

Hanford Single-Shell Tank Leak Causes and Locations - 241-A Farm

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Richland, WA 99352

U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DRF

UC: N/A

Cost Center: 2KE00

Charge Code: 201334

B&R Code: N/A

Total Pages: 169 JDA 9/10/13

Key Words: leak location, leak cause, tank, integrity assessment, A Farm, A-104, A-105, leak assessment

Abstract: This document identifies 241-A Tank Farm (A Farm) leak causes and locations for the 100 series leaking tanks (241-A-104 and 241-A-105) identified in RPP-ENV-37956, Hanford A and AX Farm Leak Assessment Report. This document satisfies the A Farm portion of the target (T04) in the Hanford Federal Facility Agreement and Consent Order milestone M-045-91F.

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By Janis D. Aardal at 10:54 am, Sep 10, 2013

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EXECUTIVE SUMMARY

This document identifies 241-A Tank Farm (A Farm) leak causes and locations for the 100-series leaking tanks in A Farm. The leak causes and locations report for all of the 100-series single-shell leaking tanks is one of the targets (M-045-91-T04) in the Hanford Federal Facility Agreement and Consent Order milestone M-045-91F. The T04 target requires that the Department of Energy (DOE) provide to State of Washington, Department of Ecology (Ecology) a report on the 100-series single-shell tanks which have been or will be identified as having leaked in RPP-32681, Rev. 0, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*, leak assessment reports.

The leak assessment report for A Farm, RPP-ENV-37956, *Hanford A and AX Farm Leak Assessment Report*, lists two 100-series tanks that continue to be classified leaking tanks in A Farm, 241-A-104 (A-104) and 241-A-105 (A-105). One tank, 241-A-103 (A-103), previously classified as a leaking tank was identified in RPP-RPT-37956 as requiring re-assessment of the classification per TFC-ENG-CHEM-D-42, *Tank Leak Assessment Process*. The tank A-103 re-assessment, RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*, recommended that the classification be changed to “Sound.” The remaining three 100-series tanks in A Farm are classified as sound.

This A Farm leak causes and locations document is part of a series of tank farm reports that identify leak causes and locations for 100-series leaking tanks. A summary and conclusions document will be issued, RPP-RPT-54909, *Hanford Single-Shell Tank Leak Causes and Locations – Summary*, that compiles the results from all of the leak causes and locations tank farm reports when they have been issued which will fulfill the T04 target requirements.

Identification of tank leak locations focused on liquid level data and radioactivity detected in drywells and laterals. Tank A-104 was first suspected of leaking in March 1975 due to radioactivity being detected in lateral 14-04-02 under the northern portion of the tank shortly after the start of sluicing in September 1974. Radioactivity continued to increase and sluicing was halted in April 1975 and the supernatant was pumped. Additional radioactivity was detected spreading eastward and under the southern portion of the tank through May 1975 and appeared to stabilize by the end of 1975.

Tank A-105 was first suspected of leaking in November 1963 when radioactivity was first detected in lateral 14-05-03 under the south east portion of tank A-105. A sidewall leak was postulated as the liquid level had just been increased from 260-in to 280-in. Radioactivity in lateral 14-05-03 declined after reducing the liquid level with the thought the leak had self-healed. The tank was gradually refilled with no indication of leakage and the tank was considered operational. On January 28, 1965, tank A-105 experienced a rapid pressurization event that resulted in the tank liner bulging upward 8½-ft; radioactivity was detected one month later in a small area in a lateral on the north edge of the tank. Subsequent visual inspection showed that the bottom liner had separated from the wall liner around 75% of the tank’s perimeter. There was no change in liquid level after the event and the tank continued to store waste until February 1968 when tank A-105 was declared a confirmed leaker. Supernatant was then transferred to tank A-103 and sluicing campaigns were initiated to remove the tank solids. Sluicing resulted in radioactivity being detected in previous and new locations.

There are several liner leak cause conditions that were examined but the most likely cause of a tank A-104 or tank A-105 leak were the thermal conditions and problematic liquid level control in tank A-105. Also, the tank design associated with the orthogonal intersection between the liner bottom and wall did not allow for the thermal conditions encountered. In addition, there is the possibility of corrosion with the initial water cover in both tanks but especially tank A-105 which contained up to 18-in of water for seven years. The storage of PUREX sludge supernatant waste may have increased the propensity for stress corrosion cracking in tank A-104. Cold temperatures experienced during A Farm construction present the possibility of impact loading of the steel (e.g. a dropped tool or piece of equipment from scaffolding) which had the potential for creating micro-fissures in the steel liner. Some or all of the factors can act serially or together to contribute to tank liner failure.

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Abbreviations and Acronyms

241-A	A
241-A Tank Farm	A Farm
ALC(s)	air lift circulator(s)
ARHCO	Atlantic Richfield Hanford Company
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BGS	below grade surface
BPF	Blueprint File
B & PVC	Boiler & Pressure Vessel Code
c/m, cpm	counts per minute
c/s, cps	counts per second
DOE	Department of Energy
DST(s)	double-shell tank(s)
Ecology	State of Washington, Department of Ecology
GM	gamma
GMP	gamma probe
H ₂ SO ₄	sulfuric acid
HLW	high level waste
LL	liquid level
MDL	minimum detection limit
NaI	sodium-iodide
NO ₂ ⁻	nitrite
NO ₃ ⁻	nitrate
OCP	open circuit potential
OH ⁻	hydroxide
ORP	Office of River Protection
PCSACS	PC Surveillance Analysis Computer System
PUREX	Plutonium Uranium Extraction (fuels reprocessing) Plant
SCC	stress corrosion cracking
SGLS	Spectral Gamma Logging System
SP	scintillation probe
SRS	Savannah River Site
SSP	shielded scintillation probe
SST(s)	single-shell tank(s)
WRPS	Washington River Protection Solutions, LLC

Units

BTU	British thermal unit
Ci	curie
°F	degrees Fahrenheit
ft	feet
gal	gallon
hr	hour
K	1000

kgal	kilogallon (10^3 gallons)
in	inches
L	liter
M	moles per liter
mR	millirem
mil	millimeter
pCi	picocurie (10^{-12} curies)
pCi/g	picocurie per gram
ppm	parts per million
psi	pounds per square inch
yr	year

Waste Type Abbreviations

AR	244-AR Vault waste
B	221-B Plant strontium solvent extraction waste
PUREX HLW	PUREX high-level waste
OWW	PUREX organic wash waste
P or P1	PUREX HLW supernatant
PSS	PUREX sludge supernatant

1.0 INTRODUCTION

The Hanford Federal Facility Agreement and Consent Order target M-045-91F-T04 indicated that part of the RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*, reporting would include leak causes and locations reports for all of the 100-series single-shell leaking tanks. This document is part of a series of documents that identifies leak causes and locations of 100-series single-shell leaking tanks that have been identified in the individual RPP-32681 tank farm leak assessments. An overall leak causes and locations summary and conclusions document will be prepared along with background and common tank farm information when all of the 100-series single-shell leaking tanks have been addressed (RPP-RPT-54909, *Hanford Single-Shell Tank Leak Causes and Locations -Summary and Conclusion*, to be issued). The information from RPP-RPT-54909 will be incorporated into the summary conclusions report on leak integrity for the Hanford Federal Facility Agreement and Consent Order milestone M-045-91F.

The 241-A Tank Farm (A Farm) tanks with leak losses are addressed in this document on an individual tank basis. The A Farm assessment in RPP-ENV-37956 (*Hanford A and AX Farm Leak Assessment Report*) reported leak losses for the 241-A-104 (tank A-104) and 241-A-105 (tank A-105) tanks and recommended that 241-A-103 (tank A-103) tank be re-assessed using TFC-ENG-CHEM-D-42, Rev B-2 (*Tank Leak Assessment Process*). The re-assessment of tank A-103 using TFC-ENG-CHEM-D-42, Rev B-2, resulted in the recommendation that the tank integrity status be change from “Assumed Leaker” to “Sound Tank” (RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*).

The identification of A Farm tank leak locations relied on the first indication of radiation detected in laterals and drywells as well as liquid level decreases as appropriate. Tank A-105 experienced a steam eruption that resulted in an 8½-ft bulge of the tank bottom and separation of the tank bottom from the wall liner around 75% of the tank’s perimeter.

The A Farm leak causes were identified as tank design, liner bulging, thermal conditions and possibly chemistry-corrosion, and tank construction conditions.

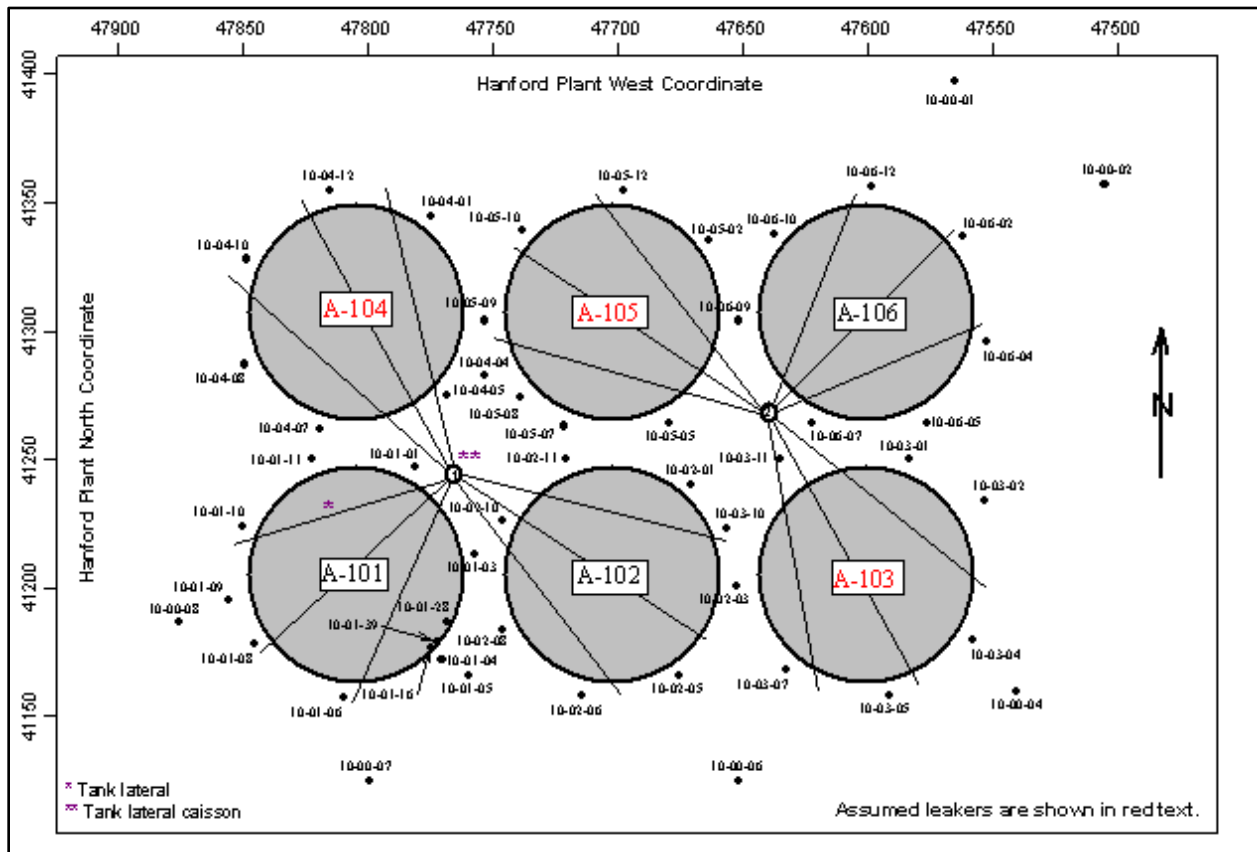
Two meetings were held to review status of tanks A-104 and A-105 with the Office of River Protection (ORP) and the State of Washington, Department of Ecology (Ecology) personnel. A review on December 3, 2012, provided a summary of previous leak causes and locations documents, future projections and covered the information that had been generated on the tank A-105 leak locations and causes. A second meeting on January 15, 2013, provided a review of the tank A-104 leak causes and locations along with a comparison of the available information on the other A Farm tanks. Comments were received, responses developed, and additions/revisions were made to the document (see Appendix A).

2.0 A FARM BACKGROUND

The A Farm is comprised of six Single-Shell Tanks (SSTs) boiling waste tanks built during 1954-1955. The tanks are arranged in two rows of three, forming a cascade. Each of the A Farm tanks has a nominal 1,000,000 gallon capacity. The A Farm tanks consist of a carbon steel liner inside a reinforced concrete shell. The concrete shell is a domed structure approximately 46.5-ft in height at the apex and ~83-ft in diameter at the footings. The steel tank liner covers the 75-ft inner diameter tank bottom and sidewalls to a height of ~32-ft as measured from the tank center. The flat tank bottom connects orthogonally to the sidewall. Each tank was originally equipped with 9 to 11 risers, a 20-in diameter vapor exhaust pipeline that penetrated the tank dome, and four airlift circulators that were operated to suspend solids, mix the tank contents, and dissipate heat.

Figure 2-1 shows a schematic of the A Farm tanks with location of the laterals and drywells.

Figure 2-1. A Farm Leaking Tanks with Laterals and Drywells



Note: The individual assessment of tank A-103 using TFC-ENG-CHEM-D-42, Rev B-2, resulted in the recommendation that the tank integrity status be change from "Assumed Leaker" to "Sound Tank" (RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*).

Tanks A-104 and A-105 contained various waste types throughout operation which are listed in Table 2-1. The following sections describe some of the important common tank features and conditions that could affect tank leak location and cause. Affected tanks are noted where the features and conditions do not apply to all. This is followed by an A Farm tank by tank analysis of the possible leak causes and locations for each of the leaking tanks. The sections contain excerpts from RPP-ENV-37956.

Table 2-1. Leaking A Farm Tanks with Waste Type

Tank	Waste Type¹
A-104	B, AR, P1, PSS, OWW
A-105	PUREX HLW

1. Waste types are listed in the Waste Type Abbreviations, page vi.

3.0 A FARM COMMONALITIES

3.1 TANK DESIGN/CONSTRUCTION

3.1.1 Tank Design

The A Farm tanks had multiple design features that could contribute to stresses or possible leak paths when the tank was being operated including:

- Orthogonal intersection between the flat steel bottom and the sidewall
- Fillet weld used between the bottom and sidewall intersection
- Less rigorous weld inspection testing
- Partial asphaltic membrane waterproofing

These features are common to all A Farm tanks.

The steel bottom of the A Farm tanks intersects the sidewalls orthogonally similar to 241-SX Farm tanks rather than the knuckle transitions in earlier designed tank farms (BPF-73550, Drawings D-2 and D-3, *Specification for Construction of Composite Storage Tanks (B, C, T, and U Tank Farms)*). The A Farm tank footing and sidewall construction joint is shown on Figure 3-1 (H-2-55912, *Base Footing and Wall Reinforcing, Purex Waste Disposal Facility*). This figure shows the 7-in water stop at the base footing to wall construction joint and other details. The earlier 241-BCTU Farm tanks notched footing construction joint does not incorporate a water stop. There are no sidewall construction joints shown on H-2-55912 which is a departure from the five sidewall construction joints for the 241-SX Farm tanks (H-2-39512, *75 FT. Tank Base Footing and Wall Reinforcing, Waste Disposal Facility, 241-SX*). The 6-in thick flat bottom A Farm tanks also differ from the 3.3% sloped bottom of the 241-SX Farm tanks where the thickness near the center is 10 ³/₄-in including the liner, grout, and asphalt membrane.

**Figure 3-1. A Farm Tanks Base Footing and Wall Reinforcing
(Drawing H-2-55912)**

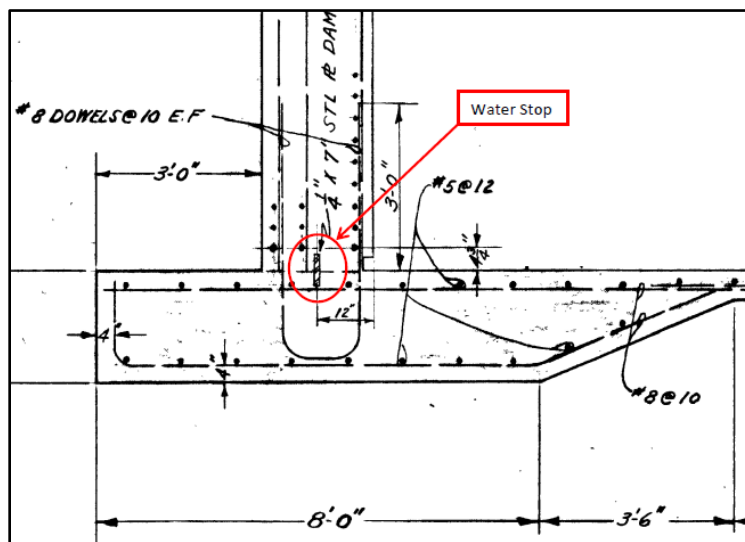
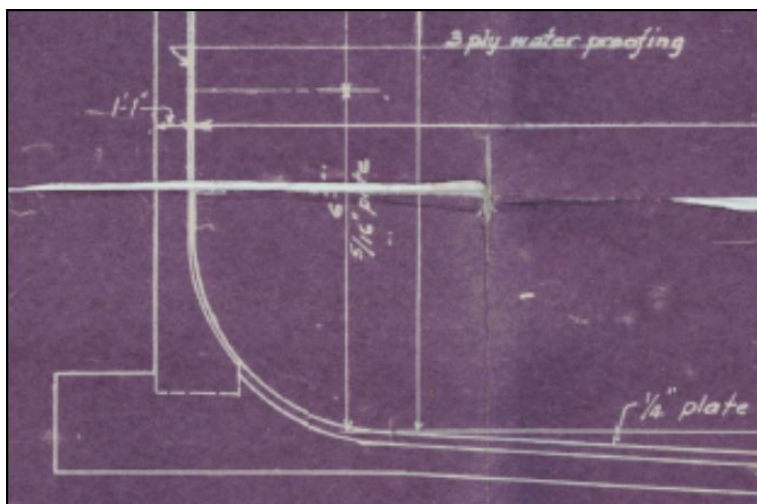


Figure 3-3. 241-BCTU Farm Tanks Knuckle Configuration with Three Ply Waterproofing (BPF-73550, Drawing D-2 and D-3)



The design of the A Farm tanks was the second tank farm design after the 241-BCTU Farm tanks that diverged from the round bottom knuckle design used in the earlier waste tanks. A fillet weld was used to close the seam where the sidewall and tank bottom liners meet versus the butt welding of the knuckle transition of earlier tank designs. A review of the basic differences between fillet and butt welds indicates that the superior butt welds would be preferred for the tank farm waste tanks (see Table 3-1).

Table 3-1. Basic Fillet and Butt Weld Differences

Some excerpts from Steel Designer and Steel Construction Handbooks

Attribute	Fillet Weld	Butt Weld
Preparation Costs	Inexpensive	Expensive
Welding Speed (Progress)	Fast	Slow
Load Bearing	Good for static loads (structures)	Good for dynamic loads (pressure vessels)
Quality	Inferior resistance to fatigue High potential for crack propagation More distortion and stress buildup	Greater resistance to fatigue Weld is stronger than base metal Minimal change in stress
Inspection	Harder to perform high quality inspection (unable to radiograph)	Easier to perform high quality inspection (radiograph)

A review of literature to compare historical failure rates for fillet welds and butt welds did not identify any relevant information that could be related to the tank farm waste tanks. There was recognition that the base of the A Farm tanks was considered fixed and excessive steel stresses could be expected during pressure surges and elevated temperatures (LET-070357, "Commentary Report for Structural Review and Cost Estimate of the Tank Designs," from H.W. Stivers addressed to J.B. Fecht, July 3, 1957). Tank farm experience indicates that several SSTs with fillet welds failed during service which was recognized by the Single-Shell Tank Integrity Expert Panel as a factor in future tank use (RPP-RPT-45921, Recommendation ST-2, *Single*

Shell Tank Integrity Expert Panel Report).

The problem that the orthogonal joint design introduces including changes in asphaltic waterproofing is described in the following excerpt from HW-57274 (*Instability of Steel Bottoms in Waste Storage Tanks*):

“A steel liner which fits tightly inside a concrete shell provides no means for differential thermal expansion. Such expansion can result in high compressive stresses in the steel which may produce elastic instability. Instability is particularly likely to occur in the flat bottom of the liner resulting in rippling of the bottom. This is more apt to occur in designs in which the junction at the lower corner is 90 degrees as in the SX Tanks than in designs in which a radius is used as in the BX and TX Tanks of earlier design. Empty tanks in the SX farm have been observed to have rippled bottom liners before filling.”

“A hydraulic head would tend to flatten the ripples but filling with hot waste would tend to increase the degree of rippling because of the restraint of the concrete shell. Under certain conditions this might cause rupture of a joint. The severity of the rippling is believed to have been demonstrated by the instability of the bottom of tank 113-SX after it was emptied. It is suggested that the restraint offered by the concrete shell be reduced by a return to the use of an asphalt expansion joint between the steel shell and the concrete shell.”

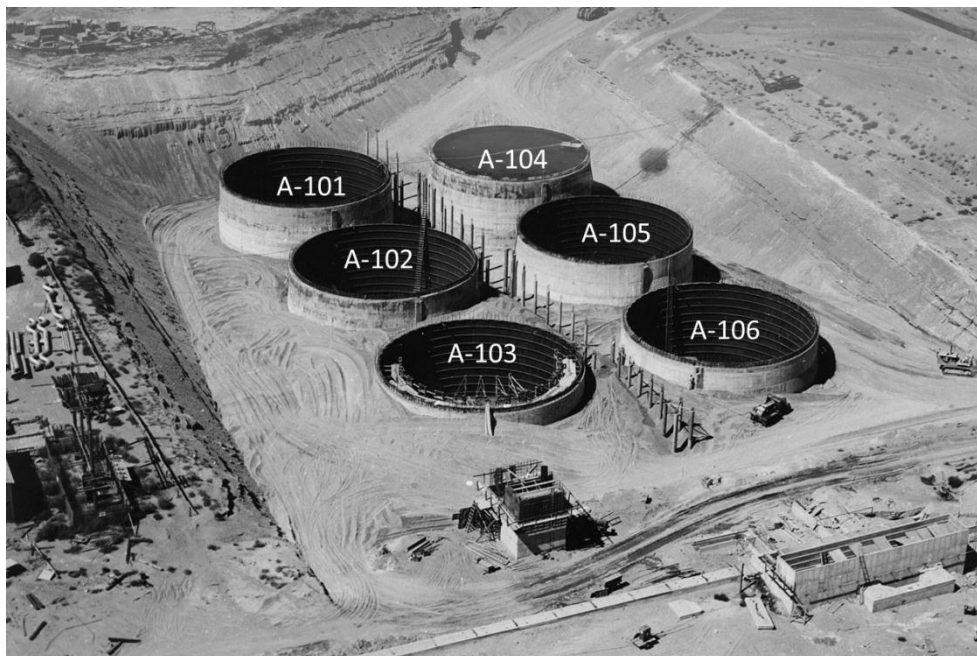
The ripples identified in the preceding paragraphs probably refer to the visual effects of either the support structure for the bottom liner during construction or the overall stress inherent in the welding of multiple steel plates making up the bottom liner. Construction photographs were reviewed; however, no photographs were available to verify the presence of ripples in the tank bottom liner after hydrostatic testing. The small discontinuous ripples of probably less than a few inches in height observed during construction differ from bulging indicated in this report. Bulging is typically indicated by the degree of bottom liner uplift of more than several inches over a relatively larger area after the tank is being or has been filled.

Filling with hot waste could heat any water in the grout at the bottom of the tank or organics from the asphalt existing below the grout potentially trapping pressurized vapor (HW-57274). Several of the design changes lead to thermal expansion limiting characteristics which could result in forces that cause the liner to deform (bulge). The design of the orthogonal sidewall to bottom joint was postulated to trap the pressurized vapor under the liner because the liner edge was embedded in the structural concrete, preventing pressure release up the sidewalls. This in turn increased the temperature due to the lower vapor space heat transfer coefficient and decreased the heat transfer from the bottom of the tank which compounded the situation.

3.1.2 Tank Construction Conditions

The A Farm construction temperatures were examined to determine if the tank liner fabrication occurred at or below the metal ductile-to-brittle temperature transition. The photograph in Figure 3-4 shows the A Farm under construction on August 30, 1954.

**Figure 3-4. A Farm Construction Photograph August 30, 1954
(Photograph #N1D0057755)**



The metallurgical factors that limited carbon steel's ability to resist impact at low temperature were perhaps not well understood when A Farm was constructed and were not specified for the 0.375-in thick ASTM A 283, *Standard Specifications for Intermediate Tensile Strength Carbon Steel Plates*, mild carbon steel liner at the time. Current standards for construction of pressure vessels ASME Boiler & Pressure Vessel Code (B&PVC), Section VIII, *Rules for Construction of Pressure Vessels*, provides for a minimum design metal temperature of 18°F for vessels constructed of carbon and low alloy steels of nominal thickness ≤ 10 -mm (0.394-in). For the purposes of this report, it will be assumed that the 18°F design temperature is applicable to the fabrication of ASTM A 283 carbon steel at the time of A Farm construction.

Boxes from the list of Vendor Information Reports for A Farm were searched for any Chemical and Physical Test Reports for the tank steel plates used in the farm but none were found. No other information for A Farm was found during the search.

A review of toughness and the ductile-to-brittle transition temperature for carbon steels (designated as "impact transition temperature") in *Mark's Standard Handbook for Mechanical Engineers, Tenth Edition*, indicates that carbon content can have a significant effect. Decreased carbon content not only raises the propagation energy needed for crack growth but also lowers the temperature for transition from ductile-to-brittle behavior (reference Fig 6.2.11 in *Marks*), suggesting that the B&PVC Section III low temperature service limit may be lower than what could be expected for steel of the vintage used in A Farm construction. The concentrations of carbon and trace impurities and their effect on this property are not specifically known, and low temperature impact resistance could only be determined reliably by impact testing of actual tank specimens.

Below the transition temperature, the metal loses its ability to absorb forces such as induced loads, or the impact of falling objects without fracturing. In this circumstance it is possible for micro-fissures or hairline cracks to be created. Later, when the metal is subjected to high stress, it might be possible for the cracks to propagate through the metal, or possibly subject the weakened areas to increased corrosion.

Any low temperatures experienced during construction at or less than the 18°F allowable temperature where impact loading (e.g. a dropped tool or piece of equipment from scaffolding) had the potential for creating micro-fissures may have triggered fissures in the steel liner (see Sections 4.3.2 and 5.3.2).

Design, fabrication, and erection of the tank steel lining were in accordance with Specification HWS-5614, *Specifications for PUREX Waste Disposal Facility, Project CA-513-A*. Welding and inspection requirements were listed in HWS-5614.

The possible variability of liner steel from either different runs from the same supplier, or because of multiple suppliers, could affect the resistance to low temperatures.

3.2 IN-TANK DATA

The general information in this section is further developed and applied to the leaking tanks in Sections 4.4 and 5.4 for tanks A-104 and A-105, respectively, to understand implications of the conditions that could affect liner leaks and identify possible liner leak locations.

3.2.1 Liquid Level

The leaking A Farm tanks (A-104 and A-105) did not experience liquid level decreases that were reported to be due to the tank leaking. Fluctuations in liquid level were reported for tank A-105 in September 1963 (prior to the pressurization event in January 1965), some increases as large as 12-in or 33 kgal. It is possible the tank bulged during this time as the supernatant was pumped out of the tank nine months earlier leaving the liquid level at 10-in setting up a differential between the grout vapor pressure and hydrostatic pressure. Liquid level data for tank A-104 was apparently not reviewed for a decrease when the tank was first suspected of leaking based on radioactivity being detected in the laterals as there was no mention in the documents reviewed.

3.2.2 Temperature

Document HW-59919 issued October 22, 1959 (*Limitations for Existing Storage Tanks for Radioactive Wastes from Separations Plants*) indicated that the self-boiling waste operating temperature should be maintained between 220°F and 250°F. The maximum sludge temperature should not exceed 300°F. Document HW-59919 contained the first boiling waste limitations on temperature. Thermal shock creates stress both from rapid temperature rise as well as high temperatures.

The same document states that tank contents should also be heated slowly to not exceed the recommended rate of 2°F per day along with other temperature requirements for filling boiling waste tanks. The filling temperature requirements upon initial filling with waste are designed to provide enough time at controlled temperature and other waste parameters (specific gravity and

liquid depth) to remove grout moisture gradually so that the grout moisture vapor pressure does not exceed the hydrostatic pressure. Bulging of the tank bottom liner can be caused by exceeding the hydrostatic pressure. Initial rate of rise temperatures are not available in all cases.

Temperature data used for the A Farm evaluations were taken from RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*, and temperature data sheets and are designated as Bulb temperatures. The Bulb temperature nomenclature designation for sludge was first found in HW-83906-C-RD (*Chemical Processing Dept 200 W Area Tank Farm Inventory & Waste Reports 01/1957 Thru 12/1958*, page 000126) as an annotation on the Status of Waste Farms form for February 1958. This was stated as “S = Bulb Temp of Sludge @ 2” off bottom.” The liquid temperature was stated as “L=Liquid Temp @ 5 ft off bottom.” There was another annotation in HW-83906-C-RD (page 000185) that indicated the sludge temperature was designated as “Bulb” and the liquid temperature was designated as “SCAN”. Typed in at the bottom of this page was the following: S – Temperature of sludge approximately 3-in off of the tank bottom and L - Temperature of liquid approximately 5-ft off of the tank bottom. However, the bulb temperature design and the degree of data uncertainty are unclear as no documentation for this information has been located.

3.2.3 Liner Observations

A bulge in a tank liner may result in the direct failure of the liner or cause enough stress or thinning on the steel liner plates and welds that they become more susceptible to the effects of corrosion. Experience indicates that bulging tends to be a dynamic phenomenon, and it is possible that a tank with no measured bulge at one point in time may actually have had a displaced liner that was not detected at another time. Multiple flexing of the tank liner as a bulge forms and returns to normal may set up stresses that even though the liner does not reach the elastic limits could result in a location that are more susceptible to corrosion.

RHO-R-39, *Boiling Waste Tank Farm Operational History*, and ARH-R-43, *Management of Radioactive Wastes Stored in Underground Tanks at Hanford*, contain tables that list the A Farm tanks that were inspected for a bulge as well as the tanks where a liner bulge was confirmed.

Tank A-105 may have experienced a bulge in 1963 before the 1965 steam eruption. A bulge of the tank bottom liner may have set up conditions that resulted in the 1965 steam eruption (see tank A-105 section).

A possible indicator of a bulge may be broken air lift circulator (ALC) turnbuckle guy rods and/or bent piping which can be seen in some photographs (see Section 3.2.5).

3.2.4 Chemistry

The types of corrosion that may occur in the Hanford Site SSTs include uniform corrosion, stress corrosion cracking (SCC), pitting, crevice, and liquid-air interface corrosion which were identified in HNF-3018, *Single-Shell Tank Sluicing History and Failure Frequency*.

Uniform corrosion rates for SSTs are reported to be generally less than 1 mil/year (HNF-3018) for the SSTs. Carbon steel exposed to alkaline solutions has a low general corrosion rate (PNL-5488, *Prediction Equations for Corrosion Rates of A-537 and A-516 Steels in Double-Shell*

Flurry, Future Purex, and Hanford Facilities Wastes). However, the presence of the nitrate ion may induce various forms of localized attack (i.e., SCC, pitting, etc.).

Nitrate Ion-Induced Stress Corrosion Cracking

Stress corrosion cracking is the growth of cracks in a corrosive environment. It can lead to unexpected sudden failure of normally ductile metals subjected to a tensile stress, especially at elevated temperatures. Stress corrosion cracking is highly chemically specific in that certain alloys are likely to undergo SCC only when exposed to a small number of chemical environments. The chemical environment that causes SCC for a given alloy is often one which is only mildly corrosive to the metal otherwise.

Nitrate ion-induced SCC is the predominant threat to the integrity of the steel liners in the SSTs and double-shell tanks (DSTs) at the Hanford Site and many investigations have been performed to establish the parameters under which the tanks can be protected from this threat. This work, together with the efforts of many others, led to the adoption of the waste chemistry control limits for SCC prevention in 1983 (OSD-T-151-00017, *Operating Specifications for the Aging Waste Operations in Tank Farms 241-AY and 241-AZ*).

The factors governing the rates of nitrate ion-induced SCC cracking by Hanford Site DST wastes were recently reviewed (RPP-RPT-47337, *Specifications for the Minimization of the Stress Corrosion Cracking Threat in Double-Shell Tank Wastes*). In brief, the test results led to the conclusion that the rates of nitrate ion-induced SCC depended on the properties of the steel, the applied potential versus the open circuit potential (OCP), the temperature and the concentrations of aggressive substances such as nitrate ion, and the potential inhibitors such as hydroxide and nitrite ion.

The technical work has shown that SCC is promoted by high temperatures, high nitrate ion concentrations, low hydroxide ion concentrations, low nitrite ion concentrations, and low nitrite ion/nitrate ion concentration ratios. Tanks with maximum temperatures less than 122°F would not be expected to experience significant SCC damage regardless of waste types (HNF-3018, Rev. 0). Tanks with the maximum temperatures above 122°F and a ratio of nitrate concentration to the sum of nitrite and hydroxide concentrations greater than 2.5 would be expected to suffer SCC-related damage (HNF-3018, Rev. 0). The concentration of nitrate and temperature are parameters that have the most effect on SCC. However, the pH (hydroxide) and nitrite can inhibit SCC. The current DST operating specifications for chemistry are reported in OSD-T-151-00007, Rev. 10, *Operating Specifications for the Double-Shell Storage Tanks*. While the chemistry specifications stated in this document were prepared for the DSTs, corrosion mechanisms and corrosion protection mechanisms applicable to DST primary tank metal liners are equally applicable to the older SST metal liners.

Localized Corrosion: Crevice, Pitting, and Liquid-Air Interface Corrosion

Crevice corrosion can occur in regions where a small volume of solution cannot readily mix with the bulk solution such as under deposits, between metal flanges, and other confined areas. Once initiated, crevice corrosion proceeds by the same mechanism as pitting corrosion (RPP-RPT-33306, *IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*).

Pitting corrosion is the localized corrosion of a metal surface confined to a point or small area that takes the form of cavities. Pitting corrosion in dilute solutions ($\text{NO}_3^- < 1\text{M}$) of waste has been studied at the Savannah River Site (SRS). Pitting has been determined to not be a problem at hydroxide concentrations greater than 1M for any of the dilute waste solutions tested (WSRC-TR-90-512, *Effect of Temperature on the Nitrite Requirement to Inhibit Washed Sludge*, Oblath and Congdon 1987, *Inhibiting Localized Corrosion during Storage of Dilute Waste*). Nitrate ion was determined to be the usual controlling aggressive species when its concentrations ranged between 0.01M and 1M (WSRC-TR-90-512). The presence of hydroxide ion and nitrite ion has shown to inhibit pitting corrosion due to the aggressive nitrate ion. This work led to the conservative recommendation that the concentration of nitrite ion be greater than 0.033M for the avoidance of pitting in dilute solutions of nitrate ion at pH 10 and 40°C (104°F) (RPP-ASMT-53793, Rev. 0, *Tank 241-AY-102 Leak Assessment Report*).

The chemical compositions required for prevention of pitting corrosion can also be applied as limits for prevention of liquid-air interface corrosion at the surface of the supernatant. Crevice, pitting, and liquid-air interface corrosion are types of localized corrosion possible in the SSTs; however, historically SCC is the more predominant type of corrosion of concern.

Historical Corrosion Control

The earliest chemical specifications for SSTs addressing pH, nitrite, nitrate, and hydroxide are listed in Table 3-2 (ARH-1601, Section D, *Specifications and Standards for the Operation of Radioactive Waste Tank Farms and Associated Facilities*, 1973).

Table 3-2. ARH-1601 Specifications 1973

Waste Tank Farms and Associated Facilities Specifications	
Variable	Specification
pH	Minimum 8.0
NO_2^-	500 ppm
NO_3^-	< 6M
OH^-	< 7M

There was no similar specification found that addressed all of these parameters during the operation of A Farm prior to 1973. If the ARH-1601 specifications were in effect during A Farm waste storage, the storage of undesirable concentrations of NO_2^- , NO_3^- , and OH^- would result in vulnerability to SCC and/or localized corrosion.

Historical waste sample data as well as temperatures are typically not available for the SSTs and limited data were recovered for tanks A-104 and A-105. Thus, the concentrations of NO_2^- , NO_3^- , and OH^- listed in Sections 4.4.4 and 5.4.4 are typical concentrations that were reported for the waste types listed that could be based on limited data and/or were values obtained from process flowsheets. Therefore, waste chemistry conditions are speculative when sample and temperature data are unavailable, and especially when multiple waste types are present in the tank.

3.2.5 Photographs

Missing or disconnected ALC turnbuckle guy rods could indicate that there was bulging of the bottom liner sufficient to cause the upper connection to fail with the guy rod sinking below the liquid surface (missing). Each ALC was anchored to the tank floor by three one-half inch diameter guy rods. In several tanks, broken ALC turnbuckle guy rods and/or bent piping are visible. Some ALC turnbuckle guy rods were also hanging free from the upper connection as it had apparently become disconnected from the bottom connection either at the attachment plate or the plate itself pulled away from the bottom of the tank.

Photographs of tank A-105 taken after the steam eruption show bent ALCs and the raised bottom liner confirming the 8 ½-ft liner bulge. The torn liner can also be seen in photographs with the gap shown between the two torn steel pieces.

Both of the leaking tanks as well as some of the sound A Farm tanks contained ALCs that have one or more disconnected turnbuckle guy rods (see Section 6.0).

3.3 EX-TANK DATA

The general information in this section is further developed and applied to the leaking tanks in Sections 4.4 and 5.4 for tanks A-104 and A-105, respectively, to understand implications of the conditions that could affect liner leaks and identify possible liner leak locations.

3.3.1 Laterals

A prototype five lateral leak detection system was installed under tank SX-113 after indications of a >4-ft liner bulge in 1958. The tank SX-113 prototype laterals were installed 10-ft under the tank and varied between 6-ft and 12-ft below the bottom of the tank over the course of a lateral. The horizontal alignment was calculated to be within ~2-ft (HW-60749, *Leak Detection System for Active Tanks Interim Report*). The alignment was addressed in HW-60749 and included the following: “The subcontractor was permitted to complete the five laterals to the best of his ability without official alignment checks because of the short time limit of the construction schedule.” In addition, the document included future specifications to control alignment.

In 1963, lateral leak detection systems were installed underneath the six A Farm tanks. The scope and design criteria for drilling laterals were documented in HW-68661 (*Proposed Leak Detection System for Existing Storage Tanks Containing Self-Boiling Radioactive Wastes (Scope and Design Criteria)*). The driller was required to check the alignment of the laterals every 20-ft during the installation according to this document and it was assumed installation of the laterals were improved as no records of vertical or horizontal variation were found after the original tank SX-113 lateral installation.

Each lateral is a 3-in pneumatic stainless steel tubing enclosed in 4-in carbon steel pipe. The laterals are horizontal and extend radially from a large caisson (12-ft diameter) that is located between up to four tanks. A “lateral shack” was constructed over each caisson. The access to each lateral is through a separate vertical tube (also made of 3-in pneumatic stainless steel) that extends up to the floor of the lateral shack. The lateral tube transitions from vertical to horizontal at the bottom of the caisson through a 90° elbow with a 4-ft bend radius. The laterals

are numbered clockwise from 1 to 3. Probes are inserted into each lateral, driven to the end of the lateral with compressed air, and slowly withdrawn to monitor for gamma radiation that could indicate waste leakage from a tank. Operation of the laterals and details of the probes and data are described in RPP-RPT-27605, *Gamma Surveys of the Single-Shell Tank Laterals for A and SX Tank Farms*. The criteria for lateral monitoring frequency are defined in SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

Four temperature monitoring laterals were installed 2-ft under tank A-105 with thermocouples to measure the soil temperature near the base of the tank and readings were started in 1968 (see Section 5.4.2.1).

3.3.2 Drywells

Four of the original A Farm drywells were drilled in 1955. The remainder of the 48 A Farm drywells were drilled starting in 1962 (GJ-HAN-106 to 111). Drywells were drilled vertically from the surface drywell coordinates and detailed drywell information, e.g. pipe dimensions and configuration, for the leaking A Farm tanks are addressed in references cited in the individual tank segments. Three soil sampling test wells were drilled for specific leak determinations for tank A-105.

Drywells would not be useful to detect tank releases that enter the soil from the tank unless the volume released is sufficiently large to facilitate lateral transport to a drywell typically to within ~1-ft of the drywell. The vertical height of a tank liner leak may not be directly related to the point of detection in the drywell. This is especially true for small leaks that may flow downward some distance before encountering the drywell.

The "00" series drywells were installed between 1955 and 1969, usually around the periphery of the farm and extend from 150-ft to 340-ft BGS. Others with tank numbers embedded in the drywell number were constructed between 1962 and 1964 and generally to 100-ft BGS (or less). The usual number of drywells surrounding an A Farm tank was seven. If there are more, then there likely was some concern regarding a release which was being investigated.

Four gamma ray probe types were used to monitor gamma in drywells to detect leaks (RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm-200 East Area*). The most widely used probe was the unshielded gross gamma sodium-iodide (NaI) probe (or probe 04) and the shielded NaI probe is also referred to as probe 14. The NaI probe (04) is very sensitive and able to record gamma ray activity from 30 counts per second (cps) up to about 40,000 cps (15mR/hr) before the data becomes unreliable. The next most commonly used probe was the Red-GM (or probe 02) which is less sensitive but can reliably record gross gamma at much higher levels of activity (up to ~500R/hr). Operation of these and other probes are discussed in HNF-3136. A scintillation probe (SP) was also used to measure low levels of radiation in the drywells; however, prior to June 1973 drywell readings less than 50,000 cpm were reported as such. Leak location identification is primarily focused on the first indication of a leak and is therefore typically concerned with the lower levels of gross gamma detection.

Drywell sections contain figures taken from RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm-200 East*, showing continuing or new contamination in the drywells based on BGS depth from 1975 to 1995. However, these figures do not indicate the amount of radioactivity found at these depths. In 1998, a baseline characterization of the gamma-ray-emitting radionuclides distributed in the vadose zone sediments beneath and around A Farm was performed using spectral gamma logs (SGLS) and documented in GJO-HAN-23 (*Vadose Zone Characterization Project at the Hanford Tank Farms A Tank Farm Report*). Individual vadose zone characterization summary data reports were issued in 1998 for the U Farm tanks with results reported in the leaking tank segments. The gross gamma detection sensitivity is higher than SGLS (~10 pCi/g versus ~0.1 pCi/g equivalent Cs-137). Therefore, radioactivity <10 pCi/g does not appear on the gross gamma figures (GJO-HAN-18). Co-60 has a higher detection threshold; therefore, SGLS will detect Co-60 at much lower levels than what is detected by gross gamma logging. The SGLS logging can confirm both Cs-137 and/or Co-60 radioactivity which can assist in the leak location analysis, with the SGLS data weighted more heavily for interpreting drywells. The criteria for drywell monitoring are defined in RHO-ST-34 (*A Scientific Basis for Establishing Drywell-Monitoring Frequencies*) with the monitoring frequency found in SD-WM-TI-356 (*Waste Storage Tank Status and Leak Detection Criteria*).

All of the radiation readings in drywells are assumed to be maximum or peak readings unless otherwise noted and are from the Red-GM probe unless otherwise indicated. The individual tank segments report the available drywell data in the drywell sections. The drywell summary section provides the analyses of the associated drywells and any direct pushes associated with the tank that is of concern.

3.4 LINER LEAK LOCATIONS

Liquid level decreases, if detected, are typically the first indication of a tank liner leak in non-boiling tank conditions. Liquid level decreases are typically confirmed by drywell and/or lateral radioactivity. The radial drywell radioactivity is also dependent on any possible flow paths from the actual tank liner location to the drywell itself as well as the waste viscosity and distance to the drywell. Drywells can also be an indication of the tank liner sidewall leak depending on the vertical location but need to be analyzed relative to non-tank leaks associated with pipe lines or other sources.

A bottom liner leak detected by lateral or drywell radioactivity may have penetrated the waterproof membrane at any location or pooled on the waterproof membrane and followed concrete cracks or breaks in the footing to a different location including the top of the tank footing. Therefore, the point of waste egress from the tank liner may not be the point of entry of the leaking waste to the soil. Radioactivity detected in drywells is typically dependent on the leak path through the concrete sidewall or footing and soil conditions. Also, if the drywell radioactivity is detected above the footing there could be a possibility of a sidewall leak or leaks associated with pipe lines or other sources. If enough information is available, liquid level and drywell radioactivity can be used to locate the approximate vertical location of a liner leak. Lateral radioactivity almost always indicates a leak at or below the footing.

