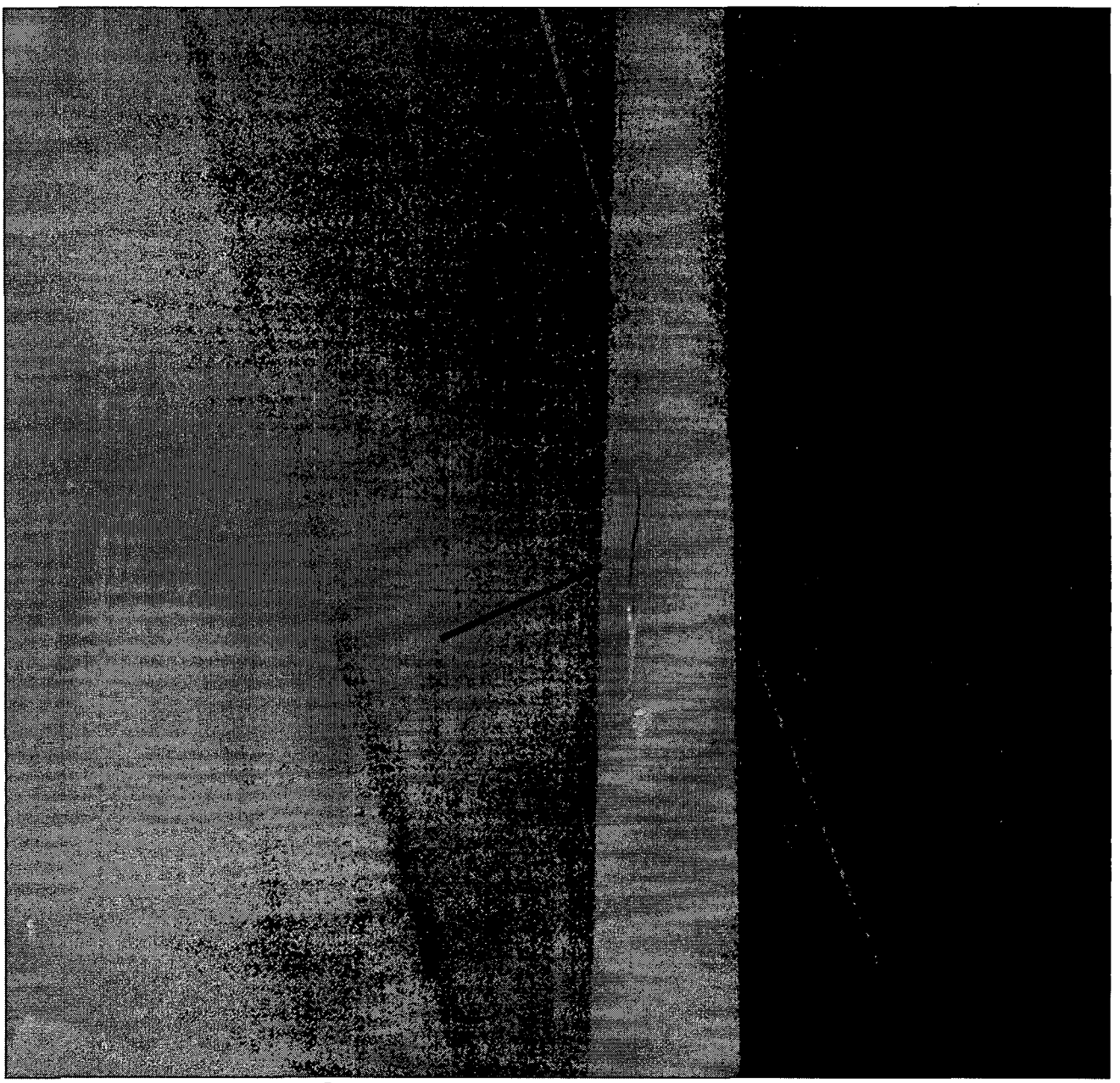
Analysis evaluated potential failure modes for this event. The potential failure modes were established based on the guidance provided in LS-AA-125-1003, Attachment 6, *Equipment Apparent Cause Evaluation Guide*, industry operating experience (see Previous Events section of Root Cause Report), and the expertise of Dresden Engineers.

Ruptured Standpipe

The visual inspection completed on 6/17/09 of the Unit 1 Condensate Storage Tank (CST) standpipe revealed two areas with fish mouth ruptures as well as another area with a through-wall crack. It has been determined that the most probable root cause of these is the freezing of the standpipe during historical operating methods.

Interview with Operations Department first-line supervisor regarding past Operating methods and philosophies that may have led to the freezing of the 1A CST standpipe provided the following insight. Approximately eight years ago the water management plan for the outage included draining 2/3 A & B CST and 1A CST as low as allowable by the tech specs. This was performed with the tanks cross-tied. After this evolution was completed the 2/3 CST and 1A CST crosstie valve was then closed and the 1A CST was drained to the U2 Reactor Feed Pump bedplate until the tank was empty. Operations would secure the heating if the tank was less than 20% to prevent damage to the heating coils.

It is suspected that the tank was left empty with no heating during weather conditions that were cold enough to freeze the residual water in the pipe causing the indications noted when the pipe was inspected. The reason that this evolution was used was to have the available inventory to allow the drain down to commence in a faster manner. This method of water management hasn't been used in the last seven years and it is believed that the damage to the standpipe is historic in nature.



Lowest Standpipe Failure, ~10 ft off the bottom

Middle Standpipe Failure.

