Tank 241-C-110 Leak Assessment Report

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EXECUTIVE SUMMARY

Tank 241-C-110 is a 530,000 gallon capacity, 75-foot diameter, mild steel-lined concrete shell tank located at the west corner of the 16-tank C Tank Farm. The tank was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank. The classification was based on gross gamma soil contamination readings detected at the 53' to 56' depth in drywell 30-10-09, located about 15 feet below the tank's foundation. The contamination was found in October, 1974, immediately after the drywell was drilled adjacent to the tank.

When the soil contamination was detected, tank 241-C-110 contained about 376,000 gallons of waste, including 165,000 gallons of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period. By 1982 the gross gamma peak in the drywell had decayed to background.

In 1984 the "Questionable Integrity" and "Confirmed Leaker" tank classifications were combined and changed to "Assumed Leaker". A leak volume estimate was not made until 1989, when a 2,000 gallon volume was assigned based on the tank 241-C-110 manual tape sensitivity of +/- 0.75".

Document RPP-ENV-33418 Rev. 1, "Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases," published in February, 2008, reviewed the tank 241-C-110 leak history for purposes of retrieval technology selection. The report concluded that there was an alternative explanation for the contamination measured in the drywell, and that the tank may not have leaked.

The process for investigating potential tank leaks is described in Engineering procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process". The commitment for a formal tank 241-C-110 leak assessment was made by reference in Letter 08-TPD-015, S. J. Olinger, Office of River Protection to J. A. Hedges, State of Washington Department of Ecology, "Hanford C Farm Leak Assessments," April 9, 2008.

The leak assessment used a panel of experienced CH2M HILL Hanford Group, Inc. engineers and managers to review the tank 241-C-110 historical data and re-evaluate the basis for declaring the tank an "Assumed Leaker". The panel consisted of: Dennis J. Washenfelder, (Assessment Coordinator, Technical Integration Program Manager); Daniel G. Baide, (West Systems Engineering Manger); David A. Barnes, (Surveillance System Engineer, in-tank and ex-tank surveillance); David W. Brown (C Tank Farm Maintenance and Facility Operations Manager); Laroy S. Krogsrud (C Tank Farm Single-Shell Waste Tank System Engineer); and Phillip C. Miller (Environmental Support and Assessment Program Manager).

Based on review of the historical data, the panel developed plausible hypotheses for the observed tank behavior:

Leak Hypothesis:

"A leak from tank 241-C-110 caused the elevated radiation reading in drywell 30-10-09."

Non-Leak Hypothesis:

"An overflow from tank 241-C-110 via inlet or outlet line penetrations, a transfer line leak, or other unplanned release created the elevated radiation reading in drywell 30-10-09."

The consensus of the assessment team was that the available data indicate that the Non-Leaker hypothesis is the most likely explanation for the elevated radiation reading in the drywell. The tank's stable liquid level surface bracketing the period when the drywell gross gamma peak was discovered, the natural decay of the drywell gross gamma peak following discovery, and an interior tank photo showing evidence of waste in and above the tank inlet line penetrations indicate that tank overfilling is the most likely cause of the observed radiation in the drywell.

The recommendation of the assessment team was that the integrity status of tank 241-C-110 be changed from "Assumed Leaker" to "Sound".

The results of this assessment were presented to the Executive Safety Review Board on June 26, 2008. The Board concurred with the recommendation of the assessment team.

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Abbreviations and Acronyms

DOE-GJO DOE Grand Junction Office

DOE-RL Department of Energy Richland Operations Office

SST single-shell tank

Units

ft foot

id inside diameter

in inch

kgal kilogallon (1,000 gallons)

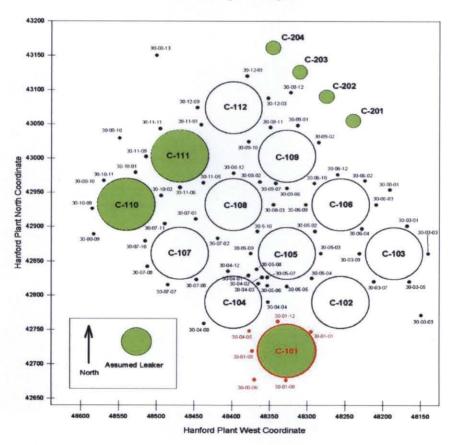
1.0 INTRODUCTION

This document provides the results of a formal leak assessment performed on tank 241-C-110 (tank C-110). The leak assessment process is described in Engineering procedure TFC-ENG-CHEM-D-42, Rev. A-1, *Tank Leak Assessment Process*. The commitment for a formal tank C-110 leak assessment was made by reference in Letter 08-TPD-015, S. J. Olinger, Office of River Protection to J. A. Hedges, State of Washington Department of Ecology, "Hanford C Farm Leak Assessments," April 9, 2008.

Tank C-110 is a 530,000 gallon capacity, 75-foot diameter, mild steel-lined concrete single-shell tank located at the west corner of the 16-tank C Tank Farm. The tank was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank.

Figure 1-1. 241-C Farm Plot Plan.

Tank C-110 is located in the west corner of the tank farm, the first tank in the three-tank C-110, - 111, and -112 Cascade. Drywells illustrated in the plan are identified by their associated tank number and clock position from North.



The classification was based on gross gamma soil contamination readings detected at the 53' to 56' depth in drywell 30-10-09, located about 15 feet below the tank's foundation. The contamination was found in October, 1974, immediately after the drywell was drilled adjacent to the tank.

When the soil contamination was detected, tank 241-C-110 contained about 376,000 gallons (kgal) of waste, including 165,000 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period. By 1982 the gross gamma peak in the drywell had decayed to background.

In 1984 the "Questionable Integrity" and "Confirmed Leaker" tank classifications were combined and changed to "Assumed Leaker". A leak volume estimate was not made until 1989, when a 2,000 gallon volume was assigned based on the tank 241-C-110 manual tape sensitivity of +/- 0.75" (8901832B R1).

Document RPP-ENV-33418 Rev. 1, "Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases," published in February, 2008, reviewed the tank 241-C-110 history for purposes of retrieval technology selection. The report concluded that there was an alternative explanation for the contamination measured in the drywell, and that the tank may not have leaked.

2.0 METHOD OF ANALYSIS

The method of analysis used was Engineering Procedure TFC-ENG-CHEM-D-42, *Tank Leak Assessment Process*. The formal leak assessment process is based on probabilistic analysis to assess the mathematical likelihood (probability) that a specific tank is leaking or has leaked. The technical basis for the process and additional details and examples of the methodology for implementing the process can be found in HNF-3747 *Tank Leak Assessment Technical Background*. For each step, a description of the process, products, and responsibilities is provided.

The leak assessment used a panel of experienced CH2M HILL Hanford Group, Inc. engineers and managers to review the tank C-110 historical data and re-evaluate the basis for declaring the tank an "Assumed Leaker". The panel consisted of: Dennis J. Washenfelder, (Assessment Coordinator, Technical Integration Program Manager); Daniel G. Baide, (West Systems Engineering Manger); David A. Barnes, (Surveillance System Engineer, in-tank and ex-tank surveillance); David W. Brown (C Tank Farm Maintenance and Facility Operations Manager); Laroy S. Krogsrud (C Tank Farm Single-Shell Waste Tank System Engineer); and Phillip C. Miller (Environment Support and Assessment Program Manager). The team met between April 29, 2008 and June 18, 2008 to gather and review information, develop the Leak and Non-Leak Hypotheses, and reach a consensus recommendation for tank C-110.

3.0 SUMMARY OF TANK HISTORY

Tank C-110 is a 530,000 gallon capacity, 75-foot diameter, mild steel-lined concrete single-shell tank located at the west corner of the 16-tank C Tank Farm. The tank was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank. Of the twelve 100-Series C Farm tanks, three – C-101, C-110, and C-111 - are classified as an "Assumed Leaker".

Tank C-110 did not see severe service based on the process history records that are available. It did not store high-heat waste. It is unlikely that it was exposed to repeated, rapid heating and cooling cycles, based on the wastes stored in the tank, although actual temperature records have not been located.

Discussions with the authors of RPP-ENV-33418 Rev. 1 indicate that waste stored in the tank did not meet current AC 5.16 Corrosion Mitigation Controls for the period May, 1946 - March, 1947, when the tank was used as part of a cascade for B Plant 1st Cycle Decontamination Waste with a pH of ~8 (Current Administrative Control 5.16 requirements are pH \ge 12).

During the 1970 - 1972 period about 1.4 million gallons of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period.

4.0 SUMMARY OF AVAILABLE DATA

4.1 TANK FEATURES AND CONFIGURATION

4.1.1 Features and Configuration

Tank 241-C-110 is a 530,000 gallon capacity, 75-foot diameter, mild steel-lined concrete single-shell tank located at the west corner of the 16-tank C Tank Farm. The tank has 4 side fill inlet nozzles: V-138, -139, and -140, connected to the 241-C-153 Diversion Box. The 4th inlet nozzle is a capped spare. Capping was accomplished in a variety of ways: friction fit, gasketed caps; plugged with wooden plugs; or plastic-bagged. The centerline of the inlet nozzles is at 17'-4", equivalent to ~547,500 gal of waste storage. A cascade overflow line to tank C-111 has a 16'-11.5" centerline, equal to ~535,000 gallons of waste storage. The steel liner extends to 19'.

During construction of the early tank farms, concrete viaducts were used to support the transfer pipeline runs from the edge of the construction excavation to the tanks. Figure 1 shows a portion of the pipeline viaducts being erected during the 241-BX Tank Farm construction.

Figure 4-1. 241-BX Tank Farm Construction.

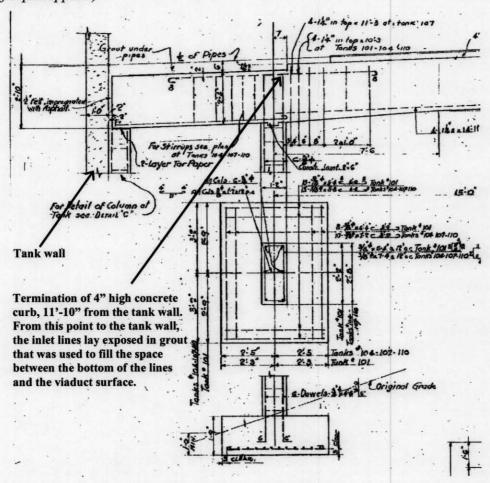
Forms for the concrete pillars that will support the pipeline viaduct have been erected in this 1947 photo. The earliest tank farms, including 241-B, -C, -T, and -U, used viaducts to support waste transfer pipelines between the edge of the tank farm excavation and the tanks. (N1D0001281 1375-NEG 241-BX 8-15-1947)



Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports" shows that the viaduct has a 4" high curb running along both edges. The curbing stops about 11'-10" from the tank wall. At about 9'-10" from the tank wall the viaduct surface steps down and the void space between the pipes and the viaduct surface is grouted. At this point the viaduct begins fanning out from 2'-8" wide to 7'-4" wide to support the spread placement of the fill lines through the tank wall. The concrete viaduct terminates 2" from the tank wall; the void space is filled with 2" asphalt-impregnated felt.

Figure 4-2. Pipeline Concrete Viaduct Details.

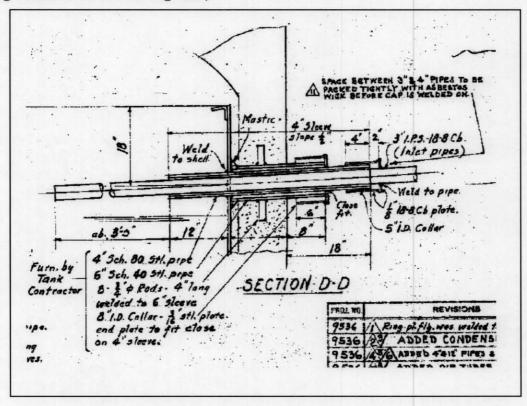
The viaduct has a 4" high curb running along both edges. The curbing stops about 11'-10" from the tank wall. At about 9'-10" from the tank wall the viaduct surface steps down and the void space between the pipes and the viaduct surface is grouted. At this point the viaduct begins fanning out from 2'-8" wide to 7'-4" wide to support the spread placement of the fill lines through the tank wall. The concrete viaduct terminates 2" from the tank wall; the void space is filled with 2" asphalt-impregnated felt. If the tank was overfilled, the waste could have backed-up through the spare inlet line and escaped from around the loose-fit end cap. The uncurbed portion of the viaduct would not have contained the waste, and it would easily spread immediately adjacent to the tank wall. (Drawing W-74108 Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports)



The inlet lines pass through the tank wall via a 4' long 4" Schedule 80 pipe sleeve. A 5" id cap shrouds the 4" sleeve at the entry point of the 3" line, and was welded to the 3" line, allowing the 3" line to float in the ~ 1/4" annular void space inside the sleeve. Before welding the cap, the void space between the 3" line and the 4" sleeve was packed with asbestos wick (Drawing H-W-72743 "Hanford Engineer Works - BLD. #241 75'0" Dia. Storage Tanks T-U-B & C Arrangement").

Figure 4-3. Inlet Line Tank Wall Penetration Detail.

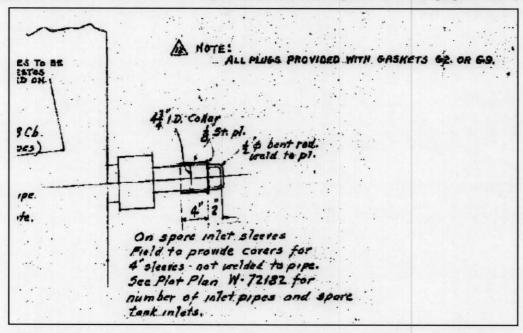
The inlet lines pass through the tank wall via a ~4' long 4" Sch. 80 pipe sleeve. A 5" id cap shrouds the 4" sleeve at the entry point of the 3" line (3" SST 18-8 tubing, and is welded to the 3" line, allowing the 3" line to float in the ~ 1/4" annular void space inside the sleeve. Before welding the cap, the void space between the 3" line and the 4" sleeve is packed with asbestos wick. It seems unlikely that the flexible asbestos wick packing could have placed very far into the 4' long 1/4" annular space. (Drawing H-W-72743 Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement).



Drawing H-W-72743 also shows the detail for the spare inlet nozzle cover. The 4-3/4" ID x 4" cover was fit over the 4" pipe sleeve and not welded in place. The OD of 4" Schedule 80 pipe is 4-1/2", so the clearance between the nozzle cover and the pipe sleeve would be about 1/8" all around. However, based on a 1951 investigation, the drawing may not represent actual as-built conditions. The 1951 field installation of some of the spare inlet nozzles on single-shell tanks (SSTs) was conducted after waste had been discharged through a spare inlet from tank BX-102 (HW-20742, Loss of Depleted Metal Waste Supernate to Soil). This investigation of the covers on spare inlet nozzles revealed "... some have blanks which are welded tight, some have tapered wooden plugs driven in the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with a waterproofing membrane and then sealed in cement" (HW-20742 page 5 item 2).

Figure 4-4. Spare Inlet Line Cover Detail.

The 4-3/4" ID x 4" cover is fit over the 4" pipe sleeve and not welded in place. The OD of 4" Sch. 80 pipe is 4-1/2", so the clearance between the nozzle cover and the pipe sleeve would be about 1/8" all around. However, based on a 1951 investigation, the drawing may not represent as-built conditions. The 1951 field installation of some of the spare inlet nozzles on SSTs was conducted after waste had been discharged through a spare inlet from tank BX-102. This investigation of the covers on spare inlet nozzles revealed "... some have blanks which are welded tight, some have tapered wooden plugs driven in the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with a waterproofing membrane and then sealed in cement". (Drawing H-W-72743 Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement and HW-20742, Loss of Depleted Metal Waste Supernate to Soil, page 5 item 2)



4.2 IN-TANK DATA

4.2.1 Surface Level Behavior

Tank C-110 was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank based on gross gamma soil contamination readings found at the 53' to 56' depth in drywell 30-10-09, about 15 feet below the tank's foundation. The contamination was detected in October, 1974, immediately after the drywell was drilled adjacent to the tank. When the soil contamination was detected, C-110 contained about 376 kgal of waste, including 165 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period.

During the 1970 - 1972 period about 1.4 million gallons of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period.