The lack of radioactivity above background in a drywell indicates that if there was a liner leak it either occurred at another location, the leak flow was insufficient to be detected with the probes used in the drywell, or the leak was not able to be detected with the gamma probe. When there is no radioactivity detected in a drywell or no recoverable data for a drywell it is not included as part of the leak location analysis.

3.5 POSSIBLE LINER LEAK CAUSE(S)

Analysis which centered on tank design/construction, in-tank data, and ex-tank data indicates that there were up to five A Farm tank conditions that could contribute to a failed liner: tank design, liner bulging, thermal conditions, chemistry-corrosion, and tank construction conditions. Waste chemistry was not controlled to the degree necessary to minimize corrosion when tanks A-104 and A-105 were suspected of leaking. Some or all of the factors can act serially or together to contribute to tank liner failure. The following sections will provide a tank by tank review of these conditions as they relate to liner leak causes.

Other general tank construction factors such as the quality of materials and fabrication could also contribute to tank liner failure. No evidence has been found to substantiate quality defects but they still remain a possibility as a primary or secondary liner leak cause.

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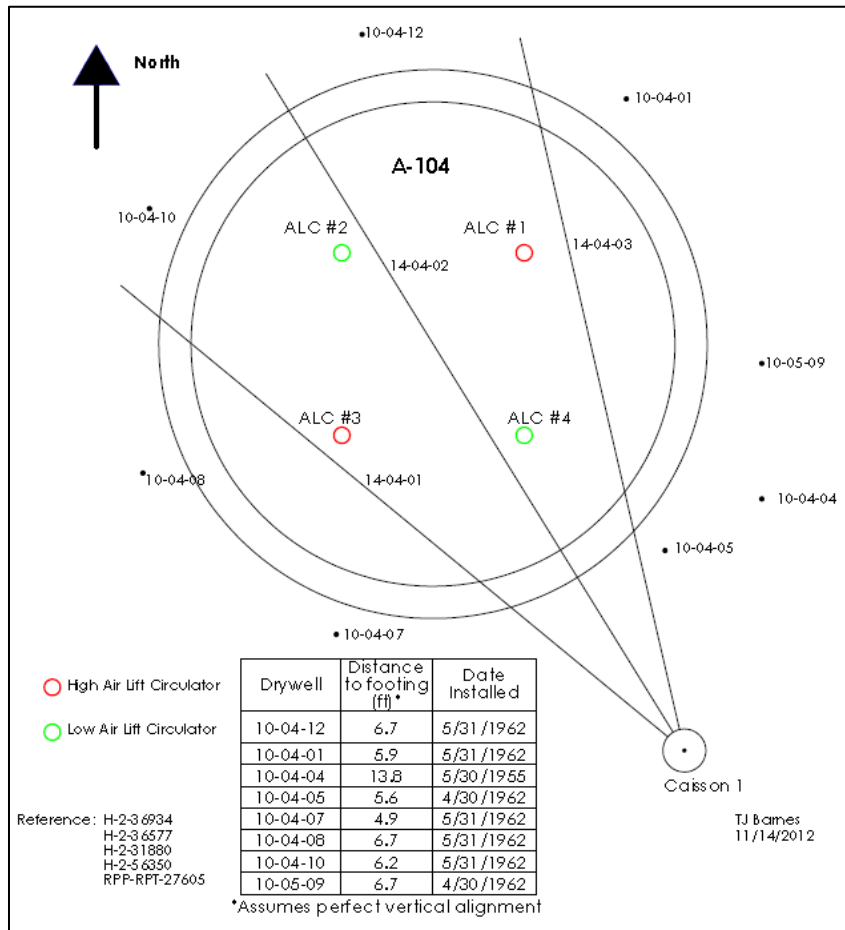
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4.1 TANK A-104 BACKGROUND HISTORY

This section provides information on the historical waste loss event associated with single-shell tank (SST) 241-A-104 (A-104). Tank A-104 has three laterals installed in 1962-1963 about 10-ft under the tank (see Figure 4-1). There are eight drywells located around tank A-104 with specified distances from the drywell to the tank footing shown in Figure 4-1: 10-04-04 installed in May 1955 and 10-04-01, 10-05-09, 10-04-05, 10-04-07, 10-04-08, 10-04-10, and 10-04-12 installed in April/May 1962.

The bottom of the tank footing is ~47-ft 10-in Below Grade Surface (BGS) with ~7.5-ft soil cover over the dome (WHC-SD-WM-TI-665, *Soil Load above Hanford Waste Storage Tanks*; H-2-55911, *Waste Storage Tanks Composite Section*). Inside tank A-104 are four air lift circulators (ALC) terminating 18-in above the tank bottom and equally spaced on a 40-ft diameter circle as shown in Figure 4-1 (H-2-56350, *Arrangement Air-Lift Circulators*). Two ALCs are designated low ALCs (8-ft 6-in tall) and two are high ALCs (17-ft 6-in tall) (H-2-56342, *Details Air-Lift Circulator*).

Figure 4-1. Tank A-104 Associated Drywells and Laterals
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



4.2 TANK A-104 OPERATIONS SUMMARY

Tank A-104 was constructed from February 1954 to January 1955 and sat unused until June 1957. In June 1957, 17 kgal of "test water" were added to the tank (HW-51348, *Chemical Processing Department Waste Status Summary for June 1, 1957 through June 30, 1957*, page 8). The purpose of this test water and the source were not located in available records. It remains unclear if any water was added to the tank prior to June 1957 to counteract the vacuum pulled by the ventilation system. The monthly waste status summary reports recorded the volume of test water in tank A-104 which varied from 17 kgal to 36 kgal from June 1957 through July 1958. No explanation was located in the available records for the reported changes in the test water volume in tank A-104, but the variations could be due to calibrating instruments, additional test water added to the tank, and/or testing transfer systems.

In August 1958, tank A-104 received 20 kgal of Plutonium Uranium Extraction (PUREX) high level waste (HLW) plus 100 kgal of water (to slowly raise the temperature of the tank) (HW-57328-DEL, *Chemical Processing Department Monthly Report for August 1958*, page J5-6). The tank was warming at 158°F for five months to January 1959 (HW-59079-DEL, *Chemical Processing Department Monthly Report for January 1959*, page J6). Transfers of PUREX HLW to tank A-104 started in January 1959 and self-concentration of waste was reported in August 1959 (HW-61952, *Chemical Processing Department Waste Status Summary August 1, 1959 through August 31, 1959*, page 8), which enabled additional PUREX HLW to be periodically transferred into the tank from January 1959 through December 1961. Organic wash waste (OWW) from PUREX was also reported to have been transferred to tank A-104 from 1960 through March 1968 (IDMS Accession #D197260431, *History – 241-A Tank Farm*, and ARH-534, *Chemical Processing Division Waste Status Summary January 1, 1968 through March 31, 1968*, page 9). The OWW was concentrated (i.e. evaporated) in the tank. The peak temperature reported for tank A-104 was 437°F on February 16, 1963, but was quickly reduced to below 340°F by March 1963 by adding OWW to the tank to increase the liquid level (RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*, page B-4). Prior to the maximum temperature recorded for tank A-104, from January 30, 1963 to February 15, 1963, OWW was being transferred into the tank (IDMS Accession #D197260431). The PUREX Plant outage in December 1962 through January 1963 resulted in the lack of OWW for tank A-104 temperature control (HW-76443, *Chemical Processing Department Monthly Report January 1963*). Portable compressors were used to supply additional air to the air lift circulators which reduced the tank A-104 temperature (HW-76848, *Chemical Processing Department Monthly Report February 1963*). The waste volume in tank A-104 was generally maintained at less than 980 kgal during self-concentration of wastes.

In the first and second quarters of 1969, a total of 669 kgal of the OWW/PUREX HLW was transferred from tank A-104 to tank C-105 (ARH-1200 A, *Chemical Processing Division Waste Status Summary January 1, 1969 through March 31, 1969*, page 10, and ARH-1200 B, *Chemical Processing Division Waste Status Summary April 1, 1969 through June 30, 1969*, page 10), leaving approximately 171 kgal of solids and 69 kgal of supernatant in tank A-104. Sluicing of the solids from tank A-104 to tank A-106 was conducted from May 12, 1969 (ARH-1200 B,

page 10) through October 1969 (ARH-1200 D, *Chemical Processing Division Waste Status Summary October 1, 1969 through December 31, 1969*, page 10). An estimated 3 kgal of solids remained in tank A-104 following sluicing. The tank was refilled with 957 kgal of tempered water from tank A-101 for a leak test to confirm integrity and the tank was declared a spare (ARH-1200 D, page 10). The water temperature in tank A-104 was reported as approximately 120°F following refilling the tank with water (RHO-CD-1172, page B-14). No additional temperature data for tank A-104 was found for the period of December 1969 through August 1974 (see PC Surveillance Analysis Computer System (PCSACS) for temperature data after 1974 to present).

No waste transfers were made into or out of tank A-104 until 1972. However, the liquid volume in tank A-104 decreased from 957 kgal in October 1969 to approximately 259 kgal in January 1972 (ARH-2456 A, *Chemical Processing Division Waste Status Summary April 1, 1972 through June 30, 1972*, page 9). A tube bundle heat exchanger (200,000 Btu/hr) was reported to be installed in tank A-104 (H-2-35091, *Tk-104-A Heater*, November 7, 1969) and removed in September 1974 (Occurrence Report 74-130, *Contamination Spread*), which may explain the liquid level decrease. However, the installation date of the heat exchanger remains unknown.

Approximately 132 kgal of water was transferred from tank A-104 in the first and second quarters of calendar year 1972 (ARH-2456 A, page 9 and ARH-2456 B, *Chemical Processing Division Waste Status Summary April 1, 1972 through June 30, 1972*, page 9). Tank A-104 was then used to receive PUREX sludge supernatant (PSS waste type) from 244-AR Vault from the third quarter of calendar year 1972 (ARH-2456 C, *Chemical Processing Division Waste Status Summary July 1, 1972 through September 30, 1972*, page 9) through the second quarter of calendar year 1974 (ARH-CD-133 B, *Operations Division Waste Status Summary April 1, 1974 through June 30, 1974*, page 9). Tank A-104 also received 221-B Plant strontium solvent extraction waste (waste type B) in the fourth quarter of calendar year 1972 (ARH-2456 D, *Chemical Processing Division Waste Status Summary October 1, 1972 through December 1, 1972*, page 9) through first quarter of 1974 (ARH-CD-133 A, *Operations Division Waste Status Summary January 1, 1974 through March 31, 1974*, page 9), and water from tank A-103 in the first quarter of 1974. Excess supernatant from this mixture was periodically transferred to tanks in 241-AX Farm.

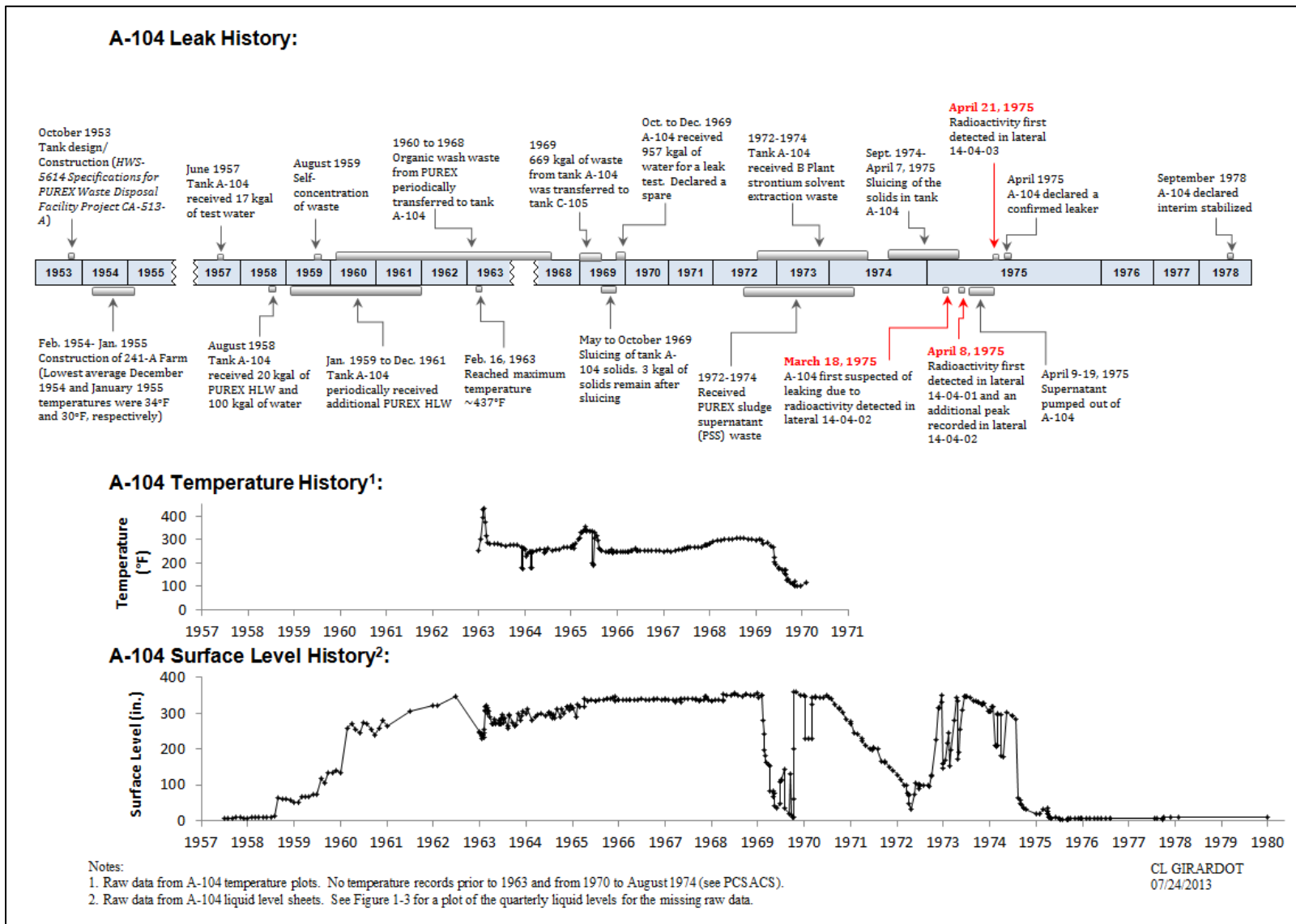
The PSS waste type contained PUREX sludge solids that did not rapidly settle in the relatively small tank 244-AR-004 in 244-AR Vault and were transferred to the much larger tank A-104 for settling (see Section 4.4.4). A total of approximately 80 kgal of PUREX sludge solids and 726 kgal of PSS were present in tank A-104 in third quarter of calendar year 1974 (ARH-CD-133 B, page 9).

Prior to sluicing tank A-104, the supernatant was pumped out of the tank leaving the liquid level reported at 56-in (or ~155 kgal) on September 1, 1974. Sluicing of the accumulated solids in tank A-104 to the 244-AR Vault was started in September 1974 and was halted April 7, 1975, due to an increase in the radiation detected in lateral 14-04-02 beneath the tank. The location of the peak activity detected in lateral 14-04-02 (center lateral) was "... approximately 18-ft in from

the northwest edge of the tank,” and “... On swing shift of April 8, 1975, a second radiation peak was observed in the same lateral and an adjacent lateral [lateral no. 1], located approximately 13 feet in from the southeast edge of the tank” (OR 75-39, *Leakage from Tank 104-A*). Gross gamma scans of drywells 10-04-01, 10-05-09, 10-04-04, 10-04-05, 10-04-07, 10-04-08, 10-04-10, and 10-04-12 did not indicate radioactivity above background (see Sections 4.5.1 and 4.5.2.9). Tank A-104 contained 65 kgal of waste, including an estimated 25 kgal of sludge when the radioactivity was detected in the laterals. Tank A-104 was declared a confirmed leaker in April 1975 (Occurrence Report 75-39). It was reported that no definite relationship between the tank leak and sluicing operation was established (RHO-ST-30, *Hanford Radioactive Tank Cleanout and Sludge Processing*). Approximately 47 kgal of supernatant were pumped from tank A-104 from April 9 through April 19, 1975 (Occurrence Report 75-39). Tank A-104 was declared interim stabilized in September 1978 and 1986 photographs indicate a dry, cracked waste surface with no visible liquid present (RHO-CD-213, *Waste Storage Tank Status and Leak Detection Criteria 200 East Area- Volume 1*).

The operational history of tank A-104 leak related details including temperature and liquid level is charted in Figure 4-2.

Figure 4-2. Operational Leak History of Tank A-104



4.3 TANK DESIGN/CONSTRUCTION

4.3.1 Tank Design

The A Farm tanks had multiple design features that could contribute to stresses or possible leak paths when the tank was being operated including:

- Orthogonal intersection between the flat steel bottom and the sidewall
- Fillet weld used between the bottom and sidewall intersection
- Less rigorous weld inspection testing
- Partial asphaltic membrane waterproofing

These features are common to all A Farm tanks (see Section 3.1.1).

4.3.2 Tank Construction Conditions

A Farm was constructed from February 1954 to January 1955. Minimum temperatures of 32°F and below were experienced on 108 days during construction; however, no minimum temperatures below 0°F were experienced. The lowest average temperatures occurred in December 1954 at 34°F and January 1955 at 30°F with four months having at least one minimum temperature between 14°F and 18°F (PNNL-15160, *Hanford Site Climatological Summary 2004 with Historical Data*).

As described in Section 3.1.2, cold weather affects the ductile-to-brittle steel transition temperature, with 18°F being the assumed unrestricted low temperature construction limitation for the carbon steel liner, which could result in a fracture upon impact. Temperatures during the A Farm construction time frame were milder than those experienced during 241-SX Farm construction where ductile-to-brittle steel transition temperatures were exceeded.

Weather precautions for welding and concrete were specified in HW-4926-S, *Standard Specification for Welding Carbon Steels* (see Section 3.1.2).

4.4 TANK A-104 IN-TANK DATA

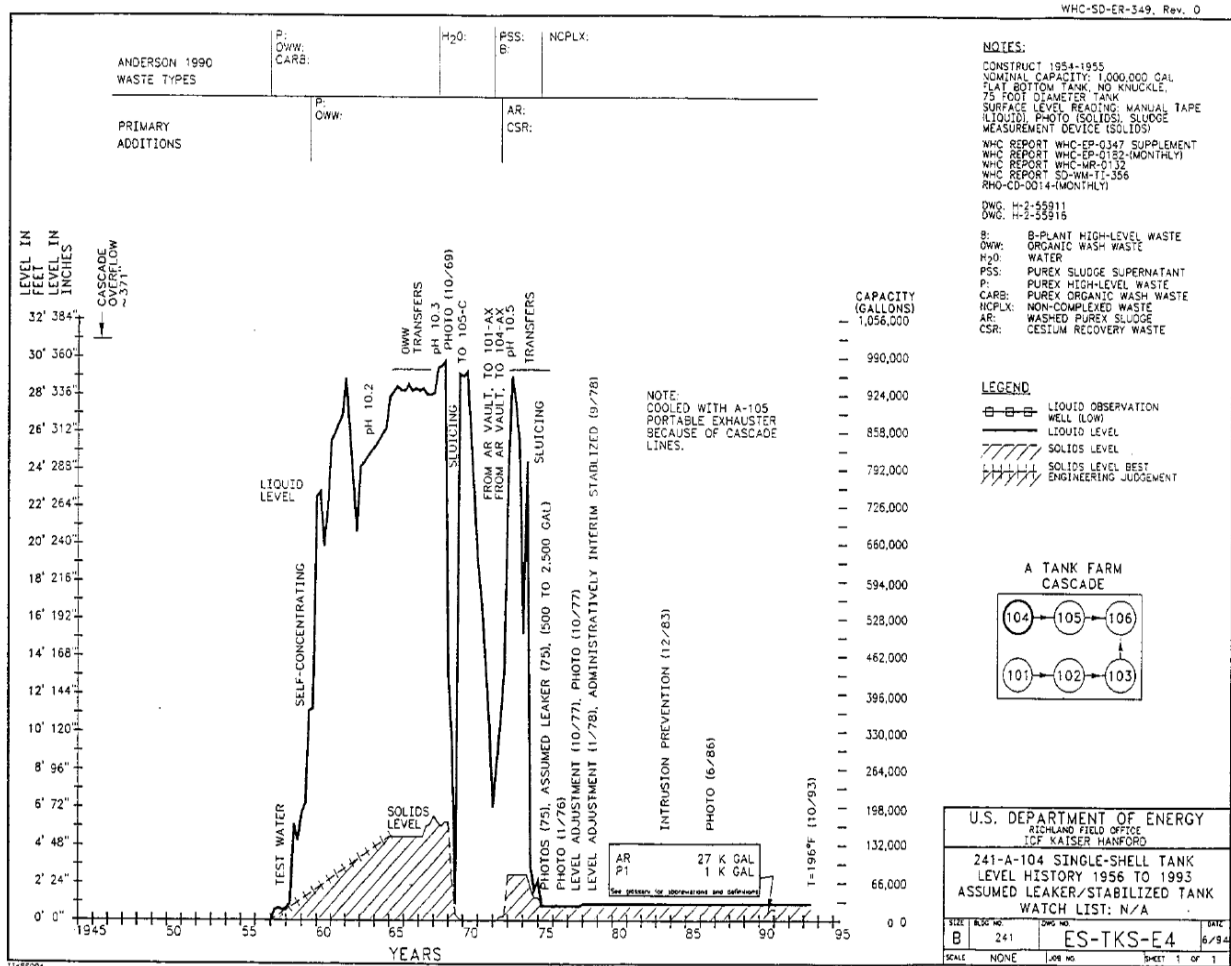
4.4.1 Liquid Level

The tank A-104 liquid level was apparently not reviewed for a decrease when radioactivity was first detected in lateral 14-04-02 in March 1975 as no mention was found in any of the monthly reports, individual letters, or previous leak assessment reports examined for this report. During this time, solids in tank A-104 were being sluiced which started September 1974 and was halted April 7, 1975 after radioactivity was detected in the laterals underneath the tank. The near constant transfers into and out of the tank during sluicing probably interfered with any meaningful liquid level analysis for a tank leak.

The liquid level plot in Figure 4-3 indicates the transfers into and out of the tank. The liquid levels are end of quarter levels so this figure may not reflect all significant transfers into and out

of tank A-104 that occurred during the operational history of the tank. See Figure 4-2 for historical monthly liquid level readings.

Figure 4-3. Tank A-104 End of Quarter Surface Level



WHC-SD-WM-ER-349, Rev 0, June 1994, Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area

4.4.2 Temperature

Document HW-59919, *Limitations for Existing Storage Tanks for Radioactive Wastes from Separations Plants*, issued October 22, 1959 states that tank contents should be heated slowly to not exceed the recommended rate of 2°F per day along with other temperature requirements for filling boiling waste tanks. The temperature requirements for filling boiling waste tanks are designed to provide enough time at controlled temperature and other waste parameters (specific gravity and liquid depth) to remove grout moisture gradually so that the grout moisture vapor pressure does not exceed the hydrostatic pressure. Bulging of the tank bottom liner can be caused by grout vapor pressure exceeding the hydrostatic pressure. The recommended uniform rate of temperature increase was also designed to prevent exceeding the maximum temperature gradient across the structural components of the tanks.

Tank A-104 was initially filled with 17 kgal of test water in June 1957 and sat unused until August 1958. Temperatures during this time could not be recovered. Beginning in August 1958, tank A-104 was initially filled with 20 kgal of PUREX HLW and 100 kgal of water and the temperature held at 158°F for five months to January 1959. Tank A-104 periodically received PUREX HLW from January 1959 through December 1961 and OWW from PUREX from 1960 to 1968. Self-concentration of waste started in August 1959 (RHO-R-39, *Boiling Waste Tank Farm Operational History*). However, no other temperature data for tank A-104 could be recovered from June 1957 to January 1963. Temperatures were recorded as approximately 257°F on January 2, 1963 and gradually rose to 428°F by February 6, 1963; the temperature rate of rise was therefore approximately 4.9°F/day. On February 16, 1963, a maximum waste temperature of approximately 437°F was reached (see Figure 4-2).

Temperatures gradually declined to approximately 260°F by December 1963 and remained relatively stable at this temperature through January 1965. In February 1965, waste temperatures began to increase and reached above 300°F by March 1965 and peaked at ~356°F at the end of April 1965 and remained above 300°F through July 1965. In August 1965, temperatures gradually declined to approximately 250°F and remained relatively stable through May 1967. Beginning in June 1967, temperatures slowly increased and reached slightly over 300°F by May 1968 and remained around 300°F until February 1969. Temperatures then gradually declined with sluicing of the solids in tank A-104 from May to October 1969. No temperature data was recovered from March 1970 until August 1974.

Tank A-104 was first suspected of leaking in March 1975 when radioactivity was detected in lateral 14-04-02 during sluicing of the tank solids which was started September 1974. Temperature data could not be located during this time. In PCSACS, a single temperature was recorded August 25, 1974 at 177°F. No additional data is available until April 1976 when temperatures were approximately 170°F (PCSACS); therefore, it is likely temperatures in March 1975 were roughly the same.

Document HW-59919 indicated that the self-boiling waste operating temperature should be maintained between 220°F and 250°F (see Section 3.2.2). The maximum sludge temperature should not exceed 300°F. As noted, the temperature exceeded this level multiple times during operation and approximately 17 months had temperatures recorded greater than 300°F.

4.4.3 Liner Observations

A bulge in a tank liner may result in the direct failure of the liner or cause enough stress or thinning on the steel liner plates and welds that they become more susceptible to the effects of corrosion. Experience indicates that bulging tends to be a dynamic phenomenon, and it is possible that a tank with no measured bulge at one point in time may actually have had a displaced liner that was not detected at another time. A thinning or weakened location may be more susceptible to corrosion (see Section 3.2.3).

Document RHO-R-39, issued December 18, 1969, lists tank A-104 as having been inspected for a liner bulge (see Appendix A1). However, a liner bulge was not identified. No additional documentation was found indicating a bottom liner bulge in tank A-104. A review of tank A-

104 photographs indicates there is a possibility a bulge was present at one time due to the presence of failed ALC turnbuckle guy rod attachments (see Section 4.4.5).

No other liner observations relating to a tank A-104 leak have been found.

4.4.4 Chemistry-Corrosion

Test water was added to tank A-104 in June 1957 and remained in the tank for one year. However, the purpose of this test water remains unknown and no mention of the water source or chemical adjustment has been found in any of the documents reviewed. Waste temperatures were not recovered until 1963. Tank A-104 first received waste in August 1958 and stored various waste types throughout operation as shown in Table 4-1. The typical concentrations for nitrite, nitrate, and hydroxide for these waste types are shown in Table 4-2. Nitrite and hydroxide are known as nitrate-induced SCC inhibitors. One key characteristic for inhibiting SCC is to maintain a high nitrite concentration to nitrate concentration ratio (see Section 3.2.4).

Table 4-1. Tank A-104 Waste Storage Chronology

Date	Waste Type	Length of Storage
June 1957 to July 1958	Water	~ 1 year
August 1958 to December 1961	PUREX HLW	~ 3 ½ years
1960 to March 1968	OWW	~ 8 years
October 1969 to August 1972	Water	~ 3 years
1972 to 1974	PSS/B	~ 2 years

Table 4-2. Waste Chemistries for Waste Types Stored in Tank A-104

Waste Types	[NO ₃]	[NO ₂]	[OH]	Meets Current DST Specification ³
B ¹	1.27	Not Reported	Not Reported	Not available
PSS ¹	4.2	0.22	0.48 ⁴	No ⁶
OWW ¹	0.06	Not Reported	Not Reported	Yes ⁷
PUREX HLW ¹	1.3	3.37 ⁵	Not Reported	Yes
Water ²	1.3 x 10 ⁻⁷	4.2 x 10 ⁻⁶	6.3 x 10 ⁻⁷	Yes

1. Reference WHC-EP-0449, 1991, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*.

2. Assumed to be raw water. Reference ERDA-1538, *Final Environmental Statement*, Vol. 2, December 1975, average chemical concentrations from October 1971 to September 1972.

3. Reference OSD-T-151-00007, Rev. 12, (2013), *Operating Specifications for the Double-Shell Storage Tanks*.

4. Reference IDMS Accession #D196248072, *Analysis of Tank Farm Samples Sample: T-2893 Tank 104-A*.

5. Average of three A Farm PUREX waste samples, RL-SEP-183 RD, *PUREX Tank Farm Supernatant Solution Composition*.

6. Does not meet the current DST specification since the hydroxide and nitrite concentrations are not greater than or equal to 1.2M.

7. According to the assumption from reference WHC-EP-0772, *Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Site Single-Shell Tanks*.

In February 1969, prior to pumping the tank A-104 supernatant out to prepare for sluicing, the waste was reported to be at a pH of 10.35 with concentrations of nitrate and nitrite to be 0.32 M

and 3.36 M, respectively (IDMS Accession D196248068, *Tk-104-A Analyses*). These results indicate the waste during this period does not exceed the chemistry limits for preventing SCC.

Tank A-104 stored tempered water from tank A-101 from October 1969 to August 1972. No sample information was found for this period. However, it is assumed that the tempered water added to the tank during this time was raw water at a pH of approximately 7.8 (ERDA-1538) as this was common tank farm practices. Temperatures during October to December 1969 ranged from approximately 104 to 120°F (see Figure 4-2). Some corrosion may have occurred during the storage of water initially in 1957 and later in 1969 (for approximately 4 years total); however, it remains inconclusive.

Tank A-104 was sampled March 25, 1974, shortly before the supernatant was pumped out to allow sluicing to start in September 1974. Results report the pH of the sample to be 10.49 and hydroxide concentration of 0.48 M (SD-WM-TI-302, *Hanford Waste Tank Sluicing History* and IDMS Accession #D196248072, *Analysis of Tank Farm Samples Sample: T-2893 Tank 104-A*).

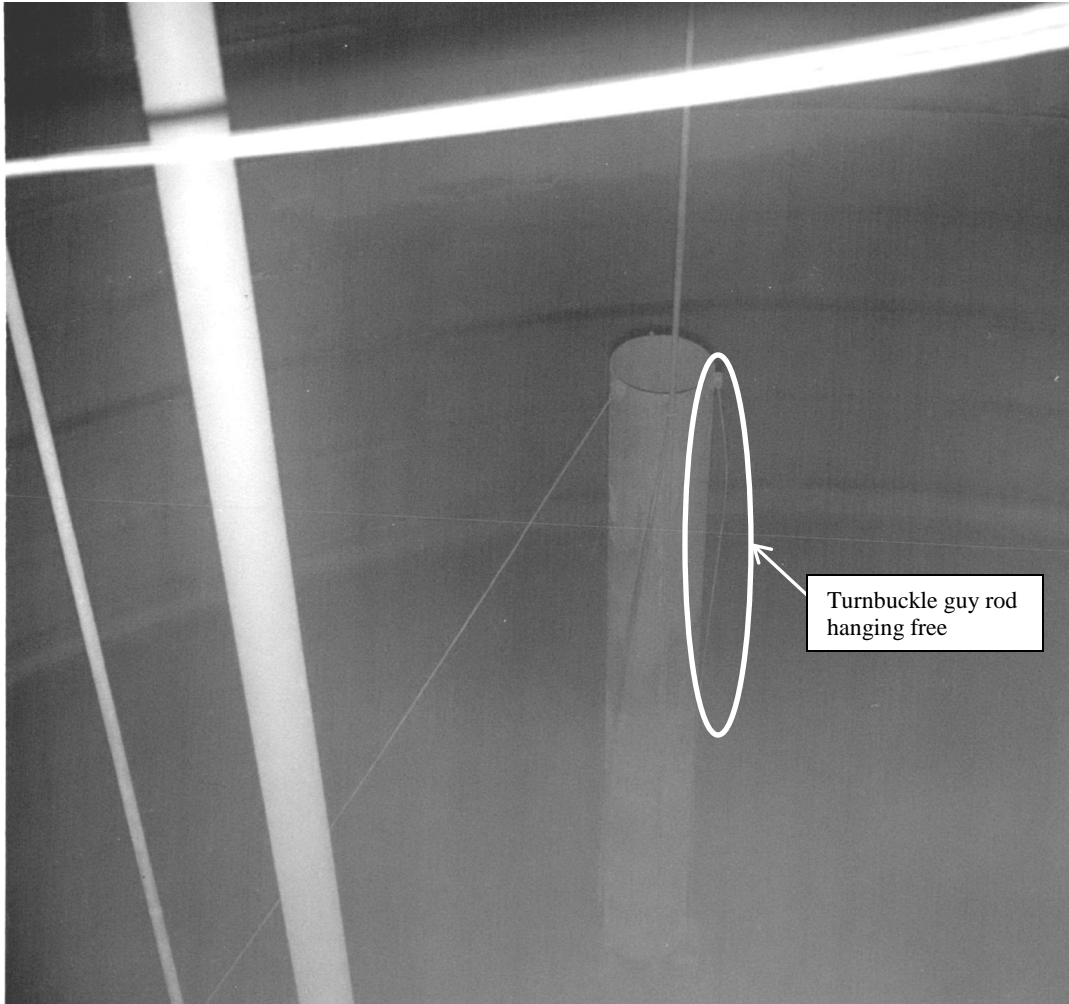
Under flowsheet conditions PUREX HLW would not be considered to have a high propensity for corrosion of the tank steel liner. Waste type PSS could create an environment conducive to SCC; however, frequent transfers into and out of the tank were occurring during this time and PSS would likely be diluted with B waste type. Tank A-104 stored waste type B and PSS from 1972 to 1974, storing for approximately three years before the tank was first suspected of leaking in March 1975.

4.4.5 Photographs

Earliest available photographs of tank A-104 taken on October 7, 1969 were reviewed. However, it is difficult to determine if a bulge was present at this time due to poor lighting and the waste surface is liquid. There are two ALCs (ALC #1 and ALC #2) that have bent piping and turnbuckle guy rods hanging free and are shown in Figure 4-4 and Figure 4-5. The next available sets of photographs were taken April 29, 1975 and May 14, 1975, shortly after tank A-104 was declared a confirmed leaker. However, it is difficult to determine if a bulge is present from these photographs due to the cloudiness of the photographs.

All available photographs of tank A-104 were reviewed. Photographs of tank A-104 taken June 25, 1986 show ALC #3 (see Figure 4-6) and ALC #4 (see Figure 4-7) with turnbuckle guy rods hanging free. This may be an indication of a liner bulge that could have resulted in failure of the turnbuckle guy rod bottom liner attachment. However, it remains unclear from the available photographs if the bottom liner of tank A-104 bulged.

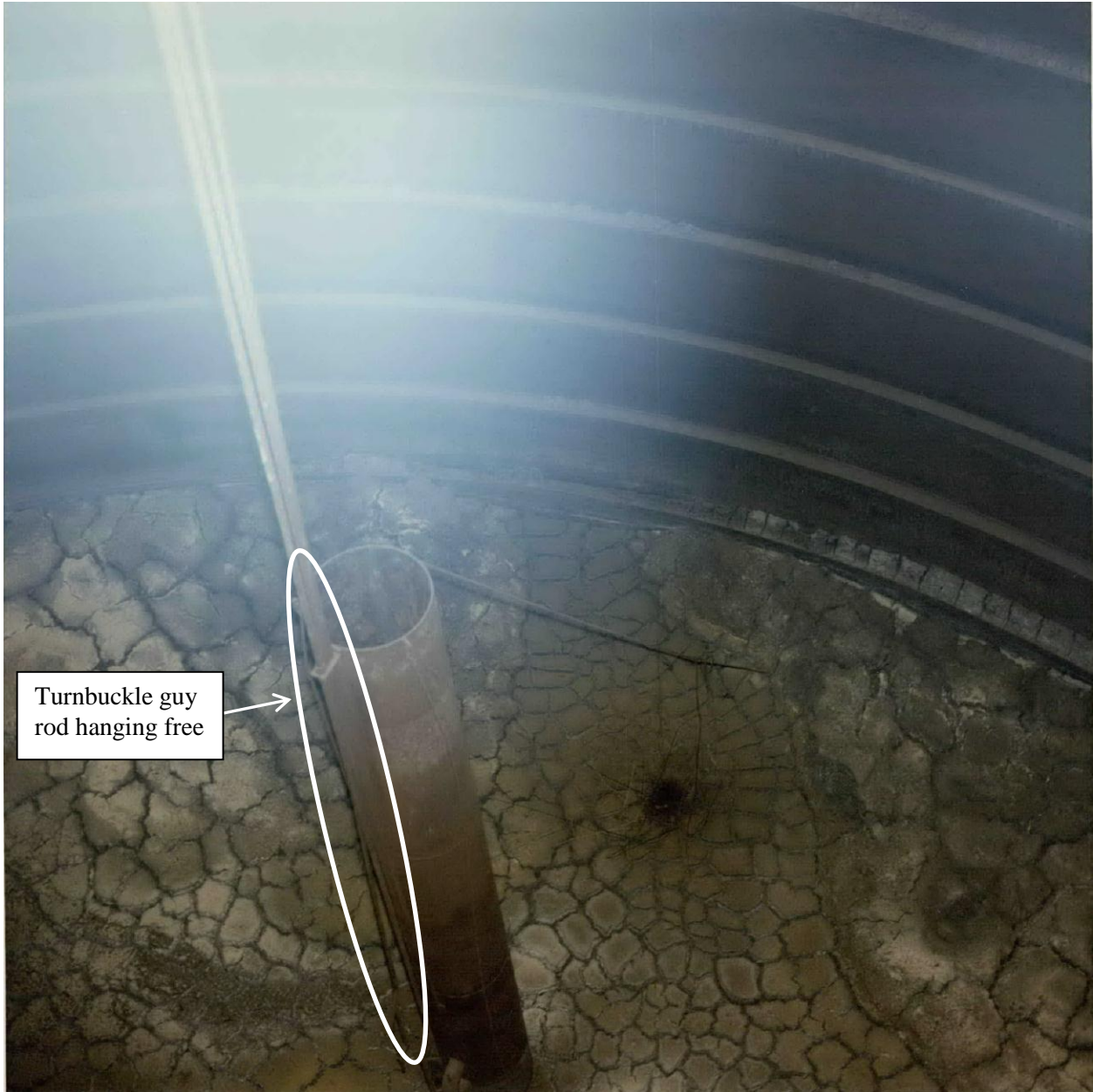
**Figure 4-4. Tank A-104 ALC #1 Photograph 0694459-34
October 7, 1969**



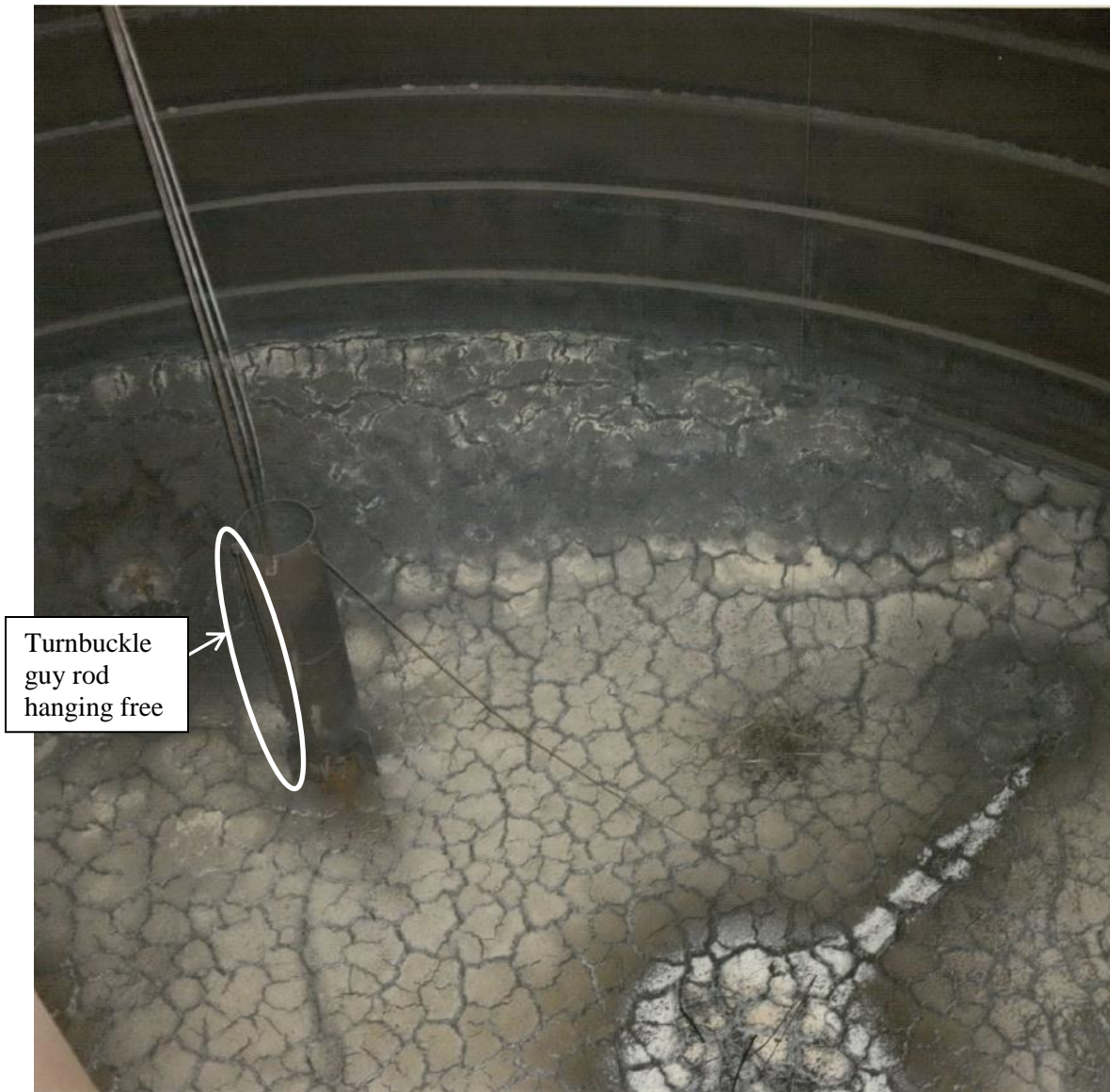
**Figure 4-5. Tank A-104 ALC #2 Photograph 0694459-20
October 7, 1969**



**Figure 4-6. Tank A-104 ALC #3 Photograph 8604129-22CN
June 25, 1986**



**Figure 4-7. Tank A-104 ALC #4 Photograph 8604129-24CN
June 25, 1986**



4.5 TANK A-104 EX-TANK DATA

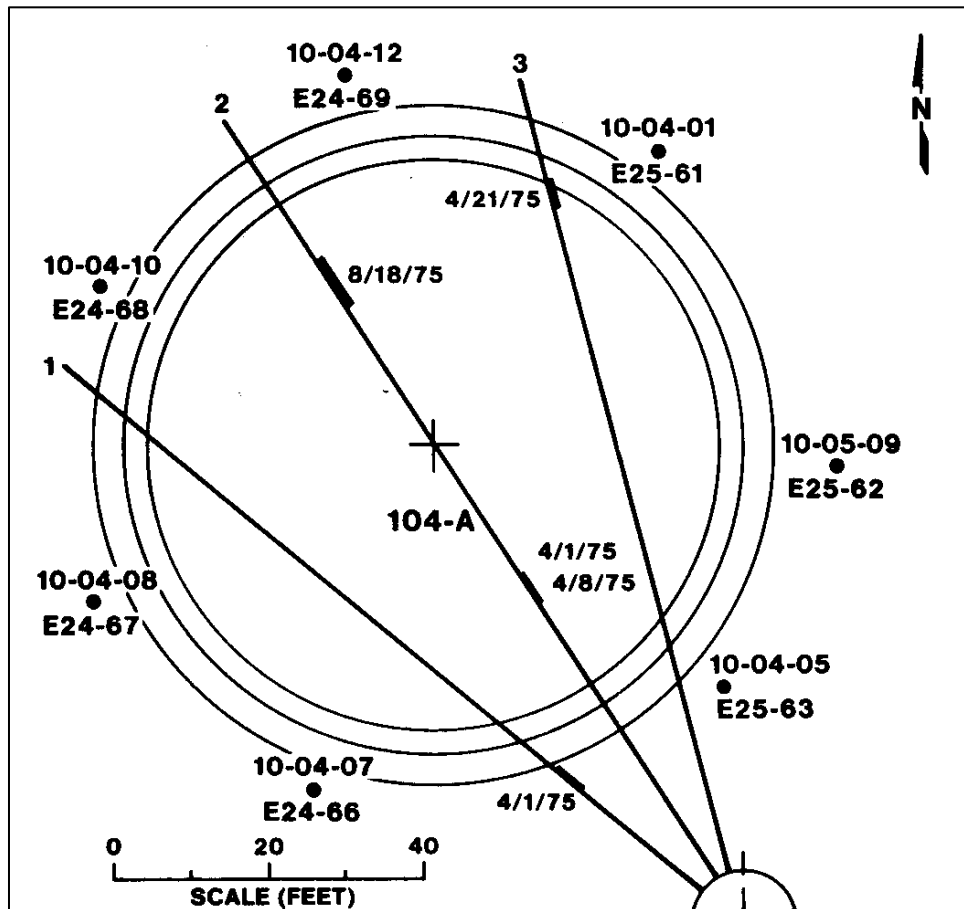
4.5.1 Laterals

The first indication of a tank A-104 leak occurred in March 1975, shortly after the start of sluicing in September 1974, when radioactivity was detected in lateral 14-04-02 (see Table C1-1). On March 18, 1975, the first indication of a tank A-104 leak was reported at 100 counts per minute (cpm) in lateral 14-04-02 at approximately 94-ft from the caisson. A week later, counts increased to 305 cpm at that location in lateral 14-04-02. Sluicing was halted April 7, 1975 due to the increase in radioactivity in lateral 14-04-02. During this time, tank A-104 contained 65 kgal of waste, including an estimated 25 kgal of sludge. The following day on April 8, 1975,

additional radiation peaks were recorded, one in lateral 14-04-02 and one in lateral 14-04-01, both along the southeast edge of the tank (see Figure 4-8). Radiation readings were monitored daily in April 1975 for all three laterals and data are shown in Appendix C1. Radiation readings continued to increase in laterals 14-04-01 and 14-04-02 throughout April 1975. The first indication of radioactivity in lateral 14-04-03 occurred on April 21, 1975 at a reading of 95 cpm along the northeast edge of the tank and increased to 480 cpm by May 2, 1975. Tank A-104 was declared a confirmed leaker in April 1975 and supernatant was pumped out of tank A-104 from April 9 through April 19, 1975.