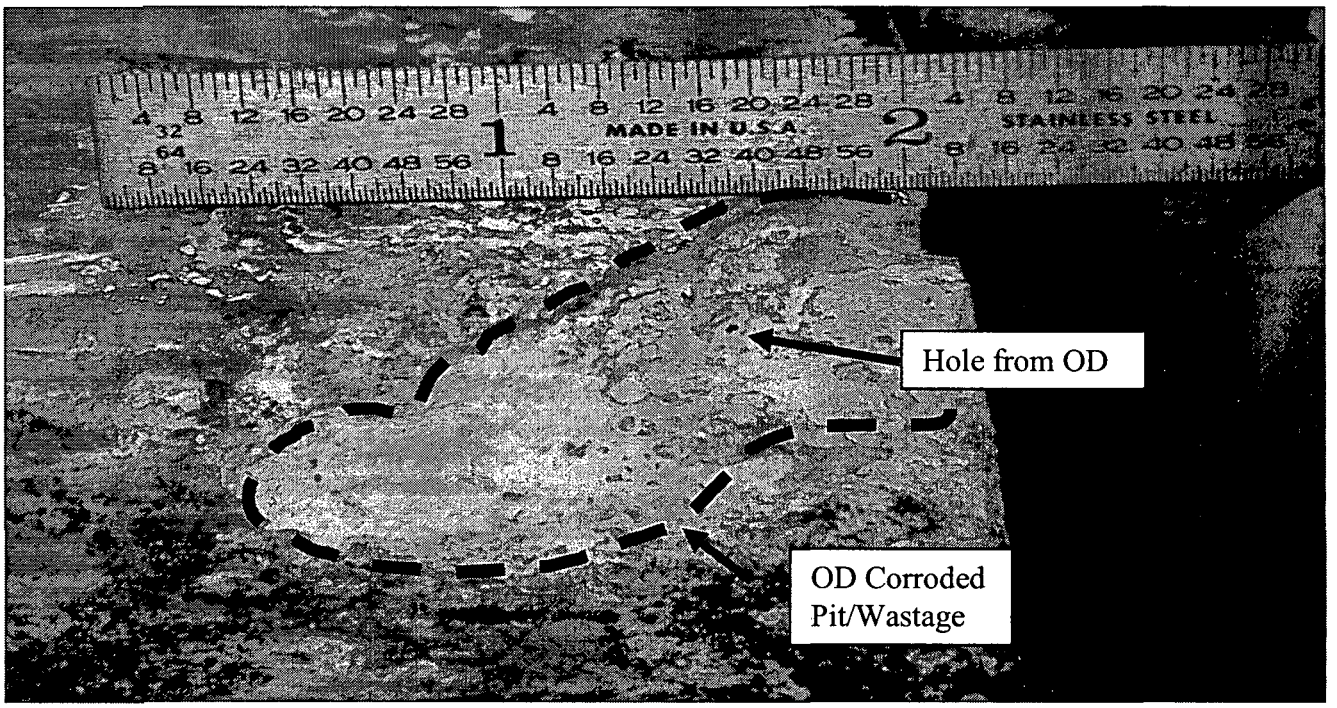
Upper Standpipe Failure

A flow path for potentially 4 hours occurs between the standpipe defect and identified leak in line 2/3-4324-4" occurs during Operations procedures for filling the Unit 1 CST. It is suspected that the contaminated tank water got into the standpipe through the defects in the standpipe. The open isolation valve then connected the standpipe to the 4-inch line and due to the head of water in the tank, there was a sufficient pressure differential to leak the contaminated CST water into the ground. No documentation could be found to determine if an internal visual inspection of this tank had previously been performed. The leak in the standpipe has existed for some time due to some of the anomalies that have been noted at the station including; elevated tritium in the shell side of the isolation condenser, and in the mid nineties contamination was discovered in the Make-up Demineralizer System. Based on the flow path that has been discovered this mechanism could have led to cross contamination between the 1A CST and the 1B Clean Demin Tank. Samples were taken on 06/16/09 and tritium levels in the 1B Clean Demin Tank were 1700 pCi/L, the only source for tritium to enter this tank was through the make-up line. It has been determined that the through-wall leak on line 2/3-4324-4" had to happened after 5/20/09 due to the tritium concentration of 200 pCi/L identified during routine samples taken for the supplemental Radiological Groundwater Protection Program (RGPP) program on 5/20/09.

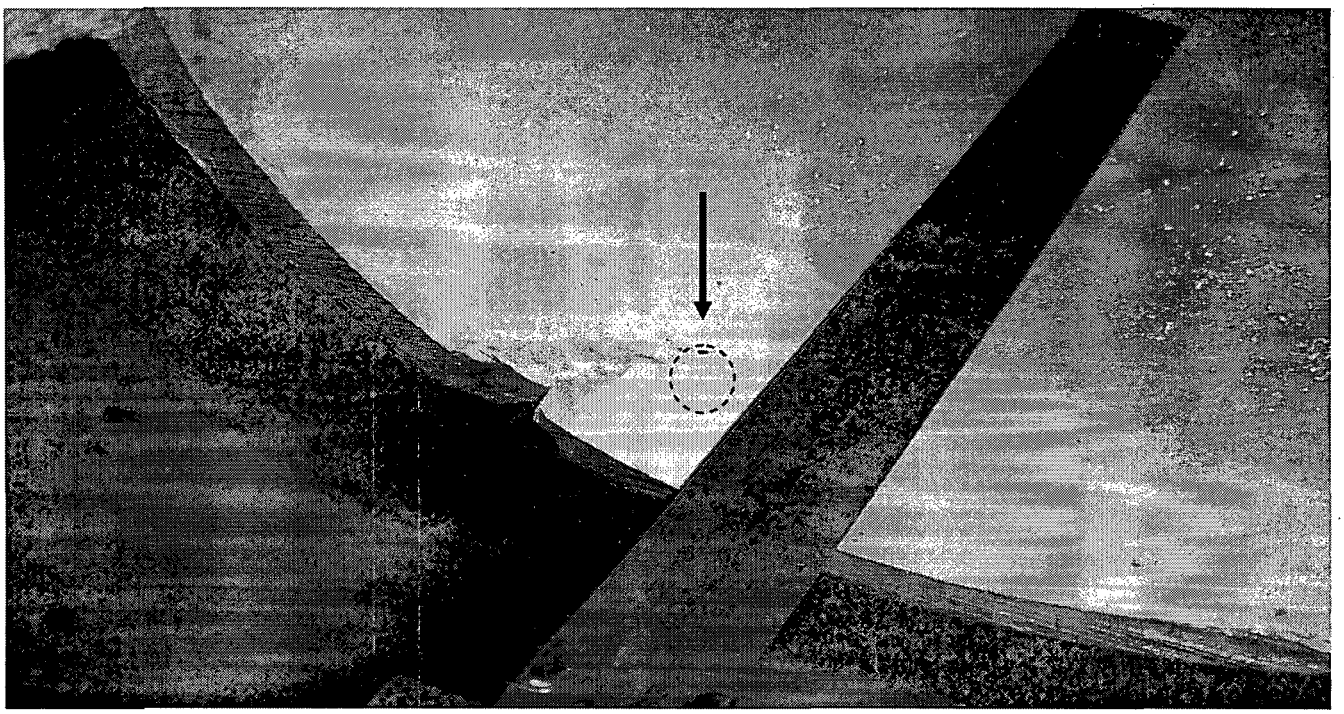
Through-wall Leak on Line 2/3-4324-4"And 2/3-3346-24"