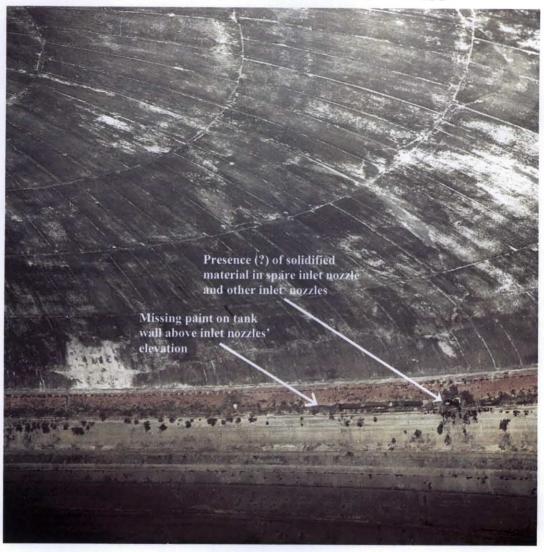
An observation reported in HW-20742 page 4 (regarding tanks in BX and BY farms, and discussed in RPP-ENV-33418 is "...The depth of liquid in these tanks is determined by subtracting the elevation of the bottom of the tank from the elevation of the flange on top of a tank riser, and then subtracting from this difference the distance from the flange to the liquid as measured by foot markers placed along the electrode wires. Some electrodes were calibrated to read the liquid depth directly - others were calibrated so that the reading must be subtracted from the overall height as explained in the foregoing. Considerable confusion exists as to the true elevation for the tank bottom and flanges on tank risers. Recent investigations of the elevations have shown that one of the bench marks is off by over a foot; that the S Division [200 Areas processing plants and tank farms] Manual, the blue prints, and the surveyors do not agree on the elevations; that some blue prints use the center of the tank bottom for the tank elevation whereas other places use the side of the tank bottom, which could cause as much as [illegible] foot error; and that recent changes in elevations on the blue prints have not been recorded on the S Division records. Some direct reading electrodes were made according to the manual elevations and some were made according to the blue print elevations."

4.2.2 In-Tank Photographs

A 1986 photograph of the side fill inlet nozzles seems to show solidified material in the mouth of the spare inlet nozzle. The same photo shows that the reddish-color paint on the interior has been lost from above the inlet nozzles, which indicates the waste level inside this tank exceeded the height of the inlet nozzles.

Figure 4-5 1986 photo of Tank 241-C-110 Interior.

Missing paint above the inlet nozzles indicates that tank must have been filled above the inlets at one time. There appears to be solidified material in the mouths of the inlet lines, including the capped spare. The cascade overflow (outlet) line to tank 241-C-111 became plugged in November, 1952; there is no information that the line was ever unplugged. During the 1970 - 1972 period about 1.4 million gallons of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period. (8605264-4CN_[N2113041] C-110 Wall, Dome, Inlet Nozzles Aug 12 1986.jpg)



4.3 EX-TANK DATA

4.3.1 Tank C-110 Drywell 30-10-09

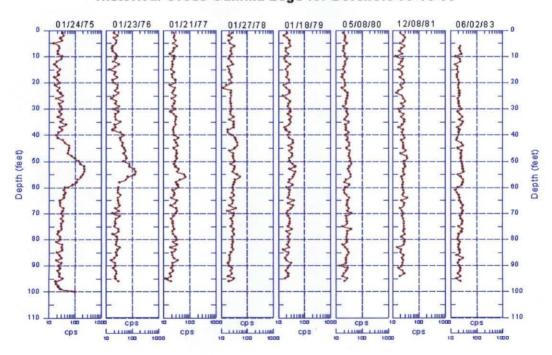
In October, 1974 gross gamma soil contamination readings were found at the 53' to 56' depth in drywell 30-10-09, about 15 feet below the tank's foundation. The contamination was detected immediately after the drywell was drilled adjacent to the tank.

By 1982 the gross gamma peak in the drywell had decayed to background at a half-life decay rate matching RuRh-106 (RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm – 200 West Area, page 351; and SD-WM-TI-356, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988). The presence of RuRh-106 with a half-life of 368 days suggests that the contamination might have been from relatively fresh waste (10 half-lives to complete decay is a rule-of-thumb.). No further changes in the drywell readings were noted.

Figure 4-6. Drywell 30-10-09 Historical Gross Gamma Logs.

Contamination was detected in Drywell 30-10-09 in October, 1974, immediately after the drywell was drilled adjacent to the tank. At that time tank C-110 contained about 376 kgal of waste, including 165 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period. By 1982 the gross gamma peak in the drywell had decayed to background. (GJ-HAN-92 Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank C-110 Appendix A, Spectral Gamma-Ray Logs for Boreholes in the Vicinity of Tank C-110, November, 1997. \hanford\data\Sitedata\HLANPlan\Geophysical_Logs\index.html)

Historical Gross Gamma Logs for Borehole 30-10-09



4.3.2 Other Tank C-110 Drywells

In 1994, the Department of Energy Richland Operations Office (DOE-RL) requested the DOE Grand Junction Office (DOE-GJO), Grand Junction, Colorado, to conduct a baseline characterization of gamma-emitting radionuclide contamination in the vadose zone at all of the Hanford Site single-shell tank farms. The baseline characterization of the C Tank Farm was accomplished by logging each of the drywells surrounding the tanks with spectral gamma logging systems.

The tank C-110 baseline report was issued in 1997. Data obtained from the drywells indicated that, "... the source of the Cs-137 contamination around this tank is a combination of surface spills and pipeline and tank leaks. On the basis of a review of historical gross gamma-ray logs for borehole 30-10-09, a tank leak may have occurred before 1975. The source of the tank leak is probably closest to borehole 30-10-09, on the west side of tank C-110." (GJ-HAN-92)

The inlet lines, including the spare inlet line, are located on the west side of tank C-110, nearest to drywell 30-10-09.

5.0 HYPOTHESES

The hypothesis posed by the assessment team was: "Does the 1974 evidence from drywell 30-10-09 provide a basis for concluding that tank C-110 had leaked?" Based on review of the historical data, the panel developed plausible hypotheses for the observed tank behavior:

- 1. Leak Hypothesis: "A leak from tank 241-C-110 caused the elevated radiation reading in drywell 30-10-09."
- 2. Non-Leak Hypothesis: "An overflow from tank 241-C-110 via inlet or outlet line penetrations, a transfer line leak, or other unplanned release created the elevated radiation reading in drywell 30-10-09."

6.0 SUMMARY OF ANALYSTS ASSESSMENT

Expert Opinion: D. G. Baide

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.20

Basis for Opinion:

- C-110 was a low heat tank with a non-aggressive process history; only 2 C-100 tanks had leaked by 1974 when drywell 30-10-09 was drilled.
- Possible manual tape reference elevation errors combined with repeated tank fills and empties could have resulted in an overflow.
- Drywell spectral gamma scans are inconclusive, mostly showing evidence of surface spills.

Expert Opinion: D. A. Barnes

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.10

Basis for Opinion:

- The tank showed no measurable change in level for about three years around the time the drywell was drilled and the contamination initially detected. It is very unlikely that the tank would maintain constant level if it were leaking.
- In-tank photos showed a high waste level beachline at the same level as the inlet nozzles, including the capped spare. From the photos the chances of an overfill appears very likely.
- When the drywell was drilled in 1974 a contamination spike was identified about 15 feet below the tank. The depth indicates it may have been there for a while, (long enough to migrate downwards at least 15 feet), but not too long since the ruthenium had not decayed away yet. Over the next 30 years the spike decayed away at the expected ruthenium decay rate, but no new contaminants were ever added at that location. This is further evidence that the deposit was a one-time event, and not a continuing tank leak. Also, the tank was relatively full on several occasions after that, and if it leaked the contamination spike would be expected to expand.
- The first full characterization spectral log was run in 1997. The contamination in 30-10-09 had decayed away, but two other drywells on the opposite side of the tank showed low levels of cesium and europium at the base. Both are directly under known piping and/or diversion boxes. Finding contamination near the base of the tank with no other history or data available does imply a tank leak. Because of the low levels identified and the presence of piping and pits that could contribute I assigned of 0.6 for the spectral gamma logs, slightly favoring a tank leak.

Expert Opinion: D. W. Brown

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.20

Basis for Opinion:

- If tank C-110 was leaking, there should have been a manual tape indication of a leak, especially over the three year period that the liquid surface level was monitored and stable.
- The gross gamma drywell scan is more indicative of an external leak or an overflow from the tank since it never increased after initial monitoring.
- The interior tank photo shows that the tank was probably filled above the inlet lines at some time. The loose-fitting cap on the spare inlet line would have allowed waste leak out.
- The later spectral gamma drywell scans results are inconclusive for a tank leak; if the drywell was located in the leak plume, then the leak would go undetected. However, the gross gamma and spectral gamma scans are not inconsistent with each other.

Expert Opinion: L. S. Krogsrud

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.22

Basis for Opinion:

- Based on the behavior of the manual tape on the liquid surface, a leak would not be suspected.
- The drywell 30-10-09 gamma peak was located below the tank foundation and did not increase over time. This behavior would be unlikely if the tank liner was leaking.

Expert Opinion: P. C. Miller

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.05

Basis for Opinion:

- The manual tape was monitoring a liquid surface at the time of the 1974 drywell event. There was no detectable change in surface level measurement, so it is unlikely that the tank was leaking.
- The gross gamma peak in the 30-10-09 drywell decayed over time. If the tank was leaking and the drywell intercepted the plume, it is unlikely that the gamma peak would have behaved this way. However a plume from a leak could have missed all of the drywells. Probably not indicative of the tank leak status.

• The spectral gamma scan indicated that the radionuclides were mostly naturallyoccurring isotopes. If the drywell intercepted a leak plume, manmade isotopes would have been present.

Expert Opinion: D. J. Washenfelder

Estimated Probability of Observed In-Tank and Ex-Tank Data if Tank had Leaked = 0.07

Basis for Opinion:

- When the soil contamination was detected, C-110 contained 165 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 mid-1975 period.
- The estimated loss was based on the +/- 0.75-inch accuracy of the manual tape measuring a liquid surface, ~ 2,000 gallons loss, rather than any field leak measurement.
- The interior tank photo of the inlet lines seems to show solidified material in the mouth of the spare inlet line. The same photo shows that the reddish-color paint on the interior has been lost from above the inlet lines, which indicates the waste level inside this tank exceeded the height of the inlet lines. Drawing H-W-72743 shows that the spare inlet cover was only loose fit over the open spare inlet line.
- By 1982 the gross gamma peak in the 30-10-09 drywell had decayed to background at a half-life decay rate matching RuRh-106. This is inconsistent with an active leak plume.
- RPP-ENV-33418 Rev. 1 Hanford C-Farm leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Releases, February, 2008, reevaluated the decision to declare C-110 an assumed leaker based on data that were not available when original leak assessment was performed in 1974. The assessment concluded that, "The C-110 leak appears to be the result of a tank overflow 17 ft 4 in (208 in) above the tank bottom. As a worst case, the liquid level in SST was steady at 144 in from the tank center from 1971 to 1975, indicating that if there was a breach in the tank wall, it was above this level."

Summary:

The consensus of the assessment team is that the tank's stable liquid level surface bracketing the period when the 30-10-09 drywell gross gamma peak was discovered, the natural decay of the drywell gross gamma peak following discovery, and an interior tank photo showing evidence of waste in and above the tank inlet line penetrations indicate that tank overfilling was the most likely cause of the observed radiation in the drywell.

7.0 CONCLUSIONS

The process for assessing the leak status of a tank is designed to estimate a leak probability. Probability is defined as a measure of the state of knowledge or belief about the likelihood that a specific state of nature (e.g., a tank has leaked or is leaking) is true. Probability must be between 0 (absolute certainty that the state of nature is not true) and 1 (absolute certainty that the state of nature is true). The process starts with a prior probability independent of the available data. This establishes any pre-evaluation bias and is typically established at 0.5 that the tank is leaking or has leaked without consideration of the specific data initiating this process (i.e., no pre-evaluation bias, either for or against a leak). Then reviews of in-tank data and ex-tank data are used to establish conditional probabilities for whether the leak hypothesis or the non-leak hypothesis is supported by the data. The conditional probabilities are used to adjust the leak probability toward a leak hypothesis (probability > 0.5) or a non-leak hypothesis (probability < 0.5).

There was consensus among the members of the assessment team that the available in-tank and ex-tank data indicated that the no-leak hypothesis was more consistent with the data. The stable liquid surface level, the natural decay of the gross gamma peak in drywell 30-10-09 after its 1974 discovery, and the in-tank photo showing evidence of the tank possibly being overfilled reduce the estimated leak probability to about 0.12 (about one chance in nine) that the observed in-tank and ex-tank data would be present if the tank were leaking.

The most likely cause of the gross gamma peak in the drywell was overfilling of the tank resulting in loss of waste through the spare inlet line.

The recommendation of the assessment team is that the integrity status of tank 241-C-110 be changed from "Assumed Leaker" to "Sound".

The results of this assessment were presented to the Executive Safety Review Board on June 26, 2008. The Board concurred with the recommendation of the assessment team.

8.0 REFERENCES

Documents:

- GJ-HN-92, "Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary
 Data Report for Tank C-110 Appendix A Spectral Gamma-Ray Logs for Boreholes in the
 Vicinity of Tank C-110," November, 1997
 \hanford\data\Sitedata\HLANPlan\Geophysical_Logs\index.html
- HNF-3747 Rev. 0, "Tank leak Assessment Process: Technical Background," December 30, 1998
- HW-20742, "Loss of Depleted Metal Waste Supernate to Soil," April 5, 1951 [D8513094]
- RPP-8321 Rev. 0, "Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm 200 West Area, June, 2001," page 351, June, 2001 [D6875724]
- RPP-ENV-33418 Rev. 1, "Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases," February 26, 2008
- SD-WM-TI-356 Rev. 0, "Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988" [D197006832]

Correspondence:

- 08-TPD-015, Letter, S. J. Olinger, US Department of Energy, Office of River Protection, to J. A. Hedges, State of Washington Department of Ecology, "Hanford C Farm Leak Assessments," April 9, 2008 [0804160133]
- 8901832B R1, Letter, R. J. Baumhardt, Westinghouse Hanford Company, to R. E. Gerton U.S. Department of Energy, Richland Operations Office, "Single-Shell Tank Leak Volumes," May 17, 1989

Meeting Minutes:

- 241-C-110 Leak Assessment Meeting #1, April 29, 2008
- 241-C-110 Leak Assessment Meeting #2, May 8, 2008
- 241-C-110 Leak Assessment Meeting #3, May 22, 2008

Drawings and Sketches:

- Drawing H-W-72743 "Hanford Engineer Works BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement"
- Drawing W-71387 "Hanford Engineer Works 75 Ft. Diam. Building No. 241 "T" "U" "B" "C" Concrete Details of Tanks"
- Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports"

APPENDIX A TANK C-110 LEAK ASSESSMENT TEAM MEETING MINUTES

A1 C-110 LEAK ASSESSMENT TEAM MEETING #1 MINUTES

| MEETING MINUTES Page 1 of | | | | | | |
|---|----------|--------------|-----------------|------------------|--|--|
| SUBJECT: 241-C-110 Leak Assessment Meeting #1 | | | | | | |
| TO: | BUILDING | i | | | | |
| Distribution | | 2750-E/B-225 | | | | |
| FROM: | CHAIRMA | N | | | | |
| DJ Washenfelder | | Same | | | | |
| DEPARTMENT-OPERATION-COMPONENT | AREA | SHIFT | DATE OF MEETING | NUMBER ATTENDING | | |
| Process Analysis/Technical Integration | | | 04/29/08 | 007 | | |

Distribution:

DG Baide*

DA Barnes*

DW Brown*

JG Field

ME Johnson

LS Krogsrud*

PC Miller*

*Leak Assessment Team Members

Need for Leak Assessment:

There is no known formal leak assessment for tank C-110. The tank was classified as "Questionable Integrity" in 1976 following the 1974 discovery of contamination in the soil around newly-drilled drywell 30-10-09 adjacent to the tank. Recently published RPPENV-33418 Rev. 1, "Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases," February 26, 2008, suggests that there is an alternative explanation for the contamination measured in the drywell, and that the tank may not have leaked.

The process for investigating potential tank leaks is described in TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process". The commitment for a formal leak assessment was made by reference in Letter 08-TPD-015, S. J. Olinger, Office of River Protection to J. A. Hedges, State of Washington Department of Ecology, "Hanford C Farm Leak Assessments," April 9, 2008.