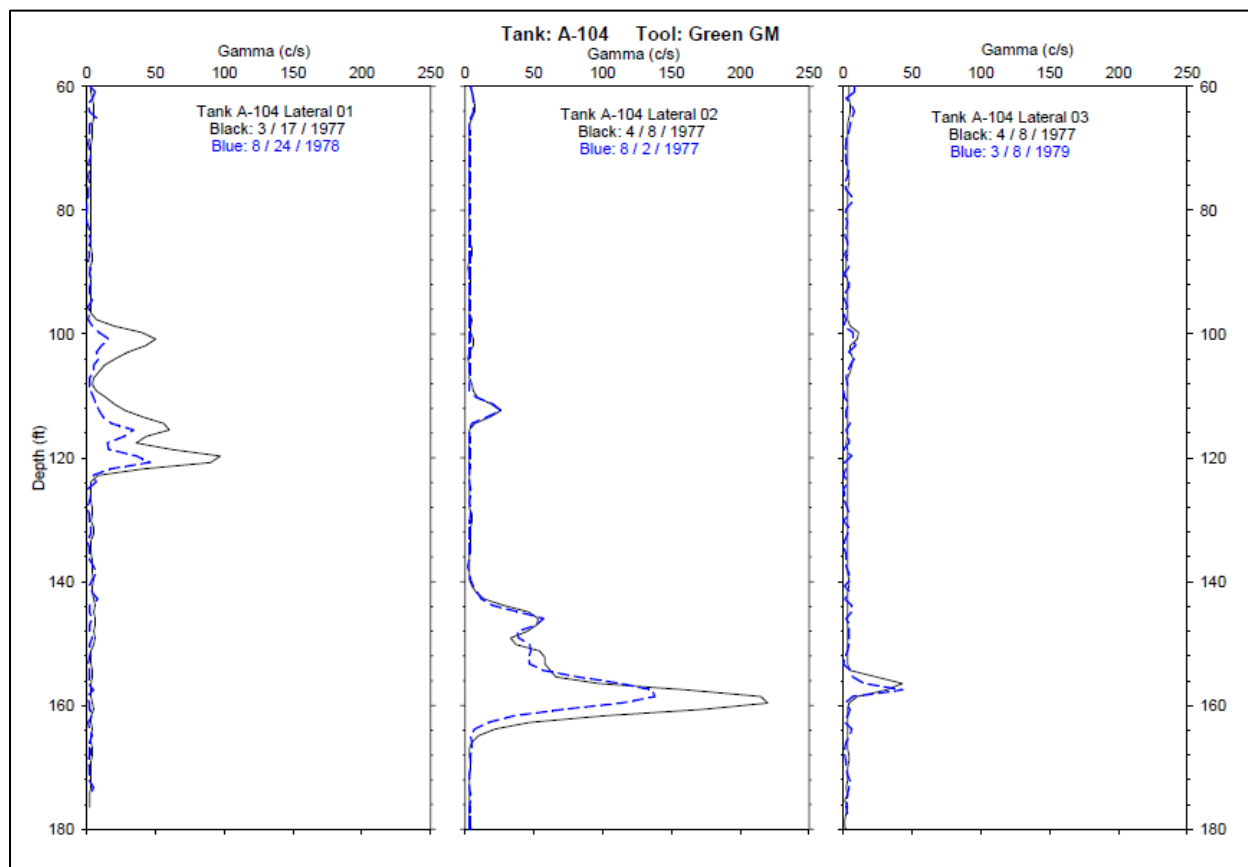
Beginning on May 1, 1975 a new peak was recorded in lateral 14-04-02 at 47-ft from the caisson at 1,200 cpm. A new peak was also recorded in lateral 14-04-01 on May 19, 1975 at 45-ft from the caisson. Gross gamma scans of the drywells around tank A-104 did not indicate radioactivity above background during this time (ARH-LD-120, *Nuclear Waste Tank and Pipeline External Leak Detection Systems*). Radiation readings remained relatively stable through 1976 and lateral scans from 1977 are shown in Figure 4-9, which show similar peaks when compared to the 1975 data. See Appendix C1 for lateral data from July 1974 through June 1986.

**Figure 4-8. Tank A-104 Historical Lateral Radioactivity
December 1975 (ARH-LD-120)**



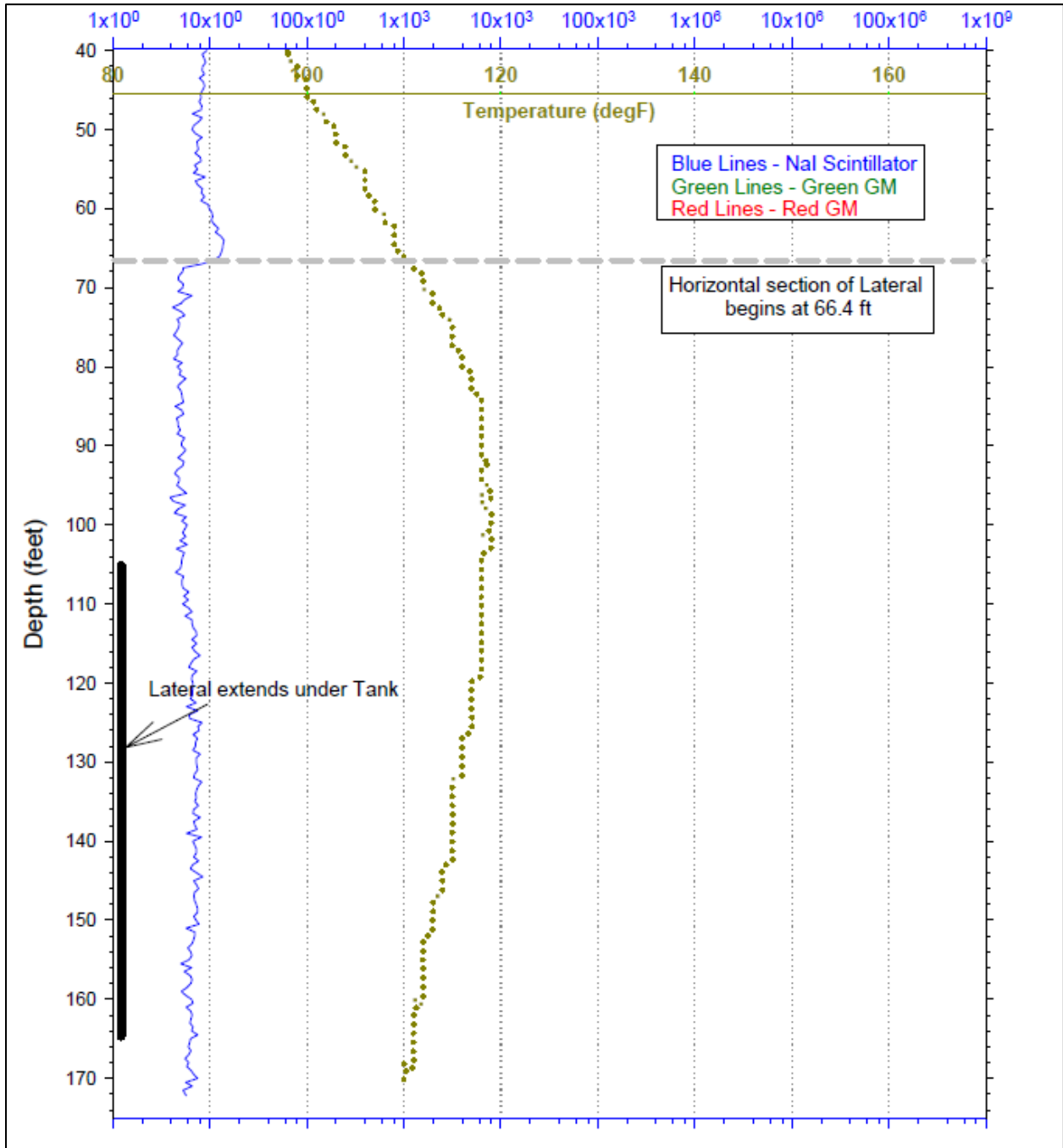
Note: There appears to be conflicts with the dates reported on this figure compared to the lateral data recovered in Appendix C1

**Figure 4-9. Tank A-104 Historical Lateral Surveys (counts per second)
(RPP-RPT-27605, Rev. 0)**



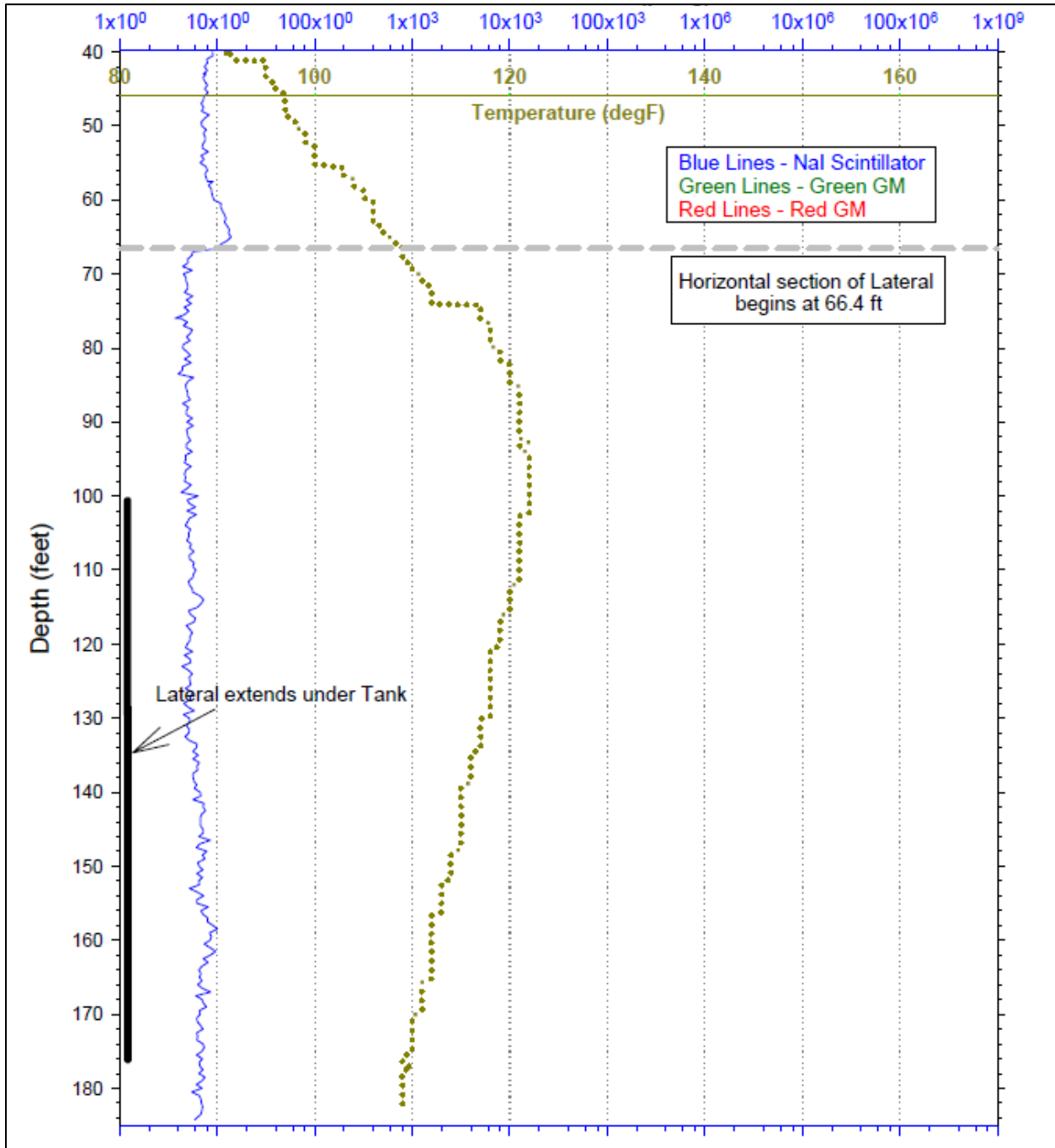
The historical gross gamma profiles shown in Figure 4-9 for laterals 14-04-01, 14-04-02, and 14-04-03 (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*, page 3-91) indicate that the contaminant or contaminants emitting this radiation were relatively short-lived (e.g., ruthenium-106, cerium-144). The April 2005 gamma surveys (see Figure 4-10 and Figure 4-11) under tank A-104 did not identify any gamma activity above background levels (RPP-RPT-27605). Lateral 14-04-03 was not surveyed during this time.

**Figure 4-10. Summary Gamma Survey for Lateral 14-04-01 on Logarithmic Scale
April 20, 2005
(RPP-RPT-27605, Rev. 0)**



Note: The lateral was not scanned with the Green and Red GM probes due to sensitivity and the level of radioactivity measured with the Nal Scintillator probe.

**Figure 4-11. Summary Gamma Survey for Lateral 14-04-02 on Logarithmic Scale
April 21, 2005
(RPP-RPT-27605, Rev. 0)**



Note: The lateral was not scanned with the Green and Red GM probes due to sensitivity and the level of radioactivity measured with the Nal Scintillator probe.

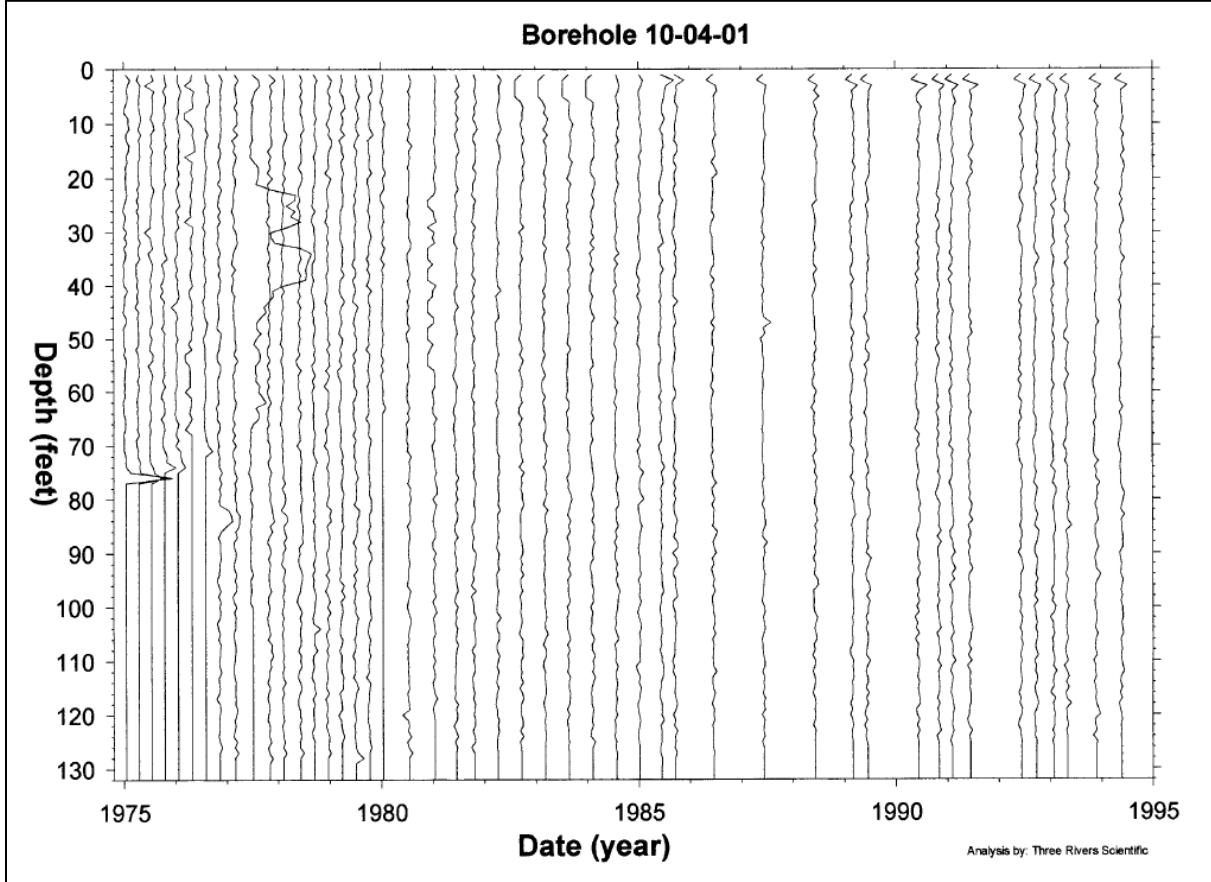
4.5.2 Drywells

There are eight drywells located around tank A-104: 10-04-04 installed in May 1955 and 10-04-01, 10-05-09, 10-04-05, 10-04-07, 10-04-08, 10-04-10, and 10-04-12 installed in April/May 1962. All of the radiation readings in drywells are assumed to be maximum or peak readings unless otherwise noted (see Section 3.3.2). The following subsections report the available drywell information and the drywell summary section provides the analyses of the associated drywells with tank A-104.

4.5.2.1 Drywell 10-04-01

Drywell 10-04-01 was drilled in May 1962 with the first recoverable reading on January 7, 1965 with three peaks of 7 cpm, 6 cpm, and 15 cpm at 50-ft, 70-ft, and 75-ft BGS, respectively (see Appendix D1). These low-level radioactivity peaks remained relatively stable through November 1965. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986 probably due to short-lived radioisotopes.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-04-01 with the maximum concentration of 8 pCi/g detected at 1-ft BGS (GJ-HAN-109). At 51-ft BGS, Cs-137 concentration was reported just above the minimum detectable limit at ~0.2 pCi/g. Document GJ-HAN-109 reports, "The near-surface anomalous activity was evident on the earliest available log (January 1975), which implies that the radionuclide contamination was in place before that time. There is no indication of anomalous activity in the borehole below the operating level of the tank." Therefore, drywell 10-04-01 is not included as part of the leak location for tank A-104. Figure 4-12 shows the depths of radioactivity from 1975 to 1995 (RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm- 200 East*).

Figure 4-12. Tank A-104 Drywell 10-04-01 (RPP-8820)

Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.2. Drywell 10-05-09

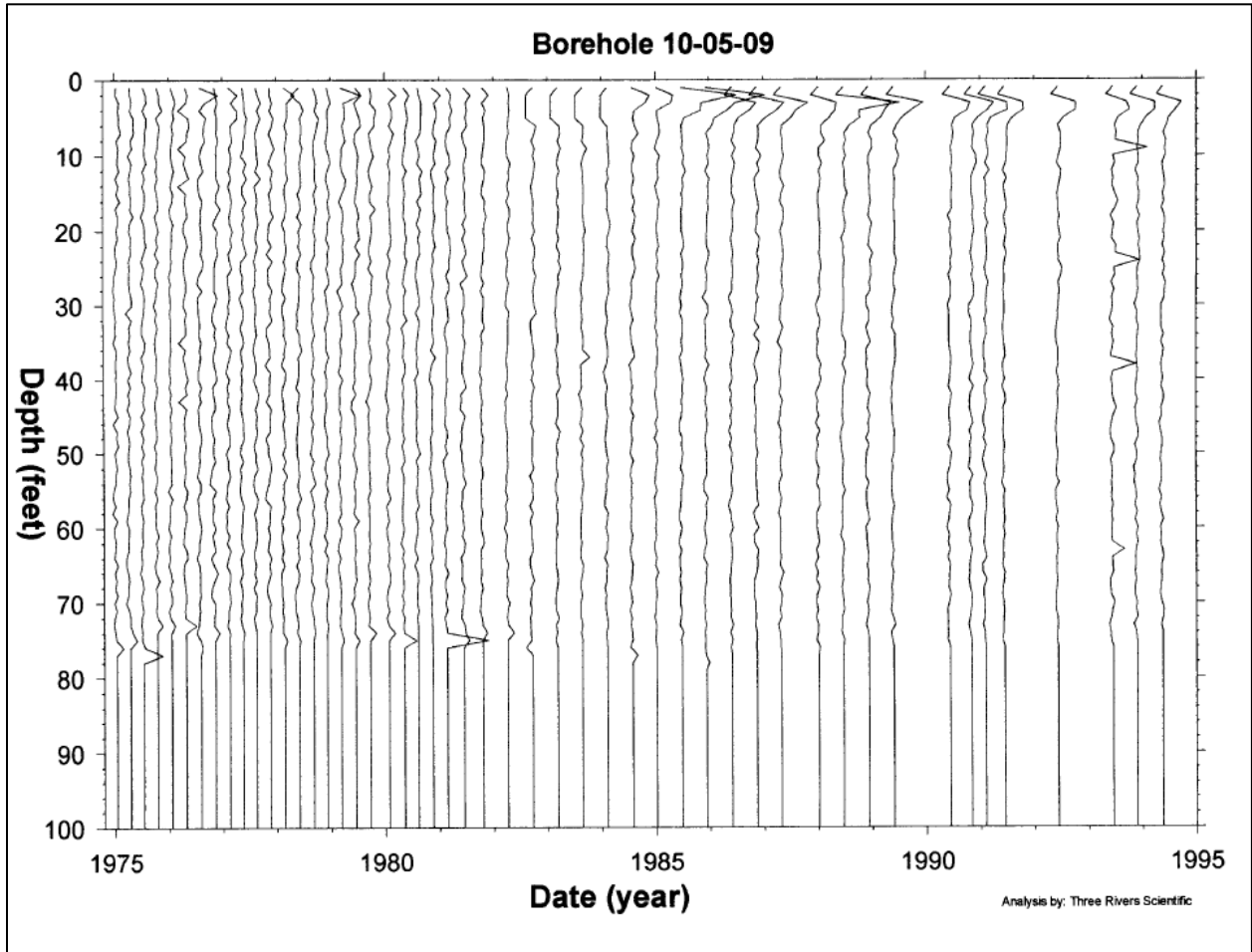
Drywell 10-05-09 was drilled in April 1962 with the first recoverable reading on January 7, 1965 with a peak reading of 15K cpm at 15-ft BGS (see Appendix D1). Radioactivity at this BGS level appeared to have been short-lived as radioactivity was relatively stable through January 1966. However, the two readings taken in May and August 1966 did not report radioactivity at the higher BGS level. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through November 1986.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-05-09 (GJ-HAN-110). From the ground surface to 15-ft BGS, Cs-137 contamination was detected nearly continuously at concentrations ranging from 0.3 pCi/g to about 90 pCi/g at a depth of 1-ft BGS. From 27.5 to 47-ft BGS, Cs-137 was also detected intermittently at concentrations just above the minimum detection limit and from 51 to 76.5-ft BGS at concentrations less than 1 pCi/g. Document GJ-HAN-110 reports, "The Cs-137 contamination detected from the ground surface to a depth of 10 ft probably resulted from a surface spill that migrated into the backfill sediment around the borehole. The contamination from 10 to 50 ft was probably carried downward from the ground surface during the drilling operation. The Cs-137 concentrations below 50 ft were too low to support shape factor analysis. Attempts to link this contamination to a source are

speculative, but the contamination may be correlatable with contamination at this depth interval in borehole 10-05-10.”

Therefore, drywell 10-05-09 is not included as part of the leak location for tank A-104. Figure 4-13 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-13. Tank A-104 Drywell 10-05-09 (RPP-8820)



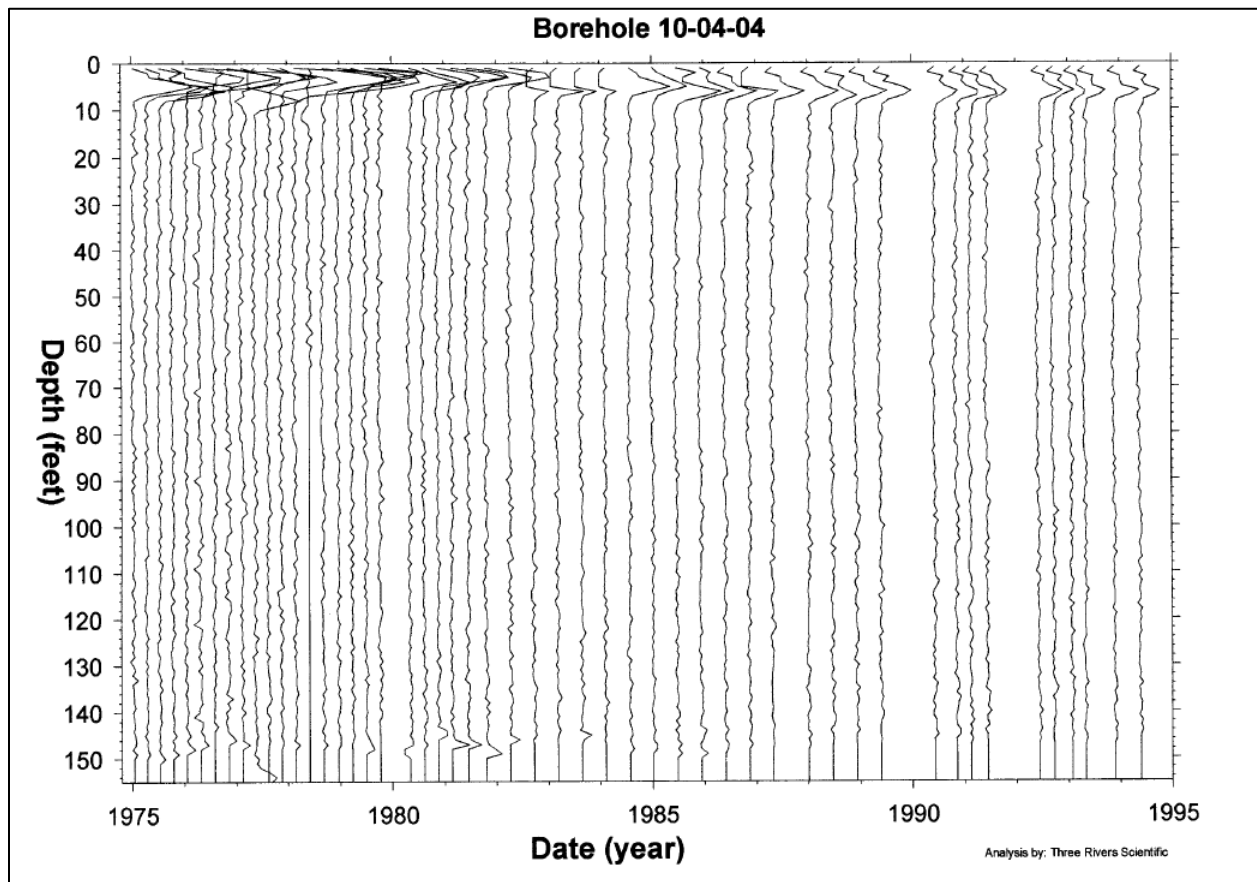
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.3. Drywell 10-04-04

Drywell 10-04-04 was drilled in May 1955 with the first recoverable readings on September 13, 1972 and reported as less than values at this time through November 1986 (see Appendix D1).

In August 1998, Cs-137 and Eu-154 were the only man-made radionuclides detected in drywell 10-04-04 (GJ-HAN-109). From the ground surface to 6.5-ft BGS, Cs-137 was detected continuously at concentrations ranging from 0.5 to 20 pCi/g and was detected at the bottom of the drywell at approximately 0.6 pCi/g. From 4.5 to 6.5-ft BGS, Eu-154 was detected continuously at concentrations ranging from 0.5 to 0.8 pCi/g. Document GJ-HAN-109 reports “Shape factor results support the interpretation that the man-made contaminants detected from the ground surface to 6.5 ft resulted from a surface spill, a nearby pipeline, or a combination of these. The contamination at the bottom of the borehole is most likely particulate matter that has fallen into the borehole from the ground surface.” Therefore, drywell 10-04-04 is not included as part of the leak location for tank A-104. Figure 4-14 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-14. Tank A-104 Drywell 10-04-04 (RPP-8820)



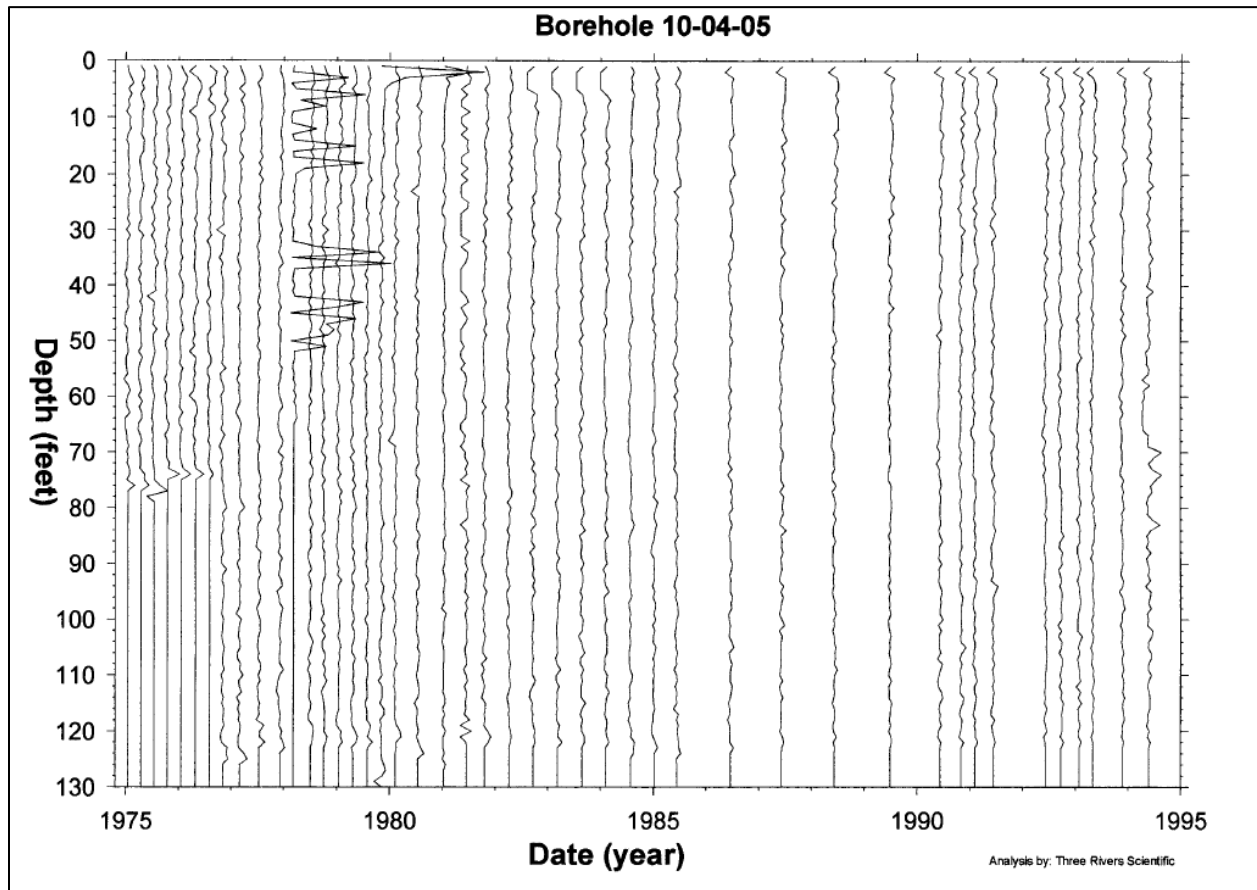
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.4. Drywell 10-04-05

Drywell 10-04-05 was drilled in April 1962 with the first recoverable reading on January 7, 1965 with three peak readings of 7, 8, and 18 cpm at 50, 70, and 75-ft BGS, respectively (see Appendix D1). Radiation levels remained relatively stable through November 1965. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-04-05 and was detected continuously from the ground surface to 15-ft BGS at concentrations ranging from 0.2 to 5 pCi/g (GJ-HAN-109). Low-level Cs-137 contamination was also detected from 24 to 28-ft BGS, from 49 to 75-ft BGS, and at the bottom of the drywell from 121.5-ft to 123-ft BGS. The maximum Cs-137 concentration was 5 pCi/g at 1-ft BGS. Document GJ-HAN-109 reports, “Shape factor results support the interpretation that the Cs-137 contamination detected between the ground surface and 5 ft probably resulted from a surface spill that migrated down into the shallow backfill surrounding the borehole. The contamination from 5 to 15 ft and 41 to 75 ft was probably dragged down during the borehole extension activities.” Therefore, drywell 10-04-05 is not included as part of the leak location for tank A-104. Figure 4-15 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-15. Tank A-104 Drywell 10-04-05 (RPP-8820)



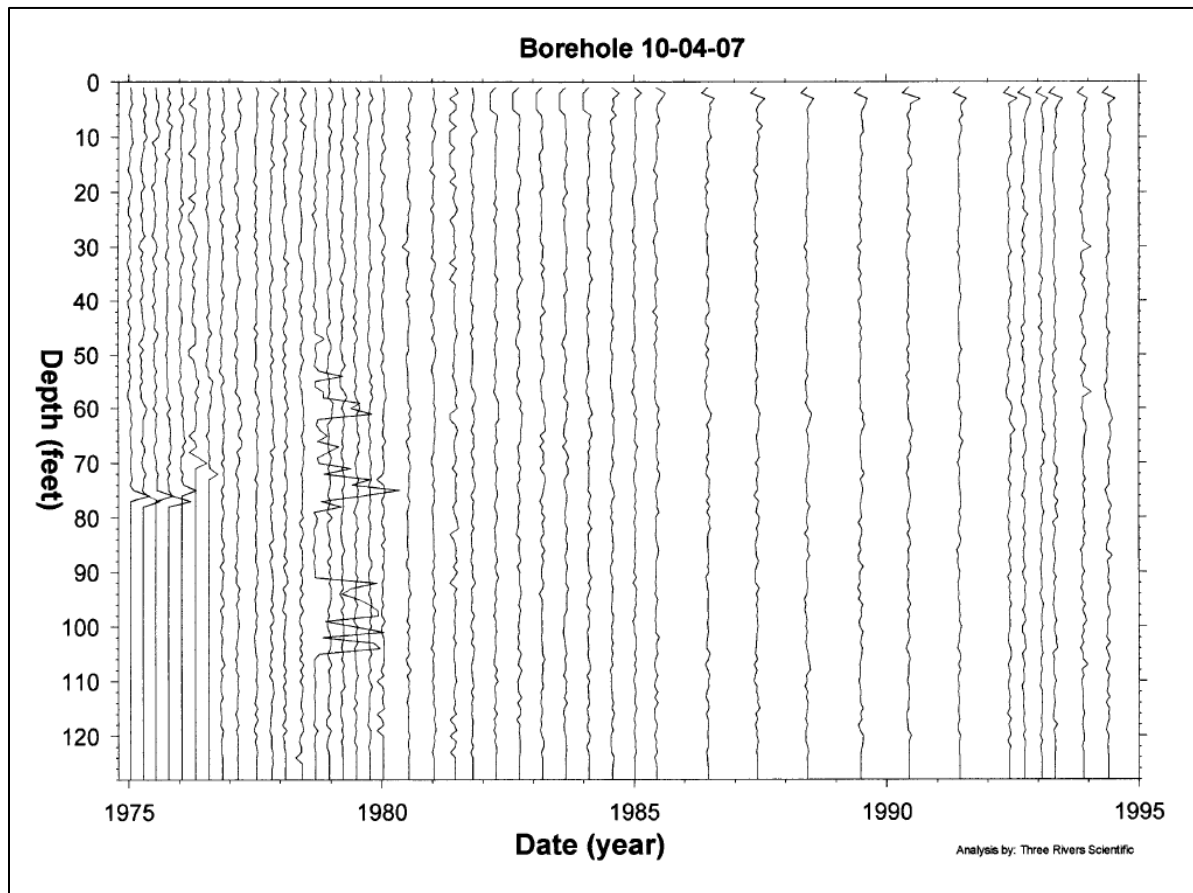
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.5. Drywell 10-04-07

Drywell 10-04-07 was drilled in May 1962 with the first recoverable reading on October 28, 1965 with three peak readings of 5, 5, and 8 cpm at 50, 73, and 75-ft BGS, respectively (see Appendix D1). Radiation levels remained relatively stable through January 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-04-07 (GJ-HAN-109). From the ground surface to 6-ft BGS, Cs-137 concentrations were recorded continuously at concentrations between 0.3 to 10.5 pCi/g, intermittently from 14 to 19-ft BGS at concentrations just above the minimum detection limit (MDL), at an isolated occurrence at 34-ft BGS at MDL, and intermittently from 120 to 125-ft BGS at concentrations below 1 pCi/g. Document GJ-HAN-109 reports, “The Cs-137 concentration detected between the ground surface and 5-ft probably resulted from a surface spill that migrated down into the shallow backfill surround the borehole. The majority of the contamination detected below this zone was probably dragged down during the borehole extension activity.” Therefore, drywell 10-04-07 is not included as part of the leak location for tank A-104. Figure 4-16 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-16. Tank A-104 Drywell 10-04-07 (RPP-8820)



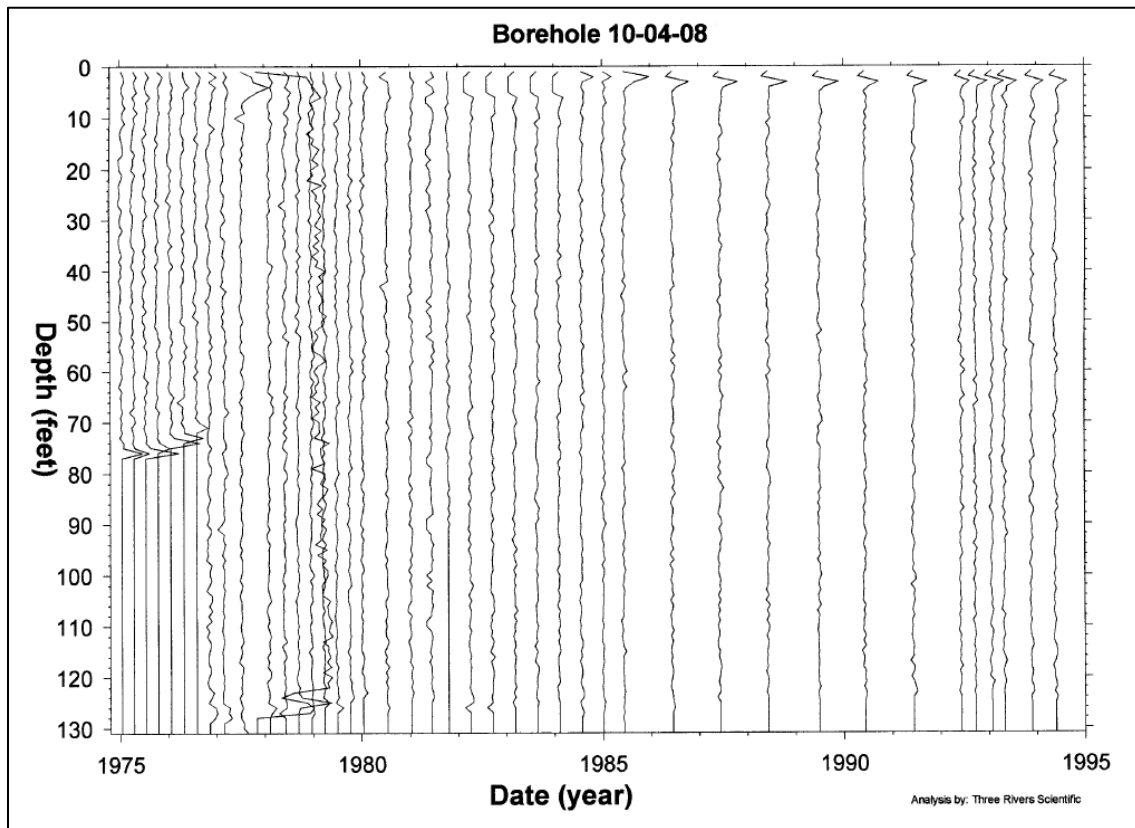
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.6. Drywell 10-04-08

Drywell 10-04-08 was drilled in May 1962 with the first recoverable reading on November 3, 1965 with two peak readings of 6 and 8 cpm at 60 and 75-ft BGS, respectively (see Appendix D1). Radiation levels remained relatively stable through January 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-04-08 (GJ-HAN-109). From the ground surface to 19-ft BGS and from 20 to 30.5-ft BGS, Cs-137 concentrations were detected. From 1 to 4-ft BGS, Cs-137 concentrations ranged from 1 to 20 pCi/g, approximately 1 pCi/g from 4 to 19-ft BGS, 0.3 to 5 pCi/g from 26 to 28-ft BGS, and 0.2 pCi/g from 55 to 70.5-ft BGS and 81 to 81.5-ft BGS. Document GJ-HAN-109 reports, “the Cs-137 contamination detected between the ground surface and 10 ft probably resulted from a surface spill that migrated down into the backfill material surrounding the borehole. The majority of the contamination detected below this zone was probably dragged down during the borehole extension activity” ...and, “The Cs-137 contamination detected from 55 to 70 ft occurs at the base of the tank; this contamination may be the result of a tank leak, but the Cs-137 concentration is too low to interpret this with confidence.” Therefore, drywell 10-04-08 is not included as part of the leak location for tank A-104. Figure 4-17 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-17. Tank A-104 Drywell 10-04-08 (RPP-8820)



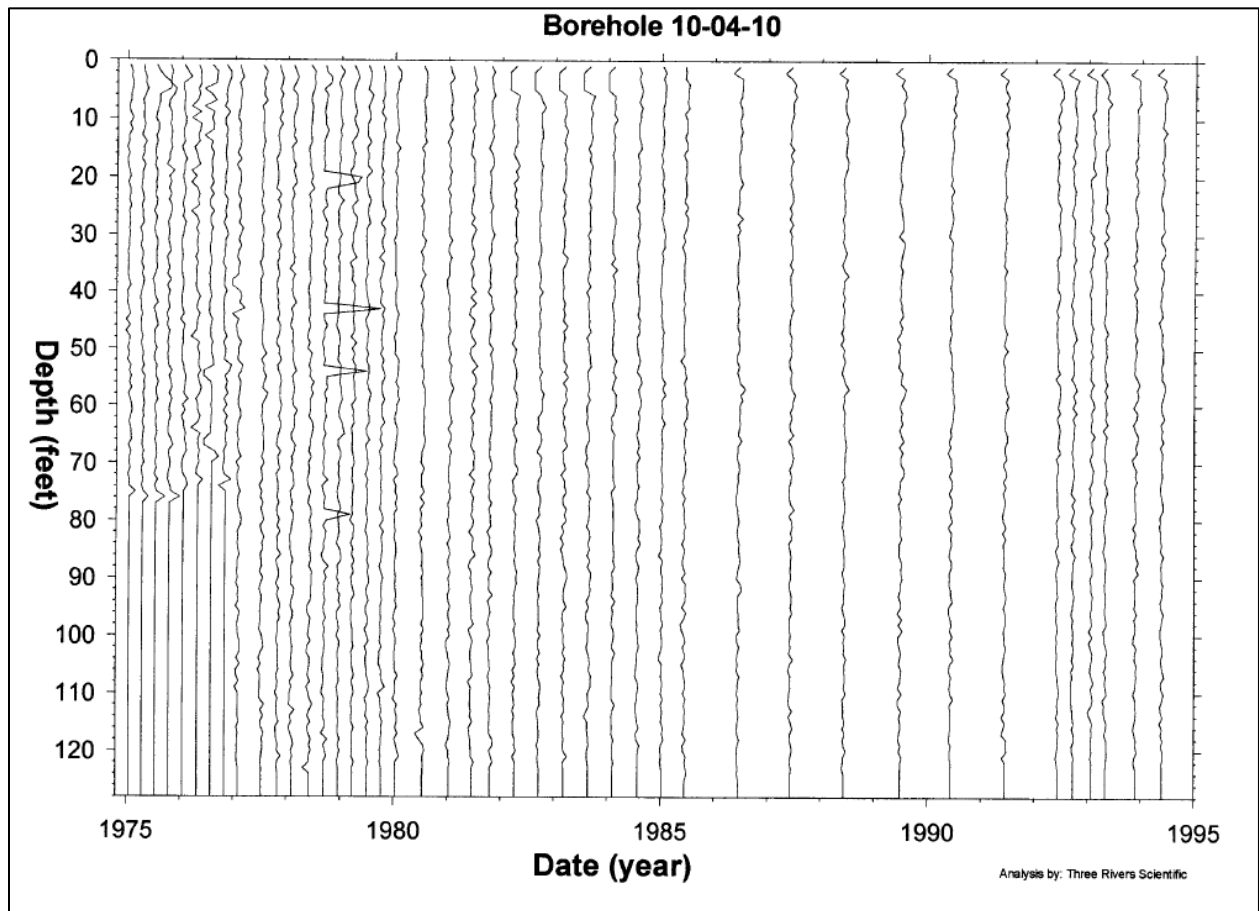
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.7. Drywell 10-04-10

Drywell 10-04-10 was drilled in May 1962 with the first recoverable reading on November 3, 1965 with two peak readings of 6 and 8 cpm at 50 and 75-ft BGS, respectively (see Appendix D1). Radiation levels remained relatively stable through January 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986.