The through-wall leaks identified on lines 2/3-4324-4" and 2/3-3346-24" were the result of external corrosion caused by the degraded protective moisture barrier wrap. The leak on line 2/3-4324-4" was approximately 1/16" in size and was located within a 2" area of external corrosion. The moisture barrier wrap installed on this line was a bituminous coating. Initial inspection of the leak location identified that the protective moisture barrier wrap was degraded to the extent that a section of the wrap was missing from this specific area. The leak on line 2/3-3346-24" was approximately .2" in size and was located within a 1" area of external corrosion. This area was not identified by G-scan due to the limitations of the technology, specifically the distance this indication was from a circumferential weld. Corporate engineering is addressing the limitations identified with this technology and have also published letter VPE090609 titled "Oyster Creek Guided Wave Inspection Root Cause which provides a status of lessons learned with guided wave and the implementation plan in support of the buried piping program at Exelon plants. The moisture barrier wrap installed on this line was a thin form of tape coating. This coating had degraded and fallen off the pipe in certain areas and had numerous areas where the taped had curled edges. Neither Design Engineering nor Sergeant & Lundy Engineers could find the pipe coating specifications for either coating. Moisture barrier wrap degradation can be attributed to various causes, soil stresses, loss of electrical resistance, improper application, improper backfill procedures, contaminants in soil, biodegradation of the adhesive and age. Although the cause of the degradation could not be determined it is believed that the most probable cause of the degradation can be attributed to biodegradation of the adhesive and age. This was determined by the brittleness of the bituminous coating, which resulted in cracking of the coating. Per previous conversations with an industry coatings expert, the life

expectancy of coatings from the late 60's early 70's was between 20 and 30 years. Line 2/3-4324-4" was installed in 1968 per as built drawings and line 2/3-3346-24" was installed during the same time 2/3A CST was constructed. The external corrosion indicates that the pipe was exposed to moisture before the through-wall leak occurred. When exposed to water, the pipe surface beneath a coating holiday or void will corrode by the same corrosion mechanism that occur on non-coated, buried piping (e.g., general corrosion, oxygen concentration cells, etc.).



Through-wall leak from OD



Through-wall Leak From ID of Pipe

Through-wall on Line 2/3-3346-24"

Evaluation: For each Causal Factor (Problem Statement) defined, describe the cause and the basis for that cause influencing the outcome of the event. Also, identify whether the cause is a root cause or contributing cause

Problem Statement	Cause (Describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
Elevated tritium levels in storm sewers	Through-wall leak on line 2/3-3346-24" due to failed barrier wrap (Root Cause 1)	The cause of the through-wall leak was attributed to degradation of the protective moisture barrier wrap. The through-wall leak was initiated from the outside diameter of the piping. The leak was located where the protective wrap was severely degraded. The degradation of the protective wrap allowed moisture to come in contact with the piping resulting in anodic dissolution. This degradation of the protective moisture barrier wrap is attributed to biodegradation of the adhesive and age.
Elevated tritium levels in storm sewers	Degraded standpipe in Unit 1 Condensate Storage tank (Root Cause 2)	Freezing of the standpipe during draining of the Unit 1 Condensate Storage Tank per the water management plan prior to 2001.Approximately eight years ago the water management plan for the outage included draining 2/3 A & B CST and 1A CST as low as allowable by the tech specs. This was performed with the tanks cross-tied. After this evolution was completed the 2/3 CST and 1A CST crosstie valve was then closed and the 1A CST was drained to the U2 Reactor Feed Pump bedplate until the tank was empty. Operations would secure the heating if the tank was less than 20% to prevent damage to the heating coils. It is suspected that the tank was left empty with no heating during weather conditions that were cold enough to freeze the residual water in the pipe causing the indications noted when the pipe was inspected.
Elevated tritium levels in storm sewers	Through-wall leak on line 2/3-4324-4" due to failed barrier wrap	The through-wall leak on line 2/3-4324-4" is considered a contributing cause due to the fact that this line is a clean water line

Problem Statement	Cause (Describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
	(Contributing Cause)	and would not have caused elevated tritium levels without the damage to the Unit 1 CST standpipe. The cause of the through-wall leak was attributed to degradation of the protective moisture barrier wrap. The through-wall leak was initiated from the outside diameter of the piping. The leak was located were the protective wrap was severely degraded. The degradation of the protective wrap allowed moisture to come in contact with the piping resulting in anodic dissolution. This degradation of the protective moisture barrier wrap is attributed to biodegradation of the adhesive and age.

Extent of Cause: Clearly describe the extent of the cause as it relates to the Causal Factors. Identify impact on other plant systems, components, structures, programs, procedures, processes, or organizations in the same manner as the identified apparent cause

Cause being addressed	Extent of Cause
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	The through-wall leaks on lines 2/3-3346-24" and 2/3-4324-4" were caused by degradation of the protective moisture barrier wrap which allowed moisture to come in contact with the piping resulting in external corrosion. The degradation of the protective moisture barrier wrap is attributed to biodegradation of the adhesive and age. This piping was installed in 1968, which amounts to 41 years of service. Dresden Station has experienced other buried piping leaks that were attributed to degradation of the protective coating. There are numerous buried pipelines on site that have been in service for 41 years or longer.
Degraded CST Stand-Pipe	There are four above-ground storage tanks that contain contaminated water that also have standpipes installed internally which are connected to clean water systems. The past Operating methods and philosophies that may have led to the freezing of the 1A CST standpipe are no longer performed on site.

Risk Assessment: (Identify the plant-specific risk consequences of the issue. For conditions that are not easily assessed quantitatively, a qualitative assessment should be included.)