Tank 241-C-110 Characteristics and Operating History:

Tank 241-C-110 (C-110) is a 530 kgal 75' diameter mild steel single-shell tank located at the west corner of the 16-tank C Tank Farm. The tank was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank based on gross gamma soil contamination readings found at the 53' to 56' depth in drywell 30-10-09, about 15 feet below the tank's foundation. The contamination was detected in October, 1974, immediately after the drywell was drilled adjacent to the tank.

There is no indication that an Unusual Occurrence report was filed when C-110 was designated as a Questionable Integrity tank. A leak volume estimate was not made until 1989, when a 2 kgal volume was assigned based on the C-110 manual tape sensitivity of +/-0.75" (Since there was no detectable surface level decrease, the loss could be no greater than ~2 kgal (0.75" x 2,750 gal/" = ~2 kgal].) (8901832B R1, Single-Shell Tank Leak Volumes, March 17, 1989). In 1984 the "Questionable Integrity" and "Confirmed Leaker" tank classifications were combined and changed to "Assumed Leaker" (8901832B R1).

When the soil contamination was detected, C-110 contained about 376 kgal of waste,

MEETING MINUTES (Continued)

Page 2 of 4

including 165 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period. By 1982 the gross gamma peak in the drywell had decayed to background at a half-life decay rate matching RuRh-106 (RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm - 200 West Area, page 351; and SD-WM-TI-356, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988). The presence of RuRh-106 with a half-life of 368 days suggests that the contamination might have been from relatively fresh waste (10 half-lives to complete decay is a rule-of-thumb.).

The tank has 4 side fill inlet nozzles: V-138, -139, and -140, are connected to the 241-C-153 Diversion Box. The 4th is a capped spare. Capping was accomplished in a variety of ways: friction fit, gasketed caps; plugged with wooden plugs; or plastic-bagged. The centerline of the inlet nozzles is at 17'-4", equivalent to $\sim 547,500$ gal of waste storage. A cascade overflow line to tank C-111 has a 16'-11.5" centerline, equal to $\sim 535,000$ gallons of waste storage.

Subsequent to the meeting Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports" was reviewed to obtain the viaduct details. The drawing shows that the viaduct has a 4" high curb running along both edges. The curbing stops about 11'-10" from the tank wall. At about 9'-10" from the tank wall the viaduct surface steps down and the void space between the pipes and the viaduct surface is grouted. At this point the viaduct begins fanning out from 2'-8" wide to 7'-4" wide to support the spread placement of the fill lines through the tank wall. The concrete viaduct terminates 2" from the tank wall; the void space is filled with 2" asphalt-impregnated felt.

The inlet lines pass through the tank wall via a 4' long 4" Sch. 80 pipe sleeve. A 5" id cap shrouds the 4" sleeve at the entry point of the 3" line, and is welded to the 3" line, allowing the 3" line to float in the ~ 1/4" annular void space inside the sleeve. Before welding the cap, the void space between the 3" line and the 4" sleeve is packed with asbestos wick (Drawing H-W-72743 "Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement").

Drawing H-W-72743 also shows the detail for the spare inlet nozzle cover. The 4-3/4" ID x 4" cover is fit over the 4" pipe sleeve and not welded in place. The OD of 4" Sch. 80 pipe is 4-1/2", so the the clearance between the nozzle cover and the pipe sleeve would be about 1/8" all around. However, based on a 1951 investigation, the drawing may not represent actual as-built conditions. The 1951 field installation of some of the spare inlet nozzles on SSTs was conducted after waste had been discharged through a spare inlet from tank BX-102 (HW-20742, Loss of Depleted Metal Waste Supernate to Soil). This investigation of the covers on spare inlet nozzles revealed "... some have blanks which are welded tight, some have tapered wooden plugs driven in the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with a waterproofing membrane and then sealed in cement" (HW-20742 page 5 item 2).

Another observation reported in HW-20742 page 4 (regarding tanks in BX and BY farms is "... The depth of liquid in these tanks is determined by subtracting the elevation of the bottom of the tank from the elevation of the flange on top of a tank riser, and then subtracting from this difference the distance from the flange to the liquid as measured by foot markers placed along the electrode wires. Some electrodes were calibrated to read the liquid depth directly - others were calibrated so that the reading must be subtracted from the overall height as explained in the foregoing. Considerable confusion exists as to the true elevation for the tank bottom and flanges on tank risers. Recent investigations of the elevations have shown that one of the bench marks is off by over a foot; that the S Division (200 Areas processing plants and tank farms) Manual, the blue prints, and the surveyors do not agree on the elevations; that some blue prints use the center of the tank bottom for the tank elevation whereas other places use the side of the tank bottom, which

MEETING MINUTES (Continued)

Page 3 of 4

could cause as much as [illegible] foot error; and that recent changes in elevations on the blue prints have not been recorded on the S Division records. Some direct reading electrodes were made according to the manual elevations and some were made according to the blue print elevations."

During the 1970 - 1972 period about 1.4 mgal of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period. An interior tank photo of the side fill inlet nozzles discovered after the meeting seems to show solidified material in the mouth of the spare inlet nozzle (Photo 8605264-4CN_[N2113041] C-110 Wall, Dome, Inlet Nozzles Aug 12 1986.jpg [Email: RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110]).

Tank C-110 did not see severe service based on the process history records that are available. It did not store high-heat waste. It is unlikely that it was exposed to repeated, rapid heating and cooling cycles, based on the wastes stored in the tank, although actual temperature records have not been located.

Discussions with the authors of RPP-ENV-33418 Rev. 1 indicate that waste stored in the tank did not meet current AC 5.16 Corrosion Mitigation Controls for the period May, 1946 - March, 1947, when the tank was used as part of a cascade for B Plant 1st Cycle Decontamination Waste with a pH of \sim 8 (Current AC 5.16 requirements are pH >/= 12).

Of the 12 100-Series C Farm tanks, three - C-101, C-110, and C-111 - are classified as Assumed or Confirmed Leakers.

Team Member Actions for July 10 Meeting:

- 1. Team: Based on discussions of tank's process and thermal history, integrity status of other C-100's, and information received from following actions, determine "Prior Probability" of a C-110 leak using the process described in HNF-3747 Section 2.4. Prior Probability is the probability that C-110 has leaked given only that is an SST and either a high-heat tank or not, but adjusted for the information such as the integrity status of similar C-100s.
- 2. ME Johnson: Find C-110 thermal history, possibly located in RHO-CD-1172. If available, forward to team members to assist with CHEM-D-42 procedure Prior Probability determination. Previous Federal Repository searches for temperature records have not been successful. Status: Search turned up no additional temperature records.
- 3. ME Johnson: Forward C-110 drawing list to DG Baide for familiarization and review. Status: List provided.
- 4. LS Krogsrud: Locate and review any in-tank photos and in-tank videos of the tank's interior surfaces. Update team members before meeting. Status: ME Johnson provided intank still photos showing tank dome and inlet and spare inlet nozzles.
- 5. DA Barnes: Review tank drywell historic data and provide evaluation to team members by next meeting.

References:

Briefings:

SST C-110 Integrity Assessment Review, ME Johnson, April 29, 2008

MEETING MINUTES (Continued)

Page 4 of 4

Correspondence - Emails:

C-110 Leak Assessment Briefing - FeCN Waste Valve Box nearby drwell [sic] 30-10-02, April 29, 2008

Emailing: 87661-8CN [N1957355] C-110 Wall, Dome, Outlet Nozzle Aug 17 1979, April 30, 2008

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008 [additional photographs attached)

RE: C-110 Leak Assessment Briefing - 1st Cycle Decontamination Waste Analyses 1951, April 29. 2008

RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110, April 30, 2008

SST C-110 Leak Assessment Team, April 9, 2008

Correspondence - Letters:

08-TPD-015, Hanford C Farm Leak Assessments, April 9, 2008

8901832B R1, Single-Shell Tank Leak Volumes, March 17, 1989 [D3688064]

Documents:

HW-20742, Loss of Depleted Metal Waste Supernate to Soil, April 5, 1951 [D8513094]

RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm - 200 West Area, June, 2001, page 351 [D6875724]

RPP-ENV-33418 Rev. 1, Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases, February 26, 2008

SD-WM-TI-356 Rev. 0, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988 [D197006832]

Drawings:

Drawing H-W-72743 "Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement"

Drawing W-71387 "Hanford Engineer Works 75 Ft. Diam. Building No. 241 "T" "U" "B" "C" Concrete Details of Tanks"

Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports"

A2 C-110 LEAK ASSESSMENT TEAM MEETING #2 MINUTES

| MEET | | Page 1 of 6 | | | | |
|---|----------|-------------|-----------------|------------------|--|--|
| SUBJECT: 241-C-110 Leak Assessment Meeting #2 | | | | | | |
| TO: | BUILDING | , | .,, | | | |
| Distribution 2750-E/B-225 | | | | | | |
| FROM: | CHAIRMA | N | | | | |
| DJ Washenfelder Same | | | | | | |
| DEPARTMENT-OPERATION-COMPONENT | AREA | SHIFT | DATE OF MEETING | NUMBER ATTENDING | | |
| Process Analysis/Technical Integration | 200-E | | 05/08/08 | 005 | | |

Distribution:

DG Baide*'

DA Barnes*'

DW Brown*1

JG Field'

ME Johnson

LS Krogsrud* '

PC Miller*

*Leak Assessment Team Members

'Attendees

Need for Leak Assessment:

There is no known formal leak assessment for tank C-110. The tank was classified as "Questionable Integrity" in 1976 following the 1974 discovery of contamination in the soil around newly-drilled drywell 30-10-09 adjacent to the tank. Recently published RPPENV-33418 Rev. 1, "Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases," February 26, 2008, suggests that there is an alternative explanation for the contamination measured in the drywell, and that the tank may not have leaked.

The process for investigating potential tank leaks is described in TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process". The commitment for a formal leak assessment was made by reference in Letter 08-TFD-015, S. J. Olinger, Office of River Protection to J. A. Hedges, State of Washington Department of Ecology, "Hanford C Farm Leak Assessments," April 9, 2008.

Tank 241-C-110 Characteristics and Operating History:

Tank 241-C-110 (C-110) is a 530 kgal 75' diameter mild steel single-shell tank located at the west corner of the 16-tank C Tank Farm. The tank was placed in service in May, 1946, and continued to receive and store waste until early 1976 when the remaining supernatant was pumped to another C Farm tank. At that time, the tank was suspected of leaking and had been classified as a "Questionable Integrity" tank based on gross gamma soil contamination readings found at the 53' to 56' depth in drywell 30-10-09, about 15 feet below the tank's foundation. The contamination was detected in October, 1974, immediately after the drywell was drilled adjacent to the tank.

There is no indication that an Unusual Occurrence report was filed when C-110 was designated as a Questionable Integrity tank. A leak volume estimate was not made until 1989, when a 2 kgal volume was assigned based on the C-110 manual tape sensitivity of +/- 0.75" (Since there was no detectable surface level decrease, the loss could be no greater than ~2 kgal [0.75" x 2,750 gal/" = ~ 2 kgal].) (8901832B R1, Single-Shell Tank Leak Volumes, March 17, 1989). In 1984 the "Questionable Integrity" and "Confirmed Leaker" tank classifications were combined and changed to "Assumed Leaker" (8901832B R1).

MEETING MINUTES (Continued)

Page 2 of 6

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Subsequent to the meeting Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports" was reviewed to obtain the viaduct details. The drawing shows that the viaduct has a 4" high curb running along both edges. The curbing stops about 11'-10" from the tank wall. At about 9'-10" from the tank wall the viaduct surface steps down and the void space between the pipes and the viaduct surface is grouted. At this point the viaduct begins fanning out from 2'-8" wide to 7'-4" wide to support the

MEETING MINUTES (Continued)

Page 3 of 6

spread placement of the fill lines through the tank wall. The concrete viaduct terminates 2" from the tank wall; the void space is filled with 2" asphalt-impregnated felt.

The inlet lines pass through the tank wall via a 4' long 4" Sch. 80 pipe sleeve. A 5" id cap shrouds the 4" sleeve at the entry point of the 3" line, and is welded to the 3" line, allowing the 3" line to float in the ~ 1/4" annular void space inside the sleeve. Before welding the cap, the void space between the 3" line and the 4" sleeve is packed with asbestos wick (Drawing H-W-72743 "Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement").

Drawing H-W-72743 also shows the detail for the spare inlet nozzle cover. The 4-3/4" ID x 4" cover is fit over the 4" pipe sleeve and not welded in place. The OD of 4" Sch. 80 pipe is 4-1/2", so the the clearance between the nozzle cover and the pipe sleeve would be about 1/8" all around. However, based on a 1951 investigation, the drawing may not represent actual as-built conditions. The 1951 field installation of some of the spare inlet nozzles on SSTs was conducted after waste had been discharged through a spare inlet from tank BX-102 (HW-20742, Loss of Depleted Metal Waste Supernate to Soil). This investigation of the covers on spare inlet nozzles revealed "... some have blanks which are welded tight, some have tapered wooden plugs driven in the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with a waterproofing membrane and then sealed in cement" (HW-20742 page 5 item 2).

Another observation reported in HW-20742 page 4 (regarding tanks in BX and BY farms is "... The depth of liquid in these tanks is determined by subtracting the elevation of the bottom of the tank from the elevation of the flange on top of a tank riser, and then subtracting from this difference the distance from the flange to the liquid as measured by foot markers placed along the electrode wires. Some electrodes were calibrated to read the liquid depth directly - others were calibrated so that the reading must be subtracted from the overall height as explained in the foregoing. Considerable confusion exists as to the true elevation for the tank bottom and flanges on tank risers. Recent investigations of the elevations have shown that one of the bench marks is off by over a foot; that the S Division [200 Areas processing plants and tank farms] Manual, the blue prints, and the surveyors do not agree on the elevations; that some blue prints use the center of the tank bottom for the tank elevation whereas other places use the side of the tank bottom, which could cause as much as [illeqible] foot error; and that recent changes in elevations on the blue prints have not been recorded on the S Division records. Some direct reading electrodes were made according to the manual elevations and some were made according to the blue print elevations."

During the 1970 - 1972 period about 1.4 mgal of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period. An interior tank photo of the side fill inlet nozzles discovered after the meeting seems to show solidified material in the mouth of the spare inlet nozzle. The same photo shows that the reddish-color paint on the interior has been lost from above the inlet nozzles, which indicates the waste level inside this tank exceeded the height of the inlet nozzles. (Photo 8605264-4CN_[N2113041] C-110 Wall, Dome, Inlet Nozzles Aug 12 1986.jpg [Email: RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110]).

Tank C-110 did not see severe service based on the process history records that are available. It did not store high-heat waste. It is unlikely that it was exposed to repeated, rapid heating and cooling cycles, based on the wastes stored in the tank, although actual temperature records have not been located.

MEETING MINUTES (Continued)

Page 4 of 6

Discussions with the authors of RPP-ENV-33418 Rev. 1 indicate that waste stored in the tank did not meet current AC 5.16 Corrosion Mitigation Controls for the period May, 1946 - March, 1947, when the tank was used as part of a cascade for B Plant 1st Cycle Decontamination Waste with a pH of \sim 8 (Current AC 5.16 requirements are pH >/= 12).

Of the 12 100-Series C Farm tanks, three - C-101, C-110, and C-111 - are classified as Assumed or Confirmed Leakers.

Leak - Non-Leak Hypothesis:

Leak Hypothesis: "A leak from tank 241-C-110 caused the elevated radiation reading in drywell 30-10-09."

Non-Leak Hypothesis: "An overflow from tank 241-C-110 via inlet or outlet line penetrations, a transfer line leak, or other unplanned release created the elevated radiation reading in drywell 30-10-09."

Team Member Actions for April 29th Meeting:

- 1. Team: Based on discussions of tank's process and thermal history, integrity status of other C-100's, and information received from following actions, determine "Prior Probability" of a C-110 leak using the process described in HNF-3747 Section 2.4. Prior Probability is the probability that C-110 has leaked given only that is an SST and either a high-heat tank or not, but adjusted for the information such as the integrity status of similar C-100s. Status: 2 of 5 writeups received
- 2. ME Johnson: Find C-110 thermal history, possibly located in RHO-CD-1172. If available, forward to team members to assist with CHEM-D-42 procedure Prior Probability determination. Previous Federal Repository searches for temperature records have not been successful. Status: Search turned up no additional temperature records.
- 3. ME Johnson: Forward C-110 drawing list to DG Baide for familiarization and review. Status: List provided.
- 4. LS Krogsrud: Locate and review any in-tank photos and in-tank videos of the tank's interior surfaces. Update team members before meeting. Status: ME Johnson provided intank still photos showing tank dome and inlet and spare inlet nozzles.
- 5. DA Barnes: Review tank drywell historic data and provide evaluation to team members by next meeting. Status: Completed.