In August 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-04-10 (GJ-HAN-109). From the ground surface to 6-ft BGS, Cs-137 concentrations were detected continuously at concentrations ranging from 0.3 to 1.5 pCi/g and intermittently from 6 to 9.5-ft BGS at approximately 0.2 pCi/g. Isolated detections occurred at 50.5-ft BGS and at the bottom of the drywell at 0.3 pCi/g. Document GJ-HAN-109 reports, “The Cs-137 contamination detected between the ground surface and 6 ft probably resulted from a surface spill that migrated down into the shallow backfill surrounding the borehole, and at least some of the contamination was dragged down during the borehole extension activity.” Therefore, drywell 10-04-10 is not included as part of the leak location for tank A-104. Figure 4-18 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-18. Tank A-104 Drywell 10-04-10 (RPP-8820)



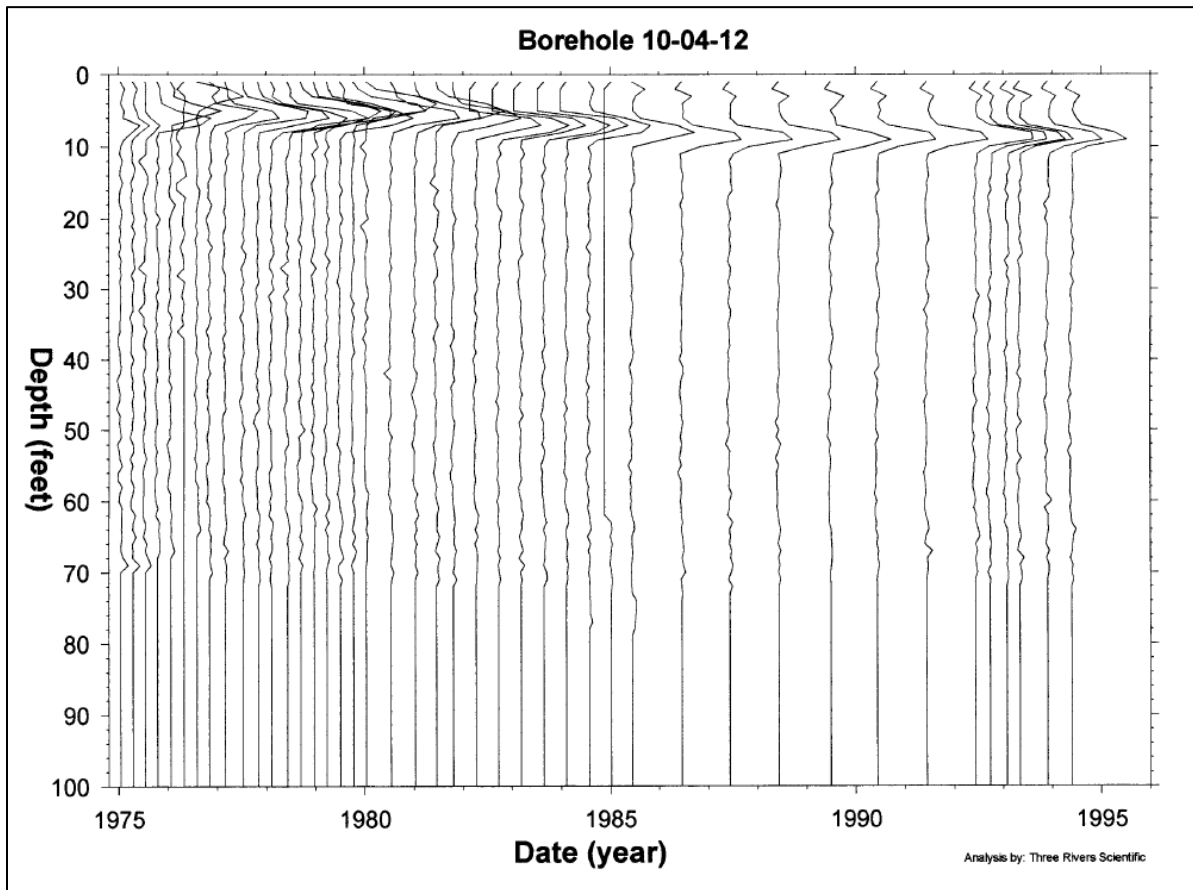
Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.8. Drywell 10-04-12

Drywell 10-04-12 was drilled in May 1962 with the first recoverable reading on January 3, 1965 with three peak readings of 600, 7 and 12 cpm at 6, 50 and 75-ft BGS, respectively (see Appendix D1). Radiation levels remained relatively stable through January 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through June 1986.

In August 1998, Cs-137, Co-60, and Eu-154 were the only man-made radionuclides detected in drywell 10-04-12 (GJ-HAN-109). From the ground surface to 9-ft BGS, Cs-137 contamination was detected continuously at concentrations ranging from 0.3 pCi/g to 16 pCi/g. From 9 to 15.5-ft BGS, Cs-137 was also detected intermittently at concentrations just above the minimum detection limit and from 70.5 to 72.5-ft BGS at concentrations less than 0.3 pCi/g. From 7.5 to 8.5-ft BGS, Co-60 was detected continuously at concentrations ranging from 0.1 to 0.3 pCi/g. From 7 to 8.5-ft BGS, Eu-154 was detected continuously at concentrations ranging from 0.5 to 1.5 pCi/g. Document GJ-HAN-109 reports, “There is no indication of elevated gamma readings in data collected from this borehole that could be attributed to subsurface contamination.” Therefore, drywell 10-04-12 is not included as part of the leak location for tank A-104. Figure 4-19 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 4-19. Tank A-104 Drywell 10-04-12 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

4.5.2.9. Drywell Summary

Tank A-104 was first suspected of leaking in March 1975 due to radioactivity being detected in lateral 14-04-02 in the northern portion of tank A-104 (see Section 4.5.1). During this time, no drywells were reported to have increased radioactivity levels.

Tank A-104 drywells 10-04-01, 10-05-09, 10-04-04, 10-04-05, 10-04-07, 10-04-08, 10-04-10, and 10-04-12 do not indicate any radioactivity associated with a tank A-104 leak. Therefore, these drywells are not included in the leak location analysis for tank A-104.

4.6 POSSIBLE TANK A-104 LINER LEAK LOCATION(S)

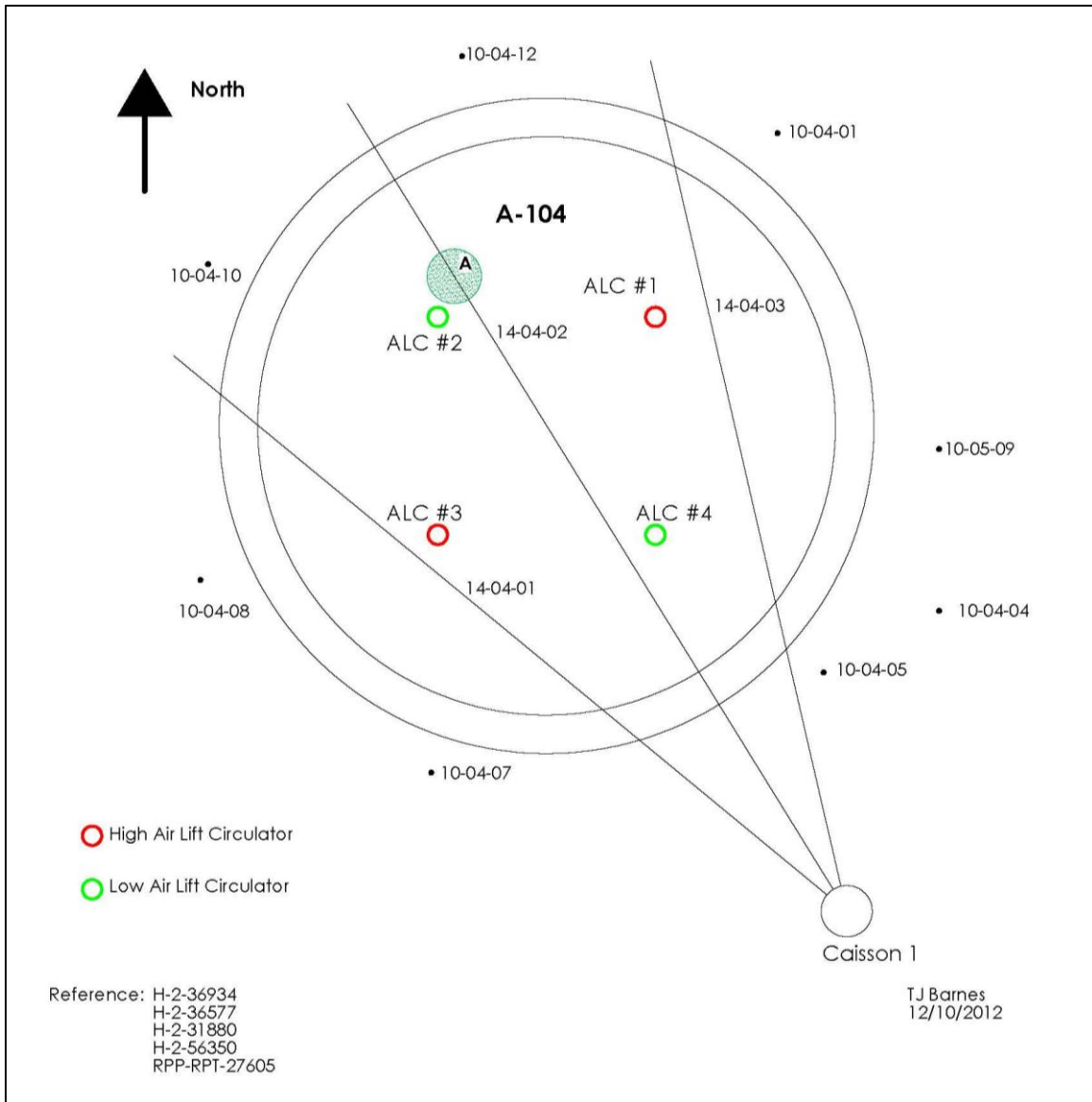
The lateral radioactivity when first detected could be an indication of the location of a liner leak. However, the liner leak may have penetrated the waterproof membrane at any location or pooled on the waterproof membrane and followed concrete cracks or breaks to a different location including the top of the tank footing.

It is likely that the majority of the tank A-104 leak occurred at the tank footing because all of the indicators, three laterals, were located at or near the tank footing. The liquid level was reported at 31-in at the end of February 1975, shortly before tank A-104 was first suspected of leaking. Therefore, it is likely the leak site or sites are located below the 31-in waste level.

4.6.1 Leak Detected in March 1975

Tank A-104 was first suspected of leaking on March 18, 1975 shortly after the start of sluicing the tank in September 1974 due to radioactivity being detected in lateral 14-04-02 in the northern portion of the tank (see site A in Figure 4-20). The peak radioactivity was reported at 100 cpm in lateral 14-04-02 at approximately 94-ft from the caisson. No radioactivity indicative of a tank A-104 leak was detected in the drywells or other laterals during this time. Tank A-104 liquid level was reported at 31-in at the end of February 1975; therefore, it is likely the leak location was below this waste level.

Figure 4-20. Tank A-104 Possible Leak Location (March 1975)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing

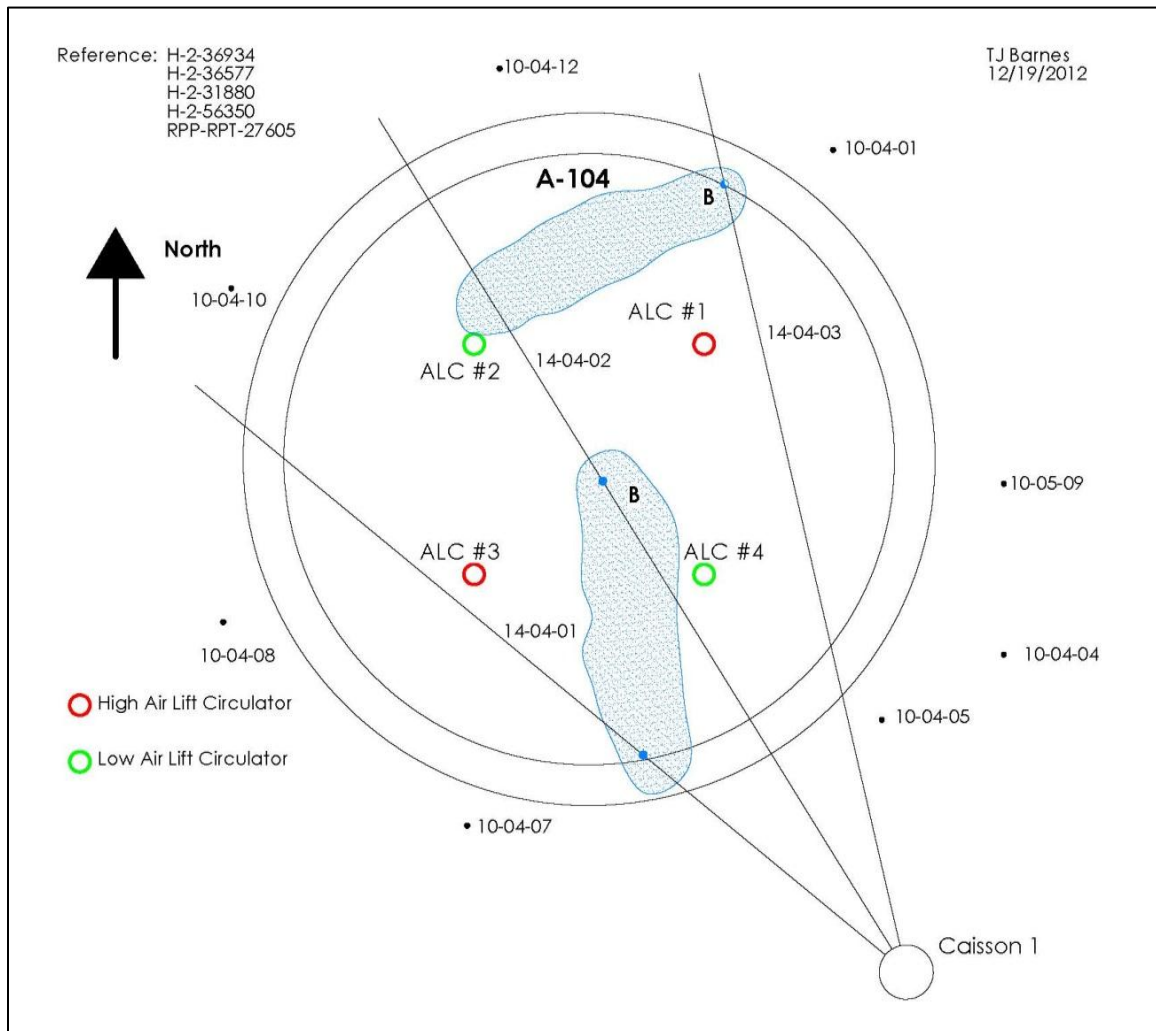


Tank A-104 was first suspected of leaking in March 1975 due to radioactivity being detected in lateral 14-04-02 in the northern portion of the tank.

4.6.2 Leak Detected in April 1975

A week after the initial radioactivity was detected in lateral 14-04-02, counts continued to increase at site A (see Figure 4-20) and sluicing was halted on April 7, 1975. The following day on April 8, 1975, radioactivity was first detected in lateral 14-04-01 and an additional peak was recorded in lateral 14-04-02, both in the southern portion of the tank (see site B in Figure 4-21). Laterals were then monitored daily throughout April 1975 and radioactivity continued to increase in laterals 14-04-01 and 14-04-02 during the month. On April 21, 1975, radioactivity was first reported in lateral 14-04-03 along the northeast edge of the tank. Tank A-104 was declared a confirmed leaker in April 1975 and supernatant was pumped out of the tank from April 9 through April 19, 1975.

Figure 4-21. Tank A-104 Leak Indication (April 1975)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing

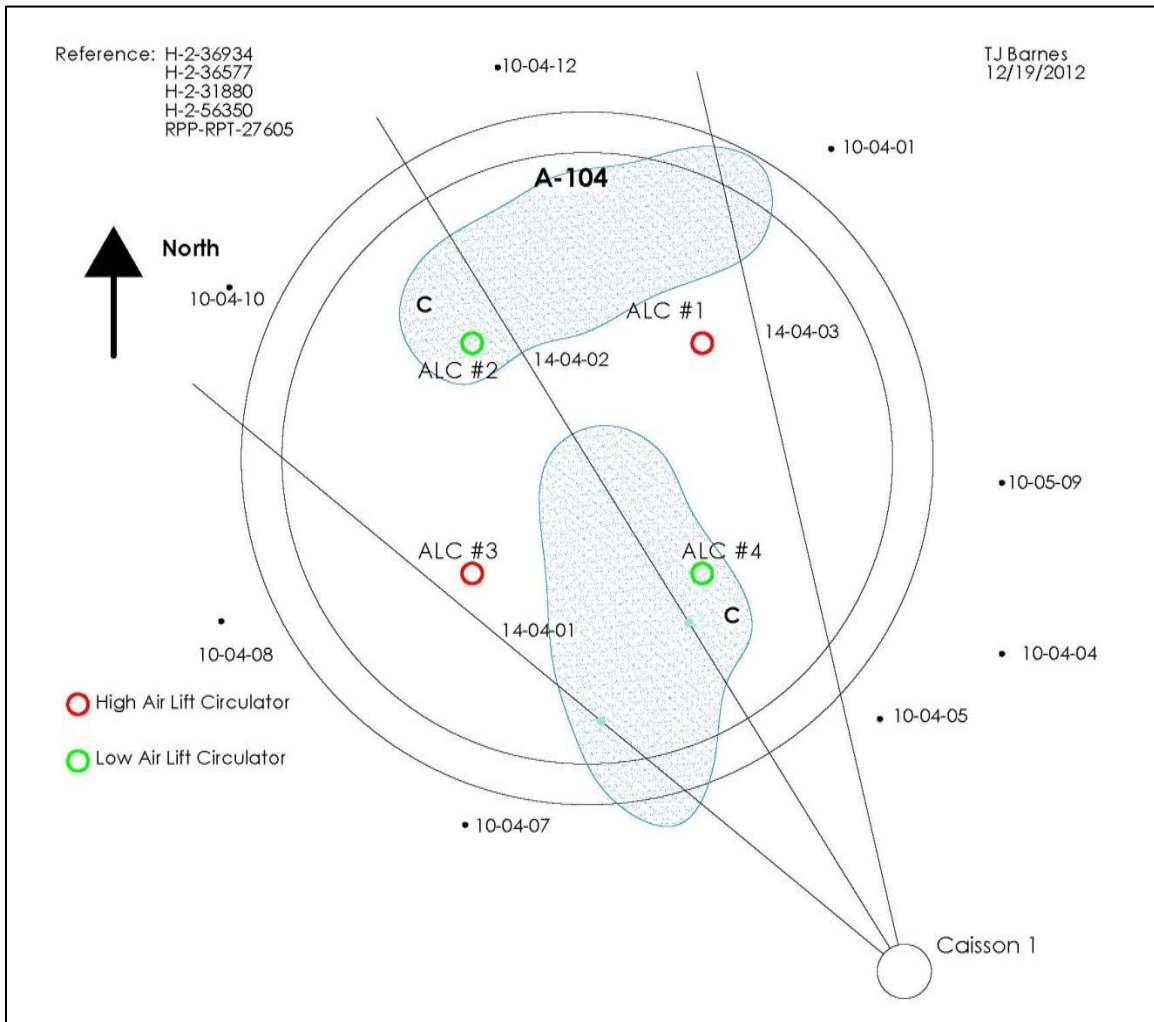


Tank A-104 was first suspected of leaking in March 1975 due to radioactivity being detected in lateral 14-04-02 in the northern portion of the tank.

4.6.3 Leak Detected in May 1975

In May 1975, additional peaks were detected in lateral 14-04-02 at 47-ft from the caisson and in lateral 14-04-01 at 45-ft from the caisson (see site C in Figure 4-22). Radioactivity in lateral 14-04-01 at site B in Figure 4-21 continued to slowly increase through June 1975. Radioactivity in lateral 14-04-02 at site B in Figure 4-21 continued to slowly increase through October 1975. Radioactivity in lateral 14-04-03 slowly increased in May 1975 at site B in Figure 4-21, and then slowly declined through October 1975. No additional peaks were reported for lateral 14-04-03 in 1975. The tank A-104 liquid level was reported at 6.5-in at the end of April 1975 and radioactivity in the laterals appeared to stabilize by the end of 1975. No radioactivity that could be indicative of a tank A-104 leak was detected in the drywells during this time.

Figure 4-22. Tank A-104 Leak Indicators (May 1975)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



Tank A-104 was first suspected of leaking in March 1975 due to radioactivity being detected in lateral 14-04-02 in the northern portion of the tank.

4.6.4 Leak Location Summary

Tank A-104 was first suspected of leaking on March 18, 1975 due to radioactivity being detected in lateral 14-04-02 in the northern portion of the tank shortly after the start of sluicing in September 1974 (see site A in Figure 4-20). Radioactivity continued to increase in lateral 14-04-02 at site A; therefore, sluicing was halted on April 7, 1975.

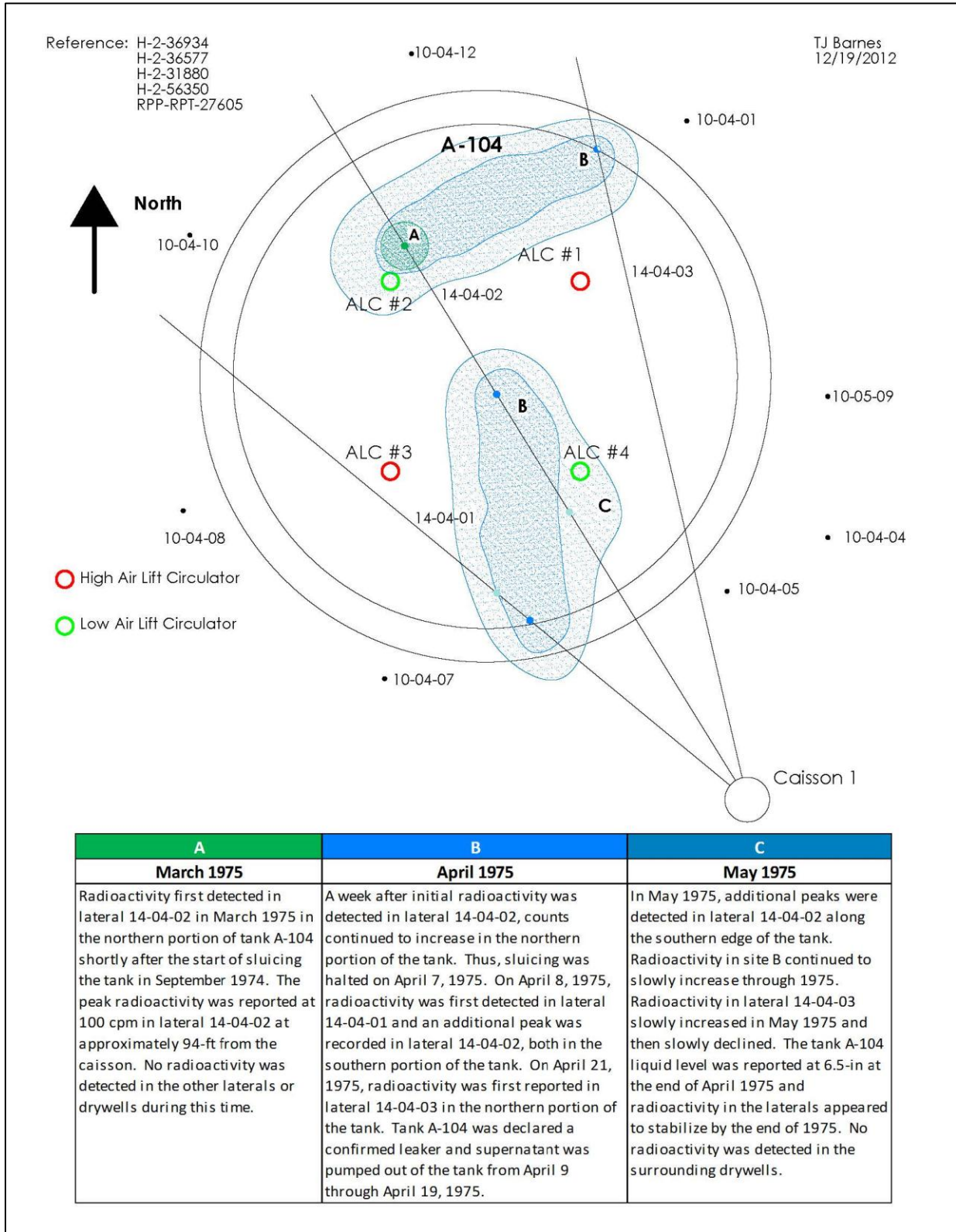
The following day on April 8, 1975, additional radiation peaks were recorded, one in lateral 14-04-01 and one in lateral 14-04-02, both along the southeast edge of the tank (see site B in Figure 4-21). Laterals were then monitored daily throughout April 1975 and radioactivity continued to increase in laterals 14-04-01 and 14-04-02 during the month. Tank A-104 was declared a confirmed leaker in April 1975 and supernatant was pumped out of the tank from April 9 through April 19, 1975. On April 21, 1975, radioactivity was first reported in lateral 14-04-03 along the northeast edge of the tank.

In May 1975, additional peaks were detected in laterals 14-04-01 and 14-04-02 along the southeastern edge of the tank (see site C in Figure 4-22). Radioactivity peaks located at site B in Figure 4-21 for laterals 14-04-01 and 14-04-02 continued to slowly increase through 1975. However, no additional radioactivity peaks were reported in lateral 14-04-03 and radioactivity reported at site B (see Figure 4-21) began to slowly decline in May 1975.

Leak locations in Figure 4-23 are based on peak readings and are a representation of possible initial and subsequent boundaries of radioactivity. It is likely the leak site or sites are located below the 31-in waste level as the tank A-104 liquid level was reported at 31-in at the end of February 1975, shortly before the tank was first suspected of leaking.

No records were found in available documents for a liner bulge occurring in tank A-104, and it remains unclear if a liner bulge once existed in the tank during its operation. After reviewing available in-tank photographs, there is a possibility of a liner bulge as indicated by ALCs #1 through #4 (see Section 4.4.5). However, a liner bulge remains inconclusive for tank A-104.

Figure 4-23. Tank A-104 Possible Radial Leak Locations and Indicators
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



4.7 POSSIBLE TANK A-104 LINER LEAK CAUSE(S)

Tank A-104 was evaluated for five conditions known to contribute to a failed liner.

4.7.1 Tank Design

The design of the A Farm tanks was the second, after 241-SX Farm, that diverged from the round bottom knuckle design used in the earlier waste tanks. The flat tank bottom liner intersects the sidewall liner orthogonally. A fillet weld was used to close the seam where the sidewall and tank bottom liners meet. Several other SSTs with fillet welds failed during service (RPP-RPT-45921, *Single Shell Tank Integrity Expert Panel Report*). Weld inspections were less rigorous. Additionally, the design discontinued the use of the three ply asphaltic membrane waterproofing between the liner and the concrete shell. These features were inferior compared to earlier tank designs and could possibly increase the likelihood of failure of the tank liner from induced stresses (see Section 3.1.1).

4.7.2 Thermal Conditions

Temperature requirements in HW-59919 issued October 22, 1959 indicated that the self-boiling waste operating temperature should be maintained between 220°F and 250°F. The maximum sludge temperature should not exceed 300°F.

The tank A-104 bulb (sludge) temperatures are shown in Appendix B1. The maximum temperature of tank A-104 reached approximately 437°F on February 16, 1963 which exceeded the maximum sludge temperature of 300°F and for approximately 17 months waste temperatures were recorded greater than 300°F.

The HW-59919 document recommended a uniform rate of temperature increase of 2°F per day. Temperatures were recorded as approximately 257°F on January 2, 1963 and gradually rose to 428°F by February 6, 1963; the temperature rate of rise was therefore approximately 4.9°F/day. The highest temperature rate of rise as well as the maximum recorded temperature occurred in January/February 1963. During this time, tank A-104 contained PUREX HLW and OWW from PUREX was being periodically transferred into the tank. There were no other increases in temperatures that exceeded the average rate of rise of 4.9°F/day during the operation of tank A-104. Exceeding the operating temperature requirements would create liner stress when thermally hot high level waste was received and stored in the tank especially without pre-heating. Tank A-104 was pre-heated prior to receiving waste but the initial heat up rate of rise is not available therefore it is unknown if the initial temperature rate of rise exceeded the recommended temperature increase of 2°F per day.

Thermal shock creates stress both from rapid temperature rise as well as high temperatures.

4.7.3 Chemistry-Corrosion

Tank A-104 stored initial test water for approximately one year in 1957 prior to receiving waste. Subsequently at the end of calendar year 1969 after sluicing the tank A-104 solids leaving a solids heel of 8-in, 957 kgal of water was transferred on top of this heel and was stored for

approximately three years. It is possible some corrosion occurred during these periods as there is no mention of chemical adjustment to inhibit corrosion. However, it is assumed that water added to the tank during these two periods was raw water at a pH of approximately 7.8 (ERDA-1538) as this was common tank farm practice.

Waste type PSS is outside the chemistry limits for preventing SCC since the addition of the concentrations of nitrite and hydroxide are not greater than 1.2 M (see Section 4.4.4). Tank A-104 received PSS waste from 1972 to 1974, storing for approximately three years before the tank was first suspected of leaking in March 1975. The PSS waste could have created an environment conducive to SCC.

No additional conditions have been identified that could accelerate corrosion of the tank steel liner.

4.7.4 Liner Observations

The table in RHO-R-39 (see Appendix A1) indicated there was no bulge present when tank A-104 was inspected for a bulge. The evidence of a liner bulge is possible in tank A-104 from all photographs, but not conclusive. Liner bulging coupled with other tank conditions could affect tank liner integrity; however, by itself bulging induces stresses that can cause breaching of the tank liner.

4.7.5 Tank Construction Temperature

The lowest average temperatures during construction of the A Farm tank liners occurred in December 1954 at 34°F and January 1955 at 30°F with four months having at least one minimum temperature between 14°F and 18°F (see Section 4.3.2). The low temperatures experienced during construction were less than the 18°F allowable temperature where impact loading had the potential for creating micro-fissures. Impact occurrences may have triggered fissures in the steel liner.

4.8 TANK A-104 CONCLUSIONS

Evidence indicates that the tank A-104 liner leaked at or near the tank footing. Based on engineering judgment and available information the following conditions contributed to the tank A-104 failed liner:

1. Thermal conditions – rate of temperature rise
2. Tank design – expansion limiting design
3. Water and PSS waste storage chemistry – corrosion - stress corrosion cracking
4. Construction conditions – ductile-to-brittle transition temperature

There are several liner leak cause conditions that were examined, but the primary cause is the tank A-104 thermal conditions. The design did not allow for expansion of the bottom liner as the tank heated which created stresses. Initial heat up rate of tank A-104 is not available but available data infer heat-up rates in excess of the allowable 2°F/day for periods of time; if the rate of rise was too high, grout moisture could have resulted in the vapor pressure under the liner

increasing enough to cause a bulge in the tank bottom liner. The highest rate of rise during waste storage occurred in February 1963 at approximately 4.9°F/day. Temperature rate of rise could have set up stresses that may have weakened the tank bottom liner where other factors such as unmeasured bulging fluctuations and corrosion may have further compromised the liner. Tank A-104 experienced the third highest temperature of all tanks, however, tanks A-103 and A-106 were even higher and those tanks are categorized as sound.

Construction conditions could have also contributed to the tank bottom liner failure but to a lesser degree.

APPENDIX A1

TANK A-104 BOILING WASTE OPERATIONAL HISTORY

Table A1-1. RHO-R-39 Boiling Waste Tank Operating Data Table

Tank No.	First Waste	Tank Pre-Heated	Pre-Heat Start	Liquid Heel Used	First Waste Rec'd From	Tank Failed	Inspected For Bulge	Bulge Present	Did Tank Boil on 1st Loading	Tank Started Boiling	Tank Emptied & Reused*	NaNO ₃ Leached from Sludge
101-SX	19 May 54	No	-	No	Redox	No	No	-	Yes	Nov 54	No	No
102-SX	Sep 54	No	-	No	101-SX, Cascade	No	No	-	No	-	No	No
103-SX	Nov 54	No	-	No	102-SX, Cascade	No	No	-	No	-	No	No
104-SX	2 Feb 55	No	-	No	Redox	No	No	-	Yes	Jun 55	No	No
105-SX	11 May 55	No	-	No	104-SX, Cascade	No	No	-	No	-	Yes	No
106-SX	Jun 54	No	-	No	Tank Farm Condensate	No	No	-	No	-	-	-
107-SX	3 Mar 56	No	-	Yes	Redox	Yes, 1964	Yes	Yes	Yes	Jun 56	Yes	Yes
108-SX	8 Nov 55	No	-	No	Redox	Yes, 1962	Yes	Yes	Yes	Jun 56	Yes	Yes
109-SX	20 Sep 55	No	-	Yes	Redox	Yes, 1965	Yes	No	Yes	Dec 55	Yes	No
110-SX	Nov 60	Yes	Apr 60	No	Redox	-	No	-	No	Between 1/61-6/61	Yes	No
111-SX	9 Jun 56	No	-	No	Redox	-	No	-	Yes	Nov 56	Yes	No
112-SX	13 Feb 56	No	-	No	Redox	Yes, 1969	Yes	Yes	Yes	Mar 56	Yes	No
113-SX	20 Feb 58	No	-	No	Redox	Yes, 1958	Yes	Yes	Yes	Apr 58	No	No
114-SX	Nov 56	No	-	No	Redox	-	No	-	Yes	Jun 57	Yes	Yes
115-SX	4 Nov 59	Yes	Sep 58	Yes	Redox	Yes, 1965	No	-	Yes	Nov 59	No	Yes
101-A	20 Jan 56	No	-	6" H ₂ O	Purex	No	Yes	No	Yes	Jul 57	Yes	No
102-A	20 Mar 56	No	-	6" H ₂ O	Purex	No	No	-	Yes	Jul 58	Yes	No
103-A	15 May 56	No	-	6" H ₂ O	Purex	No	No	-	Yes	Jul 56	Yes	No
104-A	30 Jun 59	No	-	6" H ₂ O	Purex	No	Yes	No	Yes	Aug 59	Yes	No
105-A	31 Jan 63	Yes	Jan 63	Yes	Purex	Yes, 1963	Yes	Yes	No***	Mar 63	No	No
106-A	31 Dec 60**	Yes	23 Feb 61	Yes	Purex	No	No	-	Yes	Aug 61	Yes	No
101-AX	1 Jun 65**	Yes	23 Nov 66	Yes	TK-103-A and TK-112-B	No	No	-	No***	Dec 66	Yes	No
102-AX	30 Sep 66**	Yes	2 Mar 69	Yes	TK-101-AX and TK-103-A	No	No	-	No***	Apr 69	No	No
103-AX	10 Feb 65	Yes	Nov 64	Yes	Purex	No	No	-	Yes	Apr 65	No	No
104-AX	9 Sep 66	Yes	Jun 66	Yes	Purex	No	No	-	Yes	Oct 66	No	No

* Emptied indicates supernatant was pumped out but sludge remained.

** Tanks used for temporary waste storage prior to the receipt of LW or HLW.

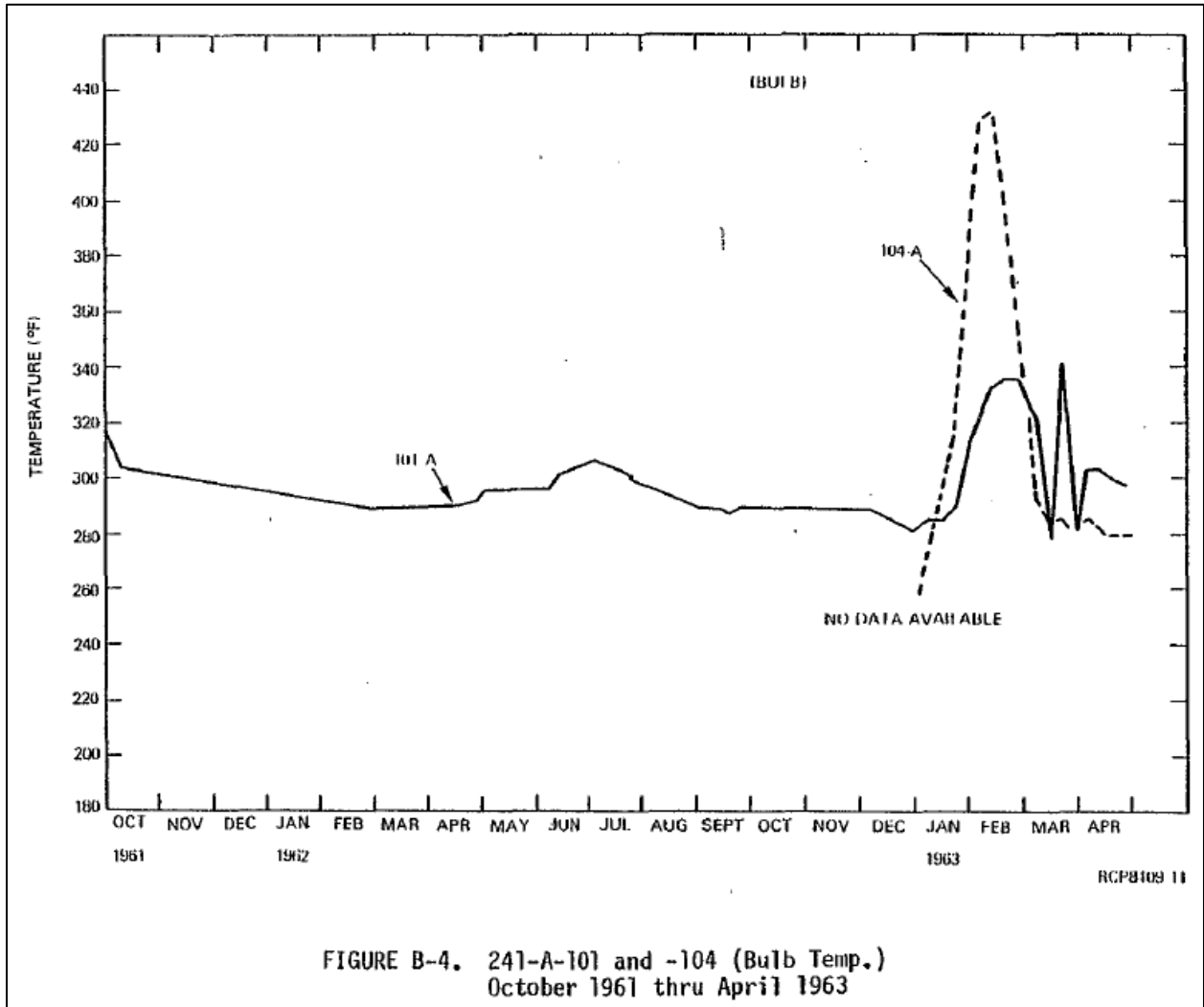
*** Did not boil until LW was routed to the tank.