Plant-specific risk consequence	Basis for Determination
Industrial Safety	There is a moderate risk of industrial safety issues caused by the leaking pipes. The inspection excavation and repair of the underground piping exposes workers to a construction environment with its inherent dangers.
Nuclear Safety	There is no increase in risk from a nuclear safety perspective. The leaks in the 4-inch, 24-inch as well as the degraded standpipe lines did not affect the plant's ability to safely shut down. In the event of an incident, the plant equipment would have functioned normally and the plant would have been shut down safely.
Chemical/Radiological /Environmental	There was a radiological and environmental risk involved with the through-wall leaks due to Tritium being released into the environment. The risk to the public was low due to the fact the tritium was contained within the protected area of the station.
Regulatory Impact	This event was reportable due to the fact that the release contained tritium at quantities greater than 0.002 curies/liter.
Production/Cost	There was no impact to production although there was an impact to the station capital budget and O&M budget due to the investigation and repairs required fro this event.

Equipment Checklist:

Step 1 **Run To Failure (RTF) Classification Check**
Is the component **incorrectly** classified as Critical, Non-Critical or Run-to-Failure per MA-AA-716-210? No

Step 2 **PM/PDM Review**
Has the past PM/PDM **not** been performed in accordance with the PCM template? No PCM Template for Buried Piping, only Cathodic Protection.

Step 3 **Maintenance Performance Assessment**
Is there a deficiency with the performance of the most recently performed maintenance? No

Step 4 **Performance Monitoring Assessment**
Has system/component monitoring been deficient in identifying normal or abnormal equipment degradation? No, Southern sections of these pipelines had been inspected with satisfactory results however the North had been inspected due to the cost of excavations required to gain access to this piping for inspection.

Step 5 **Operating Experience Review**
Is there a deficiency in how past operating experience (OPEX) applicable to this component has been addressed? No

Step 6 **PCM Template Review**
Is there a deficiency in any PCM template applicable to this component? No

Step 7 **Operational Performance Review**
Are the operating procedures or practices for this component inappropriate or unacceptable? They are acceptable per the Buried Piping Program.

Step 8 **Maintenance Practice Review**
Are there problems with the maintenance practices, behaviors or training for this component? No

Step 9 **Design Review**
Is the design configuration for this component incorrect? No

Step 10 **Manufacture/Vendor Quality Check**
Is there a concern with the quality of parts, shipping or handling? No

Step 11 **Problem/Issue Management Review**
Have previous issues not been adequately addressed including but not limited to aging, obsolescence, chronic problem, scheduling, or business planning? Yes, age related degradation of the coating is expected.

Step 12 **Latent Weaknesses**
Document in the investigation report whether the event should have been reasonably prevented by improved work preparation, effective troubleshooting, or management oversight. See Attachment 7 for guidance.

The corrective actions from the 2004 HPCI leak EACE 248494, were not extensive enough to prevent future tritiated water leaks from occurring. However, at the time of the 2004 HPCI leak, Exelon did not have a buried piping program. Based on the 2004 leak and leaks at other Exelon sites, in 2007 a standard Exelon buried piping program was established at Dresden Station. This process is being implemented and includes both sampling and piping inspections based on risk.

Step 13 **Unknown or Different Cause**
Did the equipment fail due to an unknown cause or other cause than listed in steps 1 through 11 above? No

Previous Events: (Describe the review of any relevant previous site and industry events. Explain how the OE provided useful lessons learned or insights and how it was utilized in the development of quality corrective actions. If there were no learning opportunities from the OE review, explain the basis for why it was not useful. If no applicable OE was found, describe the logical keyword searches used.)

Previous Events	Previous Event Review
OE 29020 Oyster Creek 04/15/2009	Underground Condensate Transfer piping through-wall leaks resulting in tritium being released to the environment. Causes of the leaks were attributed to degraded protective moisture barrier wrap. This degradation of the wrap resulted in Anodic dissolution. A lesson learned from this OE was the limitations of G-Scan technology and the need to properly supply the G-Scan inspectors with the correct design information prior to inspection activities.
OE 28335 Indian Point. 02/15/2009	Underground Condensate Return Line developed a through-wall leak resulting in tritium being released to the environment. The cause of this leak was determined to be degraded moisture barrier wrap. This is another example of a degraded external wrap that led to corrosion and failure of an underground pipe.
OE 27897 Davis-Besse. 10/22/2008	Through-wall leak develops on a buried 3" pipe resulting in tritium being released to the environment. This line provided a flowpath from the Condenser Pit Sump and flood pumps, which

Previous Events	Previous Event Review
	connected to a 10-inch, underground Water Treatment Backwash Sump Line to a settling basin. The cause of this leak has been attributed to a damaged protective moisture barrier wrap and a non-functional cathodic protection system. Lesson learned from this OE is that special precaution need to be taken during the excavation and backfilling activities to ensure that damage does not occur to the protective coating.
OE 27146 Quad Cities. 5/28/2008	Shoring left in an excavation led to crevice corrosion and failure of an underground pipe. The shoring was a cable spool that had been used to separate a pipe above the failed pipe during maintenance activities 15 years prior to the event. The spool was in contact with the pipe and created a crevice that allowed corrosion. The lesson learned from this OE is that all shoring bracing or other debris is removed from excavations prior to back filling.
Operating Experience Digest (OED 2007-09) External Degradation of Buried Piping. 4/2007	This OE Digest summarizes areas for improvement (AFIs) written because of weaknesses noted in protecting buried piping. Plant evaluations identified that monitoring, inspections, and processes that control the environment around the exterior of piping systems are not being implemented well, which increases the station vulnerability to pipe failure. This is an excellent reference for improvements for the Buried Piping Program.
OE 22409 Braidwood Station 04/19/2006	Tritium concentrations above reporting levels have been identified in groundwater onsite and offsite. Leaks in 1996, 1998, and 2000 from the circulating water blowdown line vacuum breakers have been shown to be the primary contributor to the tritium concentrations in the ground water. This event prompted the creation of the Buried Piping Program for Exelon. This event also identified the importance of acting quickly to identify and mitigate the effects of tritiated water leaks.
Dresden Station 09/06/05	Through-wall leak developed in the 54" Service Water header

Previous Events	Previous Event Review
Underground Service Water Leak	in vault under the Turbine Building. The cause of this leak was attributed to degraded protective moisture barrier wrap. This leak resulted in a dual unit shutdown due to the common header. Lesson learned fro this OE was that the protective moisture barrier wrap manufactured in the 60's did not have the same life expectancy as present day wrap.
Dresden Station 08/30/04 Underground HPCI Leak	Through-wall leak developed in the 24" underground HPCI line from the "B" CST. The cause of this leak was attributed to degraded protective moisture barrier wrap. Lessons learned from this event included the creation of a buried piping program. This program is designed to minimize leaks in underground piping.