Team Member Actions for May 8th Meeting:

- 1. DJ Washenfelder: Prepare HNF-3747 In-Tank, Ex-Tank, and Elicitation Forms and Formulas Templates.
- 2. DA Barnes (with MJ Rodgers): Identify which of the 67 leaking SSTs were categorized as "Assumed Leakers" solely by stable drywell readings.
- 3. Team: Review the tank C-110 chapter in RPP-ENV-334198 Rev. 1 and begin annotating the C-110 In-Tank and Ex-Tank templates so they can be reviewed at the next meeting.

References:

Briefings:

MEETING MINUTES (Continued)

Page 5 of 6

SST C-110 Integrity Assessment Review, ME Johnson, April 29, 2008

Correspondence - Emails:

C-110 Leak Assessment Briefing - FeCN Waste Valve Box nearby drwell [sic] 30-10-02, April 29, 2008

Emailing: 87661-8CN [N1957355] C-110 Wall, Dome, Outlet Nozzle Aug 17 1979, April 30, 2008

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008 [additional photographs attached)

RE: C-110 Leak Assessment Briefing - 1st Cycle Decontamination Waste Analyses 1951, April 29, 2008

RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110, April 30, 2008

SST C-110 Leak Assessment Team, April 9, 2008

Correspondence - Letters:

08-TPD-015, Hanford C Farm Leak Assessments, April 9, 2008

8901832B R1, Single-Shell Tank Leak Volumes, March 17, 1989 [D3688064]

Documents:

GJ-HN-92 Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank C-110 Appendix A Spectral Gamma-Ray Logs for Boreholes in the Vicinity of Tank C-110, November, 1997 \hanford\data\Sitedata\HLANPlan\Geophysical Logs\index.html

HW-20742, Loss of Depleted Metal Waste Supernate to Soil, April 5, 1951 [D8513094]

RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm - 200 West Area, June, 2001, page 351 [D6875724]

RPP-ENV-33418 Rev. 1, Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases, February 26, 2008

SD-WM-TI-356 Rev. 0, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988 [D197006832]

Drawings:

Drawing H-W-72743 "Hanford Engineer Works - BLD. #241 75'0" Dia. Storage Tanks T-U-B & C Arrangement"

Drawing W-71387 "Hanford Engineer Works 75 Ft. Diam. Building No. 241 "T" "U" "B" "C" Concrete Details of Tanks"

Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe

| | MEETING MINUTES (Continued) | Page 6 of 6 |
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| Supports" | | • |
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A3 C-110 LEAK ASSESSMENT TEAM MEETING #3 MINUTES

| MEET SUBJECT: 241-C-110 Leak Assessment | ING MINUT Meeting #3 | ES | | Page 1 of 2 |
|--|-------------------------|-------------|---------------------------------------|------------------|
| TO: | BUILDING | | · · · · · · · · · · · · · · · · · · · | |
| Distribution | 2750-E | /B-225 | | |
| FROM: | CHAIRMA | N | | |
| DJ Washenfelder | Same | | | |
| DEPARTMENT-OPERATION-COMPONENT | AREA | SHIFT | DATE OF MEETING | NUMBER ATTENDING |
| Process Analysis/Technical Integration | 200-E | 1 | 05/22/08 | 004 |

Distribution:

DG Baide*

DA Barnes*

DW Brown*

JG Field'

ME Johnson

LS Krogsrud*

PC Miller*'

The C-110 annotated HNF-3747 In-Tank, Ex-Tank, and Elicitation Forms and Formulas Templates were reviewed for errors and omissions, and marked up. The elicitation template - used to determine the odds and probability that a leaking tank (or a non-leaking tank) would exhibit the in-tank and ex-tank phenomena observed for the tank - has to be completed. The elicitations will probably be conducted as an individual interview with each assessment team member.

Team Member Actions for May 22nd Meeting:

- 1. DJ Washenfelder: Prepare HNF-3747 In-Tank, Ex-Tank, and Elicitation Forms and Formulas Templates.
- 2. DA Barnes (with MJ Rodgers): Identify which of the 67 leaking SSTs were categorized as "Assumed Leakers" solely by stable drywell readings. Status: Completed by Matt Rodgers, but some HNF-EP-0182 cited references were to vague to be used for the categorization. Additional work will be needed to populate the categories that include No Surface Level Measurement Change and No Drywell Measurement Change; and LOW ILL change but No Surface Level Measurement Change and No Drywell Measurement Change.
- 3. Team: Review the tank C-110 chapter in RPP-ENV-334198 Rev. 1 and begin annotating the C-110 In-Tank and Ex-Tank templates so they can be reviewed at the next meeting. Status: Template was annotated and provided to team members at the May 22 meeting.

References:

Briefings:

SST C-110 Integrity Assessment Review, ME Johnson, April 29, 2008

Correspondence - Emails:

C-110 Leak Assessment Briefing - FeCN Waste Valve Box nearby drwell [sic] 30-10-02, April 29, 2008

Emailing: 87661-8CN_[N1957355] C-110 Wall, Dome, Outlet Nozzle Aug 17 1979, April 30, 2008

A-3000-480 (10/97)

^{*}Leak Assessment Team Members

^{&#}x27;Attendees

MEETING MINUTES (Continued)

Page 2 of 2

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008

RE: C-110 Leak Assessment Briefing - Concrete Support Bridges for Pipinelines [sic] to Furst [sic] Tank in Cascade, April 29, 2008 [additional photographs attached)

RE: C-110 Leak Assessment Briefing - 1st Cycle Decontamination Waste Analyses 1951, April 29, 2008

RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110, April 30, 2008

SST C-110 Leak Assessment Team, April 9, 2008

Correspondence - Letters:

08-TPD-015, Hanford C Farm Leak Assessments, April 9, 2008

8901832B R1, Single-Shell Tank Leak Volumes, March 17, 1989 [D3688064]

Documents:

GJ-HN-92 Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank C-110 Appendix A Spectral Gamma-Ray Logs for Boreholes in the Vicinity of Tank C-110, November, 1997 \hanford\data\Sitedata\HLANPlan\Geophysical Logs\index.html

HW-20742, Loss of Depleted Metal Waste Supernate to Soil, April 5, 1951 [D8513094]

RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm - 200 West Area, June, 2001, page 351 [D6875724]

RPF-ENV-33418 Rev. 1, Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases, February 26, 2008

SD-WM-TI-356 Rev. 0, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988 [D197006832]

Drawings:

Drawing H-W-72743 "Hanford Engineer Works - BLD.#241 75'0" Dia. Storage Tanks T-U-B & C Arrangement"

Drawing W-71387 "Hanford Engineer Works 75 Ft. Diam. Building No. 241 "T" "U" "B" "C" Concrete Details of Tanks"

Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports"

A-3000-480 (10/97)

APPENDIX B TANK C-110 LEAK ASSESSMENT TEAM EXPERT ELICITATION FORMS

B1. TABLE 2 IN TANK DATA

| ACE LEVEL MEASUREMENTS (SLM) | | Observation | |
|---|---------|---------------------|-----------|
| F | | | |
| Unexplained, repeatable drop>tolerance ENRAFs were not deployed at the time of the 1977 Questionable Integrity declaration. The declaration was based on a single hit in drywell 30-10- 09 detected immediately after the drywell was drilled in 1974. | Yes | No | NA |
| Significant drop | Yes | No | NA |
| Significant trend change | Yes | No | NA |
| 40000 | | | |
| Unexplained, repeatable drop>tolerance PCSACS records do not show FIC data during the period indicating that there was no FIC in use. | Yes | No | NA |
| Significant drop | Yes | No | NA |
| Significant trend change | Yes | No | NA |
| IAL GAUGE | | | |
| Unexplained, repeatable drop-tolerance Manual tape with an electrode was used for most tank liquid level measurements during this period, and was most likely being used to monitor the C-110 liquid level. The precision of the manual tape was accepted as ±0.75 inches (see HW-51026, 1957, Page 4, Leak Detection - Underground Storage Tanks) corresponding to ~ 2062.5 gallons. When the soil contamination was detected, C-110 contained about 376 kgal of waste, including 165 kgal of supernatant. The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period. | Yes | No | NA |
| Significant drop No surface level change was detected. | Yes | No | NA NA |
| Significant trend change Historical records do not identify a trend change. | Yes | No | NA NA |
| D OBSERVATION WELL (LOW) MEASUREMENTS | | Observation | N. pusa |
| Unexplained, repeatable drop>tolerance Tank was not equipped with an LOW. | Yes | No | NA |
| Significant drop | Yes | No | NA |
| Significant trend change | Yes | No | NA |
| OBORATING EVIDENCE | Corrobo | rates SLM or LOW Da | nta Given |
| Thermocouple | Leak | Alt. Hypoth. | NA |
| (Steve K. to provide) Salt well screen | Leak | Alt. Hypoth. | NA |

| Tank was no equipped with a saltwell screen in 1974. A saltwell screen was installed in 1976 and the tank saltwell pumped between 1976 and 1979. | | | |
|---|------|--------------|-------|
| Standard Hydrogen Monitoring System | Leak | Alt. Hypoth. | NA NA |
| Tank was not equipped with a SHMS. | | | |
| Photos/Videos | Leak | Alt, Hypoth. | NA. |
| At the time of the leak investigation, the tank contained ~ 165 kgal of supernatant. Although photos probably exist from the leak investigation time period, it is unlikely that the liquid surface would have provided any additional information about the tank's integrity. | | | |
| An interior tank photo of the side fill inlet nozzles seems to show solidified material in the mouth of the spare inlet nozzle (Photo 9605264-4CN_[N2113041] C-110 Wall, Dome, Inlet Nozzles Aug 12 1986,jpg [Email: RE: C-110 Leak Assessment Briefing - Photo showing Beach line inside SST C-110]). | | | |
| The same photo shows that the reddish-color paint on the interior has been lost from above the inlet lines, which indicates the waste level inside this tank exceeded the height of the inlet lines. | | | |
| Weather conditions | Leak | Alt. Hypoth. | NA |
| Barometric pressure | Leak | Alt. Hypoth. | NA |
| Precipitation | Leak | Alt. Hypoth. | NA |
| Temperature | Leak | Alt, Hypoth. | NA |
| Surface flooding The liquid surface was being monitored with a manual tape, and showed no detectable decrease in level for the 1972 - mid-1975 period indicating there was no water intrusion from external sources. | Leak | Alt. Hypoth. | NA |
| Process history During the 1970 - 1972 period about 1.4 mgal of B Plant concentrator bottoms and IX waste were received and transferred through the tank, equivalent to several fills and empties. Available monthly and quarterly production records show the tank's liquid level at the end of each reporting period, which is not indicative of the maximum fill level the tank may have experienced during the period. Tank C-110 did not see severe service based on the process history records that are available. It did not store high-heat waste. It is unlikely | Leak | Alt. Hypoth. | NA NA |
| that it was exposed to repeated, rapid heating and cooling cycles, based on the wastes stored in the tank, although actual temperature records have not been located. An observation reported in HW-20742 page 4 (regarding tanks in BX and BY farms is " The depth of liquid in these tanks is determined by subtracting the elevation of the bottom of the tank from the elevation of the flange on top of a tank riser, and then subtracting from this difference the distance from the flange to the liquid as measured by foot markers placed along the electrode wires. Some electrodes were calibrated to read the liquid depth directly - others were calibrated so that the reading must be subtracted from the overall height as explained in the foregoing. | | | |

| "Considerable confusion exists as to the true elevation for the tank bottom and flanges on tank risers. Recent investigations of the elevations have shown that one of the benchmarks is off by over a foot; that the S Division [200 Areas processing plants and tank farms] Manual, the blue prints, and the surveyors do not agree on the elevations; that some blue prints use the center of the tank bottom for the tank elevation whereas other places use the side of the tank bottom, which could cause as much as [illegible] foot error; and that recent changes in elevations on the blue prints have not been recorded on the S Division records. Some direct reading electrodes were made according to the manual elevations and some were made according to the blue print elevations." | | | |
|---|------|--------------|-------|
| Occurrence reports The tank was classified as "Questionable Integrity" in 1976 following the 1974 discovery of contamination in the soil around newly-drilled drywell 30-10-09 adjacent to the tank. There is no indication that an Unusual Occurrence report was filed when C-110 was designated as a Questionable Integrity tank. A leak volume estimate was not made until 1989, when a 2 kgal volume was assigned based on the C-110 manual tape sensitivity of +/- 0.75" | Leak | Alt. Hypoth. | NA . |
| Construction history | Leak | Alt. Hypoth. | NA NA |
| Gas Release Events | Leak | Alt. Hypoth. | NA |
| Equipment maintenance calibration | Leak | Alt. Hypoth. | NA |
| Waste characteristics Tank C-110 did not see severe service based on the process history records that are available. It did not store high-heat waste that might have reduced the tank's service life or contributed to accelerated loss of integrity. It is unlikely that it was exposed to repeated, rapid heating and cooling cycles, based on the wastes stored in the tank, although actual temperature records have not been located. Discussions with the authors of RPP-ENV-33418 Rev. 1 indicate that waste stored in the tank did not meet current AC 5.16 Corrosion Mitigation Controls for the period May, 1946 - March, 1947, when the tank was used as part of a cascade for B Plant 1st Cycle Decontamination Waste with a pH of ~8 (Current AC 5.16 requirements are pH >/= 12). | Leak | Alt. Hypoth. | NA . |
| In-tank operations In February 1956, the TBP Plant supernatant waste was transferred from C-110 to 241-CR Vault for ferrocyanide scavenging of cesium and strontium (HW-41812, Waste Status Summary; Separations Section, Separations - Projects and Personnel Development Sub-Section, February 29, 1956, p 4). The scavenging was not conducted in the tank. | Leak | Alt. Hypoth. | NA NA |
| Other (specify) - Construction Features - Inlet Lines The tank has 4 side fill inlet lines: V-138, -139, and -140, are connected to the 241-C-153 Diversion Box. The 4th is a capped spare. Capping was accomplished in a variety of ways: friction fit, gasketed caps; plugged with wooden plugs; or plastic-bagged. The centerline of the inlet lines is at 17-4", equivalent to ~ 547,500 gal of waste storage. The inlet lines pass through the tank wall via a 4" long 4" Sch. 80 pipe sleeve. A 5" id cap shrouds the 4" sleeve at the entry point of the 3" line, and is welded to the 3" line, allowing the 3" line to float in the ~ 1/4" annular void space inside the sleeve. Before welding the cap, the void space between the 3" line and the 4" sleeve is packed with asbestos wick (Drawing H-W-72743 "Hanford Engineer Works - BLD.#241 75"0" Dia. Storage Tanks T-U-B & C Arrangement"). | Leak | Alt. Hypoth. | NA |