Note: SX-111 was found to have been NaNO₃ Leached

APPENDIX B1

TANK A-104 TEMPERATURES DECEMBER 1962-MARCH 1970

Figure B1-1. RHO-CD-1172 Tank A-104 Temperature December 1962 through April 1963



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B1-2. RHO-CD-1172 Tank A-104 Temperature May 1963 through November 1964

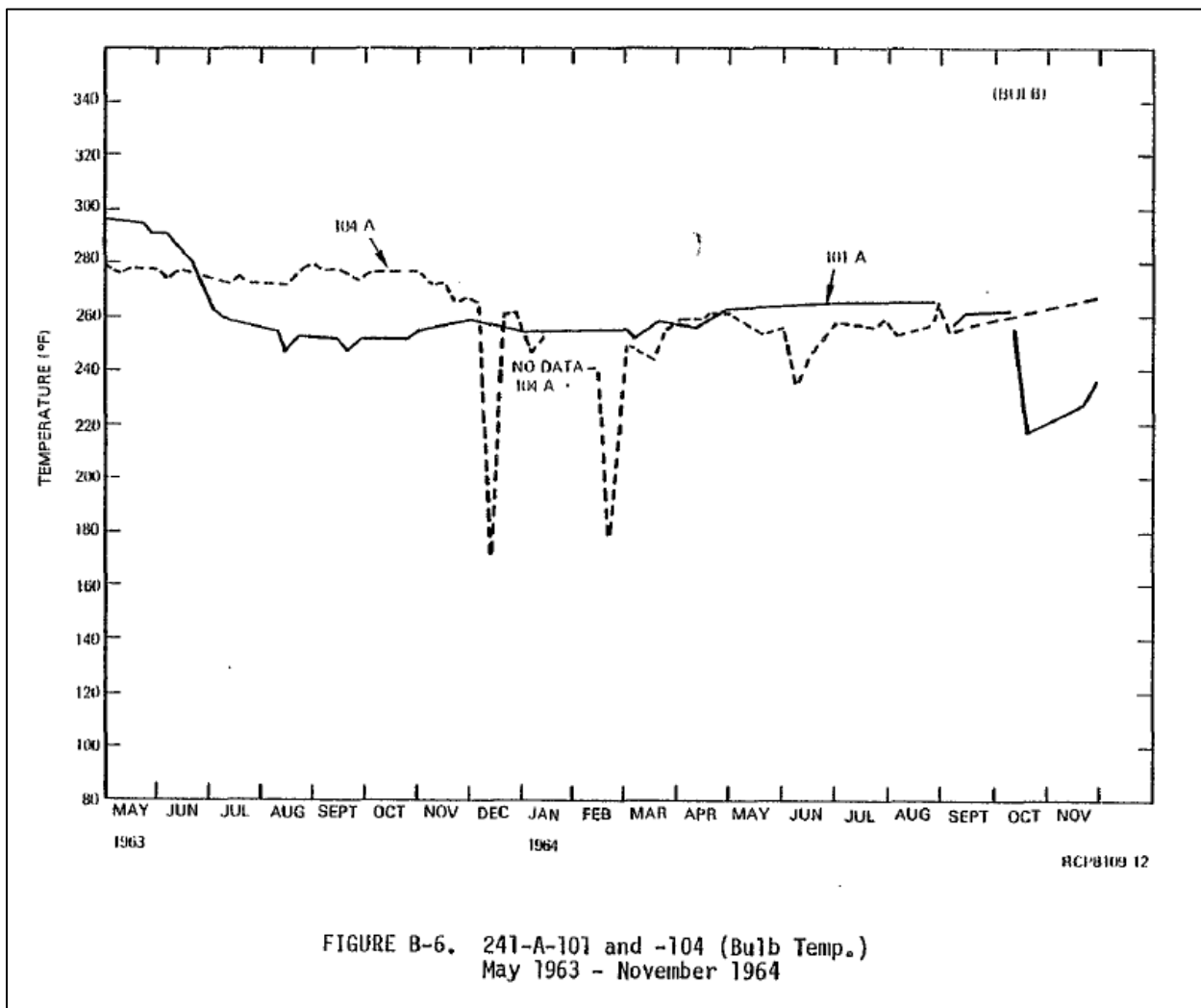
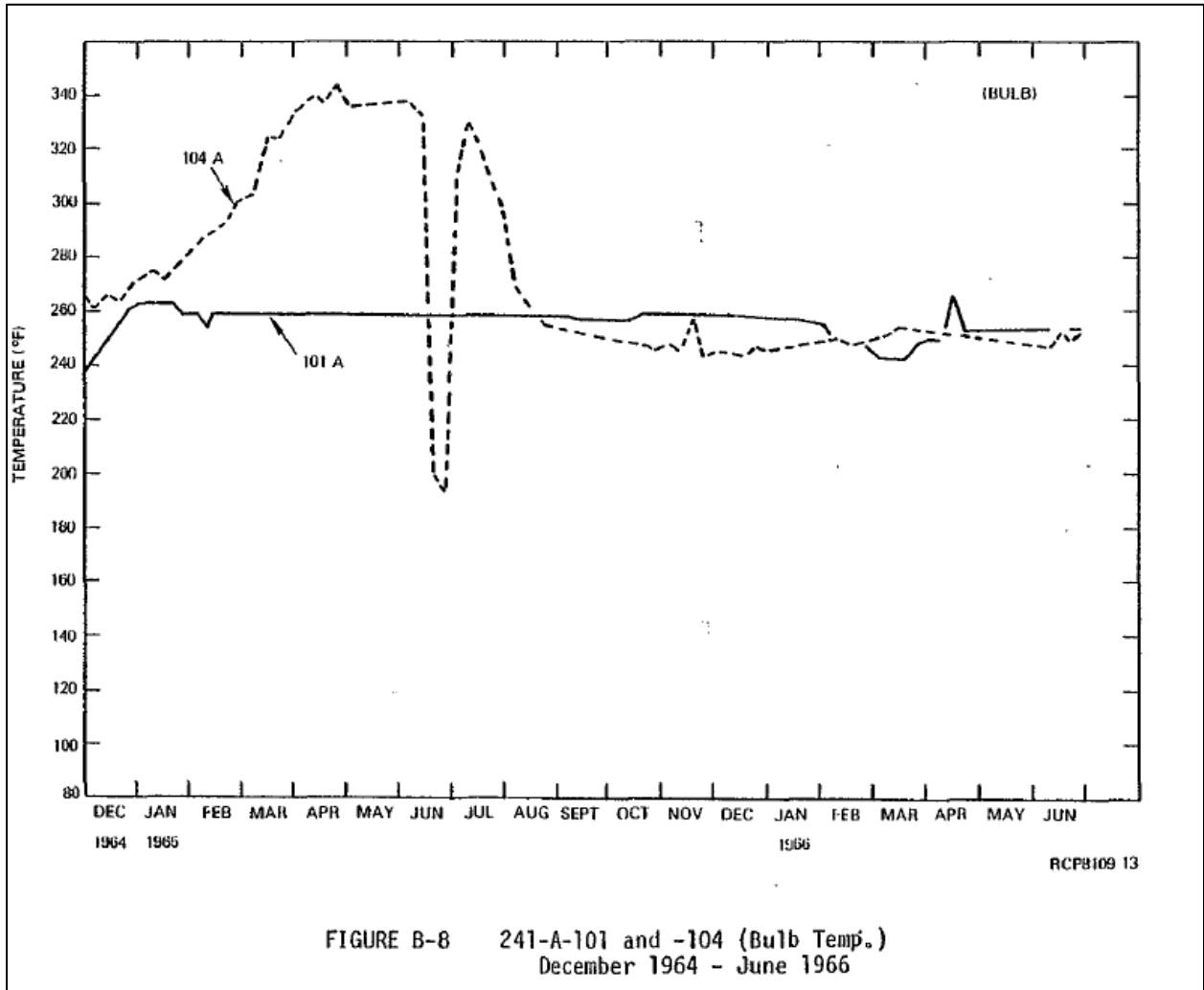
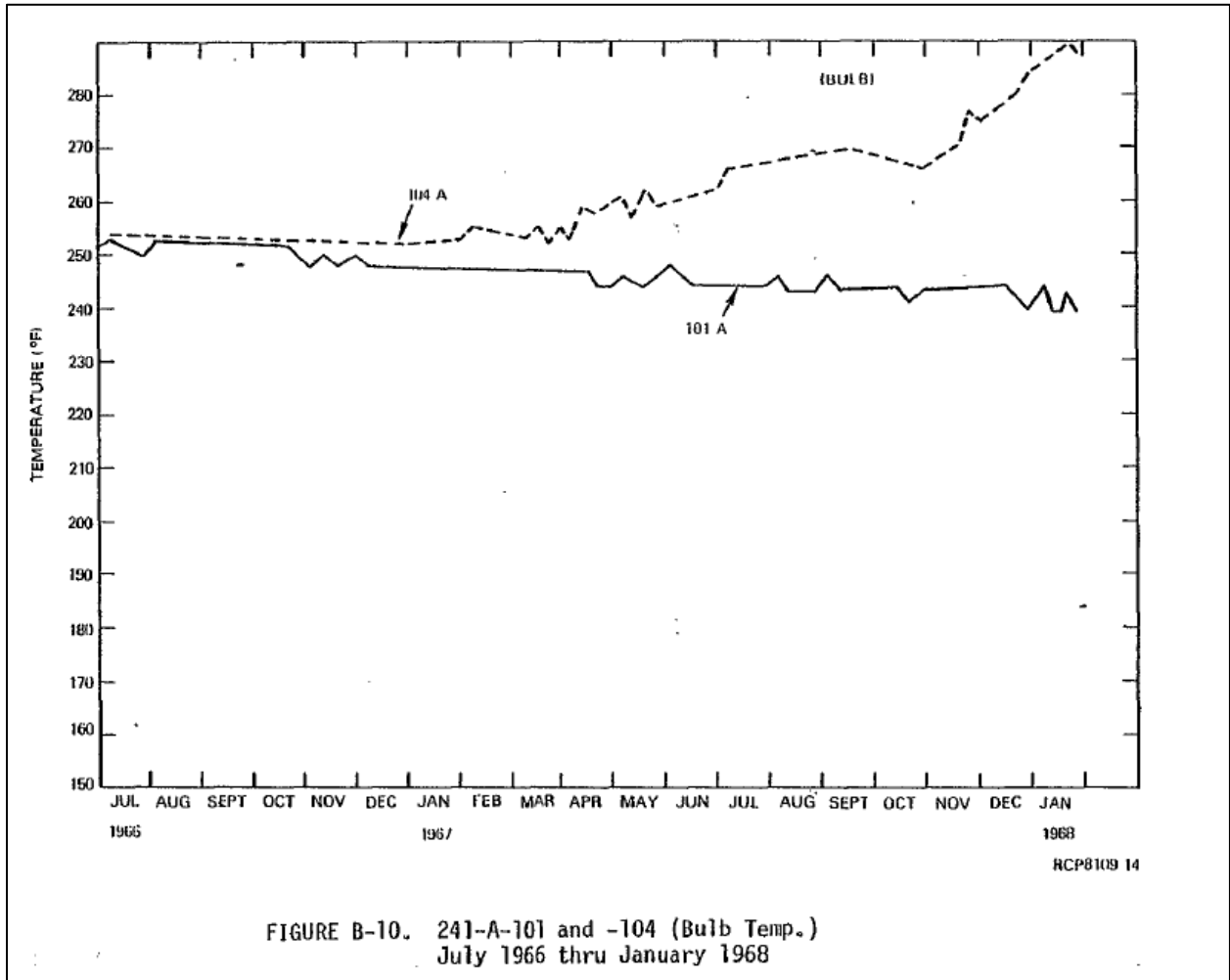


Figure B1-3. RHO-CD-1172 Tank A-104 Temperature December 1964 through June 1966



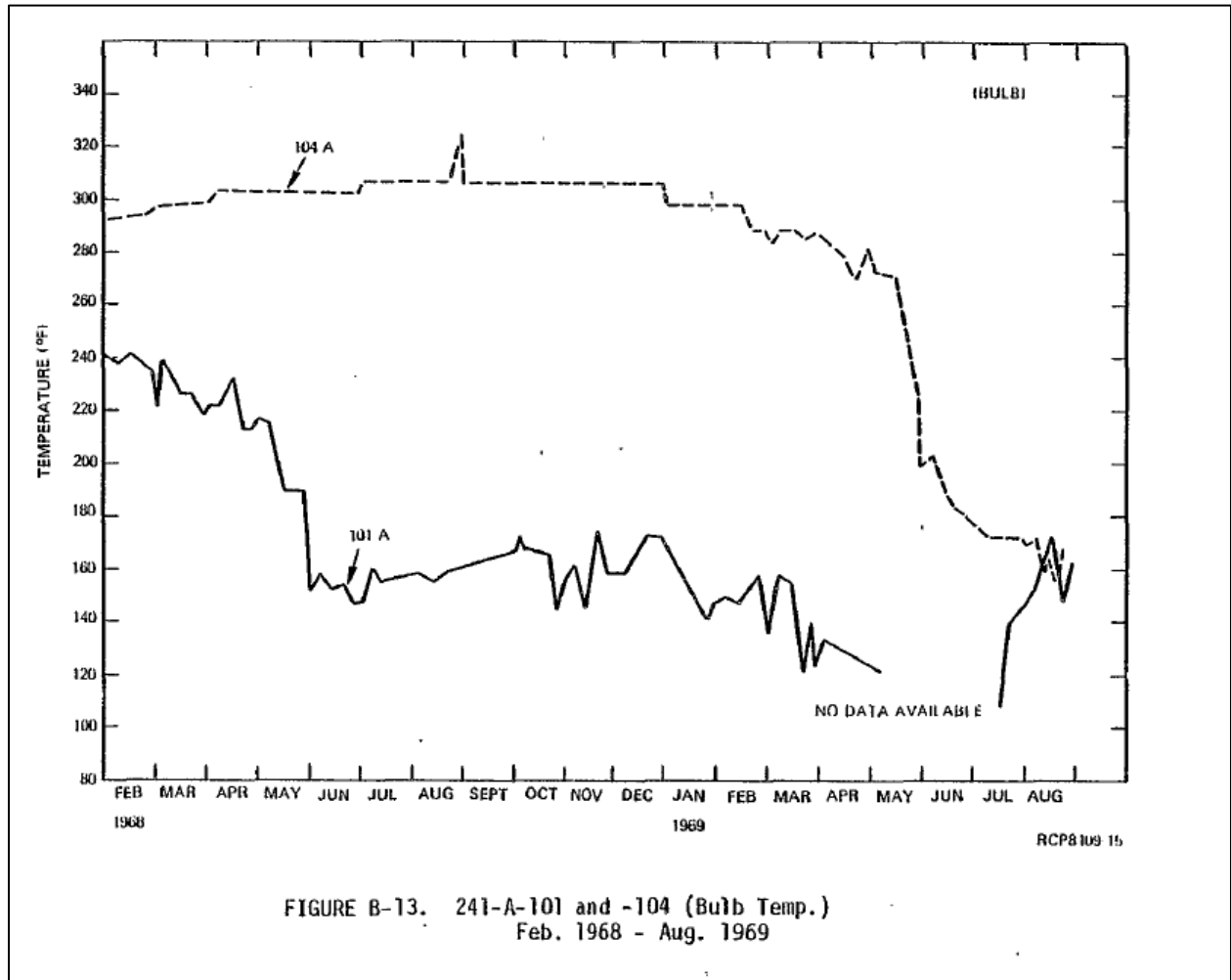
Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B1-4. RHO-CD-1172 Tank A-104 Temperature July 1966 through January 1968



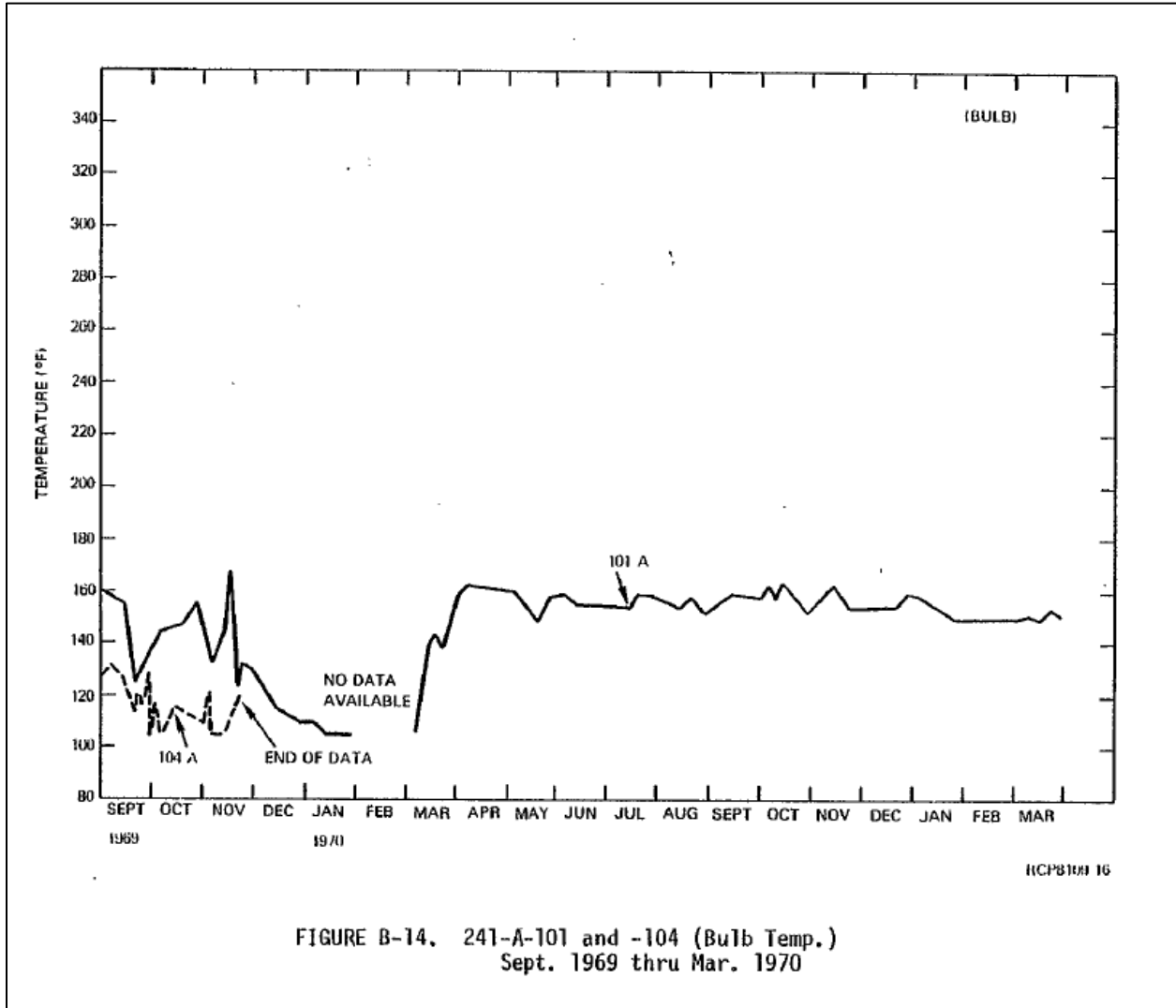
Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B1-5. RHO-CD-1172 Tank A-104 Waste Temperature February 1968 through August 1969



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B1-6. RHO-CD-1172 Tank A-104 Temperature September 1969 through March 1970



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

APPENDIX C1
TANK A-104 LATERAL ACTIVITY

**Table C1-1. Tank 241-A-104 Lateral Radioactivity (K counts per minute)
(July 1974 through June 1986)
(Occurrence Report 75-39) (1 of 4 sheets)**

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³
7/25/1974	< 25	N/A ¹	7/25/1974	< 25	N/A ¹	7/25/1974	< 25	N/A ¹
9/25/1974	< 60	N/A ¹	9/25/1974	< 60	N/A ¹	9/28/1974	< 55	N/A ¹
10/4/1974	< 90	N/A ¹	10/4/1974	< 90	N/A ¹	10/4/1974	< 55	N/A ¹
11/5/1974	< 50	N/A ¹	11/5/1974	< 90	N/A ¹	11/4/1974	< 50	N/A ¹
12/10/1974	< 30	N/A ¹	12/10/1974	< 30	N/A ¹	12/10/1974	< 30	N/A ¹
12/31/1974	< 30	N/A ¹	12/31/1974	< 30	N/A ¹	12/31/1974	< 50	N/A ¹
1/7/1975	< 50	N/A ¹	1/7/1975	< 50	N/A ¹	1/7/1975	< 75	N/A ¹
1/16/1975	< 50	N/A ¹	1/16/1975	< 50	N/A ¹	1/16/1975	< 60	N/A ¹
1/20/1975	< 60	N/A ¹	1/20/1975	< 50	N/A ¹	1/20/1975	< 55	N/A ¹
1/30/1975	< 30	N/A ¹	1/30/1975	< 35	N/A ¹	1/30/1975	< 50	N/A ¹
2/5/1975	< 30	N/A ¹	2/5/1975	< 35	N/A ¹	2/5/1975	< 50	N/A ¹
N/A ¹			2/11/1975	< 30	N/A ¹	2/11/1975	< 50	N/A ¹
N/A ¹			2/12/1975	< 50	N/A ¹	2/12/1975	< 55	N/A ¹
2/18/1975	< 55	N/A ¹	2/18/1975	< 60	N/A ¹	2/18/1975	< 50	N/A ¹
N/A ¹			2/25/1975	< 50	N/A ¹	2/25/1975	< 50	N/A ¹
3/4/1975	< 55	N/A ¹	3/4/1975	< 50	N/A ¹	3/4/1975	< 50	N/A ¹
N/A ¹			3/11/1975	< 60	N/A ¹	3/11/1975	< 50	N/A ¹
N/A ¹			3/18/1975	100	93.6	3/18/1975	< 60	N/A ¹
3/25/1975	< 65	N/A ¹	3/25/1975	305	93.6	3/25/1975	< 60	N/A ¹
4/8/1975	105	38.6	4/8/1975	220	67.6	4/8/1975	< 50	N/A ¹
				700	95.6			
4/8/1975	105	38.6	4/8/1975	200	67.6	4/8/1975	< 50	N/A ¹
				1170	95.6			
4/8/1975	155	38.6	4/8/1975	495	67.6	4/8/1975	< 60	N/A ¹
				1305	95.6			
N/A ¹			4/8/1975	420	67.6	N/A ¹		
N/A ¹				1860	95.6			
N/A ¹			4/8/1975	390	67.6	N/A ¹		
N/A ¹				1665	95.6			
N/A ¹			4/8/1975	375	67.6	N/A ¹		
N/A ¹				1725	95.6			
4/9/1975	210	38.6	4/9/1975	600	67.6	4/9/1975	< 50	N/A ¹
				1965	95.6			
N/A ¹			4/9/1975	855	67.6	4/9/1975	< 50	N/A ¹
N/A ¹				1980	95.6			

**Table C1-1. Tank 241-A-104 Lateral Radioactivity (K counts per minute)
(July 1974 through June 1986)
(Occurrence Report 75-39) (2 of 4 sheets)**

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³
N/A ¹			4/9/1975	615	67.6	N/A ¹		
				2055	95.6			
4/10/1975	205	38.6	4/10/1975	800	67.6	4/10/1975	< 50	N/A ¹
				2850	95.6			
4/11/1975	185	38.6	4/11/1975	750	67.6	N/A ¹		
				3100	95.6			
4/12/1975	205	38.6	4/12/1975	850	67.6	N/A ¹		
				3200	95.6			
4/13/1975	245	38.6	4/13/1975	1050	67.6	N/A ¹		
				2850	95.6			
4/14/1975	345	38.6	4/14/1975	1000	67.6	N/A ¹		
				3200	95.6			
4/15/1975	420	38.6	4/15/1975	950	67.6	N/A ¹		
				3350	95.6			
N/A ¹			4/16/1975	1150	67.6	N/A ¹		
				3800	95.6			
4/17/1975	465	38.6	4/17/1975	900	67.6	N/A ¹		
				3750	95.6			
N/A ¹			4/18/1975	1100	67.6	N/A ¹		
				4150	95.6			
4/19/1975	445	38.6	4/19/1975	750	67.6	N/A ¹		
				3750	95.6			
4/20/1975	475	38.6	4/20/1975	1100	67.6	4/20/1975	< 50	N/A ¹
				4850	95.6			
4/21/1975	680	38.6	N/A ¹			4/21/1975	95	96
4/22/1975	1785	38.6	4/22/1975	700	67.6	4/22/1975	205	96
				4350	95.6			
N/A ¹			4/23/1975	1100	67.6	N/A ¹		
				3900	95.6			
N/A ¹			4/24/1975	900	67.6	4/24/1975	390	96
				5250	95.6			
N/A ¹			4/25/1975	1150	67.6	N/A ¹		
				4450	95.6			
4/26/1975	1665	38.6	4/26/1975	900	67.6	4/26/1975	400	96
				4000	95.6			
4/27/1975	3400	38.6	4/27/1975	1750	67.6	N/A ¹		
				4750	95.6			

**Table C1-1. Tank 241-A-104 Lateral Radioactivity (K counts per minute)
(July 1974 through June 1986)
(Occurrence Report 75-39) (3 of 4 sheets)**

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³
4/28/1975	3650	38.6	4/28/1975	1050	67.6	4/28/1975	320	96
				5000	95.6			
4/29/1975	2450	38.6	N/A ¹			N/A ¹		
5/1/1975	2745	38.6	5/1/1975	1200	47	N/A ¹		
				4900	93			
5/2/1975	4350	38.6	N/A ¹			5/2/1975	480	96
5/5/1975	4520	38.6	N/A ¹			N/A ¹		
5/7/1975	4450	38.6	5/7/1975	1150	67.6	5/7/1975	325	96
				4550	95.6			
5/19/1975	650	45	N/A ¹			5/16/1975	365	96
	5800	35						
N/A ¹			N/A ¹			6/6/1975	280	96
6/9/1975	1350	45	6/9/1975	1000	47	6/9/1975	275	96
	6450	35		5300	93			
N/A ¹			N/A ¹			6/16/1975	235	98
N/A ¹			N/A ¹			6/23/1975	385	98
N/A ¹			N/A ¹			6/30/1975	365	98
N/A ¹			10/6/1975	997	48	10/6/1975	258	93
				7550	97			
1/7/1976	325	53	1/6/1976	720	48	1/6/1976	330	93
	450	46		5850	97			
	3380	34						
N/A ¹			2/24/1976	600	48	N/A ¹		
				300	84			
				5600	97			
4/6/1976	700	55	4/6/1976	1000	48	4/6/1976	220	93
	500	47		300	84			
	2100	35		5680	97			
N/A ¹			6/2/1976	5400	97	N/A ¹		
				600	48			
7/12/1976	750	38	7/12/1976	750	48	7/12/1976	273	94
	640	74		640	84			
	5580	87		5580	97			
10/4/1976	1100	55	N/A ¹			11/5/1976	180	93
	650	48						
	1100	37						

**Table C1-1. Tank 241-A-104 Lateral Radioactivity (K counts per minute)
(July 1974 through June 1986)
(Occurrence Report 75-39) (4 of 4 sheets)**

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³	Date	Peak (cpm)	Distance (ft) ³
3/3/1977	1260	55	3/3/1977	2310	97	3/1/1977	178	93
	575	48		400	48			
	780	37						
4/1/1977 ²	120	58.6	3/22/1977 ²	15000	125.5	3/22/1977 ²	60	76.6
	74	51.6		3600	115.5		17	21.6
	57	40.6		2400	71.5			
11/1/1977	88	59.6	N/A ¹			N/A ¹		
	67	53.6						
	28	42.6						
N/A ¹			2/10/1978	8100	125.5	1/4/1978	56	76.6
				5280	115.5		7.7	18.6
				2400	71.5			
6/8/1978	80	59.6	N/A ¹			N/A ¹		
	54	53.6						
	28	38.6						
12/5/1978	53	60.6	12/5/1978	2580	125.5	12/5/1978	36	76.6
	36	54.6		2400	115.5		23	75.6
	16	39.6		720	71.5		10.8	18.6
10/10/1979	30	59.6	10/10/1979	2160	126.5	N/A ¹		
	31	55.6		2760	115.5			
	14	40.6		900	78.5			
10/16/1980	12	49.6	10/16/1980	1320	121.5	10/16/1980	22	90.6
10/23/1981	11	54.6	10/23/1981	1320	122.5	10/23/1981	12	90.6
N/A ¹			N/A ¹			1/13/1982	9	89.6
12/15/1982	< 10	N/A ¹	12/15/1982	960	124.5	12/15/1982	< 10	N/A ¹
8/26/1983	< 10	N/A ¹	8/26/1983	960	122.5	8/26/1983	< 10	N/A ¹
9/15/1983	< 10	N/A ¹	9/15/1983	780	124.5	N/A ¹		
11/18/1983	< 10	N/A ¹	11/18/1983	840	124.5	N/A ¹		
10/15/1984	< 10	N/A ¹	10/15/1984	840	127.5	N/A ¹		
9/16/1985	< 10	N/A ¹	9/16/1985	720	126.5	N/A ¹		
6/20/1986	< 10	N/A ¹	6/20/1986	660	125.5	N/A ¹		

Note: ¹N/A: Data not available

²New monitoring equipment

³Length is distance from the caisson

APPENDIX D1

TANK A-104 GROSS GAMMA DRYWELL DATA

**Table D1-1. Tank 241-A-104 Drywell Radioactivity (K counts per minute) (January 1965 to November 1986)
(Drywell Data Sheets Retrieved on December 6, 2012 and SD-WM-TI-356) (1 of 2 sheets)**

10-04-01			10-04-04			10-04-05			10-04-07			10-04-08			10-04-10			10-04-12			10-05-09																																					
Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)																																			
1/7/1965	7	50	N/A ¹	1/7/1965	7	50	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	1/3/1965	600	6	1/7/65	15	15	6	50	6	70	7	73																																			
	6	70			8	70																		12	75																																	
	15	75			18	75																																																				
11/3/1965	5	60	N/A ¹	11/3/1965	6	70	10/28/1965	5	50	11/3/1965	6	60	11/3/1965	6	50	11/3/1965	500	6	11/3/65	6	16	9	74																																			
	9	75			15	75		5	73		8	75		6	60		6	60		25	19																																					
								10	75		5	70																																														
N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	11/12/1965	160	6	N/A ¹	5	50	N/A ¹	12	73																																						
N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	11/18/1965	380	6		N/A ¹	6		50	N/A ¹	11	75																																				
5.8	25	N/A ¹	11/22/1965	6	25	11/22/1965	5	25	11/22/1965	5.7	25	11/22/1965	5	25			11/22/1965		500		6	11/22/65	6	25	11/22/65	6	25																															
5.5	50			8	50		5.2	50		4.4	50		5.4	50	6.2	25		7	50																																							
7	73			5	70		5.9	70		5.5	70		5.8	70	5	50		5	50	5	70																																					
11	75			18	75		9.8	75		8.5	75		8.2	75	7.8	74		7.8	74	11	76																																					
N/A ¹	N/A ¹	N/A ¹	1/7/1966	N/A ¹	7	50	1/7/1966	7	50	1/7/1966	7	50	1/7/1966	7	50	1/21/1966	450	6	1/27/66	15	15	12	58																																			
																								N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹												
																																															12	58	7	70	6	70	8	74	8	50	6	50
																																															7	70	11	74	10	70	7	73				
8	75	8	75	8	75	8	75	15	75																																																	
N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹																																			
N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹	N/A ¹																																			
9/13/1972	< 6	N/A ¹	9/13/1972	< 6	N/A ¹	9/13/1972	< 6	N/A ¹	9/13/1972	< 12	N/A ¹	9/13/1972	< 12	N/A ¹	9/13/1972	< 12	N/A ¹	9/13/1972	< 12	N/A ¹	9/13/72	< 6	N/A ¹																																			
2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/1973	< 6	N/A ¹	2/1/73	< 6	N/A ¹																																			
4/9/1973	< 6	N/A ¹	4/9/1973	< 6	N/A ¹	4/9/1973	< 6	N/A ¹	4/4/1973	< 6	N/A ¹	4/4/1973	< 6	N/A ¹	4/4/1973	< 6	N/A ¹	4/9/1973	< 6	N/A ¹	4/9/1973	< 6	N/A ¹																																			
6/26/1973	< 6	N/A ¹	6/26/1973	< 6	N/A ¹	6/26/1973	< 6	N/A ¹	6/26/1973	< 6	N/A ¹	6/26/1973	< 6	N/A ¹	6/27/1973	< 6	N/A ¹	6/26/1973	< 6	N/A ¹	6/26/73	< 6	N/A ¹																																			
7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/1973	< 6	N/A ¹	7/5/73	< 6	N/A ¹																																			
8/10/1973	< 6	N/A ¹	N/A ¹	N/A ¹	N/A ¹	8/10/1973	< 6	N/A ¹	8/10/1973	< 6	N/A ¹	8/10/1973	< 6	N/A ¹	8/10/1973	< 6	N/A ¹	8/10/1973	< 6	N/A ¹	8/10/73	< 6	N/A ¹																																			
9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/1973	< 6	N/A ¹	9/6/73	< 6	N/A ¹																																			
10/4/1973	6.1	12	10/4/1973	< 6	N/A ¹	10/4/1973	6.8	20	10/4/1973	< 6	N/A ¹	10/4/1973	6.1	20	10/4/1973	6.5	11	10/4/1973	6.2	12	10/4/1973	6.2	36																																			
11/8/1973	9.5	17	11/9/1973	< 6	N/A ¹	11/9/1973	9.7	18	11/8/1973	9.5	17	11/8/1973	9.1	18	11/8/1973	9.6	11	11/8/1973	9.2	18	11/9/1973	8.5	17																																			
2/1/1974	< 6	N/A ¹	1/5/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹	2/7/1974	< 6	N/A ¹																																			
4/6/1974	< 6	N/A ¹	4/6/1974	< 6	N/A ¹	4/6/1974	< 6	N/A ¹	4/6/1974	< 3	N/A ¹	4/6/1974	< 12	N/A ¹	4/6/1974	< 12	N/A ¹	4/6/1974	< 12	N/A ¹	4/6/74	< 6	N/A ¹																																			
5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹	5/4/1974	< 6	N/A ¹																																			
6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹	6/6/1974	< 6	N/A ¹																																			
7/8/1974	< 3	N/A ¹	7/8/1974	< 6	N/A ¹	7/8/1974	< 6	N/A ¹	7/8/1974	< 6	N/A ¹	7/8/1974	< 6	N/A ¹	7/1/1974	< 6	N/A ¹	7/1/1974	< 6	N/A ¹	7/1/1974	< 6	N/A ¹																																			
8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹	8/5/1974	< 6	N/A ¹																																			
9/2/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹	9/9/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹	9/2/1974	< 6	N/A ¹																																			
10/14/1974	< 3	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹	10/14/1974	< 6	N/A ¹																																			
11/4/1974	< 6	N/A ¹	11/14/1974	< 6	N/A ¹	11/4/1974	< 6	N/A ¹	11/4/1974	< 6	N/A ¹	11/4/1974	< 6	N/A ¹	11/4/1974	< 6	N/A ¹	11/4/1974	< 6	N/A ¹	11/4/74	< 6	N/A ¹																																			
12/17/1974	< 6	N/A ¹	12/10/1974	< 6	N/A ¹	12/10/1974	< 6	N/A ¹	12/9/1974	< 6	N/A ¹	12/9/1974	< 6	N/A ¹	12/9/1974	< 6	N/A ¹	12/16/1974	< 6	N/A ¹	12/2/1974	< 6	N/A ¹																																			

**Table D1-1. Tank 241-A-104 Drywell Radioactivity (K counts per minute) (January 1965 to November 1986)
(Drywell Data Sheets Retrieved on December 6, 2012 and SD-WM-TI-356) (2 of 2 sheets)**

10-04-01			10-04-04			10-04-05			10-04-07			10-04-08			10-04-10			10-04-12			10-05-09		
Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)
1/13/1975	< 3	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/1975	< 6	N/A ¹	1/13/75	< 6	N/A ¹
7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/1975	< 3	N/A ¹	7/14/75	< 3	N/A ¹
1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/1976	< 3	N/A ¹	1/5/76	< 3	N/A ¹
11/15/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	11/22/1976	< 3	N/A ¹	12/6/76	< 3	N/A ¹
6/21/1977	< 3	N/A ¹	6/13/1977	< 3	N/A ¹	6/20/1977	< 3	N/A ¹	6/6/1977	< 3	N/A ¹	6/6/1977	< 3	N/A ¹	6/6/1977	< 3	N/A ¹	6/6/1977	< 3	N/A ¹	6/15/77	< 3	N/A ¹
10/31/1977	< 3	N/A ¹	11/28/1977	< 3	N/A ¹	10/31/1977	< 3	N/A ¹	10/31/1977	< 3	N/A ¹	10/31/1977	< 3	N/A ¹	10/31/1977	< 3	N/A ¹	10/31/1977	< 3	N/A ¹	11/28/77	< 3	N/A ¹
12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/1978	< 3	N/A ¹	12/19/78	< 3	N/A ¹
12/17/1979	< 3	N/A ¹	12/19/1979	< 3	N/A ¹	12/17/1979	< 3	N/A ¹	12/17/1979	< 3	N/A ¹	12/19/1979	< 3	N/A ¹	12/3/1979	< 3	N/A ¹	12/17/1979	< 3	N/A ¹	12/19/79	< 3	N/A ¹
10/7/1980	< 3	N/A ¹	12/15/1980	< 3	N/A ¹	10/7/1980	< 3	N/A ¹	10/7/1980	< 3	N/A ¹	10/7/1980	< 3	N/A ¹	10/7/1980	< 3	N/A ¹	10/7/1980	< 3	N/A ¹	12/15/80	< 3	N/A ¹
10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/1981	< 3	N/A ¹	10/19/81	< 3	N/A ¹
12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/1982	< 3	N/A ¹	12/13/82	< 3	N/A ¹
11/15/1983	< 3	N/A ¹	11/15/1983	< 3	N/A ¹	11/15/1983	< 3	N/A ¹	11/15/1983	< 3	N/A ¹	11/15/1983	< 3	N/A ¹	11/15/1983	< 3	N/A ¹	11/21/1983	< 3	N/A ¹	11/15/83	< 3	N/A ¹
11/15/1984	< 3	N/A ¹	10/15/1984	< 3	N/A ¹	11/15/1984	< 3	N/A ¹	10/15/1984	< 3	N/A ¹	10/15/1984	< 3	N/A ¹	10/15/1984	< 3	N/A ¹	10/15/1984	< 3	N/A ¹	10/17/84	< 3	N/A ¹
9/16/1985	< 3	N/A ¹	9/20/1985	< 3	N/A ¹	6/11/1985	< 3	N/A ¹	6/11/1985	< 3	N/A ¹	6/11/1985	< 3	N/A ¹	6/11/1985	< 3	N/A ¹	6/11/1985	< 3	N/A ¹	9/16/85	< 3	N/A ¹
6/16/1986	< 3	N/A ¹	11/13/1986	< 3	N/A ¹	6/19/1986	< 3	N/A ¹	6/19/1986	< 3	N/A ¹	6/16/1986	< 3	N/A ¹	6/16/1986	< 3	N/A ¹	6/16/1986	< 3	N/A ¹	11/13/86	< 3	N/A ¹

Note: ¹N/A: Data not available

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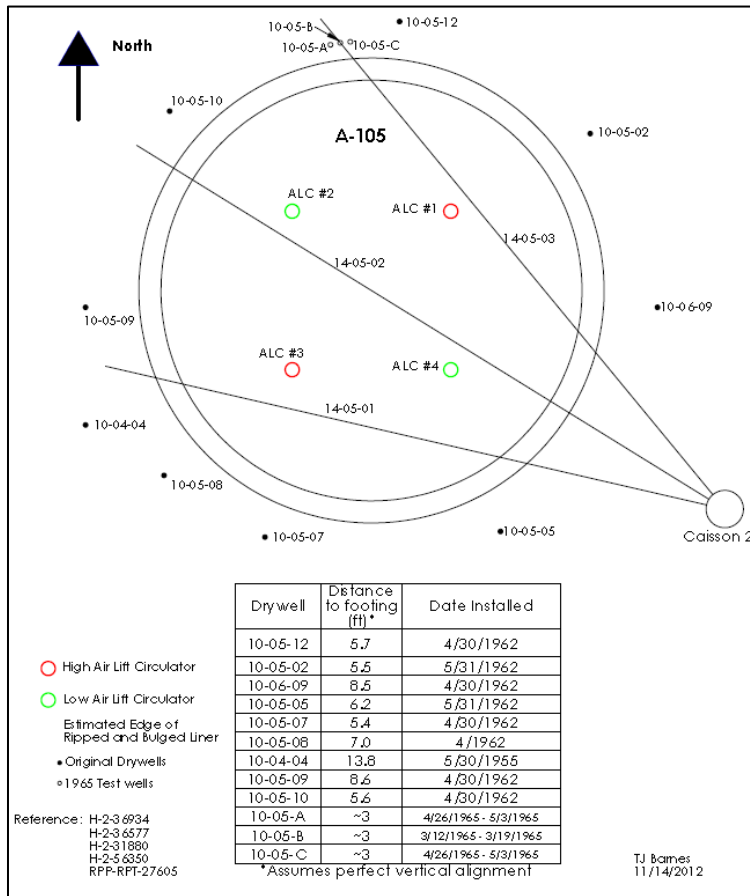
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5.1 TANK A-105 BACKGROUND HISTORY

This section provides information on the historical waste loss event associated with single-shell tank (SST) 241-A-105 (A-105). Tank A-105 has three laterals installed in 1962-1963 about 10-ft under the tank (see Figure 5-1). There are nine drywells located around tank A-105 with specified distances from the drywell to the tank footing shown in Figure 5-1: 10-06-09, 10-05-05, 10-05-07, 10-05-08, 10-04-04, 10-05-09, 10-05-10, and 10-05-12 installed in April 1962 and 10-05-02 installed in May 1962. Three additional wells were drilled in 1965 near the north end of lateral 14-05-03 (see Section 5.5.1).

The bottom of the tank footing is ~47-ft 10-in Below Grade Surface (BGS) with ~7.5-ft soil cover over the dome (WHC-SD-WM-TI-665, *Soil Load above Hanford Waste Storage Tanks*; H-2-55911, *Waste Storage Tanks Composite Section*). Inside tank A-105 are four air lift circulators (ALCs) terminating 18-in above the tank bottom and equally spaced on a 40-ft diameter circle as shown in Figure 5-1 (H-2-56350, *Arrangement Air-Lift Circulators*). Two ALCs are designated low ALCs (8-ft 6-in tall) and two are high ALCs (17-ft 6-in tall) (H-2-56342, *Details Air-Lift Circulator*).

Figure 5-1. Tank A-105 Associated Drywells and Laterals
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



5.2 TANK A-105 OPERATIONS SUMMARY

Tank A-105 was constructed from February 1954 to January 1955 and sat unused until May 1962. After A Farm startup in 1955, each tank received 6-in of water as protection against possible bottom liner lifting from vacuum generated by the ventilation exhaust blower during equipment testing (ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and its Implications on Waste Containment and Control*). Tank A-105 liquid level gradually increased from 6-in of water in 1955 to 18-in of water in May 1962 from accumulation of water additions to various vapor seals over the seven year period.

Tank A-105 started receiving aged Plutonium Uranium Extraction (PUREX) (fuels reprocessing) Plant high level waste (HLW) supernatant from tank A-103 in May 1962. Tank A-105 received 330 kgal of PUREX HLW supernatant over the period of 20 days during this first addition. After initially receiving waste, waste temperatures rose from approximately 115°F to 133°F over the 20 day period which may not have resulted in the complete removal of grout moisture (see Section 5.4.2). Additional aged PUREX HLW supernatant was added to tank A-105 from tanks A-103 and A-102 in December 1962 and the temperature increased to 150°F. In January 1963 the contents of tank A-105 were pumped to tanks C-103 and A-101 leaving a 10-in heel of waste in A-105. Thermally hot condensate was added to tank A-105 to heat the tank in preparation to receive HLW directly from the PUREX Plant.

Beginning in February 1963, tank A-105 began receiving HLW directly from the PUREX Plant. Temperatures rose from approximately 110°F at the end of January 1963 to 210°F over 28 days during this time and the temperature rate of rise was ~3.3°F per day. PUREX HLW contained significant concentrations of fission products that resulted in the waste self-boiling. Tank A-105 was brought up to boiling temperatures at a nearly uniform rate with HLW and reached boiling on March 5, 1963. Waste temperatures for tank A-105 were generally maintained between 180°F and 285°F from February 1963 through March 1965 (RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*, pages B-39 to B-45). It was reported in RPP-ENV-37956 that the maximum waste temperature was approximately 320°F in March 1963 for tank A-105. However, it appears this was an anomaly as temperatures were below 275°F (RHO-CD-1172) during this period and waste temperatures never reached above 300°F (see Figure 5-2).

In September 1963 unexplained liquid level fluctuations were noted, some as large as 33 kgal (or 12-in) (WHC-MR-0264, *Tank 241-A-105 Leak Assessment*). It was assumed that these liquid level fluctuations were the result of steam forming under the tank liner and deforming it upward. As temperature levels dropped, the liquid levels dropped further supporting the steam theory (WHC-MR-0264).

On November 19, 1963, there were indications that tank A-105 developed a small leak because of radioactivity detected in lateral 14-05-03. Tank A-105 was about half filled at this time (ARH-78). Radioactivity in lateral 14-05-03 was reported to be 17,000 counts per minute (cpm) and increased to 150,000 cpm seven days later. The tank level had been raised from 260-in to 280-in four months earlier. It was reported in WHC-MR-0264, "This led to the assumption that

the radiation reading in the lateral was due to a side wall leak, so the level was reduced to 260 inches. This action resulted in a slow reduction in radioactivity in the lateral, which led the operators to the conclusion that the leak was indeed in the side wall or was minor and had self-healed.” The liquid level was reduced to 260-in in December 1963 (WHC-MR-0264). From 150,000 cpm reported in November 1963, the radioactivity in lateral 14-05-03 decreased by a factor of three to approximately 50,000 cpm by March 1965 (ARH-78).

Since radioactivity in the lateral 14-05-03 decreased, it was assumed the tank was no longer leaking. Tank A-105 was then gradually filled and by October 1964, the liquid level had reached the suspected leak zone with no indication of further leakage. The tank was considered operational and was filled to capacity in December 1964 (WHC-MR-0264). In January 1965, tank A-105 contained 866 kgal of waste. Periodic transfers of PUREX cell drainage and flush solutions were added to the tank through June 1965 when space became available in tank A-105 as a result of waste evaporation (RL-SEP-659, *Chemical Processing Department Waste Status Summary January 1, 1965 through June 30, 1965*).

On January 28, 1965, tank A-105 experienced a rapid pressurization event that resulted in the tank liner bulging upward as much as 8 ½-ft (see Section 5.4.3). Later visual inspection would show that the floor liner had separated from the wall liner around 75% of the tank's perimeter (TRAC-0022, *An Estimate of Bottom Topography, Volume, and Other Conditions in Tank 105A, Hanford, Washington* [Woodward-Clyde]). The maximum recorded temperature of ~285°F was in January/February 1965 (see Figure 5-2). Radioactivity was detected in March 1965 in a small area of lateral 14-05-03 in the north portion underneath the edge of the tank. However, there was no change in the waste surface level, and the tank continued to actively store waste until February 1968. The tank liquid level was maintained between 850 to 887 kgal through January 1968 by addition of water. In October 1967, radioactivity was also detected in lateral 14-05-02 beneath tank A-105 in the northwestern portion of the tank (WHC-MR-0264). Shortly before the pressurization event, a letter written November 17, 1964 reports, “*Tank 105-A now contains more waste, in terms of equivalent tons of uranium production, than any other tank*” (RL-SEP-87, *PUREX Waste Tank 241-A-105 Fill Limit*). Also stated in RL-SEP-87 was the recommendation that HLW additions to tank A-105 should be stopped when the tank contains waste representing 11,000 tons of uranium production, which was 22% higher than the amount added to any prior filled waste tank. The basis for filling tank A-105 used an 8M sodium ion limit to indirectly control the waste temperature during the fill period (HW-74914, *PUREX Tank Farm Fill Program*).