Immediate Actions: (Describe the immediate or compensatory actions taken or planned.)

Immediate Actions Taken or Planned (Include AT Assignment #)		Owner	Due Date
IR written to document the discovery of elevated tritium levels in the storm drain system	IR 00928304		Complete
Staffed the Outage Control Center to support the investigation			Complete
Generated work order to track all work associated with the investigation as well as the repairs	WO 01241421		Complete
Performed a Prompt Investigation.	IR 00928304 Assignment 02	Kevin Marchi	Complete
Initiated a complex troubleshooting plan.	IR 00928304 Assignment 16	Tom Mohr	In Progress
Installed bladders in storm sewers		Maintenance	Complete
Perform G-Scan inspections on all piping within the excavation		Rick Sisk	Complete

Immediate Actions Taken or Planned (Include AT Assignment #)		Owner	Due Date
Replaced section of degraded piping on line 2/3-4324-4"	Work order: 01241421-41	Maintenance	Complete
Drained the Unit 1 CST and performed visual inspection of internals	Work order: 01241421-25	Josh Picket	Complete
Removed degraded standpipe in unit 1 CST and install blind flange	Work order: 01241421-43	Maintenance	Complete
Install clamp on degraded section of piping on line 2/3-3346-24"	Work order: 01241421-24	Maintenance	Complete
Perform G-Scan of remaining piping in area of CST that has not been completed	IR 00928304 Assignment 21	Rick Sisk	1/14/2010
Install carbon fiber wrap on lines 2/3-3346-24", 2/3-3327-12" and 2/3-3329-16"	Work Order: 01249222-01	Construction	9/1/2009
Backfill Excavation	Work Order: 01249222	Construction	09/10/2009

Corrective Actions to Prevent Recurrence (CAPRs): (For each root cause, list all actions implemented or planned to be implemented to prevent recurrence of the event. Reference Attachment 12 for CAPR attributes. Identify the action, the assignee, and the due date.)

Root Cause Being Addressed (Include TapRoot Codes)	Corrective Action to Prevent Recurrence (CAPR) (Include AT Assignment #)	Owner	Due Date
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4" due to failed barrier wrap	Rehabilitate all identified degraded buried piping located in the Condensate Storage tank area that contains contaminated water. Rehabilitation methods may include, Carbon Fiber wrap, Cured-In-Place lining, Wholesale replacement with HDPE pipe. **CAPR: 00928304-27**	Rick Sisk	1/10/2012

Root Cause Being Addressed (Include TapRoot Codes)	Corrective Action to Prevent Recurrence (CAPR) (Include AT Assignment #)	Owner	Due Date
Degraded Standpipe due to freezing	Remove standpipe and install blind flange **Work Order: 01241421-43**	Maintenance	Complete

Corrective Actions: (For all causes identified, list the Corrective Actions (CAs) or Action Items (ACITs) implemented or planned to be implemented. Identify the action, the assignee, and the due date.)

Cause Being Addressed (Include TapRoot Codes)	Corrective Action (CA) or Action Item (ACIT) (Include AT Assignment #)	Owner	Due Date
Through-wall leak on line 2/3-4324-4"	Replace degraded section of piping on line 2/3-4324-4" **Work order: 01241421-41**	Maintenance	**Complete**
Through-wall leak on line 2/3-4324-24"	Install clamp on degraded section of piping on line 2/3-3346-24" **Work order: 01241421-24**	Maintenance	**Complete**
Degraded standpipe in unit 1 CST	Remove standpipe from unit 1 CST and install blind flange **Work order: 01241421-43**	Maintenance	**Complete**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Perform review of past G-Scan reports for piping containing contaminated water located near the Condensate Storage Tanks. Identify any remaining sections of piping that has not been inspected **ACIT: 00928304-20**	Rick Sisk	**8/14/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Complete G-Scan inspections of remaining piping containing contaminated water in area of the Condensate Storage Tanks. **CA: 00928304-21**	Rick Sisk	**1/14/2010**

Cause Being Addressed (Include TapRoot Codes)	Corrective Action (CA) or Action Item (ACIT) (Include AT Assignment #)	Owner	Due Date
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Perform a review of all buried piping and identify all piping containing contaminated water. **ACIT: 00928304-22**	Rick Sisk	**9/11/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Ensure G-Scan inspections are completed on all piping containing contaminated water to achieve 100% coverage **CA: 00928304-23**	Rick Sisk	**1/14/2011**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Generate Portfolio Director entry for the rehabilitation of buried piping containing contaminated water **ACIT: 00928304-24**	Rick Sisk	**9/18/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Prepare plan for the rehabilitation of all buried piping on site that contains contaminated water. Rehabilitation methods may include, Carbon Fiber wrap, Cured-In-Place lining, Wholesale replacement with HDPE pipe. **CA: 00928304-25**	Rick Sisk	**3/19/2010**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Review and revise if necessary the current additional ground water monitoring plan **ACIT: 00928304-29**	Ed Rowley	**10/16/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Determine locations for additional sampling wells. **ACIT: 00928304-30**	Ed Rowley	**10/23/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Install additional ground water sampling wells **CA: 00928304-31**	Pete Karaba	**10/30/2009**
Through-Wall leaks on lines 2/3-3346-24" and 2/3-4324-4"	Ensure carbon fiber wrap is installed on excavated sections of lines 2/3-3346-24", 2/3-3327-12" and 2/3-3329-16"	Joe Kotowski	**12/11/2009**

Cause Being Addressed (Include TapRoot Codes)	Corrective Action (CA) or Action Item (ACIT) (Include AT Assignment #)	Owner	Due Date
	CA: 00928304-26		

Effectiveness Reviews (EFRs): (Determine which CAPRs or CAs need to be reviewed for effectiveness after they are completed. Specifically describe which activities, processes, behaviors, etc. need to be analyzed and state the requirements for an acceptable effectiveness review determination. Identify specific actions, owners, and due dates.)