B2 TABLE 3 EX-TANK DATA

| | | Observation | |
|--|-----------|-------------|----------|
| nuclides | | | |
| Man-made? Contamination was discovered in drywell 30-10-09 when it was first monitored in October 1974. Analysis of the decay rate for the period between 1975 and 1979 indicated the t1/2 was consistent with Ru-106. | Yes | No | NA. |
| Multiple? Spectral gamma logging conducted in 1997 showed very low concentrations of Cs-137 in all of the drywells surrounding the tank. Because of the low concentrations, it was concluded that Cs-137 was not a tag for a C-110 leak. | Yes | No | NA. |
| oution | , and | | |
| Peak at bottom of tank? | actual da | ta | No or NA |
| Results of SGL scans of the drywells surrounding C-110 are documented in GJ-HAN-92, Vadose Zone Characterization project at the Hanford Tank Farms: Tank Summary Data Report for Tank C-110, November 1997 (\hanford\data\Sitedata\HLANPlan\Geophysical_Logs\index.html): "Cs-137 contamination was detected in the upper portions of all the boreholes surrounding tank C-110. This near-surface contamination is probably the result of surface spills that migrated into the backfill material around the tank. | avida de | | |
| "The Cs-137 contamination detected in borehole 30-10-02 from 44 to 63.5 ft and borehole 30-07-11 from 49 to 74.5 ft may be the result of a tank or pipeline leak that has migrated into the Hanford formation sediments beneath the tank. The contamination appears to be correlatable and continuous between the two boreholes. | | | |
| "The Cs-137, Co-60, and Eu-154 contamination detected in borehole 30-07-11 from 1 to 4 ft is probably from material remaining within the transfer line. Soil sampling was conducted around the tank. In addition, an investigation conducted in 1992 indicated that the contamination detected in the borehole at this depth was actually contained in an improperly designed salt-well transfer line. | | | |
| "Data collected from boreholes 30-00-24, 30-00-22, and 30-00-11 indicate Cs-137 contamination in the upper section of all these boreholes. Because these boreholes are located far from tank C-110, the contamination in these boreholes is probably not associated with leaks or spills from tank C-110. All three boreholes are located near diversion boxes and their associated piping. The contamination detected around these boreholes is probably associated with the diversion boxes, rather than tank C-110." | | | |
| Peak near surface? None of the Grand Junction SGL scans indicated high levels of Cs-137 near the drywells. Most hits were attributed to surface spills or transfer line leaks. | actual de | ita | No or NA |
| Increased activity in between? | actual de | ita | No or NA |
| The state of the s | actual da | ita | No or NA |

| The Grand Junction report GJ-HAN-92 does not discuss activity across drywells. Other limited historical data were available in RPP-ENV-33418 Rev. 1. | | | |
|--|-----|----|-----|
| y over time | | | |
| Abrupt increase (bottom)? | Yes | No | NA. |
| By 1982 the gross gamma peak in the drywell had decayed to background at a half-life decay rate matching RuRh-106 (RPP-8321, 2001, Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm – 200 West Area, page 351; and SD-WM-TI-356, Waste Storage Tank Status and Leak Detection Criteria, September 30, 1988). The presence of RuRh-106 with a half-life of 368 days suggests that the contamination might have been from relatively fresh waste (10 half-lives to complete decay is a rule-of-thumb.). | | | |
| Abrupt increase (elsewhere)? | Yes | No | NA. |
| The Grand Junction report GJ-HAN-92 does not discuss activity across drywells. Other limited historical data were available in RPP-ENV-33418 Rev. 1. The hits show a steadily decreasing peak with time. | | | |
| Gradual increase (bottom)? The Grand Junction report GJ-HAN-92 does not discuss activity across drywells. Other limited historical data were available in RPP-ENV-33418 Rev. 1. The hits show a steadily decreasing peak with time. | Yes | No | NA |
| Gradual increase (elsewhere)? The Grand Junction report GJ-HAN-92 does not discuss activity across drywells. Other limited historical data were available in RPP-ENV-33418 Rev. 1. The hits show a steadily decreasing peak with time. | Yes | No | NA |

| CORROBORATING EVIDENCE | Corroborates SG | L or GGL Data Given | |
|---|-----------------|---------------------|----------|
| Moisture Probe | Leak | Alt. Hypoth. | NA |
| Psychrometrics | Leak | Alt. Hypoth. | NA |
| Bore hole core sample | Leak | Alt. Hypoth. | NA |
| Laterals | Leak | Ait. Hypoth. | NA |
| Tank has no laterals. | | | 729000 |
| Weather conditions | Leak | Alt. Hypoth. | NA |
| Barometric pressure | Leak | Alt. Hypoth. | NA |
| Precipitation | Leak | Alt. Hypoth. | NA |
| Temperature | Leak | Alt. Hypoth. | NA |
| Surface flooding The southwest corner of C farm has a run-on berm to prevent intrusive surface flooding; there are no other berms. There is a storm water runoff ditch located east of the tank farm to the depression between AN and C farms. These minimal features indicate that surface flooding has probably never been a problem for the tank farm. | Leak | Alt. Hypoth. | NA |
| Process history | Leak | Alt. Hypoth. | NA |
| Drywell drilling logs | Leak | Alt. Hypoth. | NA |
| Occurrence reports None associated with C-110 were identified in RPP-ENV-33418 Rev 1, Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-111, 241-C-105, and Unplanned Waste Releases, February 2008. | Leak | Alt. Hypoth. | NA |
| Surface spills | Leak | Alt. Hypoth. | NA |
| P. Miller to provide) | | | 25502 |
| Transfer line leaks In November 1952, the cascade overflow line from C-110 to C-111 was noted as being plugged. The tank on filling with TBP Plant waste failed to cascade to C-111 (HW-26486, Manufacturing Department Radiation Hazards Incident Investigation and HW-27627, Radiological Sciences Department Investigation Radiation Incident), but C-110 was not reported as being filled above the spare inlet nozzles. An estimated 5 gallons of waste was inadvertently discharged to the surface on November 26, 1952, when a pump was being installed in C-110 (HW-27627). The resulting ground and equipment contamination was reported as being removed. This pump was used to transfer waste from C-110 to C-111 since the cascade overflow line was plugged. | Leak | Alt. Hypoth. | NA NA |
| A valve box used for transferring ferrocyanide-scavenged waste was positioned near drywell 30-10-02. The scavenged wastes still contained a small concentration of soluble Cs-137, Sr-90, and sometimes Co-60. Drawing H-2-2909; Piping Arrangement and Details 1st Cycle Waste Scavenging 241-0 Farm locates this valve box at the 3-o'clock position. All piping and valve flanges were to be welded per notes on this drawing. However, leakage from these valves could have occurred. | | | |
| Construction history | Leak | Alt. Hypoth. | NA |

| C-110 was constructed to the first-generation tank design and was designed for non-boiling waste with a temperature of less than 220 °F. The tank is 75 ft in diameter and has a capacity of 530,000 gallon (gal). Tanks C-110, -111, and -112 are part of a three-tank cascade. The tanks in the cascade series are arranged with each successive tank sited at an elevation 1 ft lower than the previous tank, creating a gradient allowing fluids to flow from one tank to another as they were filled. | | | |
|--|------|--------------|-------|
| Equipment maintenance calibration | Leak | Alt. Hypoth. | NA NA |
| Waste characteristics | Leak | Alt. Hypoth. | NA NA |
| In-tank operations | Leak | Alt. Hypoth. | NA NA |
| Other (specify) - Construction Features - Concrete Pipe Supports Drawing W-74108 "Hanford Engineer Works Building No. 241-T-U-B & C Concrete Details of Pipe Supports" was reviewed to obtain the concrete bridge viaduct details. The drawing shows that the viaduct has a 4" high curb running along both edges. The curbing stops about 11'-10' from the tank wall. At about 9'-10" from the tank wall the viaduct surface steps down and the void space between the inlet lines and the viaduct surface is grouted. At this point the viaduct begins fanning out from 2'-8" wide to 7'-4" wide to support the spread placement of the fill lines through the tank wall. The concrete viaduct terminates 2" from the tank wall; the void space is filled with 2" asphalt-impregnated felt. | Leak | Alt. Hypoth. | NA |

B3 TABLE 6 ELICITATION FORMS

Expert Opinion: D. G. Baide

Tank 241-C-110 Leak Assessment Elicitation Form and Formulas (from HNF-3747, Rev. 0)

L(SLM) - p(SLML)p(SLM)NL). If purface level data are not available for the leak assessment, then L(SLM) - 1 systML) = ['posierior'] probability that the surface level measurement data would be observed, if the tank is a basisr. $p(SLM|ML) = \{posterior/porbability that the surface level measurement data would be observed, if the tank is a roon-leater, <math>p(SLM|ML) = 1 \cdot p(SLM|ML)$ il there are several excentially redundant surface level measurements (e.g., EHPAF, FIC, MT), the probabilities should be assessed only for the more diagnostic and reliable one. Low heat tank with non-single-thet tank, and it is either a fighted tank has leaked given only two pieces of information: it is a aggressive process. Instruction of the process instruction of the process instruction of the process of the process instruction of the process of Considering the surface level measurement data reviewed for the leak assess MT elevation errors, repeated fills and empties could have resulted in an overflow. An overtise from tank 241-C-110 via inlet or outlet line penetrations, a transfer line leak, or other unplanned release created the elevated radiation reading in dyseell 30-10-09. Likilhood Ratio L(SLM) A leak from tank 241-C-110 oaused the elevated radiation reading in dywell 30-10-09. 0.25 å In-Tank Data Surface Level Measurement - Part 2 Prior Probability - Part 1 D(SLMINL) P(NL) 08'0 Conditional Probabilities 분 True State p(SLM|L) (if no SLM, enter NA, here and in Parts 4 and 5) DA Barnes/DJ Washenfelder p(F) 6/10/2008 DG Baide Surface Level Measurement Elicitation Date: Elicitation from Eliciation by: Hypotheses: Non-Leaker: Leaker:

In-Tank Data Liquid Observation Well - Part 3

0,40

| ŝ | |
|--|------|
| r(row) | 1.00 |
| P(LOW INL) | * |
| Liquid Observation (if no LOW, enter NA here and in Perts 4 and 5) | 2 |
| Liquid Observation Well | |

p(LOWINL)) = ['posterior'] probability that the LOW intensitial fiquid level data would be observed, if the tank is not a baker, p(LOWINL) = 1 - p(LOWINL)

LLCWN) = piLOWIL)piLOWINL). I LCW intentitital figuid level data are not available for the leak assessment, then L(LOW) = 1

p(LOWIL) = ['posterior'] probability that the LOW intentitial liquid level data would be observed, if the tank is a leater.

Considering the intensitial liquid level data reviewed for the leak accessmen

| ı | | | |
|--------------------|---------------------|------------------------|---------------------|
| Infacta Lava I Man | O Dinid - I build O | neurilliaw notternesch | dependence - Part 4 |

| Surface Level Measurement - Liquid Observation Well Interdependence - Part 4 surface Level easurement - leasurement - leasuremen | ce Level Measure | Surface Level Measurement - Liquid Observation (if no Well Interdependence | |
|--|-------------------------|--|--|
| E(SLMILOW, NL.) | mem - Liquid O | p(SLM LOW,L) (if no LOW, enter NA) | |
| | bservation Well Interde | | |

p(SUMICW,NI.) = ['posterior'] probability that a surface level measurement data would be observed if the LDW interstitied liquid level measurement data are observed, and if the tank is a non-leafer. p(SUMILCW,NI.) = 1 - p(SUMILCW,I.)

p/SLMLCW LL = ["posterior"] probability that the surface ferel measurement data would be observed if the LCW intensitial fauld level data are observed, and if the tank is a teaker.

Considering that in-tank data courses may be interdependent:

L(SLMILOW) = $\mu(SLMILOW, L(pp(SLMILOW, NL))$. Teither surface fevel measurement data or LCW intersitial liquid fevel data are not available for the leak assessment, then L(SLMILOW) = 1.

If there is no Low, skip to the next part.

| Liquid Observation Well - Surface Level Measurement Interdependence - Part S Id Observation - Surface Level (if no SLM, enter NA) Pr(LOW SLM, NL) Pr(LOW | Well- | |
|---|------------------------|----|
| Measurement Interd | on Well - Surface Leve | NA |
| | Measurement Interd | NA |

pLCW/SLM,NL) = [bosterior] probability that a LOW intersitial fould level measurement decrease would be observed if a sustace level measurement decrease is observed, and if the tark is a non-lealest. ppt/LOW/SLM,NL) = 1 - ppt/LOW/SLM,L)pt/LOW/SLM,NL). Feither surface level data or LOW interestitating level data are not wailable for the back sessesment, then LOW/SLM, = 1.

p(LON/SLM.L) = [bosterior] probability that the LOW interstitial fquid level data would be observed if a surface level measurement decrease is observed, and if the tank is a teater.

Considering that in-tank data sources may be interdependent

Ex-Tank Data - Spectral Gamma Drywell Logs - Part 7

Considering the historical gross gamma drywell logs reviewed for the leak assessment:

a in gross

p(GZLL) = ["posterior"] probability that the gross gamma logs would be observed, if the tank is a leaker, poster, only
p(GZLNL) = ["posterior"] probability that the gross gamma logs would be observed, if the tank is a non - halten;
so not an active p(GZLNL) = 1 p(GGLN).

L(GGL) = p(GGL|L)p(GGL)NL). If gross gamma logs are not available for the leak assessment, then L(GGL) =

| SGL scens don't sh much - mostly evide of surface spills | |
|--|------|
| r(sor) | 0.43 |
| p(SGLNL) | 0.70 |
| p(SGLL) (if no SGL, enter NA here and in Parta 8 and 9) | 08'0 |
| Spectral Gamma Drywell Logs | |

p(SSLLL) = [posterior] probability that the spectral gamma drywell logs would be observed, if the tank is a leader. Considering the spectral gamma dryw ell logs reviewed for the leak assessment:

p(SSLINL) = [posterior] probability that the spectral garrana drywell logs would be observed, if the tank is a non-leater, p(SSLINL) = 1 - p(SSLILL) how

L(SSL) = P(SSL|L)p(SSLNL). If special gamma drywell logs are not available for the leak assessment, then L(SSL) = 1.

Considering that ex-tank data sources may be interdependent

piGAL(SAL) = ['posterior'] probability that the gross gamma logs would be observed if the spectral gamma logs are are observed, and if the tank is a leater.

p(GAL(SALM) = (Posterior) probability that the gross gamma logs would be observed if the spectral gamma logs are observed, and if the tank is a non-basies: p(GAL(SALM) = 1 - p(GAL(SALM)

L(GGLISGL)

p(GGLISGL,NL)

p(GGL|SGL,L)

Log Gross Gamma Log-Spectral Gamma

Gross Gamma Log - Spectral Gamma Log Interdependence - Part 8

1.00

Spectral Gamma Log - Gross Gamma Log Interdependence - Part 9

L(SGL[SGL)) = p(SGL[SGLL) P(SGL[SGL, N.)). If either gross gamma logs or spectral gamma logs are not available for the leak assessment, then L(SGL[SGL) = 1.

Considering that ex-tank data sources may be intendependent:

p/SGLGGLL) = [posterior] probability that the spectral garma logs would be observed if the gross gamma logs are observed, and if the lark is a leater.

p(SQL(SGL,M.) = ['posterior'] probability that the spectral gamma logs would be observed if the gross gamma logs are are observed, and if the tank is a non-batter. p(SGLSGL,M.)= 1 - p(SGL(SGL,L)

L(SGLIGGL)

p(SGL|GGL,NL)

p(SGL|GGL,L)

Spectral Gamma
Log - Gross Gamma
Log
Log
Interdependence

L/93L/34L) = p/9GL(GGLL)/p/9GL(GGLNL). If ether gross gamma logs or specifial gamma logs are not available for the leak assessment, then L(9GL(GGL) = 1.

| 8 |
|--------|
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| g B |
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| Ē |
| 웉 |
| 8 |

1.00

0.50

0.50

| 0.67 | 1.00 | 1.00 | 1.00 |
|------|----------------|------------|-----------|
| 1.50 | L(SGL) 0.43 | L(GGL SGL) | L(SGL GGL |

Which In-Tank Condition Applies? (Mark X in Box)

SLM & LOW; SLM most Important? SLM & No LOW? LOW & NO SLM?

L(SLM) = p(SLML)p(SLM)N.). If surface level data are not available for the leak assessment, then L(SLM) = 1

If there are several essentially redundent surface level measurements (e.g., ENPAF, FIC, MT), the probabilities should be assessed only for the more diagnostic and reliable one.

0.25

0.80

0.20

In-Tank Data Liquid Observation Well - Part 3

Expert Opinion: D. A. Barnes

Tank 241-C-110 Leak Assessment Elicitation Form and Formulas (from HNF-3747, Rev. 0)

piSUMIL) = ["posierior"] probability that the surface level measurement data would be observed, if the tank is a heaker. p(NL) = 'prior' probability that an assumed sound tank has not leaked given the same data. p(NL) = 1- p(L) Considering the surface level measurement data reviewed for the leak assessment: Ω₀ = "prior" odds in favor of the leak hypothesis. Ω₀ = p(L)/p(NL) piSLMINL) - ['posterior'] probability that the surface level measi a non - leaker. p(SLMINL) - 1 - p(SLMIL) Liklihood Ratio L:NL An overflow from tank 241-C-110 via inlet or cutlet line penetrations, a transfer line leak, or other unplanned release created the elevated radiation reading in drywell 30-10-09. L(SLM) 1.00 A leak from tank 241-C-110 caused the elevated radiation reading in drywell 30-10-09. ď In-Tank Data Surface Level Measurement - Part 2 Prior Probability - Part 1 True State p(SLMINL) p(NL) 0.50 Conditional Probabilities p(SLMIL) (If no SLM, enter NA here and in Parts 4 and 5) 0.50 D'C DJ Washenfelder DA Barnes 6/6/2008 Surface Level Measurement Elicitation Date: Elicitation from: Eliciation by: Hypotheses: Non-Leaker: Leaker:

| VINL) L(LOW) | 1.00 |
|---|-------|
| (LOWIL) OW. enler NA and in Parts 4 and 5) | NA NA |
| Liquid Observation (if no LOW, enlar NA here and in Parts 4 and is parts 4 and 5) | |

pt_OWIL) = ("posterior") probability that the LOW interstitial liquid level data would be observed, if the tark is a leaker.