In April 1967, a cyclic liquid level variation began to occur in tank A-105 (ARH-78). A typical cycle consisted of a 9 to 10-in drop in liquid level in a matter of minutes followed by a relatively stable period lasting about 20 hours. The liquid level then gradually returned to its original level in about a day. No significant movement of the steel liner could be detected during this time. It was assumed the explanation for this cyclic liquid level variation was due to the area between the bulged tank liner and concrete pad alternating between a vapor and liquid phase (ARH-78).

In February 1968, the supernatant in tank A-105 was transferred out of the tank to tank A-103 (leaving approximately 1-ft of supernatant cover over the sludge at the bulged area) and eventually to the 221-B Plant for cesium recovery processing (Interoffice Memorandum 7G420-06-004, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration during Sluicing in August 1968"). The residual PUREX HLW supernatant in tank A-105 was subsequently diluted using dilute waste from tank A-101 from February 25, 1968 through March 24, 1968. From April 20, 1968 through June 1968, cesium denuded supernatant from 221-B Plant operations was used to further dilute seven times the supernatant heel in tank A-105 in preparation for sluicing the sludge. The Cs-137 concentration in the cesium denuded supernatant from 221-B Plant used to dilute the HLW supernatant in tank A-105 was an average of 1.38 Ci/gal (0.58 Ci/gal decay corrected to January 2006) (Interoffice Memo 7G420-06-004). The flushes of the supernatant heel in tank A-105 were transferred to tank A-103, then to tank AX-102, and finally to 221-B Plant for cesium recovery processing.

Following the dilution and flushing of tank A-105 supernatant heel, two sluicing campaigns were conducted to remove the sludge from tank A-105. The first sluicing campaign began August 14, 1968, using the dilute supernatant in tank A-102 that was transferred to tank A-103 (Interoffice Memo 7G420-06-004). The Cs-137 concentration of the sluicing fluid was estimated to be 0.53 Ci/gal to 0.58 Ci/gal (decay corrected to January 2006). The sludge sluiced from tank A-105 was transferred into tank A-103. After starting tank A-105 sluicing on August 14, 1968, radioactivity in laterals 14-05-01 and 14-05-02 initially increased. After three weeks, radiation levels in laterals 14-05-01 and 14-05-02 were reported to be relatively stable and sluicing continued (see Section 5.5.1). Sluicing of tank A-105 was halted in November 1968 when little of the remaining sludge could be removed. Approximately half of the sludge was removed during this first sluicing campaign.

Samples of the remaining sludge in tank A-105 were obtained and tested to evaluate methods to expedite further sludge removal from this tank. Inhibited 1M H₂SO₄ was demonstrated to effectively soften the tank A-105 sludge samples (Internal Letter from W. C. Schmidt and P. W. Smith to R. E. Smith, "Dissolution of TK-105-A Sludge with Inhibited Sulfuric Acid," December 23, 1968).

As stated in ARH-1515, *Atlantic Richfield Hanford Company Semiannual Report Process Development May 1, 1969 through October 31, 1969*, page 130,

"Approximately 750 gallons of 1M sulfuric acid, containing 1,500 ppm of the inhibitor, Rhodine A, were sprayed onto the top two-inch layer of hard cake in Tank 105-A. The acid was sprayed at 2.5 gpm in a semi-circular pattern in the center of the tank. Following addition of the acid, this area of the tank was sluiced for 35 hours. A comparison of photographs taken before adding acid and after sluicing indicated that the sludge in the test area was successfully removed."

Cesium denuded supernatant, generated in the 221-B Plant and contained in tank A-103, was again used as the sluicing fluid. The sludge sluiced from tank A-105 was transferred into tank

A-103 (Interoffice Memo 7G420-06-005, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration during Second Sluicing Campaign Conducted July 1969 through November 1970"). No additional sludge removal activities in tank A-105 were conducted until August 25, 1970.

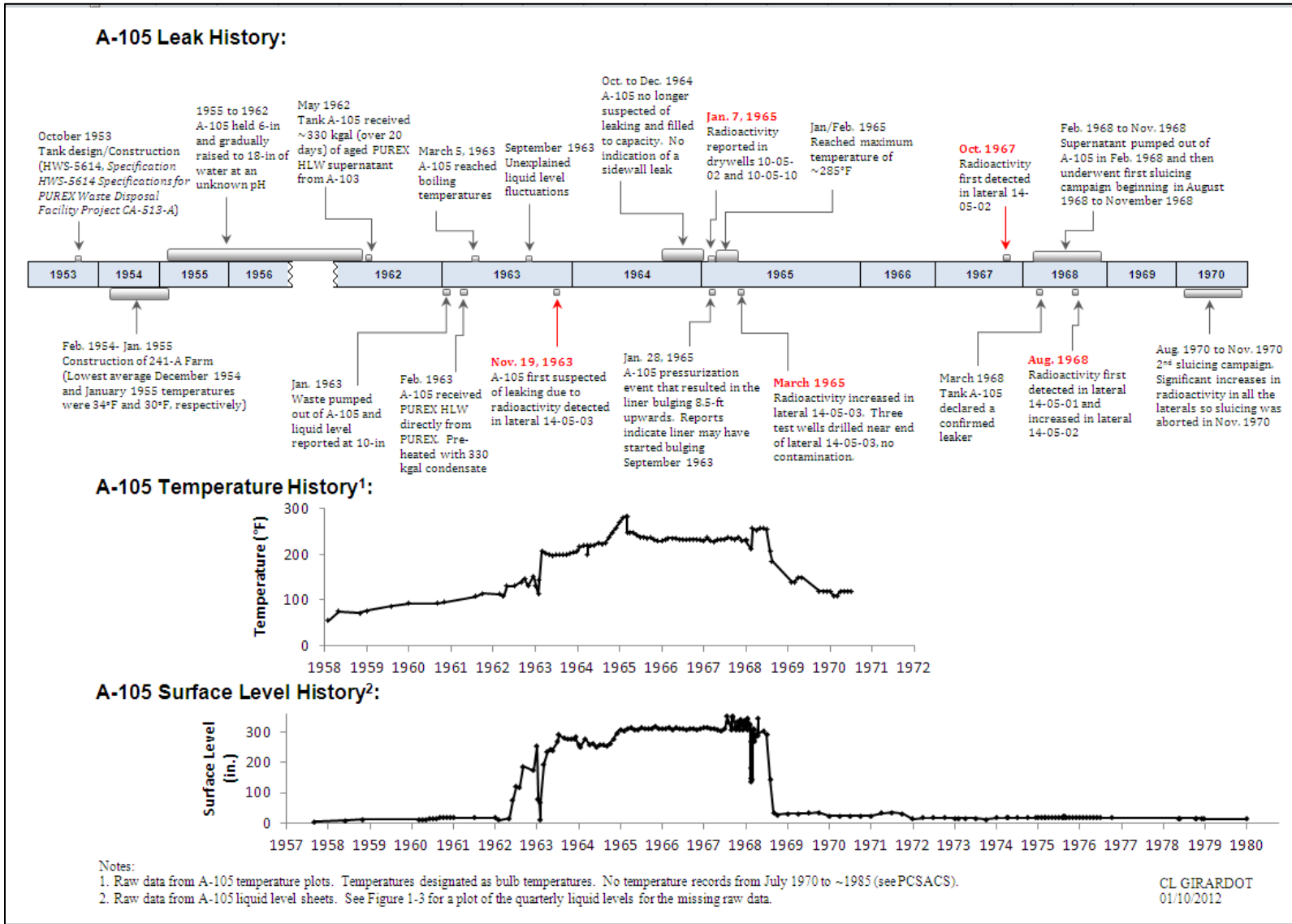
Inhibited sulfuric acid was again used on August 25, 1970 to soften the sludge in tank A-105. The softened sludge was then sluiced using cesium denuded supernatant contained in tank A-103. The sludge slurry was transferred from tank A-105 to A-103. Following the completion of this phase of the sludge removal from tank A-105, approximately 33 kgal of supernatant and 33 kgal of sludge were reported to remain within the tank. The supernatant contained in tank A-105 was described as being a mixture of 221-B Plant cesium ion exchange waste (i.e. cesium denuded ion exchange waste) and PUREX HLW. The estimated concentration of the cesium denuded supernatant used to conduct sluicing of tank A-105 sludge to tank A-103 from August to November 1970 was 0.51 Ci/gal, decayed to January 2006 (Interoffice Memo 7G420-06-005). In November 1970, significant increases in radioactivity were reported for all the laterals under tank A-105 indicating that leaks were active. Therefore, sluicing operation was aborted on November 17, 1970.

In 1977 stereoscopic photographs were taken along with sludge levels and other measurements to determine the amount of sludge remaining in the tank as well as develop a topographical map of the tank bottom (TRAC-0022). The topographical map of the tank bottom produced in 1977 clearly shows the bottom of the steel liner is ripped and separated from the sidewall along approximately $\frac{3}{4}$ of the tank bottom (see Section 5.4.3 for additional details).

Following the sluicing of the waste, water was periodically added to tank A-105 from November 1970 through December 1978 for evaporative cooling of the remaining sludge. An estimated 610 kgal of water was added to tank A-105 for cooling and flushing of the ALCs (WHC-MR-0264, page 22). The estimated amount of water evaporated from tank A-105 from November 1970 through December 1978 is 378 to 410 kgal (WHC-EP-0410, *Tank 241-A-105 Evaporation Estimate 1970 through 1978*). Therefore, an estimated 200 to 232 kgal of water are unaccounted for and may have leaked from tank A-105. The estimated overall leak volume for tank A-105 is between 10 kgal to 277 kgal, updated as of 1991 (WHC-EP-0182, Rev. 42). The estimated leak volume for the initial leak prior to August 1968 was 5 kgal to 15 kgal, and the estimated leak volume while the tank was being sluiced August 1968 to November 1970 was between 5 kgal and 30 kgal (WHC-MR-0264). Tank A-105 was declared interim stabilized in March 1979.

The operational history of tank A-105 leak related details including temperature and liquid level is charted in Figure 5-2.

Figure 5-2. Operational Leak History of Tank A-105



5.3 TANK DESIGN/CONSTRUCTION

5.3.1 Tank Design

The A Farm tanks had multiple design features that could contribute to stresses or possible leak paths when the tank was being operated including:

- Orthogonal intersection between the flat steel bottom and the sidewall
- Fillet weld used between the bottom and sidewall intersection
- Less rigorous weld inspection testing
- Partial asphaltic membrane waterproofing

These features are common to all A Farm tanks (see Section 3.1.1).

5.3.2 Tank Construction Conditions

A Farm was constructed from February 1954 to January 1955. Minimum temperatures of 32°F and below were experienced on 108 days during construction; however, no minimum temperatures below 0°F were experienced. The lowest average temperatures occurred in December 1954 at 34°F and January 1955 at 30°F with four months having at least one minimum temperature between 14°F and 18°F (PNNL-15160, *Hanford Site Climatological Summary 2004 with Historical Data*).

As described in Section 3.1.2, cold weather affects the ductile-to-brittle steel transition temperature, with 18°F being the assumed unrestricted low temperature construction limitation for the carbon steel liner, which could result in a fracture upon impact. Temperatures during the A Farm construction time frame were milder than those experienced during 241-SX Farm construction where ductile-to-brittle steel transition temperatures were exceeded.

Weather precautions for welding and concrete were specified in HW-4926-S, *Standard Specification for Welding Carbon Steels* (see Section 3.1.2).

5.4 TANK A-105 IN-TANK DATA

5.4.1 Liquid Level

Radioactivity was first detected in lateral 14-05-03 in November 1963, when the tank was half filled. Four months earlier, the liquid level in tank A-105 was raised from 260-in to 280-in. This led to the assumption that the radioactivity detected in lateral 14-05-03 was due to a sidewall leak, so the liquid level was reduced to 260-in in December 1963 (WHC-MR-0264). This action resulted in a slow reduction in radioactivity in lateral 14-05-03. It was concluded that the leak was indeed a sidewall leak or was minor and had self-healed. This conclusion and the fact that no storage capacity was available to receive the tank contents resulted in a decision to maintain the tank at this level. The tank remained in standby condition until enough water had boiled off to reach the maximum allowable salt concentration limit.

Prior to radioactivity being detected in lateral 14-05-03, unexplained liquid level fluctuations were noted in September 1963, some increases as large as 12-in (33 kgal). Document WHC-MR-0264 reports, *“This indicates that steam was probably forming under the tank liner and deforming it upward at this early date. In one case, following an unexplained rise in the tank level, the data indicated that a drop in level was associated with a temperature drop, further supporting the steam theory.”*

With the conclusion that the possible sidewall leak in tank A-105 had self-healed, tank A-105 was kept in service and by December 1964, the tank was filled to its calculated metric tons of uranium equivalent capacity of approximately 315-in (RL-SEP-87).

The tank was gradually refilled with no indication of leakage and the tank was considered operational. On January 28, 1965 when the steam release occurred in tank A-105, liquid levels were reported to be between 305-in and 320-in. Liquid levels were apparently not a focus during this time and no reports of unexplained liquid level changes were found. The tank continued to actively store waste until February 1968 with the liquid level maintained between 850 to 887 kgal by addition of water. In April 1967, a cyclic liquid level variation began to occur in tank A-105 (ARH-78). A typical cycle consisted of a 9 to 10-in drop in liquid level in a matter of minutes followed by a relatively stable period lasting about 20 hours. The liquid level then gradually increased to its original level in about a day. No significant movement of the steel liner could be detected during this time. It was assumed the explanation for this cyclic liquid level variation was due to the area between the bulged tank liner and its concrete pad alternates between a vapor and liquid phase (ARH-78).

From February to August 1968, the supernatant was pumped out of tank A-105 in preparation for the first sluicing campaign leaving the liquid level at approximately 35-in.

The liquid level plot in Figure 5-3 indicates the transfers into and out of the tank. The liquid levels are end of quarter levels so this figure may not reflect all significant transfers into and out of tank A-105 that occurred during the operational history of the tank. See Figure 5-2 for historical monthly liquid level readings.

Tank Thermal Histories, pages B-39 to B-45). It was reported in RPP-ENV-37956 that the maximum waste temperature was approximately 320°F in March 1963 for tank A-105. However, it appears this was a reporting anomaly as temperatures were below 275°F during this period and waste temperatures never reached above 300°F during operation (see Figure 5-2).

On January 28, 1965, tank A-105 experienced a rapid pressurization event that resulted in the tank liner bulging. During this time, waste temperatures increased from 270°F to the maximum temperature of approximately 285°F in January and February 1965 (see Figure 5-2). On March 11, 1965, when the bulb thermocouple was replaced, temperatures were reported to be approximately 250°F and remained relatively stable through June 1968. Temperatures then started to decline after removal of the tank A-105 supernatant in preparation for the sluicing with a temperature of 120°F recorded in June 1970. Waste temperatures for tank A-105 were recovered from May 1958 through June 1970 (see Appendix B2); however, no temperature data were recovered after June 1970 until 1985 (see Figure 5-2).

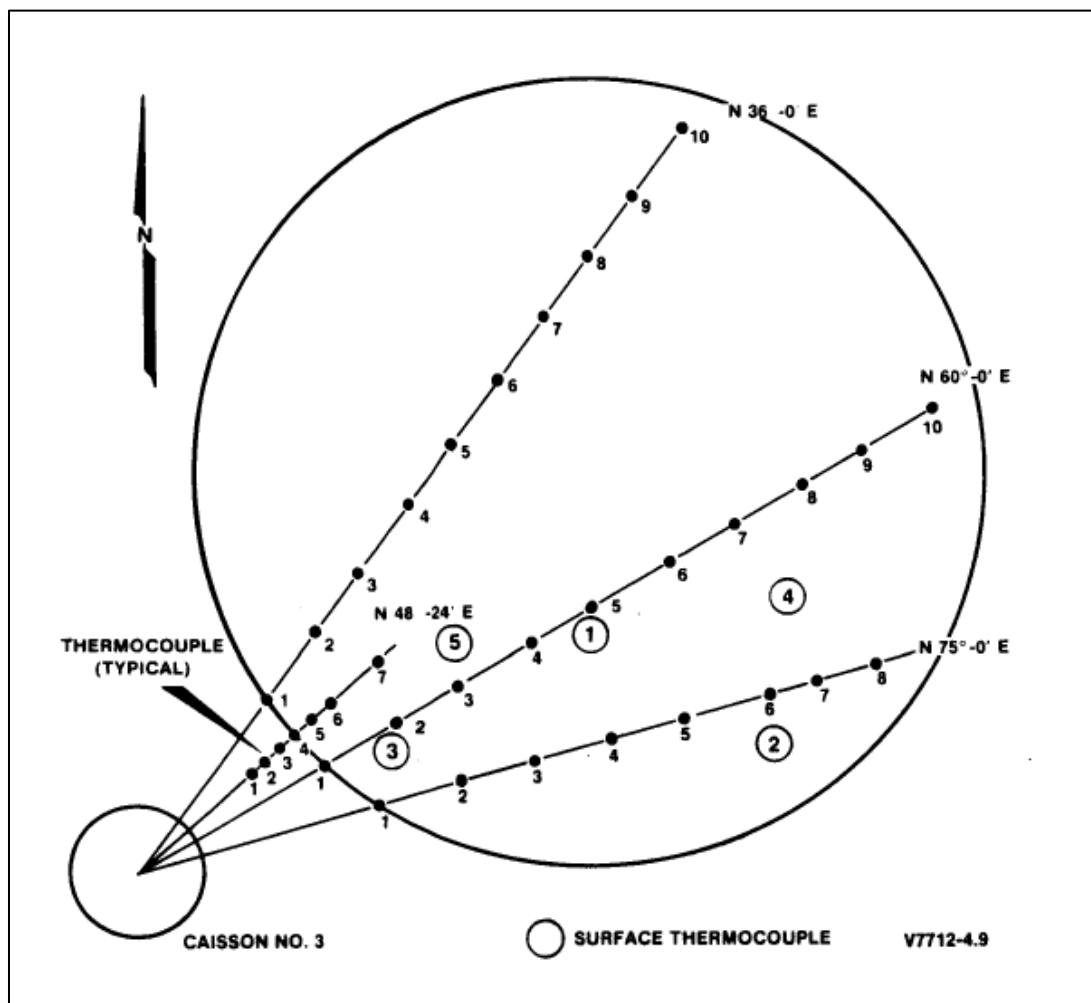
Document HW-59919 indicated that the self-boiling waste operating temperature should be maintained between 220°F and 250°F (see Section 3.2.2). The maximum sludge temperature should not exceed 300°F. As noted, the temperature did not exceed this level during operation.

5.4.2.1. Lateral Temperatures

A special probe was built to map the temperatures in the leak detection laterals (ARH-78) to better understand the accumulation of heat producing sludge under the bulged failed liner. The maximum temperature (310°F) was found in lateral 14-05-03 in the north portion of the tank. Periodic measurements were made in all three laterals after the steam eruption in January 1965 in 1965 and 1966 and by October 1966 all three lateral maximum temperatures ranged between 205°F and 220°F.

Four temperature laterals were later drilled 2-ft under tank A-105 with fixed thermocouples from caisson #3 located southwest of the tank (see Figure 5-4). Readings began in 1968 two years after the lateral temperatures mentioned above with the highest temperature of 332°F observed in both the number 8 and 9 thermocouples of lateral N 36°0'E. This indicates that the temperatures two feet under the tank were probably much higher in 1965 and 1966 which would have far exceeded the concrete temperature limit of 325°F (RHO-CD-255, *Tank 105-A Stabilization Progress Report*).

Figure 5-4. Tank A-105 Caisson #3 Temperature Laterals (RHO-CD-255)



These thermocouples were no longer the hottest when the report was written in 1978 when the highest reading in lateral N 36°0'E was reported at thermocouple number 3 at 215°F. Temperatures were later found to be higher beneath the bulged area of the tank and highest beneath the sludge pile above the liner.

5.4.3 Liner Observations

A bulge in a tank liner may result in the direct failure of the liner or cause enough stress or thinning on the steel liner plates and welds that they become more susceptible to the effects of corrosion. Experience indicates that bulging tends to be a dynamic phenomenon, and it is possible that a tank with no measured bulge at one point in time may actually have had a displaced liner that was not detected at another time. A thinning or weakened location may be more susceptible to corrosion (see Section 3.2.3).

Aged HLW supernatant was transferred into tank A-105 in 1962 and was pumped to tanks C-103 and A-101 in January 1963 leaving a 10-in heel of waste in A-105. Tank temperatures prior to

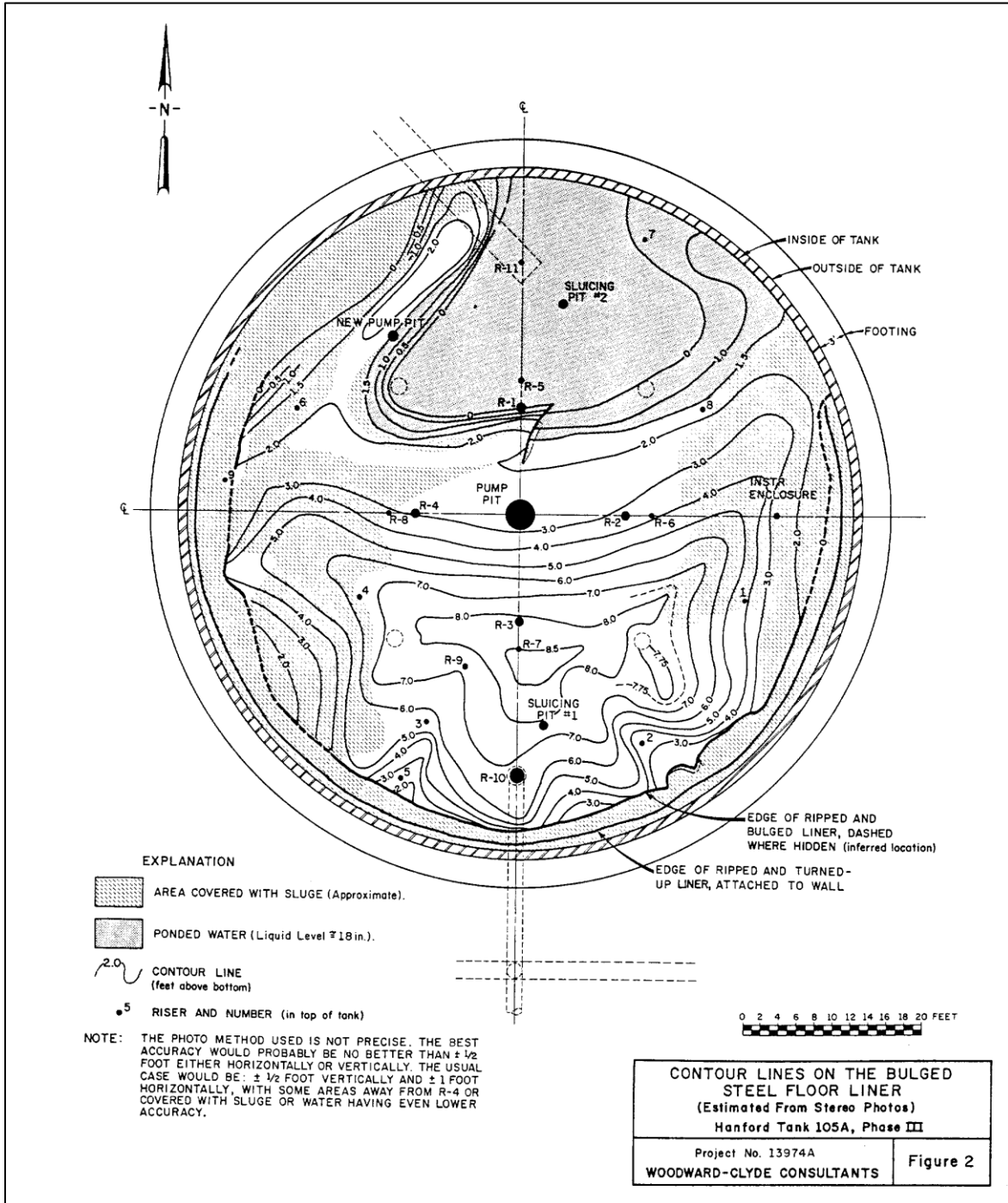
the transfer of supernatant may not have been high enough to drive all of the moisture out of the grout. If there was any remaining grout moisture near an estimated grout temperature of $\sim 130^{\circ}\text{F}$ the vapor pressure under the tank bottom liner would be 2.2 psi. The hydrostatic pressure of 10-in of waste at a 1.36 specific gravity is ~ 0.5 psi. This results in the vapor pressure under the tank bottom liner to be greater than the hydrostatic pressure which could result in bulging of the liner. September 1963 indications of unexplained liquid level fluctuations coupled with the radioactivity detected in lateral 14-05-03 would tend to confirm bulging along with an indication of bottom liner failure that may have re-introduced moisture into the grout.

On January 28, 1965, a sudden steam release occurred in tank A-105. Report, ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and its Implications on Waste Containment and Control*, reports, "The earth in the immediate vicinity of the tank was reported to have trembled, and a temporary lead cover on a riser on TK-103-A was dislodged allowing steam to vent from this opening for about 30 minutes. A water seal in the vent system designed to relieve tank pressure at 60 inches of water was not blown." This steam event was different from previous incidents in other tanks in that the event occurred while the ALCs were reported to be in operation. The 1963 indication of bottom liner bulging and possible liner failure may have set up the conditions for trapping condensate/HLW under the liner. The trapped liquid may have ultimately become superheated under the pressure of the concentration of 11,000 tons uranium equivalent HLW and temperature of 285°F to the point of a sudden steam release under the tanks bottom liner.

While preparing to add an air sparger after the steam release event to tank A-105 to enable mixing the tank contents, an obstruction approximately eight feet above the tank floor was encountered. This obstruction had been reported several months earlier, when difficulty was encountered during the use of a sludge probe (ARH-78). This indicated that the tank floor may have bulged upward prior to the steam release (WHC-MR-0264). This indication is further supported by the unexplained increases in liquid level observed in September 1963 when the tank was first brought up to boiling temperatures.

Subsequent inspection of the inside of tank A-105 revealed deformation of part of the lower sidewall, an 8 ½-ft bulge in the tank liner floor near the center of the tank, and separation between the liner floor and wall as shown in Figure 5-5 (TRAC-0022). The cavity volume between the liner and the concrete shell created by this event was estimated at approximately 80 kgal (ARH-78). Following the steam event, tank A-105 continued to actively store waste. Monitoring of the tank increased significantly. In October 1967, low level radioactivity was first detected in lateral 14-05-02 underneath tank A-105. A small leak was thought to have occurred during water additions to the 350-in waste level (ARH-78).

**Figure 5-5. Tank A-105 Contour Lines on the Bulged Steel Floor Liner
March 24, 1978 (TRAC-0022)**



5.4.4 Chemistry-Corrosion

Tank A-105 first received water in 1955 and initially received PUREX HLW in 1962. Tank A-105 only stored PUREX HLW throughout operation as shown in Table 5-1. The typical

concentrations for nitrite, nitrate, and hydroxide for these waste types are shown in Table 5-2. Nitrite and hydroxide are known as nitrate-induced SCC inhibitors. One key characteristic for inhibiting SCC is to maintain a high nitrite concentration to nitrate concentration ratio (see Section 3.2.4).

Table 5-1. Tank A-105 Waste Storage Chronology

Date	Waste Type	Length of Storage
1955 to 1962	Water	~ 7 years
May 1962 to February 1968	PUREX HLW	~ 15 months before leak detected (~5 years total)

Table 5-2. Waste Chemistries for Waste Types Stored in Tank A-105

Waste Types	[NO ₃]	[NO ₂]	[OH ⁻]	Meets Current DST Specification ³
PUREX HLW ¹	1.3	3.37 ²	Not Reported	Yes

1. Reference WHC-EP-0449, 1991, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*.
2. Average of three A Farm PUREX waste samples, RL-SEP-183 RD, *PUREX Tank Farm Supernatant Solution Composition*.
3. Reference OSD-T-151-00007, Rev. 12, 2013, *Operating Specifications for the Double-Shell Storage Tanks*.

Water was added to tank A-105 in 1955 to counteract the vacuum on the tank. No mention of the water source or chemical adjustment has been found in any of the documents reviewed. Some corrosion may have occurred during the seven years when only water was in the tank. The temperatures during the seven years ranged from 60°F to 115°F (see Section 5.4.2). In 1962 PUREX HLW was added to the water which provided corrosion protection.

Tank A-105 started receiving aged PUREX HLW in May 1962. In January 1963, tank A-105 HLW supernatant from tanks A-101 and A-103 was pumped out of the tank leaving the liquid level reported at 10-in (see Section 5.2). At the end of January 1963, condensate was added to tank A-105 in order to pre-heat the tank prior to receiving PUREX HLW directly from PUREX. The condensate was reported in 1960 to be normally at approximately pH 9 (HW-67698, *Preliminary Report on the Characterization of PUREX Tank Farm Radioactive Condensate Waste*). Caustic was to be added to the condensate tank when off standard operating conditions occurred to maintain the condensate pH above seven in 1965 (RL-SEP-239, page 5.2-1). Earlier specifications could not be found that addressed the pH of condensate.

Tank A-105 stored aged PUREX HLW supernatant for approximately eight months and PUREX HLW for seven months prior to November 1963, when radioactivity was initially detected in one of the laterals. Under flowsheet conditions PUREX HLW would not be considered to have a high propensity for corrosion of the tank steel liner. One incidence of tank farm condensate recycle to tank A-105 of approximately 330 kgal on a supernatant heel of 8 kgal may have resulted in lower pH and nitrate concentrations for a period of time.

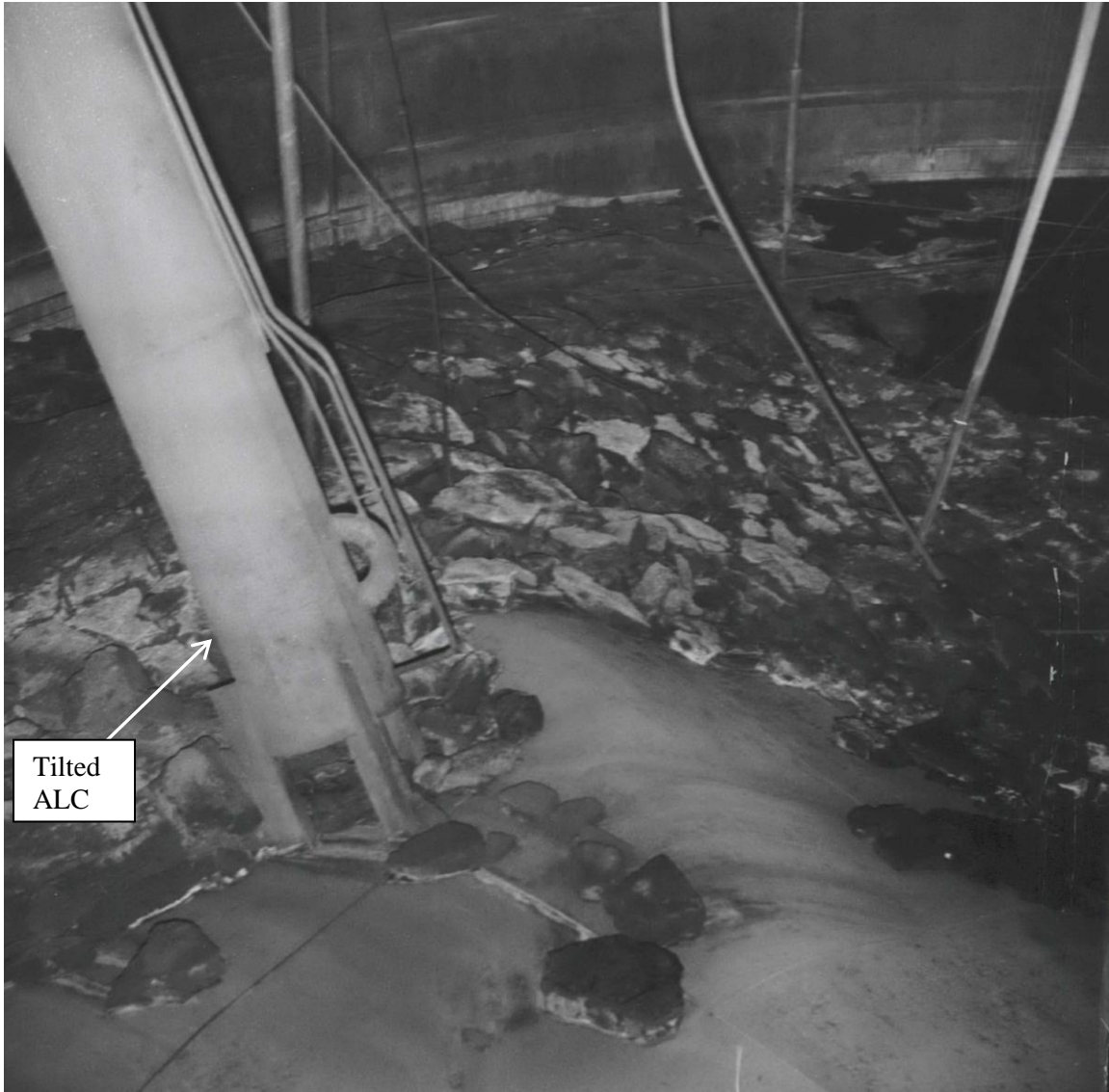
5.4.5 Photographs

Earliest available photographs of tank A-105 taken on August 28 and 29, 1968 were reviewed. The steam eruption and resulting liner bulge of 8 ½-ft occurred in January 1965 and no photographs were taken during this time. One photograph of a bent ALC with the bottom liner raised beneath the ALC is shown in Figure 5-6 that was taken in April 1969. As a result of the steam eruption, it appears two of the ALCs were tilted off vertical significantly questioning their efficiencies after 1965. However, the ALCs may have been affected during the 1963 liquid level fluctuations which may have indicated periodic bulging of the bottom liner. Air flow to the ALCs was increased to the maximum and waste temperatures were apparently controlled as they remained below 300°F (see Figure 5-2).

A photograph taken October 7, 1976 (see Figure 5-7) shows ALC #2 that remains relatively intact after the steam eruption with all the turnbuckle guy rods attached. In Figure 5-7, it appears the torn liner can be seen in front of the ALC and the existing gap between the two torn steel pieces as noted in TRAC-0022.

A review of the available photographs confirms the liner bulge of tank A-105; however, it remains unclear from the available photographs the entire extent of the ripped liner.

**Figure 5-6. Tank A-105 ALC #3 Photograph 0691646-21
April 16, 1969**



Tilted
ALC

**Figure 5-7. Tank A-105 ALC #2 Photograph 769357-19CN
October 7, 1976**



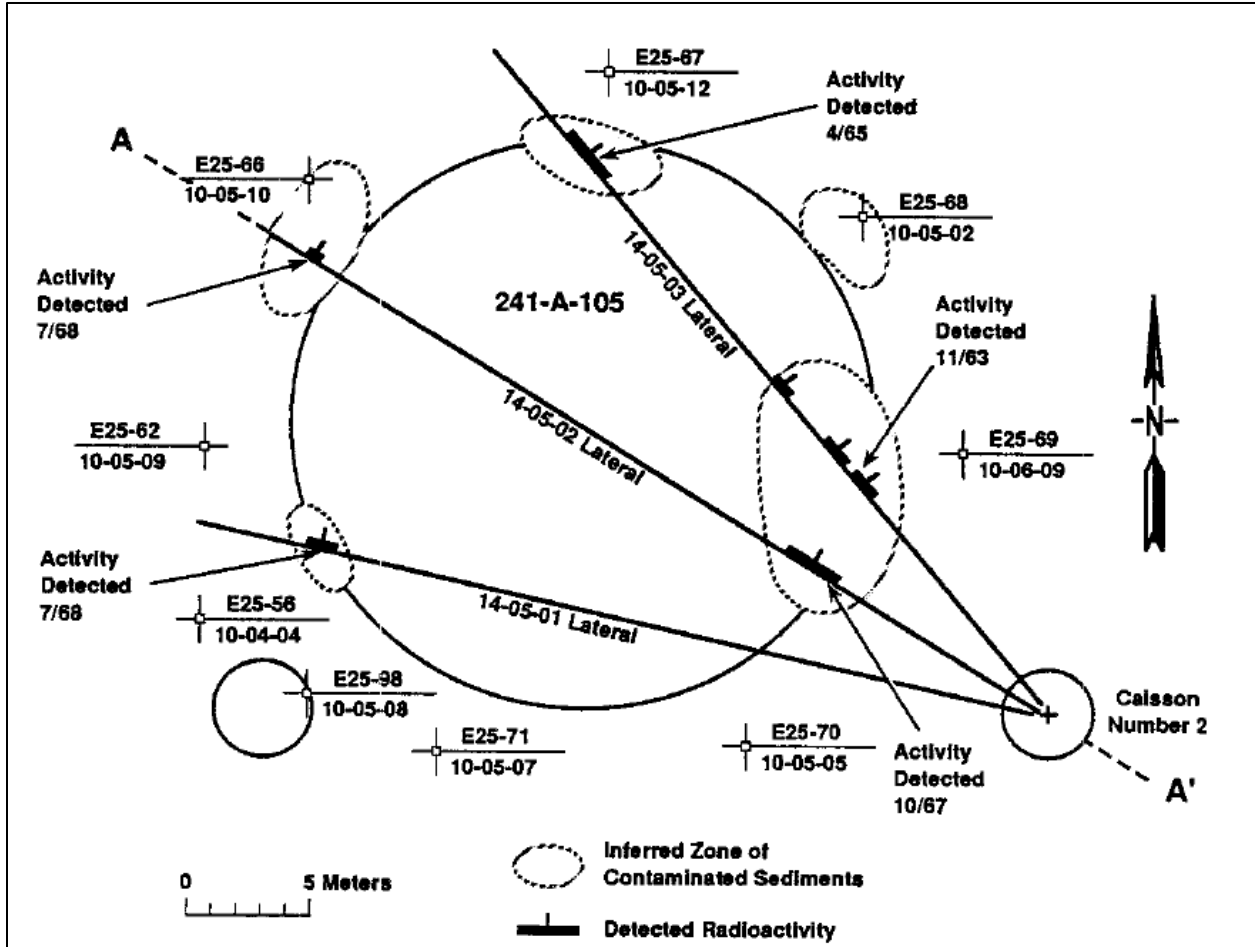
5.5 TANK A-105 EX-TANK DATA

5.5.1 Laterals

The first indication of a tank A-105 leak occurred in November 1963 when elevated gross gamma levels were measured over a small segment in lateral 14-05-03 (see Appendix C2) on the southeast side of the tank as shown in Figure 5-8. Initial readings were 17K cpm and continued to increase to 150K cpm a week later. Subsequently, radiation readings decreased to approximately 50K cpm by March 1965 indicating that the predominant gamma-emitting radionuclides were short-lived (ARH-78). During this time it was assumed radioactivity detected in lateral 14-05-03 was due to a sidewall leak between 260-in and 280-in (see Section

5.4.1). However, after additional waste was added in 1964 bringing the waste level above 280-in, no recurrence of contamination was detected in lateral 14-05-03. If a sidewall leak had occurred, it apparently self-healed. No radioactivity was detected in the other laterals or drywells during this time.

Figure 5-8. Tank A-105 Historical Lateral Radioactivity Location (WHC-EP-0412)



Note: The dates of lateral radioactivity increases and stabilization during August 1968 conflict between document WHC-MR-0264 and WHC-EP-0412 and Interoffice Memorandum 7G420-06-004.

The next reported waste loss occurred on January 28, 1965 when a sudden steam release occurred in tank A-105 (see Section 5.4.3). As a result of this event, it was reported the tank bottom liner bulged upwards 8 ½-ft near the center of the tank with separation of the steel bottom and wall. Subsurface contamination was detected March 8, 1965 at 195K cpm in lateral 14-05-03 in the north portion of the tank (see Figure 5-8). Three test wells were drilled near the end of lateral 14-05-03 to a depth of about 65-ft, or 10-ft below the tank bottom (see Figure 5-23). Soil samples taken from the test wells showed no radioactivity (RL-SEP-509, page G-2) indicating contamination was likely localized.

On October 2, 1967, low level radioactivity (approximately 2K cpm) was first detected in lateral 14-05-02 underneath the southeastern portion of the tank as shown in Figure 5-8. A small leak was thought to have occurred during water additions to the 350-in waste level (ARH-78). The dates of lateral radioactivity increases and stabilization during August 1968 conflict between documents WHC-MR-0264 and WHC-EP-0412 and Interoffice Memorandum 7G420-06-004. Document WHC-MR-0264 reported an initial increase in radiation levels in laterals 14-05-01 and 14-05-02 in August 1968 immediately after initial sluicing operations began (August 14, 1968) for purposes of removing sludge still present in the tank above the liner. However, document WHC-EP-0412 indicated the occurrence of elevated radiation readings in July 1968 in two tank perimeter locations near the ends of laterals 14-05-01 and 14-05-02 (see Figure 5-8). Radioactivity increases in these laterals on August 19, 1968 were confirmed by Interoffice Memo 7G420-06-004. After 3 weeks, radiation levels at laterals 14-05-01 and 14-05-02 were holding steady at 20K and 190K cpm, respectively (WHC-MR-0264). However, it was reported in Interoffice Memo 7G420-06-004 that radioactivity in lateral 14-05-02 continued to increase and leveled off at 410K cpm three weeks after sluicing had begun in tank A-105. Sluicing operations likely caused increased leakage from the tank, probably by loosening and removing solid build-ups at the leak site(s). Sluicing of tank A-105 was halted when little of the remaining sludge could be removed. On October 29, 1968, the activity-measuring instrument was repaired leaving the radioactivity reported in laterals 14-05-01, 14-05-02, and 14-05-03 as 20K, 190K, and 120K cpm, respectively (WHC-MR-0264).

The second sluicing campaign for tank A-105 began August 25, 1970 and ran until November 1970. In August 1970, all laterals showed increased readings compared with the October 1968 readings. Radioactivity increased to 40K cpm in lateral 14-05-01, 375K cpm in lateral 14-05-02, and 960K cpm in lateral 14-05-03. These fluctuations indicated that leaks were active and since readings remained high, the sluicing operation was aborted on November 17, 1970 (WHC-MR-0264). In May 1978, a radiation spike from 516K cpm to 1,080K cpm occurred in lateral 14-05-03 (see Appendix C2). A large nearby water line spill in February 1978 of 60 kgal that redistributed mobile gamma-emitting contaminants already present in the vadose zone appears to have been the most likely cause of this contamination increase. See Figure 5-10 through Figure 5-12 for the most recent lateral scans, which the locations correlate well with the historical data.