CAPR / CA Being Addressed	Effectiveness Review Action (Single/Collective) (Include AT Assignment #)	Owner	Due Date
Rehabilitate all of the buried piping located in the Condensate Storage tank area that contains contaminated water. Rehabilitation methods may include, Carbon Fiber wrap, Cured-In-Place lining, Wholesale replacement with HDPE pipe.	Effectiveness of the CAPR will be to verify that the remaining pipelines containing contaminated water within the CST area has been rehabilitated.. **EFR: 00928304-28**	Rick Sisk	2/14/2012

Programmatic/Organizational Issues: (Identify Programmatic weaknesses such as poor or non-existent standards, policies or administrative controls, poor program design/content that allowed the problem to occur, or insufficient scheduling requirements. Identify Organizational weaknesses such as poor or non-existent communications; weak or non-existent management expectations; inadequate Organizational planning; insufficient staffing.)

Programmatic and Organizational Weaknesses (Causal Factor)	Corrective Action (CA) or Action Item (ACIT) (Include AT Assignment #)	Owner	Due Date
The Extent of condition corrective actions from the 2004 HPCI leak EACE and underground piping was not elevated to the proper priority. (Corrective Action NI 5CL)	At the time of the 2004 HPCI leak, Exelon did not have a buried piping program. Based on the 2004 leak and leaks at other Exelon sites, in 2007 a standard Exelon buried piping program was established at Dresden Station. **ACIT-500805-82**	Rick Sisk	Complete

Other Issues: (Identify additional issues identified during the investigation and the actions to address the issues. Identify those actions completed or, for incomplete actions, the assignee, the due date, and the action tracking number.)

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT) (Include AT Assignment #)	Owner	Due Date
No issues identified	N/A	N/A	N/A

Communications Plan: (Develop a communications plan to convey the lessons learned from the RCR to the appropriate sites, groups, or individuals. Be specific on how the RCR results will be shared/communicated in the actions that are developed and enter the communications plan actions in table below)

Lessons Learned to be Communicated	Communication Plan Action (Include AT Assignment #)	Owner	Due Date
Through-wall leak associated with buried piping due to degraded protective moisture barrier wrap as well as degraded standpipe.	External OE OE29214 was issued	Rick Sisk	Complete
Through-wall leak associated with buried piping due to degraded protective moisture barrier wrap as well as degraded standpipe.	Internal OE will be issued ACIT: **00928304-14**	Rick Sisk	08/06/2009

Attachments:

	Title
A	Root Cause Report Quality Checklist
B	Tritium Sampling Timeline
C	Area Map
D	Event and Causal Chart
E	Support/Refute Matrix

ATTACHMENT A
Root Cause Report Quality Checklist
Page 1 of 2

A.	Critical Content Attributes	YES	NO
1.	Is the condition that requires resolution adequately and accurately identified?	X	
2.	Are inappropriate actions and equipment failures (causal factors) identified?	X	
3.	Are the causes accurately identified, including root causes and contributing causes?	X	
4.	Are there CAs to prevent recurrence identified for each root cause and do they tie DIRECTLY to the root cause? AND, are there CAs for contributing cause and do they tie DIRECTLY to the contributing cause?	X	
5.	Have the root cause analysis techniques been appropriately used and documented?	X	
6.	Was an Event and Causal Factors Chart properly prepared?	X	
7.	Does the report adequately and accurately address the "extent of condition" in accordance with the guidance provided in Attachment 4 of LS-AA-125-1003?	X	
8.	Does the report adequately and accurately address the "extent of cause" in accordance with the guidance provided in Attachment 4 of LS-AA-125-1003?	X	
9.	Does the report adequately and accurately address plant specific risk consequences?	X	
10.	Does the report include the Equipment Checklist, per LS-AA-125-1003 for equipment Root Causes?	X	
11.	Does the report adequately and accurately address behavioral, programmatic and organizational issues?	X	
12.	Have previous similar events been evaluated? Has an Operating Experience database search been performed to determine useful lessons learned or insights for development of corrective actions?	X	
13.	Check applicable SOER recommendation responses to see if a required revision is necessary based on the results of the RCR.	N/A	N/A
14.	If required, does the report adequately address the NRC's Safety Culture Components in accordance with the guidance provided in Attachment 20?	X	

B.	Important Content Attributes	YES	NO
1.	Are all of the important facts included in the report?	X	
2.	Does the report explain the logic used to arrive at the conclusions?	X	
3.	If appropriate, does the report explain what root causes were considered, but eliminated from further consideration and the bases for their elimination from consideration?		X
4.	Does the report identify contributing causes, if applicable?	X	
5.	Is it clear, what conditions the CAs are intended to create?	X	

ATTACHMENT A
Root Cause Report Quality Checklist
Page 2 of 2

B.	Important Content Attributes (continued)	YES	NO
6.	Has the scope identified in the RC Charter been adequately addressed during the RCA investigation and documented in the report? If not, provide documented basis for deviation.	X	
7.	Do the CAs address the root causes or contributing causes without adding unnecessary actions?	X	
8.	Is the timing for completion of each CA commensurate with the importance or risk associated with the issue?	X	

C.	Miscellaneous Items	YES	NO
1.	Did an individual who is qualified in Root Cause Analysis prepare the report?	X*	
2.	Does the Executive Summary adequately and accurately describe the significance of the event, the event sequence, root causes, CAs, reportability, and previous events?	X	
3.	Was a Technical Human Performance screening review performed in accordance with HU-AA-1212, Technical Task Risk/Rigor Assessment, Pre-Job Brief, Independent Third Party Review, and Post-Job Brief?	X	
4.	Do the CAs include an effectiveness review for CAs to prevent recurrence?	X	
5.	Were **ALL** CAs entered and verified to be in Action Tracking?	X	
6.	Are the format, composition, and rhetoric acceptable (grammar, typographical errors, spelling, acronyms, etc.)?	X	
7.	Have the trend codes been added or adjusted in Passport to match the investigation results?		X
8.	Are the appropriate attachments included, as identified in Attachment 13?	X	
9.	Wad the Exelon Nuclear Corporate Functional Area Manger (CFAM) and Peer Group Processes, AD-AA-1110, Attachments 5 and 6, reviewed to document and evaluate best practices or improvement opportunities through the peer group process?		X