Dt_OW HL) = ("posterior") probability that the LOW interstital liquid level data would be observed, if the tank is not a leaker. PLCM HL) = 1 - p(LOW IL).

Considering the interstitial liquid level data reviewed for the leak assessment

LiLOM) = piLOM/LypiLOM/NU). If LOM misnsifinal hourd level data are not available for the leak assessment then LiLOM) = 1

Considering that in-tank data sources may be interdependent:

| pendence - Part 4 | L(SLMILOW) | |
|--|---|--|
| Surface Level Mensurement - Liquid Observation Well Interdependence - Part 4 | p(SLMILOW,NL) | |
| asurement - Liquid Ob | p(SLMILOW,L) (if no LOW, enter NA) | |
| Surface Level Me | Surface Level Measurement - Liquid Observation Well Interdependence | |

| (LOWISLM) | 1.00 |
|--|------|
| id Observation - Surface Level prLOWISLM, fino SLM, enter NA) prLOWISLM, | ¥ |
| p(LOWISLM,L) (if no SLM, enter NA) | NA |
| Liquid Observation Well - Surface Level Measurement Interdependence | |

| 를 들 | Ex-Tank Data - Gross Gamma Drywell Logs - Part 6 | p/GGLIL) (if no GGL, erfler NA here and in Parts 8 and 9) | 0000 |
|-----|--|---|------|
|-----|--|---|------|

L(GGL) = p(GGLL)p(GGLNL). If gross gamma logs are not available for the leak assessment, then L(GGL) =

PISLANLOW I. - Toosland") probability had the surface by of measurement data would be observed if the LOW interstitating and evid data are observed, and if the tank is a feather.

DISLANLOW I. - Toosland") probability that a surface level measurement data would be observed if the LOW mineratal found were measurement data are observed and if the tank is a non-teaser. PISLANLOW MI. - PISLANLOW I. - PISCANLOW I. THE PISLANLOW I. - PISCANLOW I. - PISCANLOW

| OSGUNL) L(SGL) | 0.40 1.50 |
|---|-----------|
| p(SGLL) (if no SGL, enter NA here and in Parts 8 and 9) | 090 |
| Spectral Gamma Drywell Logs | |

| Gross Gamma Log - Spectral Gamma p(G Log | |
|--|-------|
| p(GGLISGL,L) | N |
| nma Log - Gamma Pi(GGL SGL,L) pi(GGL SGL,L) pi(GGL SGL,NL) Light | NA NA |
| (1691/BGL) | 1.00 |

Spectral Gamma Log - Gross Gamma Log Interdependence - Part 9

| Spectral Gamma Log - Gross Gamma Log - Log Imerdependence | 0.50 |
|--|------|
| | |
| p(SGLIGGL,NL) | 0.50 |
| L(SGLIGGL) | 1.00 |

Combined Liklihood Ratios

| 1 | 1.00 | 1.00 | 1.00 |
|---|--------|------------|------------|
| | L(SGL) | L(GGL SGL) | L(SGLIGGL) |

Which In-Tank Condition Applies? (Mark X in Box)
SLM & No LOW?
LOW & No SLM?

SLM & LOW; SLM most important?

X

Considering the spectral gamma dywell logs reviewed for the leak assessment:

p(SQLL) = (postenor) probability that the spectral gamma drywell logs would be observed, if the lank is a leaker.

p(9GLML) = ['posterior'] probability that the spectral gamma drywell logs would be observed, if the tank is a non-teaker, p(9GLML) = 1 - p(9GLLL)

L(GGL) = p(SGL|L)p(SGL|NL). If specifial gamma drywell logs are not available for the leak assessment, then L(SGL) = 1.

Considering that ex-tank data sources may be interdependent:

p(GGL(SGL,L) = (Toostehor) probability that the gross gamma logs would be observed if the spectral gamma logs are are observed, and if the tank is a leaker.

p(GGL|SGL,NU) = [Posterior] probability that the gross gamma logs would be observed if the specifial gamma logs are observed, and if the tank is a non-betwer. p(GGL|SGL,NL) = 1 - p(GGL)SGL,LL)

L(GGL(9CL) = p(GGL(5GLL)Yp(GGL(9CL)NL). If ether gross gamma logs or spectral gamma logs are not available for the leak assessment, then L(GGL(9CL) = 1.

Considering that ex-tank data sources may be interdependent:

pISQL(5GLL) = [Tootlanor] probability that the specifial gamma logs would be observed if the gross gamma logs are observed, and if the tank its a leaker.

p(SGL(SGLML) = ['posterior'] probability that the spectral gamma logs would be observed if the gross gamma logs are are observed, and if the tank is a non-baker. p(GGL(SGLML) = 1 - p(SGL(SGLLL))

LISCL(SCL) = p(SCL(SCL), p(SCL(GCL,NL). If ether gross gamma logs or specifial gamma logs are not available for the last assessment, then L(SCL(GCL) = 1.

8

L(SLM,LOW)

SLM & LOW; LOW most important?

In-Tank Liklihood Ratio

0.25

Which Ex-Tank Condition Applies? (Mark X in Box) GGL & No SGL? SGL & No GGL?

L(SGL,GGL) 0.43 GGL & SGL; GGL most important? GGL & SGL; SGL most important? Ex-Tank Liklihood Ratio

L(in,ex) Likelihood Ratio for Leak Hypothesis

Combined

0.11 0.11 á Posterior Probability for Leak Hypothesis p(NLJin,ex) 0.90 p(Llin,ex) 0.10

Notes and Key:

Manual entries (Elicited probabilities)

SLM: Surface Level Measurements LOW: Liquid Observation Well GGL: Gross Gamma Log SGL: Spectral Gamma Log For elicited probabilities, the ratio column is p(*IL)/p(*INL).

L(SLM,LOW) = L(SLM,LOW) × L(LOW) or L(LOW, SLM) × L(SLM) r(sar'ear) = r(aarlsar) x r(sar) or r(sarlaar) x r(aar) L(in,ex) = L(SLM,LOW) x L(SGL,GGL) Other calculations are as follows: $\Omega_{r} = L(in,ex) \times \Omega_{o}$ $p(L|in,ex) = \Omega t'(\Omega t+1)$

II SLM and no LOW: USLM,LOW) = L(SLM)
II SLM and IOSM and SLM most important: USLM,UOW) = L(LOW SLM); x L(SLM)
II SLM and LOW and SLM most important: USLM,LOW) = L(SLM)CW) = L(SLM)CW)

il Gat, and no Squit. L(SQL,GAt) = L(GQL) in Squit and no Gat, L(GQL,GAt) = L(GAL,GAt) = L(GQL,GAt) × L(GQL) if Gat, and Gat, and Gat, most important: L(SQL,GAt) = L(SQLG) SQL) × L(GGL) if Gat, and Squit and SQL most important: L(SQL,GAt) = L(SQC) SQL) × L(SQL)

L(In,ex) - L(SLM,LOW) x L(SGL,GGL)

 $\Omega_{\rm e}$ prolentic (post-leak assessment) odds in favor of leak hypothesis. $\Omega_{\rm e}$ =Lin.ex) x $\Omega_{\rm o}$ pL lin.ex) = posterior probability (post-leak assessment) that the tank is a leaker. (Lin.ex) = $\Omega_{\rm e}(\Omega_{\rm e}+1)$ pitL.In.ex) = posterior probability (post-leak assessment) that the tank is a leaker. p(ML.In.ex) = 1- pp.L.In.ex)

Expert Opinion: D. W. Brown

pil.) = "prior" probability that an assumed sound tank has leaked given only two pieces information: it is a single-shall tank, and it is uither a high-hast tank or not. Any specification on past surface layed drops or as tank rediscribity measurements are ignored. If there are several essentially redundant surface level measurements (e.g., ENFAF.). FIC, MIT, the probabilities should be assessed only for the more diagnostic and reliable one. L(SLM) = p/SLM(1)/p/SLM(NL). If surface lore all data are not an atable for the leafs assessment, then L(SLM) = 1 $p(M_{\lambda})$ = "polar" probability that an assumed sound tank has not leaked given that data. $p(M_{\lambda})$ = $\{-p(L)$ Ca - "prior" odds in favor of the leak hypothesis. Ca - ptLyp(NL) p(SLMNL) = [posterior] probability that the surface lar of measus observed, if the tack is a non-leaker. p[SLM]NL] = 1 - p(SLML)Should have seen a manual tape indication of a leak, expecially over the 3 year period that the liquid surface less of was montrared and stable. Likihood Ratio L:NL L(SLM) 0.18 Prior Probability - Part 1 True State p(SLM/NL) p(NL) 0.85 Conditional Probabilities p(SLML) (If no SLM, enter NA. here and in Parts 4 and 5) 0.15 3 Surface Level Measurement

In-Tank Data Liquid Observation Well - Part 3

(from HNF-3747, Ray, 0)

As overflow from tank 24+C-110 via infat or catel fire penetrations, a transfer fine leak, or other cyclenned release created the also and radiation reading in dywall 30-10-09.

A leak from tank 241-C-110 caused the elecated radiation reading in drywall 30-10-09.

Elicitation Data: Elicitation from: Elicitation by:

pit.CW/SLM.NL) = ['portation'] probability that a LCW/recentrial liquid be of measurement decrease in measurement decrease in decrease in an analysis of the stank is a non-leaker, pit.CW/SLM.NL) = 1 - pot.CW/SLM.NL) LLCW/SLM) - pit.0W/SLM,Lipit.0W/SLM,N,). II either surface lawel data or LOW interestitial found for eliding are not or alable for the less assessment, then LJLCW/SLM) = 1.

If there is no surface

pt.CW/SLM.L) = ["postation"] probability that the LOW intensiblal fequid feerel distanced be observed it a surface level measurement decrease is observed, and if the tank is a leaker.

Considering that in-tank data sources may be interdependent:

If there is no LOW, slip to the next part

| ŝ | |
|---|------|
| (NOW) | 1.00 |
| PLOWINL | NA |
| p(LOWIL) (if no LOW, enter NA. here and in Parts 4 and 5) | NA |
| Liquid Observation (il Well | |

p(LOWNL)) = posterior! probability that the LOW interstitial iquid for all data would be observed, if the tank is not a leaden: $p(LOW)(L) = 1 \cdot p(LOW)(L)$

pLOWL) = 1 posterior?] probability that the LOW interestital liquid level data would be observed, if the tank is a leaker.

Considering the intensitial liquid level data reviewed for the leak assessm

LLCW) = pLOWLVPLOWINL. If LOW interzithal fiquid for all data are not available for the leak assessment, then L(LOW) = 1

p(SLMLOW.L) = ['postacion'] probability that the surface lovel measurement data would be becaused if the LOW interchied logical lovel data are observed, and if the tank is a because.

Considering that in tank data sources may be interdependent:

p(SLMLOH,NL) = Posterior! probability that a surface leavel measurement data would be observed it the LOW intentitial ligaid lavel measurement data are observed, and it is non-basies. p(SLMILOW,NL) = 1 - p(SLMILOW,L)LISUALOW) $\sim p(SUALOW,L)p(SUALOW,NL)$. If other outside level measurement data or LOW intractitied level data are not available for the loak assessment, then LISUALOW) = 1.

| LISTMLOW |
|---|
| PSLMILOW,N.) |
| pSLMILOW.L) (3 to LOW, enter NA) |
| Surface Level Measurement - Liquid Observation Wall Interdependence |

| Part 5 | SLM) | |
|---|---|--|
| - baudence - | TOWN SEW) | |
| Measurement Interd | PLOWISHMAL | |
| Liquid Observation Well - Surface Lavel Measurement Interdeparatence - Part S | pt.OW(SLML) (if no SLM, enter NA) | |
| Liquid Observation | Liquid Observation Well - Burbos Lavel Massurement Interdependence | |

| | | _ | The GGL rea increased afti inlet lines at a The reported small to reach | |
|--|------|---|---|------|
| (WISMOTH) | 1.00 | 9 11 | (16/31) | 200 |
| p(OWISLANU.) | 2 | nma Drywell Logs - Pa | p(3GLN.) | 080 |
| pLCW/SLML) (if no SLM, unior NA) | NA | Ex-Tank Data- Gross Gamma Drywell Logs - Part & | P(SGLL) (# no GGL, enter NA here and in Parts 8 and 9) | 0.00 |
| Liquid Observation Well - Surface Level Measurement Interdependence | | قد | Gross Gamma Drywell Logs | |

Ex Tank Data - Spectral Ganma Drywell Logo - Part 7

and office in consociations of an extend lates from the task since it never pIGGLL). Prostator of probability that the gross gamma logs would be observed, if the feet includes The interior that from before that the task was probability filled above the task in a before. The interior that from before that the task was probably filled above the task in a before. The proceedings on the gaze of the first would have a short waste before waste before. Considering the historical gross gamma drywell logs reviewed for the leak assessmen I have was small. If the drywall was not located in the leak plame path, or if the leak was loo ch the drywell, then the GGL would be inconclusive.

p(GGL|NL) + Prostator() probability that the gross gamma logs would be observed, if the tank is a non-leaker, $p(GGL|NL) = 1 \cdot p(GGL|L)$

LIGGL) = piGGL()/piGGL(NL). If gross garrens logs are not available for the leak appearment, then LiGGL() = 1

| e 93L would not have obsected the leats. | LIGSL, » = PSGSL IV. PSGSL NI., II special gamma drywall logs are not as allable for the leaf, acasesment, then LIGSL.) = 1. | | Constanting the example access may be recognised. priodically that the gross genmen logs would be observed it from the priority of the priori | #16301.931.Mt.) = [*Tocaterier*] probability that the gross gamma logs would be observed and the track is a non-balas. If the speciel gamma logs are folds: 1941.Mt.) = 1. #1631.931.It.) | L(G2L(SGL) = p(G2L(SGL,L)p(GGL(SGL,ML). If either gross gamma bgs or spectral gamma bgs are not available for the lask assessment, then $L(G2L(SGL) = 1$. | A second | Contacting the man case carried may be transpossible. p(GLLL) = (Procession') producing the special general general general desired to observed, and if the bark is a leaker. does of it the group gamma logs are observed, and if the bark is a leaker. | The GGL is more informative than the SGL. The SGL and GGL scans are not inconstructed with each p(SCLGGL,NL) = ("proserving") probability that the spectral gamma logs would be observed if the train is an included possess. In page 21, 10, 10, 10, 10, 10, 10, 10, 10, 10, 1 | LISGL(GGL) $\sim p(SGL(GGL,M)$. If either gross gamma logs or spectral gamma logs or spectral gamma fogs are not available for the leak assessment, then LISGL(GGL) = 1. | | | | | | S.M. and no LOW: LGMALOW) - LGMAN LOW and no LOW: LGMALOW: LGMAN S.M. and LOW and S.M. noof importure 'LGMALOW's -LLOW:SLAR's LGSAM | II SUM AND LOW BIOLOGY BIOLOGY BIOCHINGORAN (L) |
|--|--|---|--|---|--|---|--|---|---|---------------------------|-------------------|-----------------|---|-------------------------------|---|---|
| The SGL was inconclusive for a tank leaf- If the drywellwas in the wrong location, th | | r | | | | | | The GGL is more informative than the Sother. | | 1 | | | П | п | | |
| nesh | 19.0 | rdependence - Part 8 | | (1881) | 1.00 | dependence - Part 9 | | (1801)03() | 81 | | ULOWISING 1.00 | neerleen 150 |) × | | (WITH TOW) | 6.18 Box) |
| CRITICAL | 0.60 | mma Log Interdepend | | pigg:(Sg.N.) | NA | mma Log Interdepend | | p(SGLGGL,NL) | 0+0 | clihood Ratios | USTMITOW) | (Toerlean) | Applies? (Mark X in | | | Applica? (Mark X in I |
| p(SGLL) (if no SGL, enter NA. here and in Parts 8 and 9) | 040 | Gross Gamma Log - Spectral Gamma Log Inte | | p(GGL)SGLL) | NA | Spectral Gamma Log - Gross Gamma Log Inter | | b(SCECCELL) | 050 | Combined Likilhood Ration | 100 | (1881) | Which In Tank Condition Applies? (Mark X in Box) | of important? | | Which Es Tank Condison Applies? (Mark X in Box) SGL & No GGL? |
| Spectral Garnina Drywell Logs | T | Gross Gam | Gross Gamma Log. | Spectral Gamma Log Interdependence | ľ | Spectral Ga | Spectral Gamma | Log - Grose Gamna Log Interdependence | | | L(SLM) | מפט | Which In-Tank C SLM & No LOW? LOW & No SLM? SLM & LOW; SLM most important? | SLM& LOW; LOW most important? | In-Tank Liklihood Ratio | Whie GGL & No SGL? SGL & No GGL? |

Expert Opinion: L. S. Krogsrud

Tank 241-C-110 Leak Assessment Electration Form and Formulas (from HNF-37 47, Rev. 0)

L(SLM) - p(SLM)L/p(SLM)ML). Fourince level data are not available for the leak assessment, then L(SLM) - 1 If there are several essentially redundant surface for of measurements (e.g., ENPAF, FIC, MT), the probabilities should be assessed only for the more diagnostic and reliable one. p(3LML). = ['posterior'] probability that the autiace level measurement data would be observed, if the tank is a leafer. Besed on MT behavior p(\$LM|N.) = |Pournior/probability has the surface level measurement data would be observed, if the tank is not suspect a leak.