**Figure 5-9. Tank A-105 Historical Lateral Surveys (counts per second)
(RPP-RPT-27605, Rev. 0)**

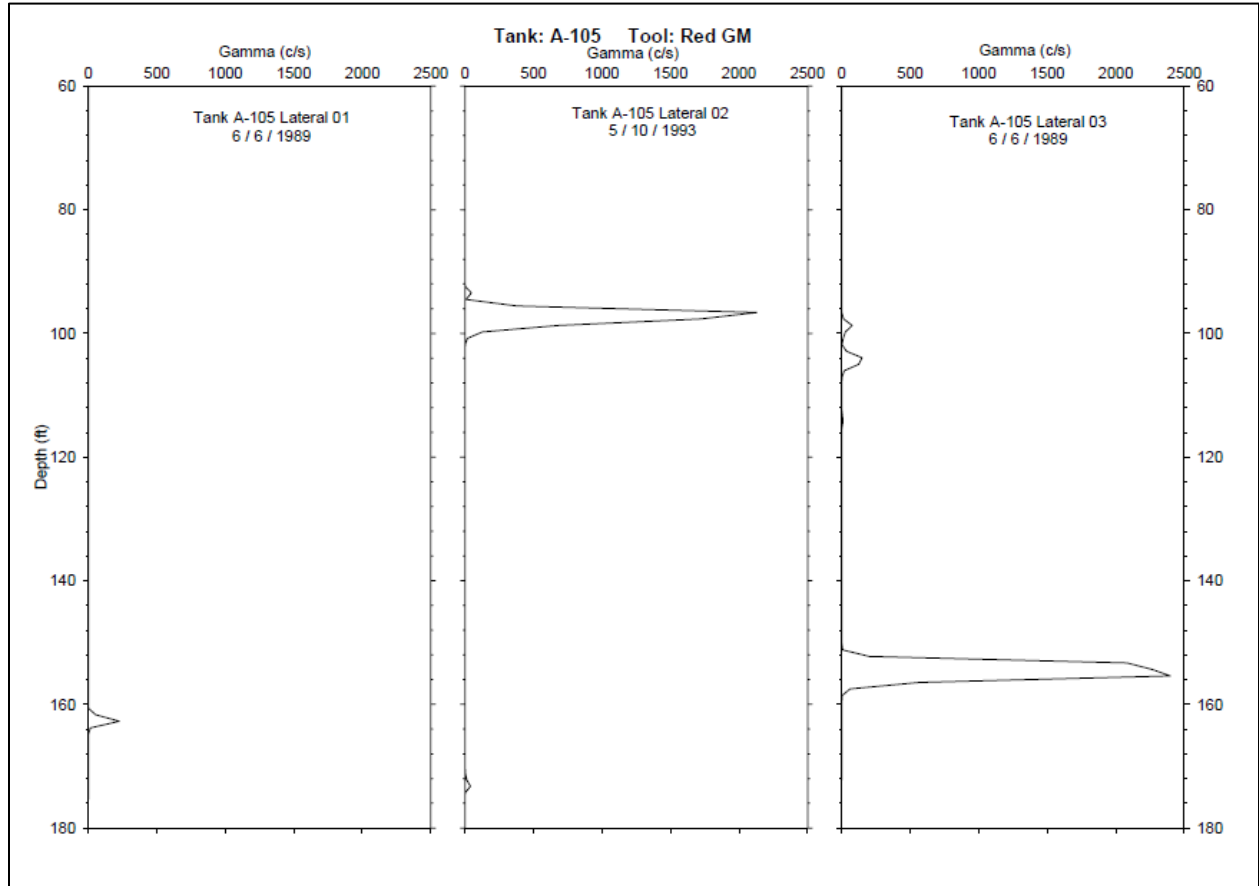


Figure 5-10. Summary Gamma Survey for Lateral 14-05-01 on Logarithmic Scale
April 19, 2005
(RPP-RPT-27605, Rev. 0)

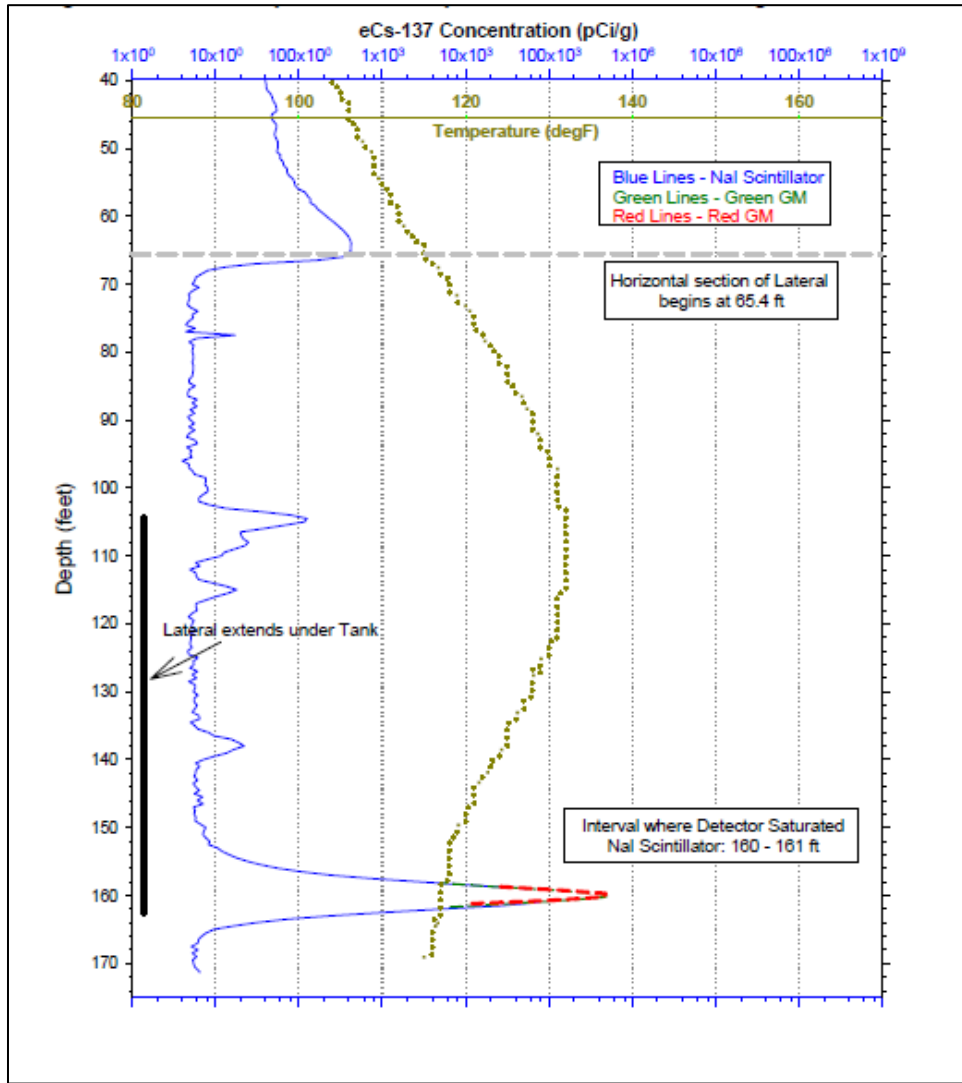
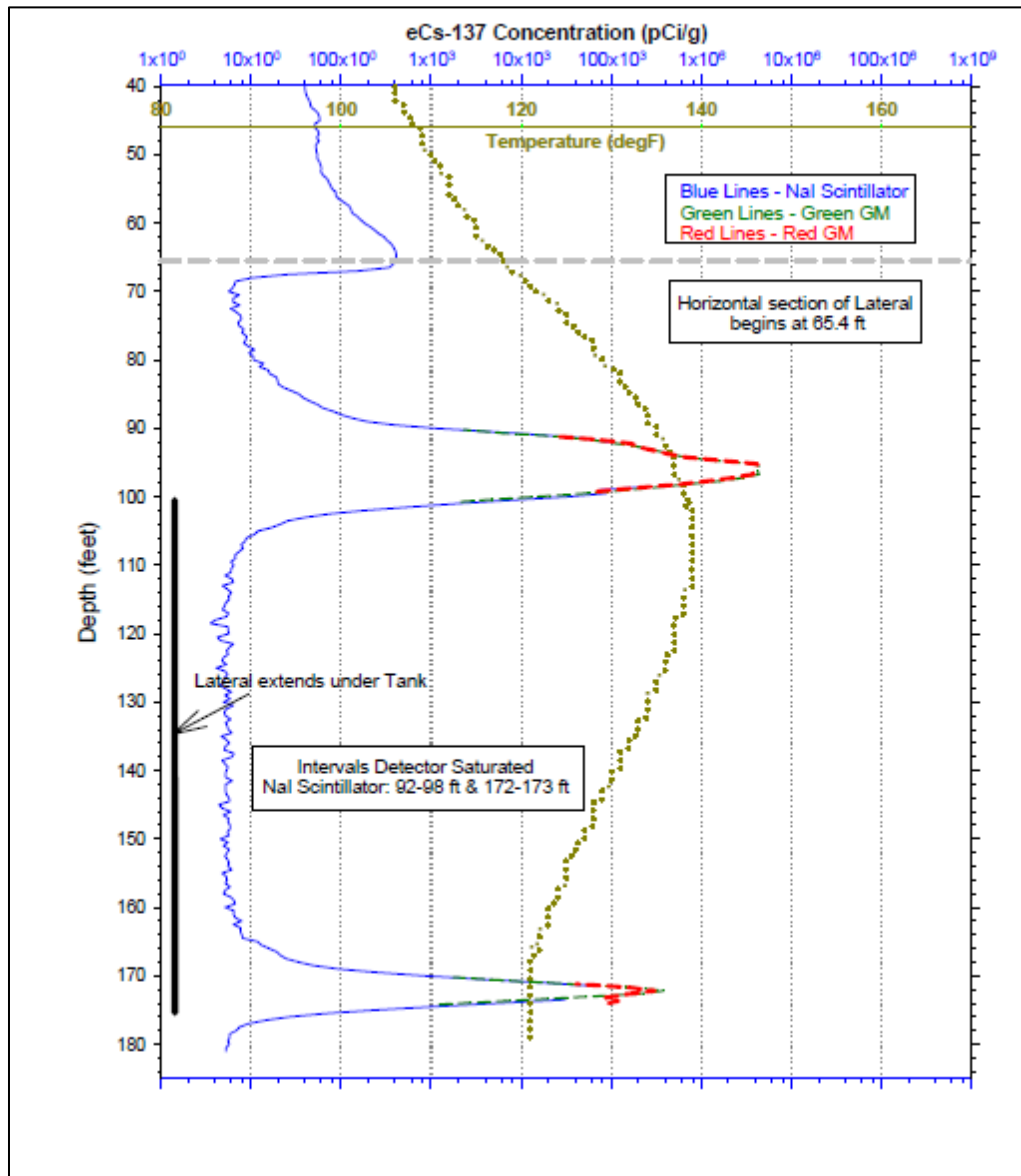
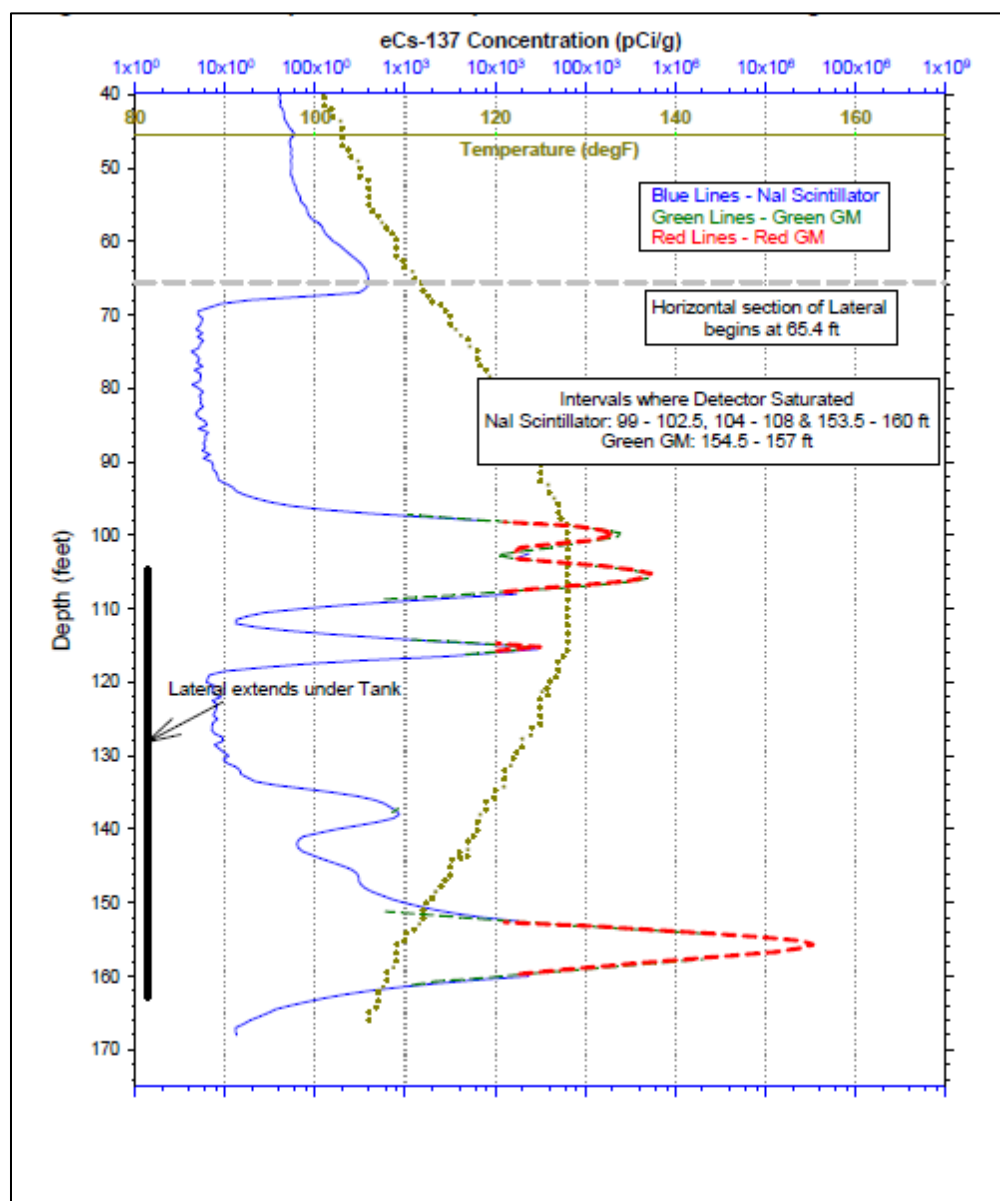


Figure 5-11. Summary Gamma Survey for Lateral 14-05-02 on Logarithmic Scale
April 19, 2005
(RPP-RPT-27605, Rev. 0)



**Figure 5-12. Summary Gamma Survey for Lateral 14-05-03 on Logarithmic Scale
April 13, 2005
(RPP-RPT-27605, Rev. 0)**



5.5.2 Drywells

There are nine drywells located around tank A-105: 10-06-09, 10-05-05, 10-05-07, 10-05-08, 10-04-04, 10-05-09, 10-05-10, and 10-05-12 installed in April 1962 and 10-05-02 installed in May 1962. Three additional test wells were drilled near the end of lateral 14-05-03 in 1965. No raw data were recovered for these test wells; however, it was reported that no radioactivity or moisture was detected in these test wells (RL-SEP-509). All of the radiation readings in drywells are assumed to be maximum or peak readings unless otherwise noted (see Section

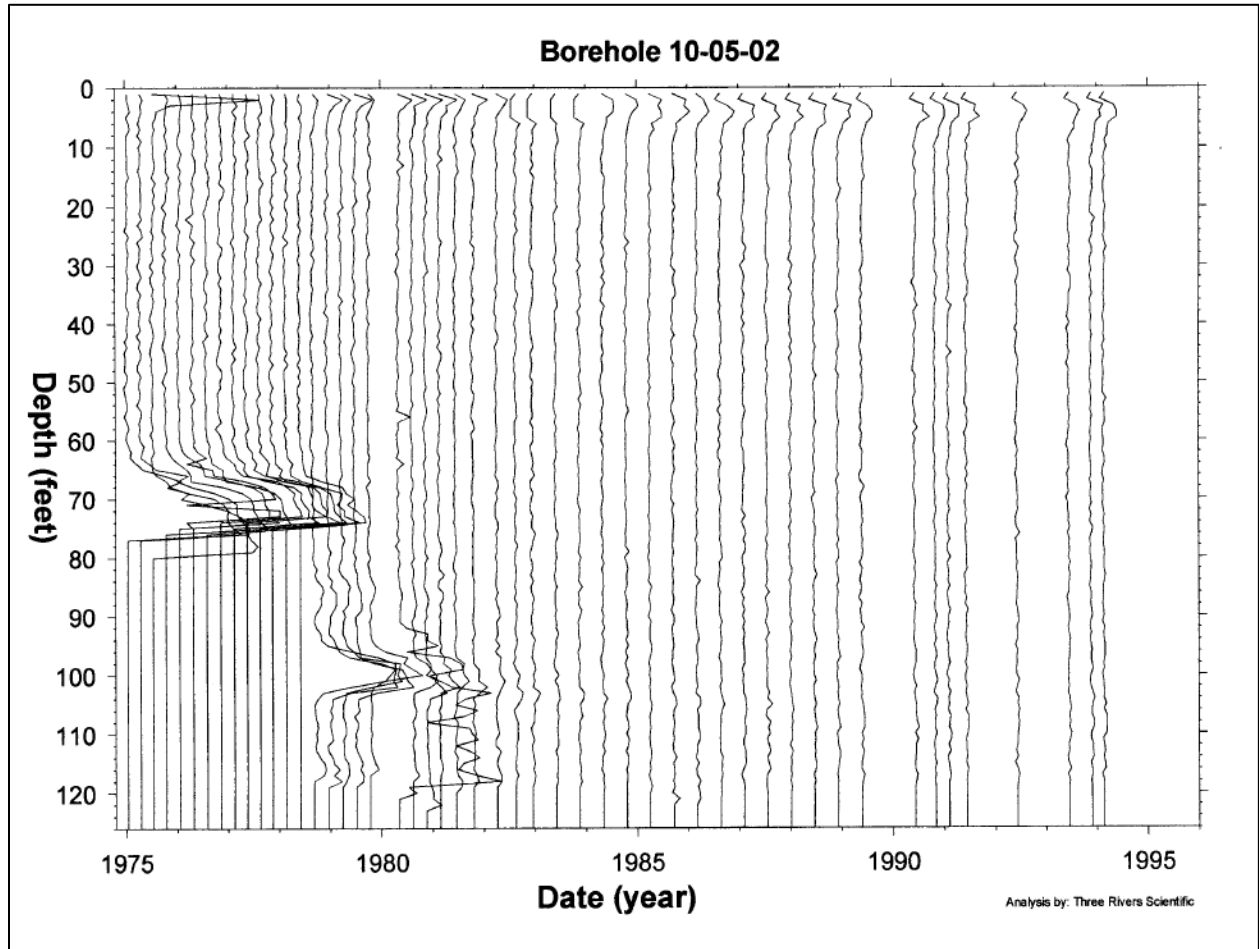
3.3.2). The following subsections report the available drywell information and the drywell summary section provides the analyses of the associated drywells with tank A-105. The bottom of the tank footing for tank A-105 is approximately 47-ft 10-in BGS.

5.5.2.1. Drywell 10-05-02

Drywell 10-05-02 was drilled in May 1962 with the first recoverable readings on January 7, 1965 with a peak of 40K cpm at 74-ft BGS. Radioactivity levels at this depth remained relatively stable from 1965 to 1978. Radioactivity levels then slowly declined and were reported at 2K cpm at 71-ft BGS in November 1986 (see Appendix D2).

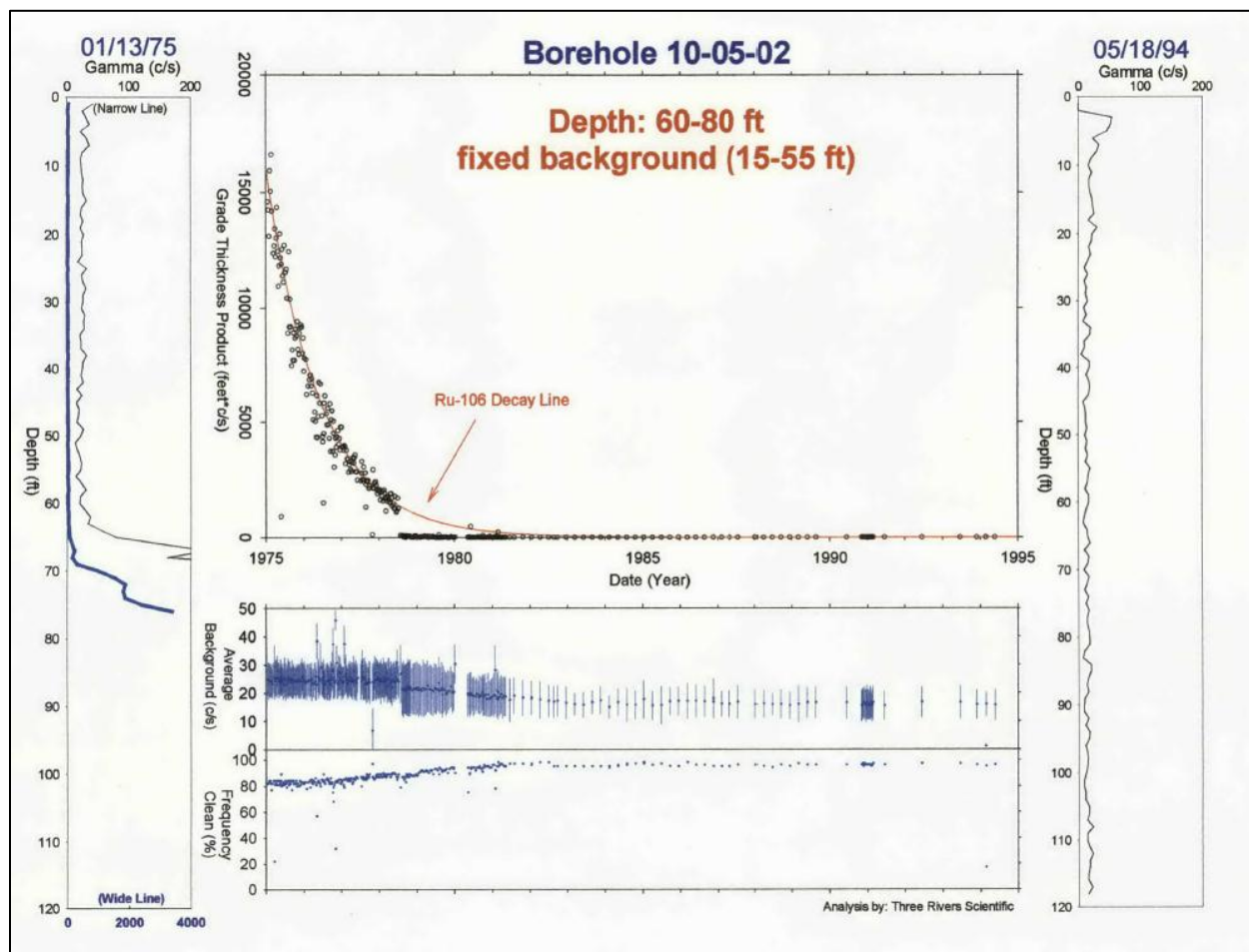
By October 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-05-02 with the maximum concentration of 10 pCi/g detected at 4-ft BGS (GJ-HAN-110). Deeper down in the drywell, Cs-137 concentration was reported as less than 1 pCi/g. Document GJ-HAN-110 reports, "The source of anomalous activity in the historical gross gamma-ray logs from 1975 to 1978 is questionable. The contaminants in this depth range may have accumulated and concentrated on the outside or inside of the casing near the original bottom of the borehole. It is possible that this concentrated material was detected by the gross gamma-ray device, but the residual contaminants in the formation were at too low a concentration to be detectable." Since Cs-137 levels were reported to be small in drywell 10-05-02, it is likely the historical radioactivity detected was short-lived, such as RuRh-106 (see Figure 5-14). The source of radioactivity detected in this drywell may have been migration of mobile RuRh-106 from a tank A-105 leak. Figure 5-13 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-13. Tank A-105 Drywell 10-05-02 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

Figure 5-14. Drywell 10-05-02 Ruthenium Decay (RPP-8820)

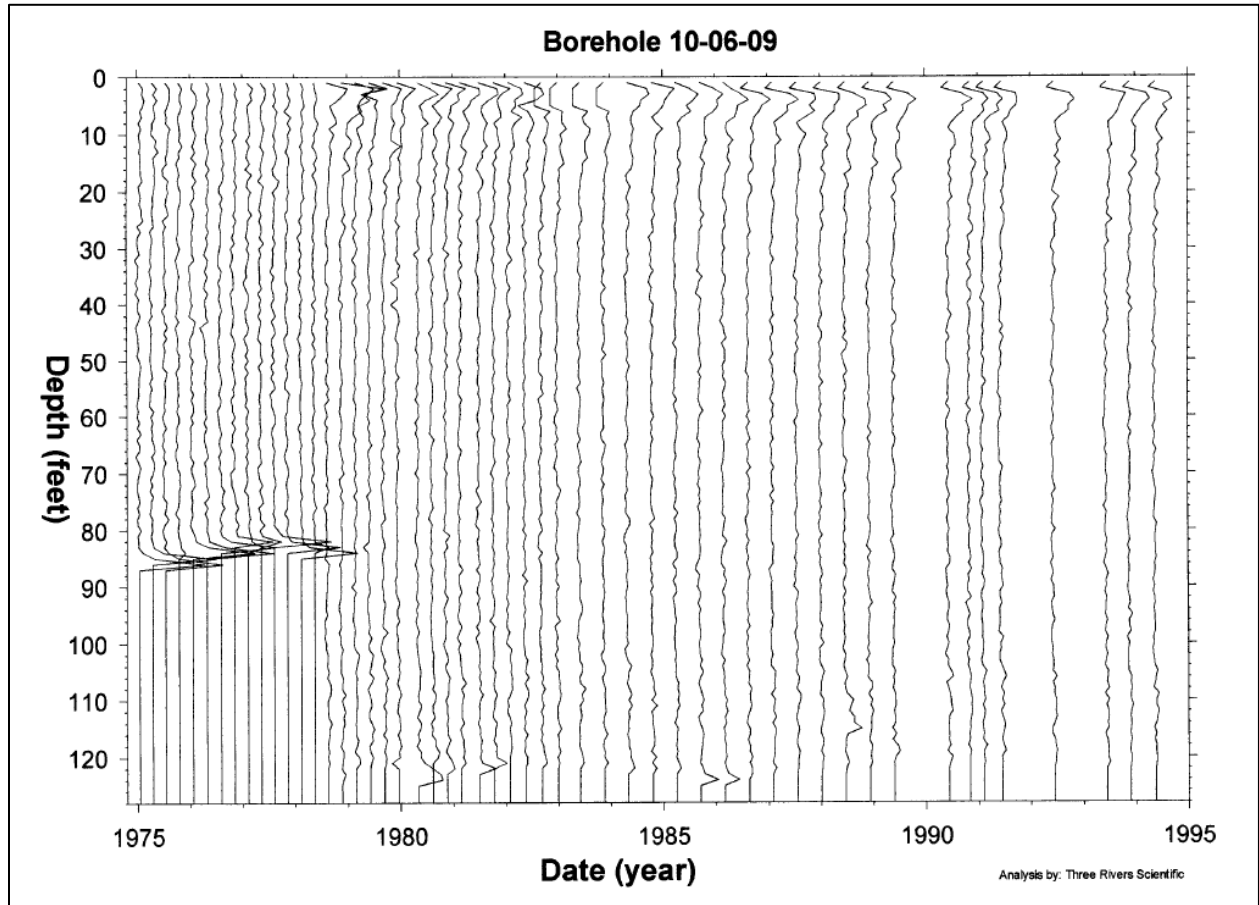


5.5.2.2. Drywell 10-06-09

Drywell 10-06-09 was drilled in April 1962 with the first recoverable readings on January 3, 1965 with two peaks of 45K cpm reported at 18-ft and 83-ft BGS. Radioactivity levels remained relatively stable at these two depths through August 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through 1986 (see Appendix D2).

In October 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-06-09 (GJ-HAN-110). From the ground surface to 15-ft BGS, Cs-137 was detected continuously at concentrations ranging from 5 to 20 pCi/g. Document GJ-HAN-110 reports, "The Cs-137 contamination detected between the ground surface and 20 ft probably resulted from the borehole extension activities. The contamination in this interval was first recognized after completion of the borehole extension and was most likely placed around the borehole when the temporary 8-in starter casing was installed." Therefore, drywell 10-06-09 is not included as part of the leak location for tank A-105. Figure 5-15 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-15. Tank A-105 Drywell 10-06-09 (RPP-8820)



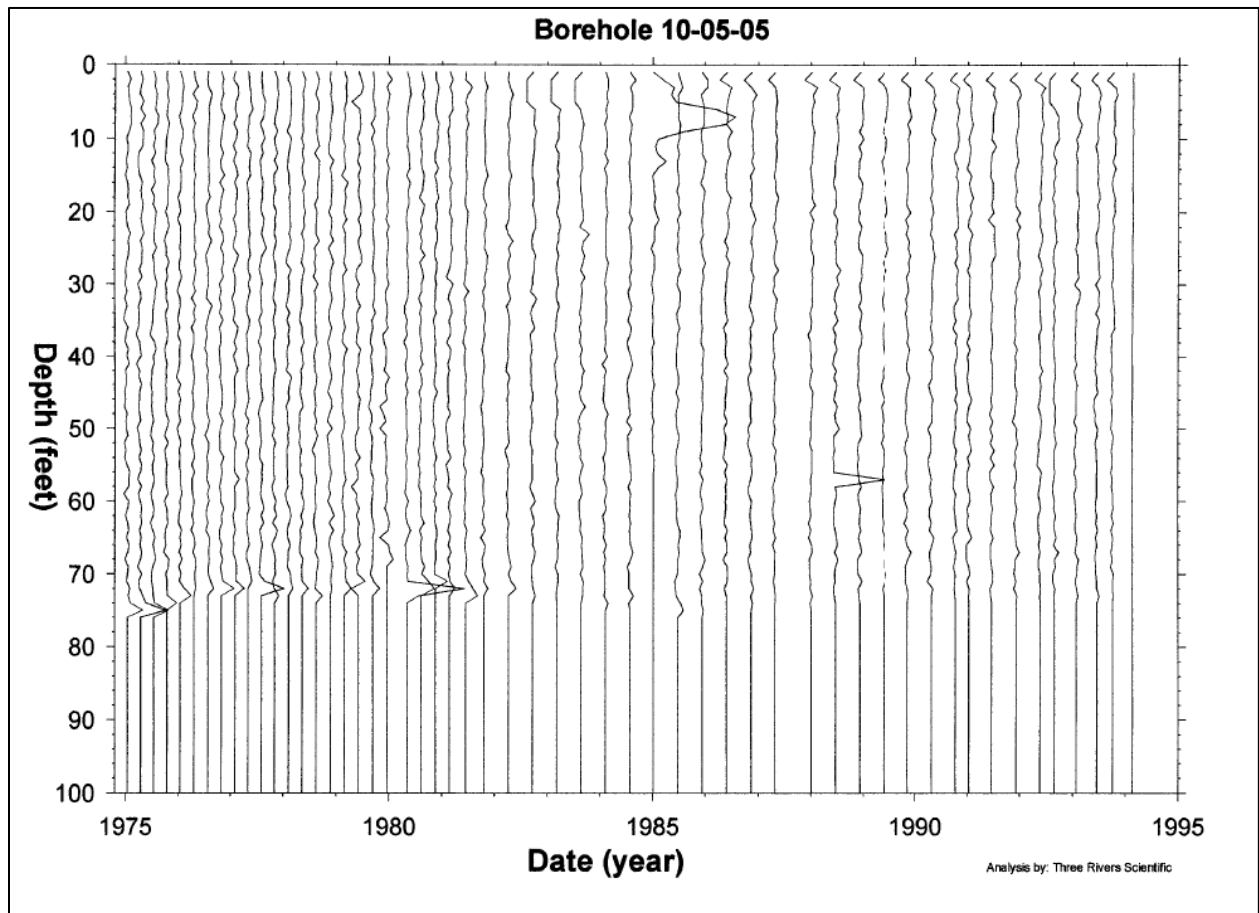
Note: Bottom of the tank footing is ~47-ft 10-in BGS

5.5.2.3. Drywell 10-05-05

Drywell 10-05-05 was drilled in April 1962 with the first recoverable reading on January 3, 1965 with a peak reading of 56K cpm at 75-ft BGS (see Appendix D2). Radiation levels remained relatively stable at this depth through August 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through 1986.

In October 1998, Cs-137 was detected nearly continuously from the ground surface to 74.5-ft BGS (GJ-HAN-110). From 6-ft to 55-ft BGS, Cs-137 concentrations were about 1 pCi/g or less and between 1 and 3 pCi/g at depths below 55-ft BGS. Document GJ-HAN-110 reports, "Shape factor results for the rest of the borehole have been interpreted to indicate a contaminant distribution that is local to the borehole casing, indicating that the contamination was probably carried down from the contaminated interval near the top of the borehole during the drilling operation." Therefore, drywell 10-05-05 is not included as part of the leak location for tank A-105. Figure 5-16 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-16. Tank A-105 Drywell 10-05-05 (RPP-8820)



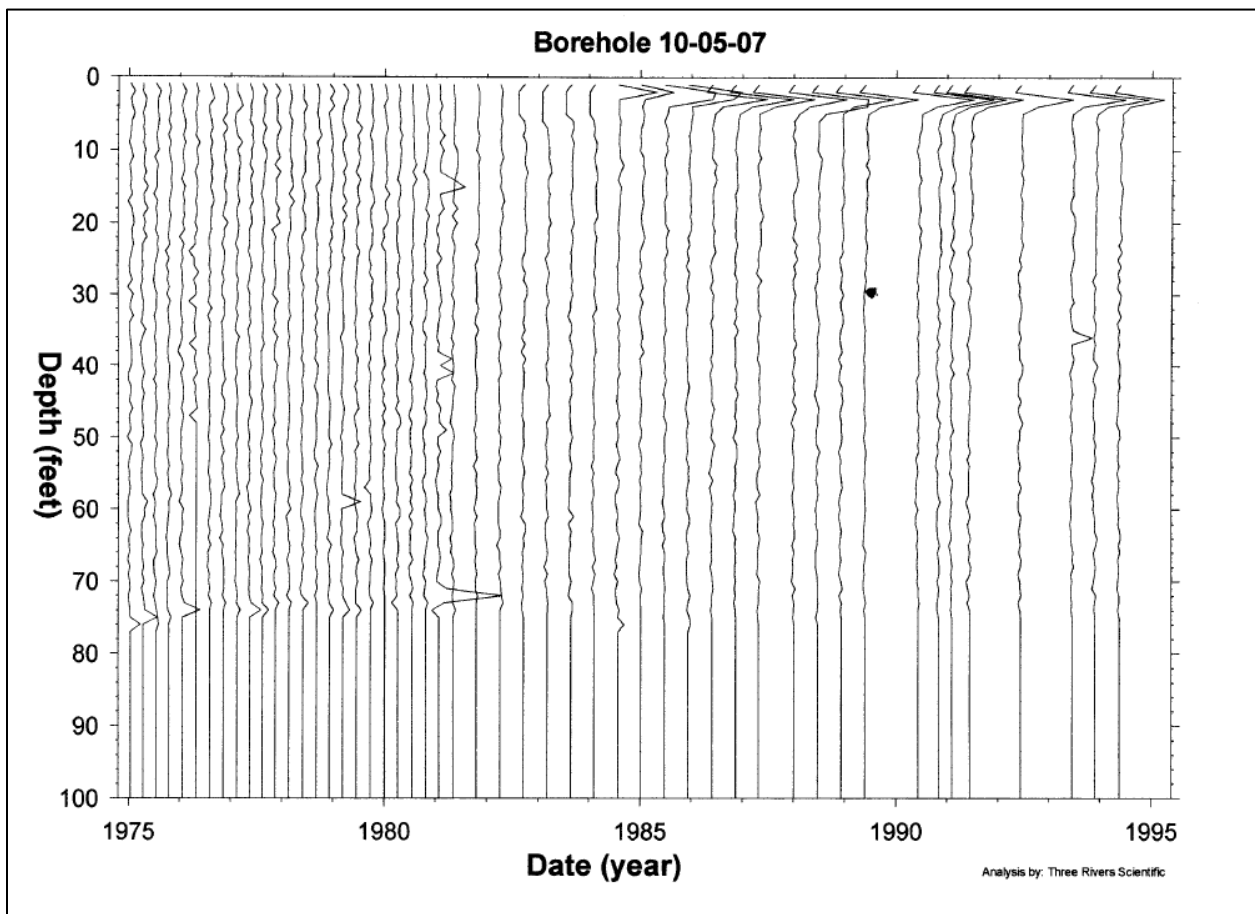
Note: Bottom of the tank footing is ~47-ft 10-in BGS

5.5.2.4. Drywell 10-05-07

Drywell 10-05-07 was drilled in April 1962 with the first recoverable reading on January 7, 1965 with a peak reading of 21K cpm at 74-ft BGS (see Appendix D2). Radiation levels were roughly the same through August 1966. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through 1986.

In October 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-05-07 (GJ-HAN-110). From 6-ft to 32-ft BGS, Cs-137 concentrations were recorded intermittently at concentrations between 0.15 pCi/g (just above the minimum detection limit) to about 1 pCi/g. From 32-ft to 57-ft BGS, Cs-137 was also noted sporadically at concentrations just above the minimum detection limit and from 57 to 75.5-ft BGS at concentrations between 0.3 pCi/g to about 1 pCi/g. Document GJ-HAN-110 reports that the Cs-137 concentration detected in this drywell was likely caused by dragdown from a surface spill. Therefore, drywell 10-05-07 is not included as part of the leak location for tank A-105. Figure 5-17 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-17. Tank A-105 Drywell 10-05-07 (RPP-8820)



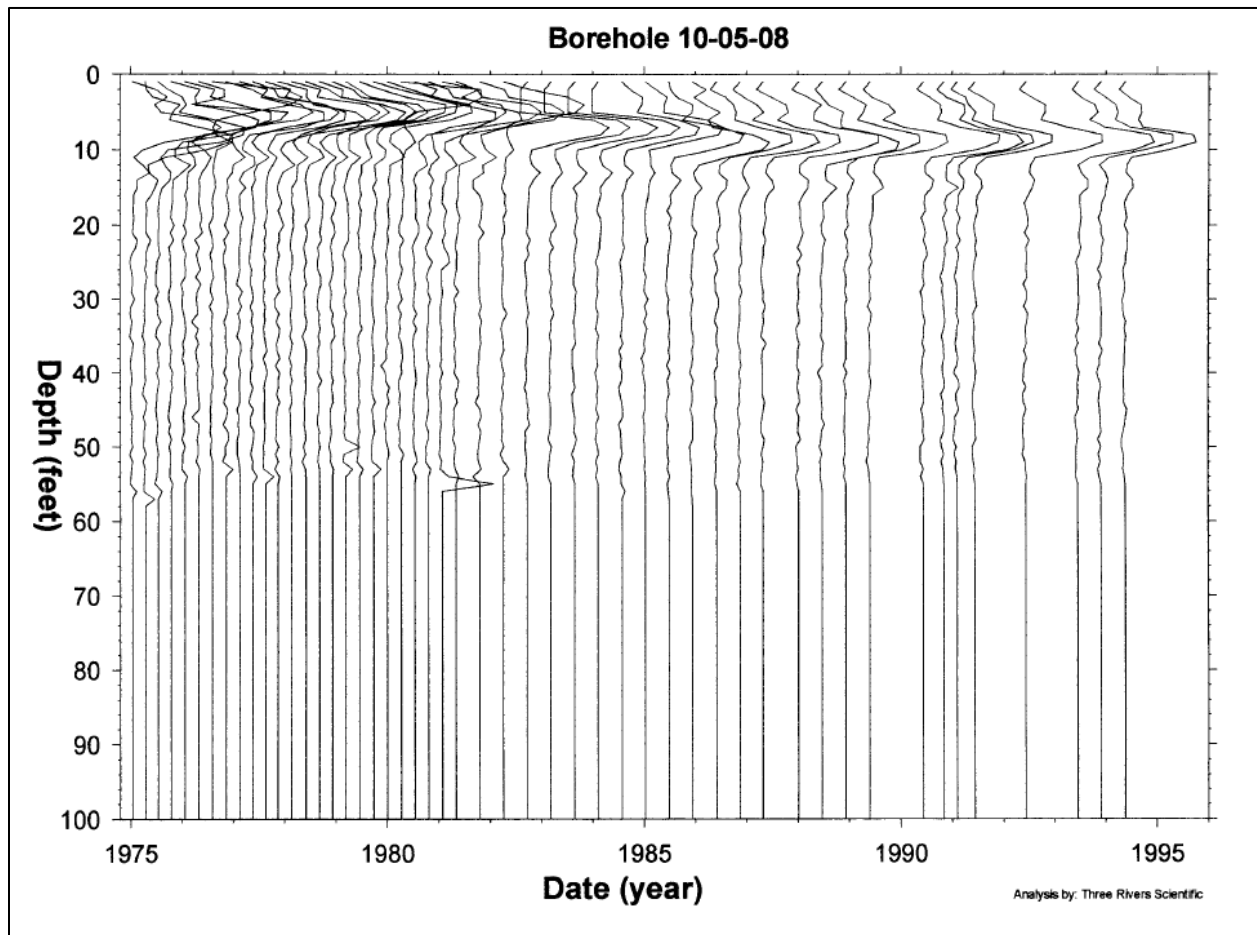
Note: Bottom of the tank footing is ~47-ft 10-in BGS

5.5.2.5. Drywell 10-05-08

Drywell 10-05-08 was drilled in April 1962 with the first recoverable reading on September 13, 1972. Radiation levels were reported as less than values from 1972 through 1986 (see Appendix D2).

In October 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-05-08 (GJ-HAN-110). From the ground surface to 21-ft BGS, Cs-137 concentrations were detected at concentrations less than 1 pCi/g below a depth of 15-ft. At 3.5-ft BGS, a Cs-137 peak was recorded at approximately 25 pCi/g, at 7.5-ft BGS at about 130 pCi/g, and at 13.5-ft BGS at 6 pCi/g. Document GJ-HAN-110 reports, “The Cs-137 contamination detected between the ground surface and 15 ft probably resulted from a surface spill or a leak from a near-surface pipeline that migrated down into the shallow backfill surrounding the borehole.” Therefore, drywell 10-05-08 is not included as part of the leak location for tank A-105. Figure 5-18 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-18. Tank A-105 Drywell 10-05-08 (RPP-8820)



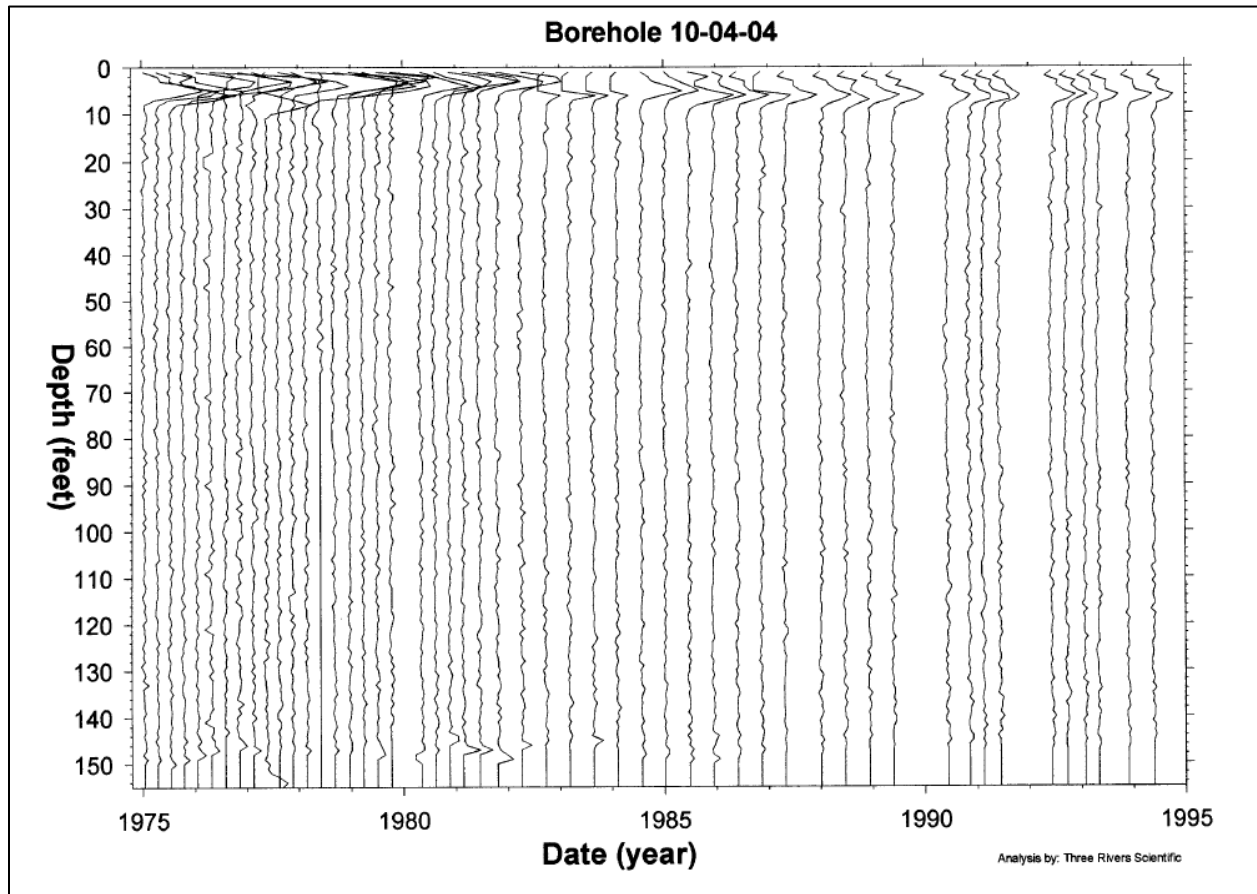
Note: Bottom of the tank footing is ~47-ft 10-in BGS

5.5.2.6. Drywell 10-04-04

Drywell 10-04-04 was drilled in May 1955 with the first recoverable reading on September 13, 1972. Radiation levels were reported as less than values from 1972 through 1986 (see Appendix D2).