*Root Cause qualified individual was on team

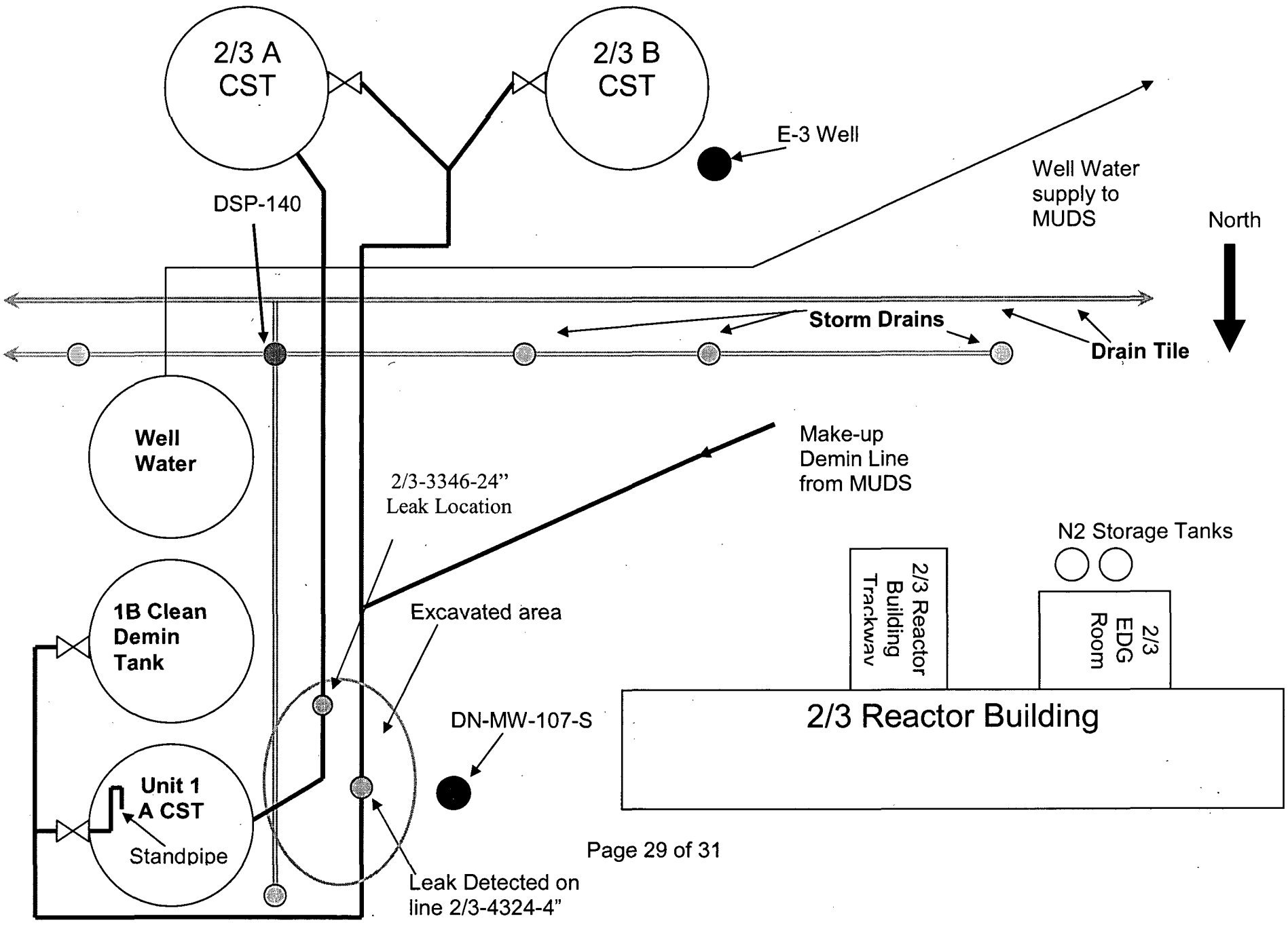
ATTACHMENT B
Tritium Sampling Timeline

Samples taken from sample well DN-MW-107-S and excavation site

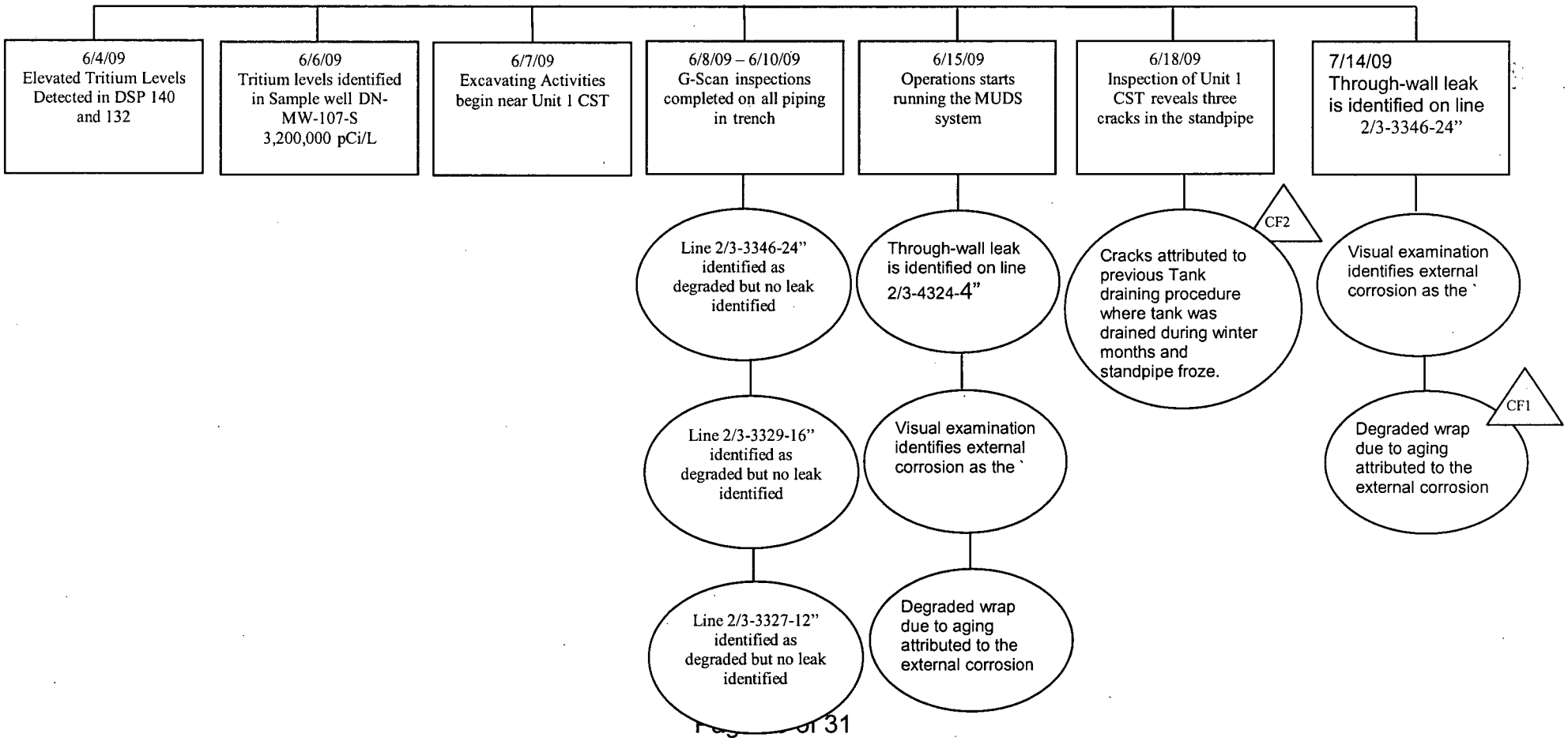
•Chemistry sample results on 05/20/09 were 200 pCi/L.
•Chemistry sample results on 06/05/09 were 3,260,000 pCi/L.
•Chemistry sample results on 06/06/09 were 3,200,000 pCi/L.
•Chemistry sample results on 06/07/09 were 3,090,000 pCi/L.
•Chemistry sample results on 06/08/09 were 2,667,903 pCi/L.
•Chemistry sample results on 06/09/09 were 782,700 pCi/L.
•Chemistry sample results on 06/10/09 were 1,281,776 pCi/L.
–The results were higher than the previous day due to heavy rains moving the Tritium in the area back into the dig area.
•Chemistry sample results on 06/12/09 were 1,236,770 pCi/L.
•Chemistry sample results on 06/13/09 were 1,479,308 pCi/L.
•Chemistry sample results on 06/14/09 were 1,360,000 pCi/L.
•Chemistry sample results on 06/15/09 were 810,400 pCi/L.
•Chemistry sample results on 06/16/09 were 1,433,000 pCi/L.
–Rain is suspected to contribute to the elevated Tritium level in combination with the high elevation of groundwater.
Chemistry sample results on 06/17/09 were 1,160,507 pCi/L.
Chemistry sample results on 06/18/09 were 1,039,724 pCi/L.
Chemistry sample results on 06/19/09 were 1,119,054 pCi/L.
Chemistry sample results on 06/20/09 were 857,100 pCi/L.
Chemistry sample results on 06/21/09 were 1,282,200 pCi/L.
Chemistry sample results on 06/22/09 were 872,600 pCi/L.
Chemistry sample results on 06/23/09 were 939,500 pCi/L.
Chemistry sample results on 06/24/09 were 1,300.000 pCi/L.
Chemistry sample results on 06/25/09 were 1,200,000 pCi/L.
Chemistry sample results on 06/26/09 were 1,270,500 pCi/L.
Chemistry sample results on 06/27/09 were 1,600,000 pCi/L.
Chemistry sample results on 06/28/09 were 1,600,000 pCi/L.
Chemistry sample results on 06/29/09 were 1,650,000 pCi/L.
Chemistry sample results on 06/30/09 were 1,800,000 pCi/L.
Chemistry sample results on 07/01/09 were 437,100 pCi/L.
Chemistry sample results on 07/02/09 were 971,000 pCi/L.
Chemistry sample results on 07/03/09 were 1,000,000 pCi/L.
Chemistry sample results on 07/04/09 were 1,300,000 pCi/L.
Chemistry sample results on 07/05/09 were 1,230,000 pCi/L.
Chemistry sample results on 07/06/09 were 1,110,000 pCi/L.
Chemistry sample results on 07/07/09 were 1,100,000 pCi/L.