Incl suspect a leak. p(L) = 'prior' probability that an assumed acound tank has leaked given only two pieces of information: it is a single-thell fault, and it is better in Methan fault or not. Any specific data on past surface level drops or ex-ter's radocably, measurements are ignored. p(NL) = "prior" probability that an assumed sound tank has not leahed given the same data. p(NL) = 1. p(L) Considering the surface level measurement data reviewed for the leak assessment: Ω_2 = "prior" odds in layer of the leak hypothesis. Ω_0 = p(L)ptNL) An overflow from tank 241-C-110 via inlet or outlet line penetrations, a transfer line leak, or other unplanned release orested the elevated radiation reading in dywell 30-10-09. LIKIIhood Ratio L(SLM) A leek from tank 241-C-110 caused the elevated radiation reading in drywell 30-10-09. 0.43 0.43 å In-Tank Data Surface Level Measurement - Part 2 Prior Probability - Part 1 True State p(SLM|NL) p(NL) 보 Conditional Probabilities p(SLML) (if no SLM, enter NA here and in Perts 4 end 5) DA Bames/DJW ashenfelder 0.30 p(L) LS Krogsrud 6/10/2008 Surface Level Measurement Elicitation Date: Elicitation from: Eliciation by: Hypotheses: Non-Leaker: Leaker:

In-Tank Data Liquid Observation Well - Part 3

| L(LOW) | 1.00 |
|--|------|
| P(LOW INL) | × |
| Liquid Observation (if no LOW IL) Nell here and in Parts 4 end 5) | NA |
| Liquid Observation Well | |

p(LOWNL) = [posterior] probability that the LOW intermitial figured level data would be observed, if the tank is not a leaker. $p(LOWNL) = 1 \cdot p(LOW)L$

L(LOW) = piLOWIL)piLOWINLY. If LOW intercitital fquid fevel data are not available for the leak assessment then L(LOW) = 1

p(LONIL) = ["posterior"] probability that the LOW intentitial liquid level data would be observed, if the tank is a leater.

Considering the intensitial liquid level data reviewed for the leak acceptament

| pendence - Part 4 | L(SLMILOW) | 400 |
|--|---|-----|
| Surface Level Measurement - Liquid Observation Well Interdependence - Part 4 | P(SLMILOW, AL) | 218 |
| easurement - Liquid Of | p(SLMILOW.L) (if no LOW, enter NA) | *** |
| Surface Level M. | Surface Level Measurement - Liquid Observation Well Interdependence | |

p/SLMILOW ML) = ['posterior'] probability that a surface level measurement data would be observed if the 1. ON't terretials itsuld level measurement data are observed, and if the bank is a non-leaker, p/SLMILOW II.) = **PSLMILOW II.

p(SLMILOW L) = [Posterior*] probability that the surface level measurement data would be observed if the LOW intensitial liquid fevel data are observed, and if the tank is a leaker.

Considering that in-tank data sources may be interdependent

L(SLMILOW) = p(SLMILOW,L)p(SLMILOW,NL). If either surface level measurement data or LCW intersitial liquid level data are not available for the leak assessment, then L(SLMILOW) = 1.

If there is no LOW, skip to the next part.

| art 5 | LM) | |
|--|--|------|
| bendence - Pr | r(rowistm) | 1.00 |
| Measurement Interde | p(LOW SLM,NL) | NA |
| Liquid Observation Well - Surface Level Measurement Interdependence - Part 5 | p(LOW SLM,L) (if no SLM, enter NA) | ¥ |
| Liquid Observati | Liquid Observation Well - Surface Level Measurement Interdependence | |

p(LOW)SUAML) = ['posterior'] probabilly that a LOW intersitial feuid level measurement decrease would be observed in a surface level measurement decrease is observed, and if the tank is a non-healer. [CUM)SUAML is -pp(LOW)SUAM(SUAM).]

p(LOW)SLML) = ['posterior'] probability that the LOW interstital figuid level data would be observed if a surface ferel measurement decrease is observed, and if the tank is a leater.

Considering that in-tank data sources may be intendependent.

 $L(LOW)SLM = \mu LOW|SLM,Lyp(LOW)SLM,NL)$. Feither surface fevel data or LOW interaited liquid level data are not available for the leak assessment, then L(LOW)SLM) = 1.

| | * * | ģ |
|--|--|-------------------------|
| _ | The peak below tank foundation did not change; unlikely if the | tank liner was leaking. |
| 9 11 | L(GGL) | 1.50 |
| nma Drywell Logs - Par | P(GGLINL) | 0.40 |
| Ex-Tank Data - Gross Gamma Drywell Logs - Part 6 | p(GGL L) (if no GGL, enter NA here and in Parts 8 | ond 9) |
| Ex | Gross Gamma Drywell Logs | |

Considering the historical gross garrera drywell bgs reviewed for the leak assessment:

P[GGLL] = [Posterior] probability that the gross gamma bgs would be observed, if the tank is a leater.

P[GGLR] = [Posterior] probability that the gross gamma bgs would be observed, if the tank is a non-tester p[GGLR], - [Posterior] to observed.

L(GGL) = p(GGL(NL). If gross gamma bgs are not available for the leak assessment, then L(GGL) =

Ex-Tank Data - Spectral Gamma Drywell Logs - Part 7

| r(sor) | 1,00 |
|--|------|
| р(зациц.) | 0.50 |
| P(SGLL.) (if no SGL, enter NA here and in Parts 8 and 9). | 0.50 |
| Spectral Gamma Drywell Logs | |

| Spectral Gamma Log - Gross Gamma Log Interdependence - Part 9 | P(SGL GGL,NL) | 0 0.50 |
|---|--|--------|
| ectral Gamma Log- | Spectral Gamma -og - Gross Gamma Log interdependence | 0.50 |

| 1.00 | riserieer) |
|------------|------------|
| L(SLM LOW) | r(agrisar) |
| L(LOW) | r(sgr) |
| L(SLM) | ולפפרו |

Which in-Tank Condition Applies? (Mark X in Box)
SLM & No LOW?
LOW & No SLM?
SLM & LOW; SLM most important? (Mark Part 4 NA)

Considering that ex-lank data sources may be interdependent:

L(SGL) = p(SGLL)p(SGLNL). If spectral gamma dywell logs are not available for the leak assessment, then L(SGL) = 1.

p(95LINL) = [bosterior] probability that the spectral gamma drywell logs would be observed, if the tank is a non-leater, p(95LINL) = 1 - p(95LIL).

p(954LL) = [posterior] probability that the spectral gamma drywell logs would be observed, if the tank is a baster.

Considering the spectral gamma drywell logs reviewed for the leak assessed

p(G2L,B32L,L) = ['posterior'] probability that the gross gamma logs would be observed if the spectral gamma logs are are observed, and if the tank is a leater. p(GALSALM) = ['posterior'] probability that the gross gamma logs would be observed if the spectral gamma logs are observed, and if the tank is a non-bales. p(GALSALM) = 1 -p(GALSALL)

L(GGL)SGL) = p(GGL)SGL)Vp(GGL)SGL,N.). Il either gross gamma logs or spectral gamma logs are not available for the balk assessment, then L(GGL)SGL) = 1.

p(SAL(SGLL) - [posterior] probability that the spectral garrena logs would be observed if the gross gamma logs are observed, and if the tark is a leaker.

p(SAL(SGLL)AL) - [posterior] probability that the spectral gamma logs would be observed if the gross gamma p(SAL(SGLA)L) - 1 - p(SAL(SGLL))

(SSAL(SGLL) - p(SGL(SGLL)) p(SGL(SGLM). If she gross gamma logs or spectral gamma logs are not available for the last assessment, then L(SGL(SGL)) - 1.

Considering that ex-lank data sources may be interdependent:

 Ω_r posterior (post-bask assessment) odds in favor of leak hypothesis. Ω_r L(in, ex) $\times \Omega_0$ p(L(in,ex) = posterior probability (post-bask assessment) that the tunk is a leaker. (L(in,ex) = $\Omega_r(\Omega_t + 1)$ p(ML(in,ex) = posterior probability (post-bask assessment) that the tank is a leaker. $p(ML(in,ex) = 1 \cdot p(L(in,ex))$ 8

In-Tank Likithood

Ratio

GGL & NO SGL?

SGL & NO SGL?

SGL & SGL; GGL most important? (Mark Part 8 NA)

GGL & SGL; GGL most important? (Mark Part 8 NA)

GGL & SGL; GGL most important? (Mark Part 8 NA)

GGL & SGL; GGL most important? (Mark Part 8 NA)

GGL & SGL; GGL most important? (Mark Part 8 NA)

Ex-Tank Likithood

Ex-Tank Likithood

Ratio

H SLM and no LOW: L(SLM,LOW) = L(SLM)
H SLM and LOW and SLM most important: L(SM,LOW) = L(LOW)SLM) × L(SLM)
H SLM and LOW and SLM most important: L(SM,LOW) = L(SLM,LOW) × L(LOW)
H SLM and LOW and LOW most important: L(SLM,LOW) = L(SLM,LOW) × L(LOW)

Combined
Likelihood Ratio for
Leak Hypothesis

L(mex) - L(SUM,LOW) x L(SOL,GEL)

|| GGL and no SGL : 1953, GGL) |
| GGL and no SGL : 1953, GGL |- 1153, |
| GGL and SGL and GGL most inportant : 1,952, GGL |- 1,952, GGL |
| GGL and SGL and GGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |- 1,952, SGL |
| GGL and SGL and SGL most important : 1,952, GGL |- 1,952, SGL |- 1,95

Posierior Probability for Leak Hypothesis

p(L|in,ex) p(NL|in,ex) Ω_1 0.22 0.78 0.28

Manual entries (Elicited probabilities)

Notes and Key:

Calculated entries

SLM: Surface Level Messurements LOW: Liquid Observation Well GGL: Gross Gemme Log

SGL: Spectral Gamma Log

For elicited probabilities, the ratio column is p(*|L)/p(*|NL).

Other calculations are as follows: $\label{eq:calculations} L(SLM,LOW) = L(SLM,LOW) \times L(LOW) \circ L(LOW) | SLM) \times L(SLM) \\ L(SCL,GaCL) = L(GGL) | SCL,SCL,SCL) \circ L(SCL,GGL) \times L(GGL,GGL) \\ L(in,ex) = L(SLM,LOW) \times L(SGL,GGL) \\ \Omega_1 = L(in,ex) \times \Omega_0 \\ p(L(in,ex) = \Omega V(\Omega 1+1) \\ \end{cases}$

Expert Opinion: P. C. Miller

Tank 244-C-110 Leak Assessment Elicitation Form and Formulas (from HNF-3747, Raz. 0)

An overflow from tank 24 s.C. 110 vis inlet or oxflet fine penetrations, a transfer fine leak, or other creplanned release created the elex stad radiation reading in drywall 30-10-09.

Leaker: Non-Leaker:

A leak from tank 241-C-110 caused the alexated radiation reading in drywall 30-10-09.

DJ Washanfeldar DA Barnes

6/12/2008 PpC Miller

Elichation Data: Elichation from: Eliciation by:

pil.) = "prior" probability that an azuamed sound tank has leated given only two pieces information: it is a single-shell tank, and it is either a high-heat tank or not. Any specificable on past surface lar et drops or as tank radiosofthity measurements are ignored. If there are several essentially rectuations current level measurements (e.g., ENGAE). FIC, MIT, the probabilities should be assessed only for the more diagnostic and reliable one. $\mathfrak{p}(M_s)$ = "tokor" probability that an assumed sound tank has not leaked given the same data. $p(M_s)$ = 1, p(L)piSLML) = ["postendar"] probability that the surface for of measurement data would be observed, if the tank is a leaker. L(SLM) = p(SLM|LV|P(SLM|NL). It surface for all data are not an allable for the leak appearment, then L(SLM) = 1 Considering the surface level measurement data reviewed for the leak asset p(SLMNL) = ("posterior") probability that the surface lay of measure observed, if the tank is a non-leaker, p(SLMINL) = 1 - p(SLMIL) Ca = "prior" odds in far or of the leak hypothesis. Ca = p(L)(p(NL) The manual type was mortioning a fquid surface at the time of the 1974 dywell ar ent. There was no detectable change in surface les el measurement, so it is unitially that the tank was leaking. (WIS) 0.05 Prior Probability - Part 1 Trus State In-Tank Data Liquid Observation Wall - Part 3 p(SLMINL) PINE 0.80 Conditional Probabilities In-Tank Data Surface Lavel Measur p(SLML) (If no SLM enter NA here and in Parts 4 and 5) 90'0 3 Surface Lavel Measurement