Chemistry sample results on 07/08/09 were 1,440,000 pCi/L.
Chemistry sample results on 07/09/09 were 1,110,000 pCi/L.
Chemistry sample results on 07/10/09 were 1,400,000 pCi/L.
Chemistry sample results on 07/11/09 were 3,500,000 pCi/L.

Chemistry sample results on 07/12/09 were 3,500,000 pCi/L.
Chemistry sample results on 07/12/09 were 3,500,000 pCi/L.
Chemistry sample results on 07/13/09 were 1,170,000 pCi/L.
Chemistry sample results on 07/14/09 were 110,000 pCi/L.
Chemistry sample results on 07/15/09 were 53,000 pCi/L.
Chemistry sample results on 07/16/09 were 33,000 pCi/L.
Chemistry sample results on 07/17/09 were 16,300 pCi/L.
Chemistry sample results on 07/18/09 were 62,000 pCi/L.
Chemistry sample results on 07/19/09 were 36,010 pCi/L.
Chemistry sample results on 07/20/09 were 58,000 pCi/L.
Chemistry sample results on 07/21/09 were 17,400 pCi/L.
Chemistry sample results on 07/22/09 were 4,300 pCi/L.

ATTACHMENT C
AREA MAP



ATTACHMENT D
Event and Causal Factor Chart



ATTACHMENT E
SUPPORT REFUTE MATRIX

Condition Report Number: 928304-03 Date: 07/13/2009

Problem Statement: Through-wall leaks on lines 2/3-4324-4" and 2/3-3346-24" due to degraded moisture barrier wrap

Failure Modes/Cause	Supporting Evidence	Refuting Evidence	Conclusions

1) Run To Failure (RTF) Classification		No known classification for piping	Not an issue
2) PM/PDM Review		No issues with PM	Not an issue
3) Maintenance Performance Assessment		No issues identified with performed maintenance	Not an issue
4) Performance Monitoring Assessment		Monitoring has not been deficient, buried Piping program is a new program and inspections are performed yearly.	Not an issue
5) Operating Experience Review		No deficiency with past OPEX applicability	Not an issue
6) PCM Template Review		No PCM template associated with Buried piping	Not an issue
7) Operational Performance Review		Operations procedures have no impact on buried piping.	Not an issue
8) Maintenance Practice Review		No problem with maintenance practices for this piping.	Not an issue
9) Design Review		The design configuration for this piping is correct.	Not an issue
10) Manufacture/Vendor Quality Check		No issue with Manufacturer/Vendor quality checks	Trend Code classified as 3W
11) Problem/Issue Management Review	Age related degradation of the coating is expected.		Age related degradation of the protective coating is an issue here at Dresden Station.