B-22

| Considering the intensitial liquid laved data reviewed for the feet assessment: pLOWIL = [*posterior*] probability than the LOW intensitial liquid lavel data would be dozen ed. if the tank is a leafest. pLOWPLI) = [*posterior*] probability that the LOW intensitial liquid feet of data would be | observed, if the tank is not a leaker. p(LOW/NL) = 1 - p(LOW/L) | $LL(W) = \rho LW(L) \rho LW(W)$ It is the intercential figurities of data are not as allable for the lask assessment, then $L(LW) = 1$ | | Considering that in tank data sources may be irtendependent: | $\rho(SLMLOW, L)$ = Tootselor] probability that the surface (see all measurement data would be observed if the LOW interestital liquid level data are observed, and if the unit is a batter. | p(SLMLOW,NL) = ("porasion") probability that a surface level measurement data would be observed if the LOW interestital legal level measurement data are observed, and if the tank is a non-leader, p(SLMLOW,NL) = 1, p(SLMLOW,L). | LISLMLOW) = $p(SUMLOW, L)p(SUMLOW, M.)$. If other surface less of measurement data or LOW intensitial liquid level data are not available for the less assurance, then LISLMCOW) = 1. | | | Considering that in-tank data sources may be interdependent: | pILOW3LML! ~ Proceeded* probability that the LOW intersitial fquid law of datawoold be observed it authors law if measurement decrease is observed, and if the tent is a laster. | piLOWSLM.NL) = ("porasion") probability that a LOW interestrial liquid law of measurement decreases would be observed if a surface law of measurement decreases in observed, and if the stant is a non-balax. piLOWSLM.NL) = 1 - ppiLOWSLM.L) | LILOWISLM; = p(LOWISLM), bp(LOWISLM, N). If other surface law of data or LOW interctified fould law of data are not are allable for the lask assessment, then LLLOWISLM) = it. | | | Connissing the Institution gross gamma drywell togs tearewell for the leak assessment: p103CLL) = "postexion" probability that the gross gamma logs would be observed, if the talk is a leaker. | PiGGLINI.) - ["posterior"] probability that the grous gamma logs would be observed, if the tark is a non - tester. piGGLINI. = 1 - piGGLIL) | L(GGL) = $p(GGLU)p(GGLML)$. If gross garma-logs are not available for the lack assessment, then L(GGL) = 1. | | Constitution of the control of the c | | $p(SG,M_s) = P_{potential}$ for debuilty that the spectral gamma dywell kgs would be observed, if the tank is a non-baker, $p(SG,M_s) = (-p(SG,M_s)$ | L(GGL) = p(GGLL) p(GGLNL). If spectral gamma dywell logs are not available for the lask encessment, then L(GGL) = 1. | |
|--|---|--|---|--|--|--|--|------|--|--|--|---|--|------|--|---|---|--|------|--|---------|--|--|------|
| | | | | | | | | | | | | | | | | he gramma pack in the 10.09 drywall decays a centime. If the tank was leaking and the drywall | intercepted the plans, it is sufficiely that the garmon peak would have believe of this way. However a plane of from a leak could have missed all of the dy-wells. Probably not indicative of the tank leak status. | | | | | The nationacides in drywell 10.09 were mostly naturally-occurring inotopes. If the drywell intercepted the plume, mannade isotopes would have a been present. | | |
| LACW) | | 8 | andanca - Pari 4 | | | LISTALOW) | | 1.00 | ent Interdependence - Part 5 | | | LILOW SLM) | | 1.00 | 91 | | L(GGL) | | 1.00 | 711 | | r(sgn | 85.4 | 29.0 |
| P(COW/NL) | | 100 | servation Wall Interdes | | | pistmilcw,NL) | | NA | | | | p(LOW)SLMINE) | | NA | nme Drywell Logs - Pa | | p(ggfl/F) | | 255 | mma Drywell Logs - Part 7 | | p/SGLINL) | | 0,60 |
| p(LOWIL) if no LOW, enter NA. here and in Parts 4 | (S pue | *** | Surino Love Manusment - Liquid Observation Wall Inturbe pandence - Part 4 | | | (if no LOW, enter NA) | | NA. | Liquid Observation Well - Surface Lavel Measuren | | 100000000000000000000000000000000000000 | (if no SLM, enter NA) | | NA | En-Tank Data- Gross Gamma Drywell Logs- Part 6 | (T)09)d | here and in Parts 8 and 9) | | 0.30 | Ex Tank Data - Spectral Gannna Dryw | p(SGLL) | (if no SGL, enter NA here and in Parts 8 and 9) | | 040 |
| Liquid Observation (if no LOW, enter PA Well wealth in Parts + | | | Surface Local Man | | Surface Lavel | 9 . | | | Liquid Observatio | | Liquid Observation | | | | 8 | | Drywell Logs | | | 1.63 | | Spectral Garnma Drywell Logs | | 1 |

| ė. | | | Spectral Gamma | ral Garnma rose Gamma Log spenderce | - | | OOS COST | 100 | Which in-Tank Condition Applies? LOW & No SLM? SLM & LOW; SLM most important? SlAut Part 4 NA) SLM & LOW; LOW most important? (Mark Part 5 NA) | In-Tank Likiihood Ratio | _ | GGL & No SGL? SGL & No GGL? | | Es. Tank Likiihood Ratio | | Combined Litelihood Raio for Leak Hypothesis |
|----|--------------|------|---|--|-----|--------------------|------------------|-----------|---|----------------------------|-------------------------------|--------------------------------|--|-----------------------------|------|--|
| | p(GSL)8(B,L) | 0.75 | Log - Gross Ga | T'BOTTOGI'T) | NA | Combined L | 100 | TSST) | Mich In Tank Condition nost important? (Mark P. most important? (Mark P. | | Mich Es Tank Condition Applie | | most important? (Mark Part 8 NA) most important? (Mark Part 9 NA) | | | |
| | p(GGISGLNL) | 0.25 | Spectral Gamma Log - Gross Gamma Log Interdeps ndence | P(SQL)GQL,NL) | NA | d Liklihood Ratios | TSTWITOWN | 3.00 | (Mark X in | | o? (Mark X in | | art 8 NA) art 9 NA) | | | |
| | (1631.831) | 3.00 | ence - Part 9 | LISGLIGGL | 8:1 | | ULCWISUM 1.00 | L(SGUGGD) | (mag) | (SLM LOW) | 6.05 Fox) | | × | רופפריפפח | 2.00 | L(in,ex) |

H 3LM and no LOW: LISUALOW) = LISLAND (W) =

L(8GL(6GL) = p(8GL(6GLL) (p)(8GL(3GLML) . If either gross gamma legs or spectral gamma legs are not available for the leak assessment, then L(8GL(6GL) = 1.

p(3CL(3CLL), a [Pooterior] probability that the spectral gamma logs would be observed if the gross gamma logs are observed, and if the tank is a leaker. p(3CL(3CL), R) - ProcessiveT probability that the operated gamma logs would be observed if the gross gamma logs are are observed, and if the tank is a non-instance p(3CL(3CL), R) - r. p(3CL(3CL), R).

p(GAL SGLL). - ["potavire"] probability that the group gamma logs would be obserted if the traffic is a ladies:
the operatoral gamma logs are are observed, and if the traff is a ladies:
(GAL SGL, M.). - ["potavire"] probability that the group gamma logs would be observed if the special gamma logs would be observed, and if the traff is a non-ladies:

Considering that as tank data sources may be interdependent:

 $L(GGL(BGL)_{+} p(GGL(BGL,L)_{p}(GGL(BGL,ML)_{+}))$. If either gross gamma logs or spectral gamma logs are not available for the lask assessment, then $L(GGL(BGL)_{+})_{+}$.

Considering that ax-tank data sources may be interdependent:

| 16:21 and no 5:31: (16:31,6:31) =

Lin,ax) - L(SLM,LOW) x L(SGL,GGL)

96

Position Probability for Lask hypothesis
p(Llinux) p(Milnux) Cr
0.05 0.00 0.00

 Ω_n = posterior (post-lack assessment) odds in law or of least hypothesia. Ω_n = Lin, ω_1 × Ω_n = $\Omega_$

· (Elicited probabilities)

Celevisted entries SLM: Surface Level Measurements For alicited probabilities, the ratio column is p("IL)(p)

Other calculations are as follows: LISTIMICNY) = LISTIMICNY) × LICONY) or LICONYSTAN × LIGIDA LIGAL, GGD. = LIGHL, GGD, x LIGGL), G.= Lin, ar.) = LIGHL, GGD, x LIGGL, ar. G= Lin, ar.) = GGD, x LIGGL, ar. pUllin, ar.) = L. p(Lin, ar.) pWLin, ar.) = L. p(Lin, ar.)

Expert Opinion: D. J. Washenfelder

 $\mathfrak{p}(\mathbb{N}_{+})$ "toto" probability that an assumed sound tank has not leaked given the same data. $p(\mathbb{N}_{+}) = 1, \, p(\mathbb{L})$ LISTAN = p.(SLMILV;p.(SLMINL). If surface for of data are not available for the leak assessment, then LISTAN = 1 Ω_1 = "pulse" odds in favor of the leak hypothesis. Ω_2 = p(L)/p(NL) L(SLM) 0.05 Prior Probability - Part 1 True State P(SLMINL) Conditional Probabilities 80 n-Tank Data Surface Level Measu 2 90'0 Surface Lavel Measurement

An orwellow from tank 201-C-110 via inlet or outlet fire penetration, a transfer fine leak, or other urglanned release created the electrical adjation reading in daywell 30-10-09.

A leak from tank 241-C-110 caused the elevated radiation reading in drywall 30-10-09

may not represent actual as-built condition

Crowing W. 741 09 *Nantord Engines Works Building No. 241-7.LLB & C. Concrete Details of Pipe Support shows that the concrete principle violation has a "thirp curb maning dough but hadge. The curbing strong boat 11-10" from the tank wall. At least 8-10" from the tank wall the violation stages and the maning dough but hadge. The curbing strong boat 11-10" from the tank wall. The violation strong and an additional strong strong wall was a strong strong and the pipe strong strong wall and the pipe strong strong

LAOW)

p(LOW/NL)

p(LOW)L) (if no LOW, enter NA here and in Parts 4 and 5)

Liquid Observa Well

In-Tank Data Liquid Observation Wall - Part 3

 $p(LOWL) = \{postenty T probability that the LOW interstitial liquid level data would be observed, if the tark is a leaker.$ Considering the interstitial liquid level data ner iswed for the leak assess

p(LOWNU) = Prosterior | probability that the LOW intential fauldier of data would be observed, if the tark is not a lastics. p(LOW)N1 = 1 - p(LOW)LLLCW) = $\phi LCW(1) \phi LCW(NL)$. It LCW interchifial iquid for all data are not available for the leak assectment, then LLCW(1)=1

Considering that in-tank data sources may be interdependent:

piSLMLOW.i.).» ["postation"] probability that the surface lead measurement data wot be observed if the LOW inscribial liquid lavel data are observed, and if the tank is a below.

 $p(SLMLOW.ML) = \Gamma$ potential probability that a surface law of measurement data work be observed if the LOW interchical legal law in measurement data are observed, and if the tank is a non-badvar. $p(SLMLOW.L) = 1 \cdot p(SLMLOW.L)$. LISLMLOW) = p/SLMLOW, Lip(SLMLOW, NL). If other surface less all measurement data or LOW interestinal lipsid layed data are not available for the less assersment, then LMLOW) = 1.

If there is no LOW, skip to the next part.

Considering that in-tank data sources may be interdependent:

pd.CW/SLML). = ['tootwater'] probability that the LCW intersitial feuid fee of datawoods be observed it a sufface for all measurement decrease is observed, and if the tank is a below.

pt.CW/SLM.NL) ~ ["postation"] probability that a LCW intentitial figurid favol in measurement decrease in measurement decrease in observed it a surface level measurement decrease in observed, and if the tank is a non-lester. pt.CW/SLM.NL) = 1 - ppt.CW/SLM.L)

LLCWISLM) - pLCMSLMLypt.CWISLM.N.L). II ether surface level data or LCW intercibial fauld for all data are not available for the leak assessment, then LLCWISLM = 1.

If there is no surface

| Surface Level Ma | Surface Lave I Measurement - Liquid Observation Wall Interdependence - Part 4 | NA beavation Wall Interd | 1.00 lepandance - Part 4 |
|--|---|-----------------------------|-----------------------------|
| Surface Level Measurement - puid Observation Well | p(SLM LGW,L) (# no LGW, enter NA) | PISTWICOV.NL) | LISUMEOW) |

| 8 3 | VISLAIN.) |
|-----|--|
| | aid Observation **Lating Law **PLOW:SLM.** anter NA. PLOW:SLMAR.** LLOW:SLM.) **Reservations of the control of the cont |

Ex-Tank Data- Gross Garnma Drywell Logs- Part 6

| Considering the Intentical gross gamma drywall logs reviewed for the leak assessment: pRGGLL). * [Presentor*] probability that the gross gamma logs would be observed, if the lands, is a leaker, probability that the gross gamma logs would be observed, if the spifical cannow have a probability that the gross gamma logs would be observed, if the lands is a non-leaker, probability that the gross gamma logs are not available for the back assessment, then L(GGL). * 1 | | Considering the specinal garman drywell logs soviewed for the bask assessment: #################################### | | Considering that ex-tank data sources may be it-audepandent: | p(GGLISGLI) = ("potatrice") probability that the gross pamma logs would be observed it the special gamma logs are are observed, and if the tank is a leafest. | $p(G_{\alpha}^{*}(S_{\alpha}^{*}, M_{\alpha}) = (Pooterier)$ probability that the group gamma logs would be choser as if the spectral gamma logs are observed, and if the track is a non-lastes. $p(G_{\alpha}^{*}(S_{\alpha}^{*}, M_{\alpha}) = 1 - p(G_{\alpha}^{*}(S_{\alpha}^{*}, S_{\alpha}^{*}))$ | L(G2L(S2L) - p(G3L(S2L) p)G3CL(SGL,NL). If either group gamma logs or spectral gamma logs are not available for the leak associament, then $L(G3L(SGL) = 1$. | | Considering that ex-tank data sources may be interdependent: | p(SQL(GSLL), = (*pozazier*] probability that the specinal gamma logs would be observed if the gross gamma logs are observed, and if the tank is a leaker. SIGL(SQLL), = (*pozazier*) probability may the specinal gamma logs would be observed, at the gross gamma logs are a observed, and if the tank is a non-leaker. FIGL(SQL, NL) = 1 - p(SQL(SQL, NL)). | Annual Los es es estada (GGLL) (p/SGLIGGLNL). If either gross gamma logs or spectral | gamma togs are not available for the least assessment, then Libral, least, 1. | |
|---|---------------------------------------|--|----------------|---|--|--|---|--|--|---|--|---|--------------------|
| Gross gamma sell contamination readings found at the 30 to 50 depth in drywell 30-10-00, about 15 lead blob the tacks includition. The contamination was detected in October, 1974, immediately alber the through the tacks in the state of the self-self-self-self-self-self-self-self- | | Floate of SGI scan of the dywalls parrounding C 110 are documented in GJ14MA 92, Vadoue Zone Chandresia stein oppose at the Mandred Tank Farmar Tank Sammary Data Report for Tank C 110. However services in the service of the service in the SGI stein C 110. The inservices in the SGI stein C 110. The inservices or contamination was described in the upper position of all the boseholes amounding tank C 110. The inservices contamination is probably the result of surface selfs that migrated rise the baddill makels amound the tank. The C-137 contamination advanted in bounded 30-10-02 from 44 to 43.9 it and bounded 30-07-11 from 48 to 7.4 it may be the sent of a tout or operated selfs with the tank regarded into the baddill makels about the search of continuous between the additional parameters. | Iwo borsholes. | | | | | | | | | | |
| | 2117 | Lisan | | nos - Part 8 | | (1631-931) | 1.00 | dependence - Pert 9 | | (1867)037) | | 8.00 | |
| piggfl/k) | nema Drywell Logo - Part 7 | жели | | ma Log interdepende. | | p(GGLSG_N.) | 2 | na Log Interdepender | | p(SGUGGL,NL) | | 0.10 | |
| piGGLL) (i no GCL, eather NA here and in Parts 8 and 8) | Es Tank Data - Spectral Ganyna Drywel | p/6/31.1.) (if no 5/31, enter HA, here and in Parts & and it) | | Gross Gamms Log - Spectral Gamms Log Interdepandance - Part 8 | | piGGL SGL,L} | NA | Spectral Gamma Log - Grose Gamma Log Inter | | p(3/3/3/16/3,1.) | | 0.90 | Constituted 1 1101 |
| Gross Gamma Dryssall Logs | Es-Te | Spectral Garama Drywell Logs | | Gross Game | Gross Gamma Log. | Log | | Spectral Gan | | Spectral Gamma Log - Gross Gamma Log Interdependence | | | |

| If SIM and no COVY, LESSALOVI); a USAM I ELOW and no SLM, LUSAMLOVI); a USAMLOVI) a LACOVISLAN x LUSAM II SLM and LOW and SLM most important: LUSLMALOVI) a LACOVISLAN x LUSAM II SLM and LOW and LOW most important: LUSLMALOVI) a LUSLMALOVI); x LUCOVI | | GGL and no SGL: LISGL.GGL) = LIGGL) SGL and no GGL : LISGL.GGL) = LISGL.GGL) = LISGL.GGL) = LISGL.GGL) = LISGL GGL) = LISGL GGL and GGL mod important: LISGL.GGL) = LIGGL.SGL LIGGL.GGL) = LIGGL.SGL x LIGGL) | Tiger's (MCT) FISH (Col) FISH (Col) | | -110, 241-C-111, The Doublator (post-lead assessment) odds in favor of leads hypothesis. Di= Lifn.ex1 x are C-110 and Di= | |
|---|--|--|---|---|---|--------------------|
| | | | | П | PRP-ENV-34446 Fav. I Hantod C-Ferm leak Assessments Report 241-C, 101, 241-C, 110, 241-C, | above this lavel." |
| | | 3 | | | | |
| L(SLM.LOW) | Box) | (887'88) (887'88) | L(in,ex) | 0.32 | ď | 0.08 |
| TISTW COM) | Applica? (Mate X in Box) rt 8 NA) x 19 NA) | 07108/11 | Lines | | p(MLineax) Da | 0.93 |
| USTM LOW) | Which Ex-Tank Condition Applies? (Mark X in Box) 601. & No GOLY 601. & SOL GOL Most important? (Mark Part 8 NA) 601. & SOL GOL Most important? (Mark Part 8 NA) GOLL & SOL GOL Most important? (Mark Part 9 NA) | 00'9 0'196\n | Límes | Posterior Probability for Leak Hypothesis | | |

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