In October 1998, Cs-137 and Eu-154 were the only man-made radionuclides detected in drywell 10-04-04 (GJ-HAN-110). From the ground surface to 6.5-ft BGS and at the bottom of the drywell, Cs-137 was detected continuously. The maximum Cs-137 concentration was 20 pCi/g at about 1-ft BGS and concentrations decreased to 2 pCi/g or less below this depth. Eu-154 contamination was detected from 4.5 to 6.5-ft BGS at concentrations less than 1 pCi/g. Document GJ-HAN-110 reports, “The man-made contaminants detected from the ground surface to 6.5 ft probably resulted from a surface spill that migrated into the backfill surrounding the borehole. The shape factor analysis suggests that some of the contamination occurs as a linear source, such as a pipeline.” Therefore, drywell 10-04-04 is not included as part of the leak location for tank A-105. Figure 5-19 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-19. Tank A-105 Drywell 10-04-04 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

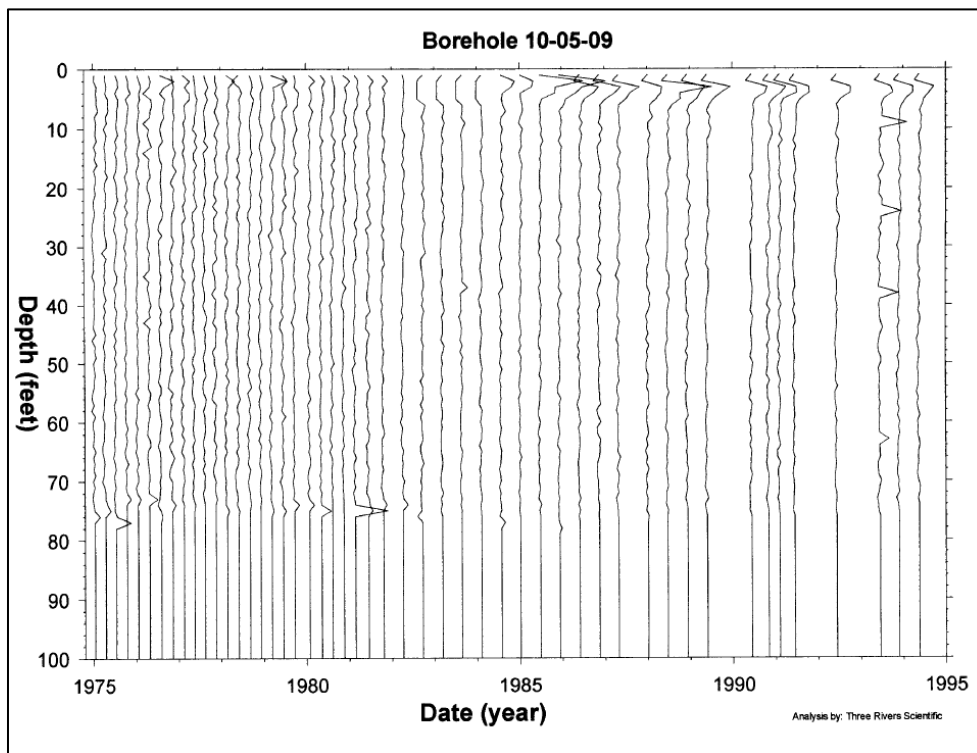
5.5.2.7. Drywell 10-05-09

Drywell 10-05-09 was drilled in April 1962 with the first recoverable reading on January 7, 1965 with a peak reading of 15K cpm at 15-ft BGS (see Appendix D2). Radioactivity at this BGS level appeared to have been short-lived as these readings in 1966 decayed to less than values in 1972. The next recoverable reading was on September 13, 1972 and reported as less than values at this time through 1986.

In October 1998, Cs-137 was the only man-made radionuclide detected in drywell 10-05-09 (GJ-HAN-110). From the ground surface to 15-ft BGS, Cs-137 contamination was detected nearly continuously at concentrations ranging from 0.3 pCi/g to about 90 pCi/g at a depth of 1-ft BGS. From 27.5-ft to 47-ft BGS, Cs-137 was also detected intermittently at concentrations just above the minimum detection limit and from 51 to 76.5-ft BGS at concentrations less than 1 pCi/g. Document GJ-HAN-110 reports, “The Cs-137 contamination detected from the ground surface to a depth of 10 ft probably resulted from a surface spill that migrated into the backfill sediment around the borehole. The contamination from 10 to 50 ft was probably carried downward from the ground surface during the drilling operation. The Cs-137 concentrations below 50 ft were too low to support shape factor analysis. Attempts to link this contamination to a source are speculative, but the contamination may be correlatable with contamination at this depth interval in borehole 10-05-10.”

Therefore, drywell 10-05-09 is not included as part of the leak location for tank A-105. Figure 5-20 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-20. Tank A-105 Drywell 10-05-09 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

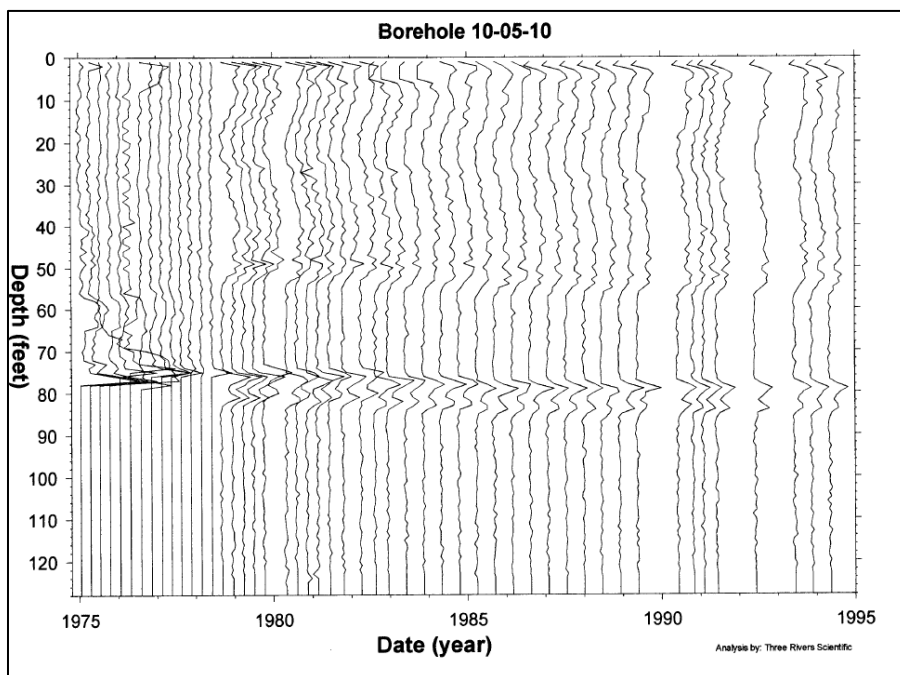
5.5.2.8. Drywell 10-05-10

Drywell 10-05-10 was drilled in April 1962 with the first recoverable reading on January 7, 1965 with three peak readings recorded at 50-ft, 70-ft, and 74-ft BGS with the maximum reading of 8K cpm at 74-ft BGS (see Appendix D2). Radiation levels were relatively stable through August 1966. The next recoverable reading was on September 13, 1972 with a peak reading of 28K cpm at 60-ft BGS. Radiation levels gradually declined at this BGS depth and were reported as less than values in November 1977. The next data point taken August 18, 1978 reports a peak of 8K cpm at 74-ft BGS and this peak remained stable through November 1986 at this lower depth.

In October 1998, Cs-137 concentrations were detected continuously in three distinct zones from the ground surface to 89.5-ft BGS at concentrations ranging from 20 to 30 pCi/g or higher (GJ-HAN-110). The zones extend from the ground surface to about 17-ft BGS, from 25 to 55-ft BGS, and about 78 to 85-ft BGS.

Document GJ-HAN-110 reports, “The zones of anomalous gamma-ray activity indicated on the historical gross gamma logs and the Cs-137 contamination detected by the SGLS from 58 to 64 ft and 76 to 86 ft appear to correlate with activity detected in lateral 14-05-02 at 170 ft. The lateral logs for this borehole indicate the presence of a fairly long-lived contaminant at this location. It appears that a plume from a leak near the northwest side of tank A-105 intercepted borehole 10-05-10 from 58 to 64 ft and 76 to 86 ft and lateral 14-05-02 at 170 ft. However, the mechanism by which the contamination arrived at these locations is not clearly understood.” However, with the quantity of water and supernatant used for cooling and leaching tank A-105 waste that some leakage occurred that provided a transport mechanism for some of the radionuclides. Figure 5-21 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-21. Tank A-105 Drywell 10-05-10 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

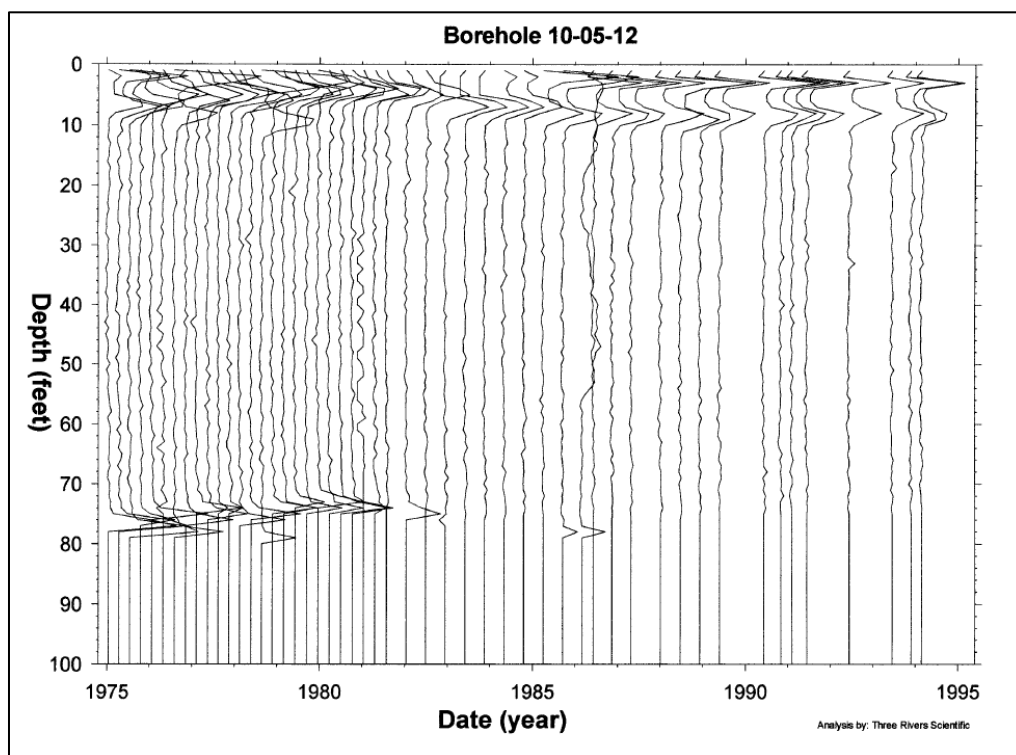
5.5.2.9. Drywell 10-05-12

Drywell 10-05-12 was drilled in April 1962 with the first recoverable reading on January 3, 1965 with four peak readings recorded at 5-ft, 50-ft, 70-ft, and 75-ft BGS with the maximum value of 110K cpm recorded at 75-ft BGS (see Appendix D2). Radiation levels remained relatively stable at these four peaks through August 1966. The next recoverable reading was on September 13, 1972 with a peak reading of 9K cpm reported at 76-ft BGS. The next data was recorded April 10, 1974 and radioactivity was reported as less than values at this time through November 1986.

In October 1998, Cs-137 concentrations were detected nearly continuously from the ground surface to 75.5-ft BGS (GJ-HAN-110). The measured Cs-137 concentrations ranged from 0.5 to 30 pCi/g at 7-ft BGS to approximately 300 pCi/g at 1.5-ft BGS. At depths between 10 and 50-ft BGS, Cs-137 concentrations were about 1 pCi/g or less. Between depths of 50 and 60-ft BGS, Cs-137 concentrations increase to between 1 and 2 pCi/g. At depths below 60-ft BGS, Cs-137 concentrations increase to about 3 to 5 pCi/g.

Document GJ-HAN-110 reports, “It is most likely that the contamination in the entire interval from 13 ft to the bottom of the borehole is restricted to the borehole casing, and was probably carried downward from the near-surface contaminated zone during the drilling operation.” Document GJ-HAN-110 also stated that radioactivity reported from the ground surface to 13-ft BGS likely resulted from surface spills that have migrated into the backfill sediments. Therefore, drywell 10-05-12 is not included as part of the leak location for tank A-105. Figure 5-22 shows the depths of radioactivity from 1975 to 1995 (RPP-8820).

Figure 5-22. Tank A-105 Drywell 10-05-12 (RPP-8820)



Note: Bottom of the tank footing is ~47-ft 10-in BGS

5.5.2.10. Drywell Summary

Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 in the southeast portion of tank A-105 (see Section 5.5.1). During this time, no drywells were reported to have increased radioactivity levels.

Tank A-105 drywells 10-06-09, 10-05-05, 10-05-07, 10-05-08, 10-04-04, 10-05-09, and 10-05-12 do not indicate any radioactivity associated with a tank A-105 leak. Therefore, these drywells are not included in the leak location for tank A-105.

Radioactivity in drywell 10-05-02 first appeared before January 7, 1965 at 74-ft BGS which was before the steam eruption on January 28, 1965 in tank A-105. It appears the source of radioactivity detected in drywell 10-05-02 was mobile RuRh-106 that may have migrated from tank A-105, possibly from the leak detected in lateral 14-05-03 in November 1963 in the southeastern portion of the tank. However, there was no indication of radioactivity in nearby drywell 10-06-09 and the radioactivity could have been from another source.

Drywell 10-05-10 first reported low-level radioactivity before January 7, 1965 with three peak readings recorded at 50-ft, 70-ft, and 74-ft BGS and remained relatively stable through August 1966. The next recoverable reading was in September 1972 with a peak reading at 60-ft BGS at higher radiation readings. It is likely radioactivity detected in drywell 10-05-10 is associated with radioactivity detected in lateral 14-05-02 in 1968 (see Section 5.5.1).

Three test wells were drilled near the end of lateral 14-05-03 to a depth of about 65-ft, or 10-ft below the tank bottom (see Figure 5-23) which did not indicate any localized contamination.

5.6 POSSIBLE TANK A-105 LINER LEAK LOCATION(S)

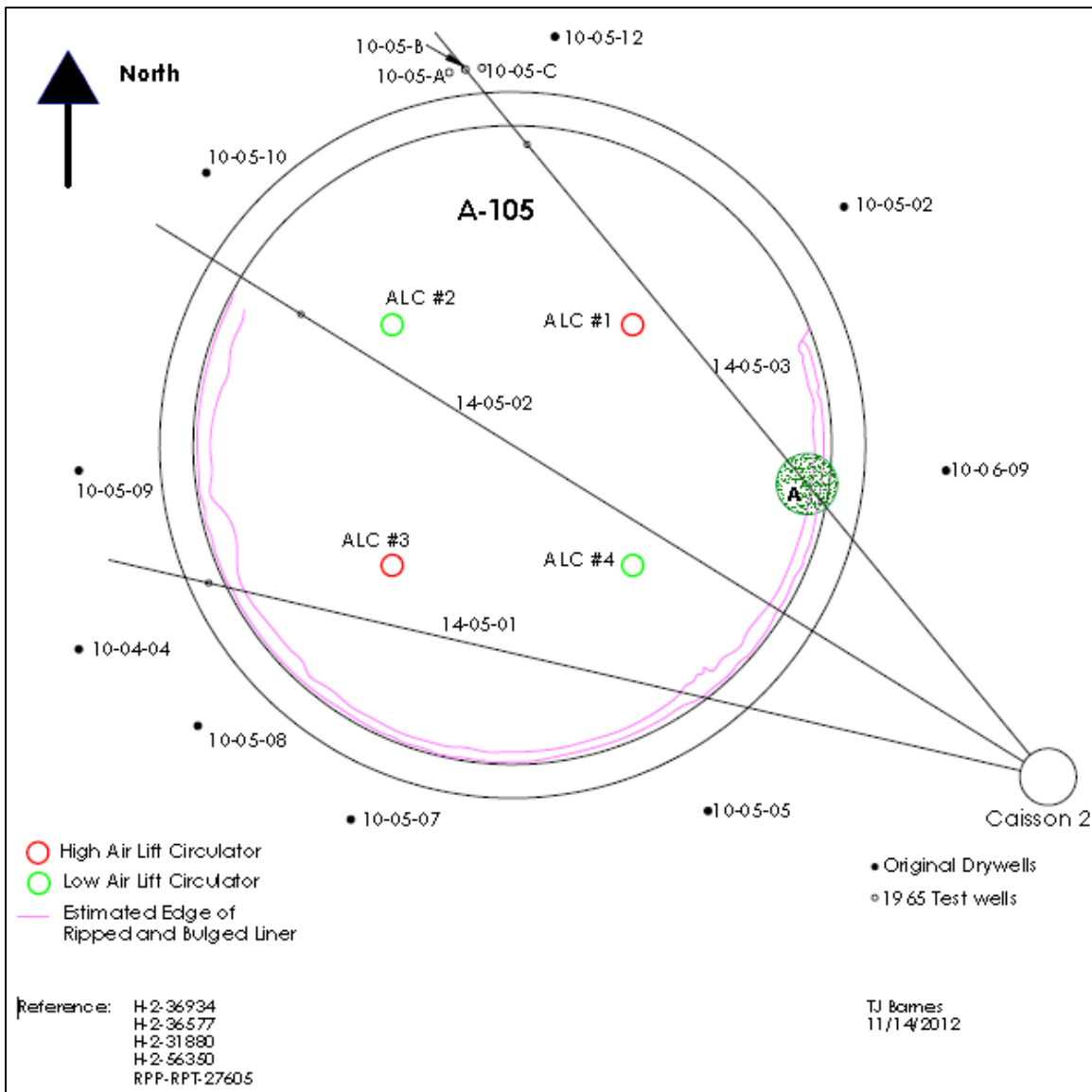
The lateral radioactivity when first detected is an indication of waste leakage from the concrete shell of the tank and could be an indication of the location of liner leak. However, the liner leak may have penetrated the waterproof membrane at a different location or pooled on the waterproof membrane and followed concrete cracks or breaks to a different location including the top of the tank footing.

It is likely that the majority of the tank A-105 leak occurred at the tank footing because all of the indicators, three laterals and one drywell, were located under or adjacent to the tank footing. A sidewall leak was initially suspected in November 1963 when radioactivity was detected in lateral 14-05-03, however subsequent liquid levels at the suspected leak zone did not indicate further leakage.

5.6.1 Leak Detected in November 1963

Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 in the southeast portion of the tank (see site A in Figure 5-23). It was postulated that a sidewall leak occurred during this time as the waste liquid level increased from 260-in to 280-in four months earlier. After the liquid level was reduced to 260-in, radiation readings in the lateral slowly decreased leading to the conclusion that a sidewall leak was minor and had self-healed. However, a sidewall leak was never confirmed. No radioactivity was detected in the other laterals or drywells, and tank A-105 remained in service.

Figure 5-23. Tank A-105 Possible Leak Location (November 1963)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



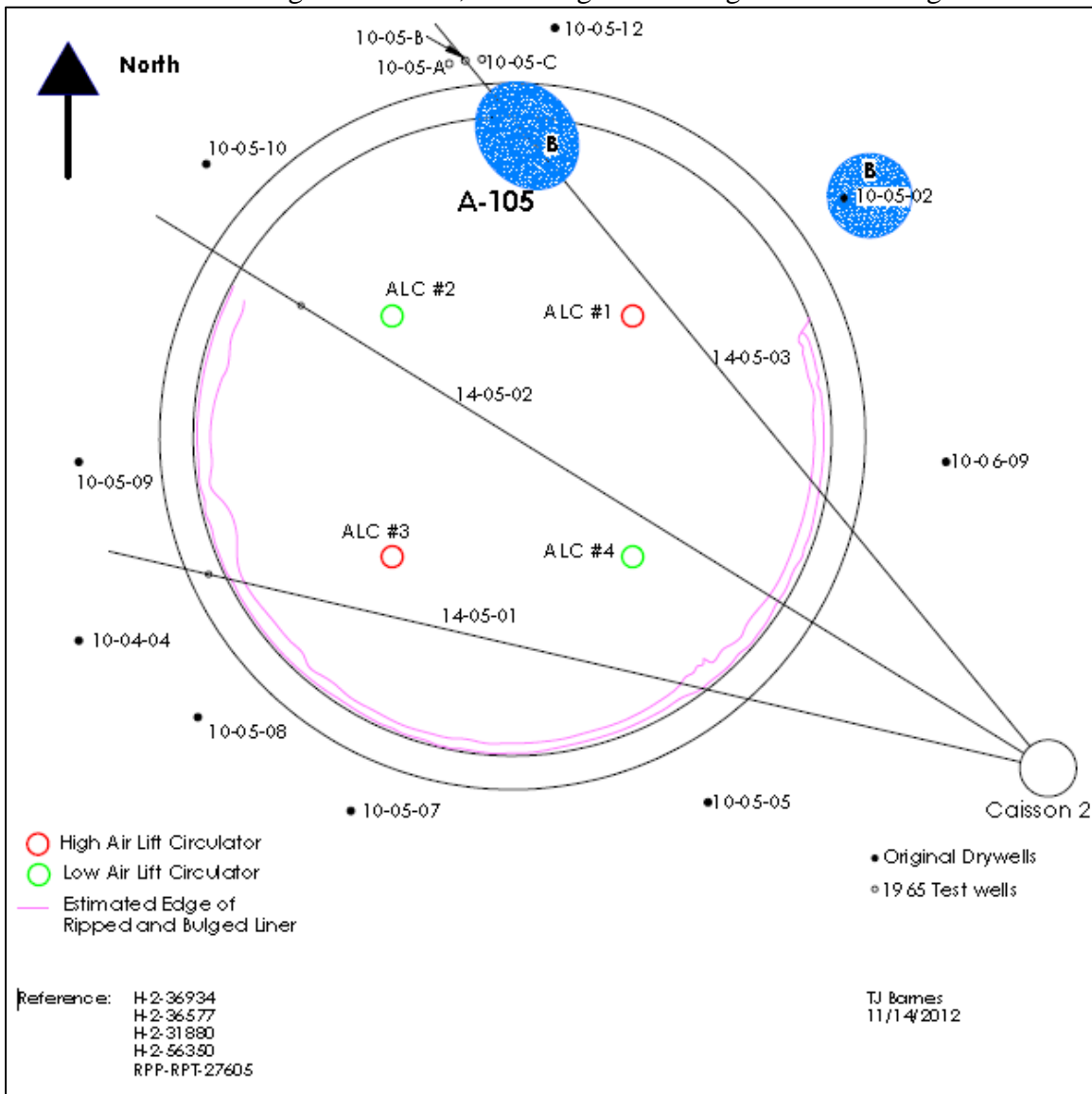
Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 near the southeast portion of the tank.

5.6.2 Leak Detected in 1965

On January 28, 1965, a steam eruption occurred in tank A-105 causing the bottom liner to tear approximately ¾ around the perimeter of the tank. One month later, radioactivity was detected in lateral 14-05-03 in the north portion of the tank (see Figure 5-24). Three test wells were drilled near this lateral; however, no radioactivity or moisture was detected in these test wells.

In January 1965, radioactivity was reported in drywell 10-05-02 at 74-ft BGS. The source of this radioactivity may have been migration of mobile RuRh-106 from a tank A-105 leak, possibly related to the November 1963 event (see Figure 5-23).

Figure 5-24. Tank A-105 Leak Indication (1965)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 near the southeast portion of the tank.

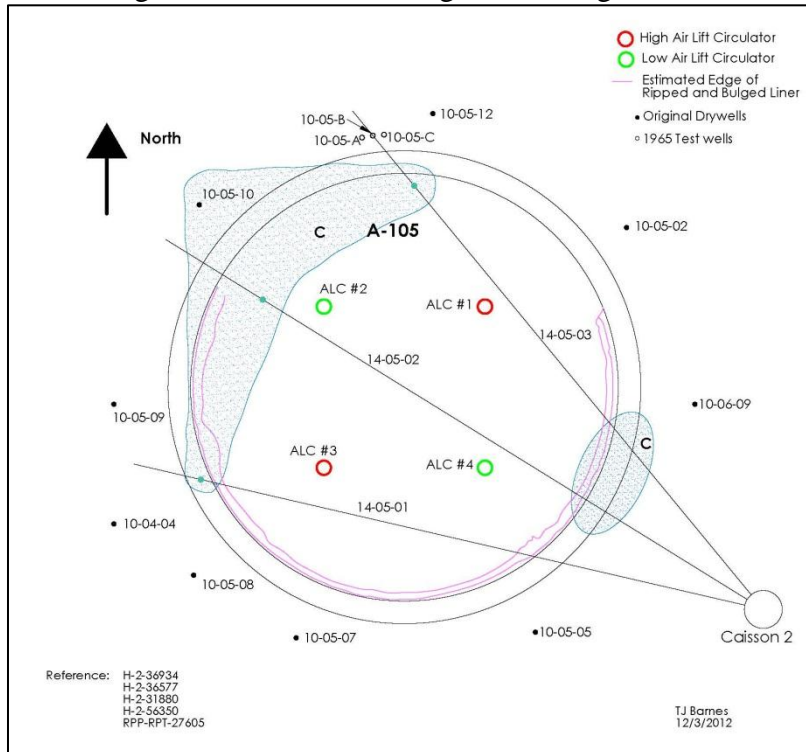
5.6.3 Leak Detected in 1968-1970

In March 1968, three years after the steam eruption, tank A-105 was declared a confirmed leaker. Two sluicing campaigns were conducted for tank A-105 in 1968 and 1970. During the first sluicing campaign from August to November 1968, radioactivity began to increase in laterals 14-05-01 and 14-05-02 (see Figure 5-25). As sluicing became ineffective, sluicing was shut down in November 1968. In January 1965, low-level radioactivity was reported in drywell 10-05-10 with three peak readings recorded at 50-ft, 70-ft, and 74-ft BGS and remained relatively stable through August 1966. The next recoverable reading was in September 1972 with a peak reading at 60-ft BGS at higher radiation readings. It is likely radioactivity detected in drywell 10-05-10 is associated with the radioactivity reported in 1968 for lateral 14-05-02, which is the earliest available data for this lateral (see Section 5.5.1).

A second, more aggressive, sluicing campaign began August 1970 and was halted November 1970 after significant increases were detected in all the laterals underneath tank A-105 (see Figure 5-25).

Prior to the first sluicing campaign, the supernatant was removed from the tank and the liquid level was reported at 35-in at the end of August 1968. The liquid level in tank A-105 was then reported at 24-in prior to the second sluicing campaign. It is likely the leak site or sites are below the 24-in waste level since radioactivity was detected in the laterals during the first sluicing campaign and increased during the second sluicing campaign.

Figure 5-25. Tank A-105 Leak Indicators (1968-1970)
 Tank inner ring is steel liner; outer ring is outer edge of tank footing



Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 near the southeast portion of the tank.

5.6.4 Leak Location Summary

Tank A-105 was first suspected of leaking in November 1963 due to radioactivity being detected in lateral 14-05-03 in the southeast portion of the tank (see site A in Figure 5-26). It was postulated that a sidewall leak occurred during this time as the waste liquid level was raised from 260-in to 280-in four months earlier. After the liquid level was reduced to 260-in, radiation readings in the lateral slowly decreased leading to the observation that a sidewall leak was minor and had self-healed. However, a sidewall leak remains inconclusive. No radioactivity was detected in the other laterals or drywells, and tank A-105 remained in service. Radioactivity remained relatively stable through March 1965 in lateral 14-05-03.

On January 28, 1965, a steam eruption occurred in tank A-105 causing the bottom liner to tear approximately $\frac{3}{4}$ around the perimeter of the tank. One month later, radioactivity was reported in lateral 14-05-03 in the north portion of the tank (see site B in Figure 5-26). Three test wells were drilled near the end of this lateral; however, no radioactivity or moisture was detected in these test wells indicating the leak was likely small and localized. Radioactivity was detected in drywell 10-05-02 at 74-ft BGS. The source of radioactivity may have been migration of mobile RuRh-106 from a tank A-105 leak, possibly related to the November 1963 event (see site A in Figure 5-26). However, there was no indication of radioactivity in nearby drywell 10-06-09 and the radioactivity detected in drywell 10-05-02 could have been from another source. No other drywells or laterals showed indications of radioactivity during this time.

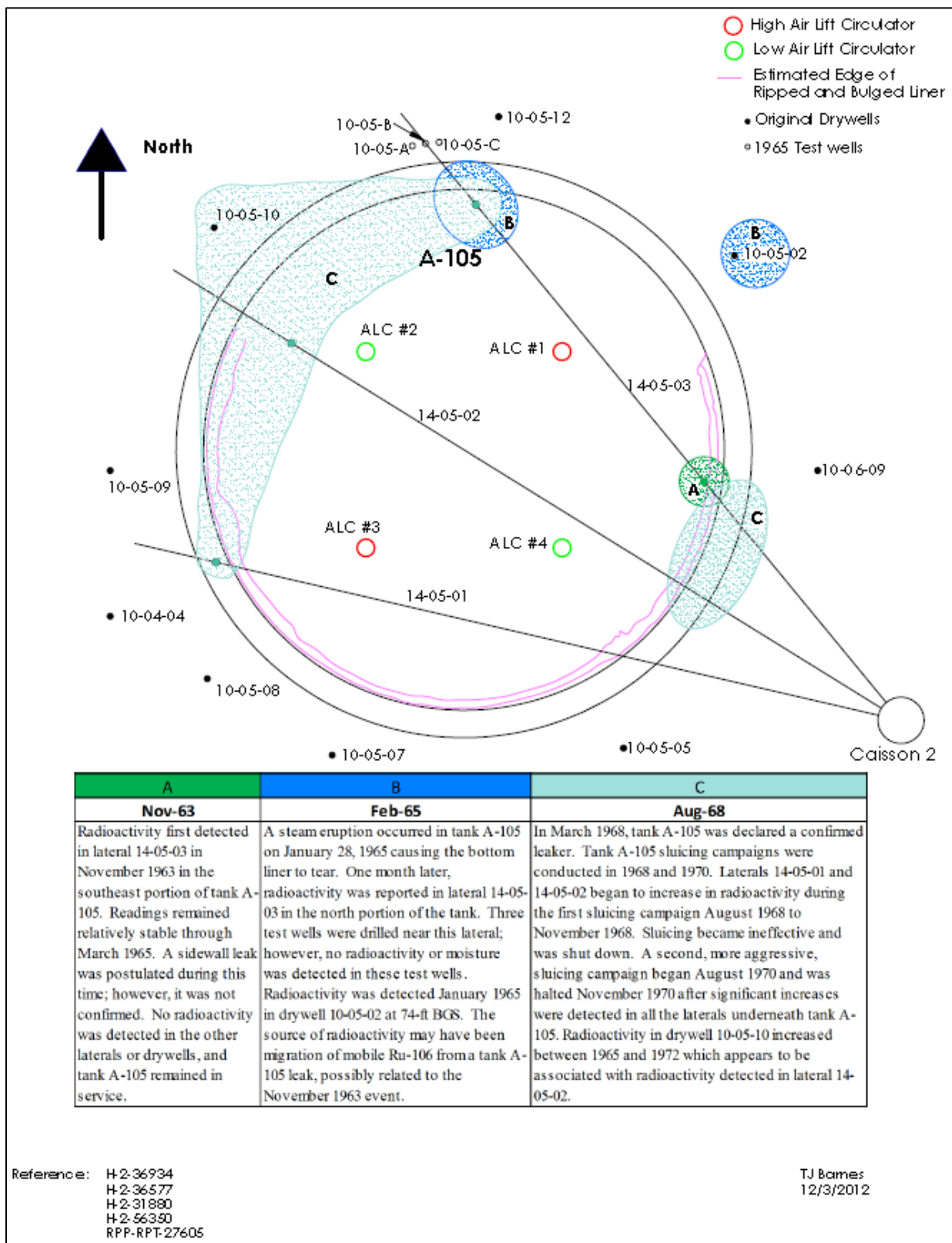
Approximately three years after the steam eruption, tank A-105 was declared a confirmed leaker in March 1968. Two sluicing campaigns were conducted on tank A-105 in 1968 and 1970. During the first sluicing campaign in August to November 1968, radioactivity began to increase in laterals 14-05-01 and 14-05-02 near the end of these laterals along the northwestern edge of tank A-105 (see site C in Figure 5-26). Sluicing became ineffective and the first sluicing campaign was shut down in November 1968. A second, more aggressive, sluicing campaign began August 1970 and was halted in November 1970 after significant increases in radioactivity were detected in all the laterals underneath tank A-105.

A liner bulge of approximately 8 $\frac{1}{2}$ -ft was detected after the January 1965 steam eruption near the center of the tank. The liner tore approximately $\frac{3}{4}$ along the tank perimeter as a result of the steam eruption as shown below in Figure 5-26. The location of the ripped liner is superimposed on Figure 5-26 in relationship to the tank leak locations and leak indicators. It is likely that the potential liner bulge indicated in 1963 started in the south east portion of the tank as the first detection of radioactivity was at the location in lateral 14-05-03 and the most severe portion of the January 1965 liner bulging was near that portion of the tank.

Leak locations in Figure 5-26 are based on peak readings and are a representation of possible boundaries of radioactivity under the tank. The radioactivity detected in drywell 10-05-02 stands alone as there is not enough information to depict the likely specific path to the source. It should be noted that the estimated edge of the ripped and bulged liner indicates that there were various leak paths through the grout, asphaltic membrane, concrete base and soil to the actual points of detection.

Figure 5-26. Tank A-105 Possible Radial Leak Locations and Indicators

Tank inner ring is steel liner; outer ring is outer edge of tank footing



5.7 POSSIBLE TANK A-105 LINER LEAK CAUSE(S)

Tank A-105 was evaluated for five conditions known to contribute to a failed liner.

5.7.1 Tank Design

The design of the A Farm tanks was the second, after 241-SX Farm, that diverged from the round bottom knuckle design used in the earlier waste tanks. The flat tank bottom liner intersects the sidewall liner orthogonally. A fillet weld was used to close the seam where the sidewall and tank bottom liners meet. Several other SSTs with fillet welds failed during service (RPP-RPT-45921, *Single Shell Tank Integrity Expert Panel Report*). Weld inspections were less rigorous. Additionally, the design discontinued the use of the three ply asphaltic membrane waterproofing between the liner and the concrete shell. These features were inferior compared to earlier tank designs and could possibly increase the likelihood of failure of the tank liner from induced stresses (see Section 3.1.1).

5.7.2 Thermal Conditions

Temperature requirements in HW-59919 issued October 22, 1959 indicated that the self-boiling waste operating temperature should be maintained between 220°F and 250°F. The maximum sludge temperature should not exceed 300°F.

The tank A-105 bulb (sludge) temperatures are shown in Appendix B2. The maximum temperature of 285°F in January and February 1965 did not exceed the maximum sludge temperature of 300°F.

The HW-59919 document recommended a uniform rate of temperature increase of 2°F per day. Temperatures were recorded as approximately 110°F in mid-April 1962 and gradually rose to 135°F by the beginning of May 1962; the temperature rate of rise was therefore approximately 1.6°F/day and may not have resulted in the complete removal of grout moisture. The highest temperature rate of rise occurred in February 1963 after receiving PUREX HLW directly from PUREX. During this time, temperatures rose from approximately 110°F on January 29, 1963 to approximately 210°F by March 1, 1963. The temperature rate of rise was approximately 3.3°F/day during this time. There were no other increases in temperatures that exceeded the average rate of rise of 3.3°F/day during the operation of tank A-105. Exceeding the operating temperature requirements would create liner stress when thermally hot high level waste was received and stored in the tank especially without pre-heating. The most severe temperatures published occurred during addition of PUREX HLW directly from PUREX in February 1963.

Thermal shock creates stress both from rapid temperature rise as well as high temperatures.

5.7.3 Chemistry-Corrosion

Water was added to tank A-105 in 1955 to counteract the vacuum on the tank. Some corrosion may have occurred during the seven years when only water was in the tank. The temperatures

during the seven years ranged from 60°F to 115°F (see Section 5.4.4). In 1962, PUREX HLW supernatant was added to the water which provided corrosion protection.

Tank A-105 stored only PUREX HLW for approximately six years and was present in the tank in November 1963, when radioactivity was initially detected in one of the laterals. According to flowsheet conditions, PUREX HLW should not result in unexpected corrosion of the tank steel liner (see Section 3.2.4).

At the end of January 1963, condensate additions were made into tank A-105 to pre-heat the tank prior to receiving PUREX HLW directly from PUREX in February 1963. The pH of the condensate additions was reported to be approximately nine, and specifications indicated additions into the A Farm tanks should be greater than a pH of eight (see Section 5.4.4). Therefore, the condensate additions should not result in unexpected corrosion of the tank steel liner.

No additional conditions have been identified that could accelerate corrosion of the tank steel liner.

5.7.4 Liner Observations

The liner bulge documented in TRAC-0022 indicated a bulge of approximately 8 ½-ft in the central portion of tank A-105. The liner bulge was studied in-depth for tank A-105, as the pressurization event in January 1965 was the greatest one experienced at Hanford as well as the size of the bulge resulting from this event.

A review of available photographs taken August 28 and 29, 1968 confirm the bulge of the tank bottom liner; however, the extent of the torn steel liner reported in TRAC-0022 could not be located in the available photographs.

The liner bulge was reported to have been caused by vaporization of water below the tank liner and/or thermal expansion of the steel resulting in the steel liner buckling due to the orthogonal fillet weld between the tank sidewall and tank bottom.

Liner bulging coupled with other tank conditions could affect tank liner integrity; however, by itself bulging induces stresses that can cause breaching of the tank liner.

5.7.5 Tank Construction Temperature

The lowest average temperatures during construction of the A Farm tank liners occurred in December 1954 at 34°F and January 1955 at 30°F with four months having at least one minimum temperature between 14°F and 18°F (see Section 5.3.2). The low temperatures experienced during construction were less than the 18°F allowable temperature where impact loading had the potential for creating micro-fissures. Impact occurrences may have triggered fissures in the steel liner.

5.8 TANK A-105 CONCLUSIONS

Evidence indicates that the tank A-105 liner leaked at or near the tank footing. Based on engineering judgment and available information the following conditions contributed to the tank A-105 failed liner:

- Thermal conditions – initial grout moisture pressurization caused bulging and partial failure of the tank bottom liner which could allow re-introduction of moisture into the grout coupled with high temperatures causing ultimate bottom liner failure
 - Liquid level control – transfer of waste to 10-in liquid level
- Tank design – expansion limiting design
- Superheated waste trapped under the tank bottom liner – complete failure of tank bottom liner
- Secondary contributing causes
 - Chemistry – corrosion from long term storage of inhibited water
 - Construction conditions – ductile-to-brittle transition temperature

There are several liner leak cause conditions that were examined but the most likely cause of the initial tank A-105 leak indication in November 1963 was the previous transfer of supernatant down to 10-in of liquid without adequate grout moisture removal and subsequent heating to boiling conditions. This could have set up a transient differential pressure condition between any residual grout vapor pressure below the tank bottom liner and hydrostatic pressure above the tank bottom liner. The differential coupled with the tank vacuum could have resulted in a bulged tank bottom liner possibly causing fissures in the tank bottom liner.

The tank design also contributed by not allowing expansion of the bottom liner as the tank heated which could have creating additional stresses. Fissures in the tank bottom liner would have allowed the introduction of condensate/HLW into the bulged area as the tank was refilled. The bulge trapped liquid could have resulted in the liquid level cycling in September 1963 as the area beneath the bulge first pressurized with vapor, expelling the remaining liquid, and then allowing liquid to refill the bulge beginning a new expulsion oscillation resulting in further compromising the integrity of the tank bottom liner. The hydrostatic head eventually increased to the equivalent HLW concentration of 11,000 tons of PUREX feed until the vapor pressure of the liquid under the bulge created a superheated steam event January 28, 1965 ripping the bottom liner resulting in further leakage.

Chemistry-corrosion and construction conditions could have also contributed to the tank bottom liner failure but to a lesser degree.

APPENDIX A2

TANK A-105 BOILING WASTE OPERATIONAL HISTORY

Table A2-1. RHO-R-39 Boiling Waste Tank Operating Data Table

Tank No.	First Waste	Tank Pre-Heated	Pre-Heat Start	Liquid Heel Used	First Waste Rec'd From	Tank Failed	Inspected For Bulge	Bulge Present	Did Tank Boil on 1st Loading	Tank Started Boiling	Tank Emptied & Reused*	NaNO ₃ Leached from Sludge
101-SX	19 May 54	No	-	No	Redox	No	No	-	Yes	Nov 54	No	No
102-SX	Sep 54	No	-	No	101-SX, Cascade	No	No	-	No	-	No	No
103-SX	Nov 54	No	-	No	102-SX, Cascade	No	No	-	No	-	No	No
104-SX	2 Feb 55	No	-	No	Redox	No	No	-	Yes	Jun 55	No	No
105-SX	11 May 55	No	-	No	104-SX, Cascade	No	No	-	No	-	Yes	No
106-SX	Jun 54	No	-	No	Tank Farm Condensate	No	No	-	No	-	-	-
107-SX	3 Mar 56	No	-	Yes	Redox	Yes, 1964	Yes	Yes	Yes	Jun 56	Yes	Yes
108-SX	8 Nov 55	No	-	No	Redox	Yes, 1962	Yes	Yes	Yes	Jun 56	Yes	Yes
109-SX	20 Sep 55	No	-	Yes	Redox	Yes, 1965	Yes	No	Yes	Dec 55	Yes	No
110-SX	Nov 60	Yes	Apr 60	No	Redox	-	No	-	No	Between 1/61-6/61	Yes	No
111-SX	9 Jun 56	No	-	No	Redox	-	No	-	Yes	Nov 56	Yes	No
112-SX	13 Feb 56	No	-	No	Redox	Yes, 1969	Yes	Yes	Yes	Mar 56	Yes	No
113-SX	20 Feb 58	No	-	No	Redox	Yes, 1958	Yes	Yes	Yes	Apr 58	No	No
114-SX	Nov 56	No	-	No	Redox	-	No	-	Yes	Jun 57	Yes	Yes
115-SX	4 Nov 59	Yes	Sep 58	Yes	Redox	Yes, 1965	No	-	Yes	Nov 59	No	Yes
101-A	20 Jan 56	No	-	6" H ₂ O	Purex	No	Yes	No	Yes	Jul 57	Yes	No
102-A	20 Mar 56	No	-	6" H ₂ O	Purex	No	No	-	Yes	Jul 58	Yes	No
103-A	15 May 56	No	-	6" H ₂ O	Purex	No	No	-	Yes	Jul 56	Yes	No
104-A	30 Jun 59	No	-	6" H ₂ O	Purex	No	Yes	No	Yes	Aug 59	Yes	No
105-A	31 Jan 63	Yes	Jan 63	Yes	Purex	Yes, 1963	Yes	Yes	No***	Mar 63	No	No
106-A	31 Dec 60**	Yes	23 Feb 61	Yes	Purex	No	No	-	Yes	Aug 61	Yes	No
101-AX	1 Jun 65**	Yes	23 Nov 66	Yes	TK-103-A and TK-112-B	No	No	-	No***	Dec 66	Yes	No
102-AX	30 Sep 66**	Yes	2 Mar 69	Yes	TK-101-AX and TK-103-A	No	No	-	No***	Apr 69	No	No
103-AX	10 Feb 65	Yes	Nov 64	Yes	Purex	No	No	-	Yes	Apr 65	No	No
104-AX	9 Sep 66	Yes	Jun 66	Yes	Purex	No	No	-	Yes	Oct 66	No	No

* Emptied indicates supernatant was pumped out but sludge remained.

** Tanks used for temporary waste storage prior to the receipt of LW or HLW.

*** Did not boil until LW was routed to the tank.

Note: SX-111 was found to have been NaNO₃ Leached

Table A2-2. ARH-R-43 Waste Tank Leak Experience Table

TABLE 3. Underground Waste Storage Tank Leak Experience

Tank	Built	First Used	Type of Waste Stored	Service	Leak First Suspected	Reason for Suspicion	Leak Confirmed by	Bulge Found	Estimated Volume of Leak, gal	Associated Cs-137, kCi
104-U	1943-44	1947	Bismuth phosphate waste Uranium recovery waste	Nonboiling	1956	Bulged liner	Refill with water (1961)	Yes	55,000*	0.09
113-SX	1953-54	1958	Redox waste	Boiling	1958	Bulged liner	Refill with salt solution (1962)	Yes	15,000**	8
106-TY	1951-52	1953	TBP waste	Nonboiling	1959	Liquid level measurements	Soil radiation readings (1959)		20,000	2
101-U	1943-44	1946	Bismuth phosphate waste Uranium recovery waste Redox waste	Nonboiling	1959	Liquid level measurements	Liquid level measurements		30,000	23
105-TY	1951-52	1953	TBP waste	Nonboiling	1960	Liquid level measurements	Liquid level measurements		35,000	4
108-SX	1953-54	1955	Redox waste	Boiling	1962	Soil radiation readings	Liquid level measurements	Yes	3,400	17
105-A	1954-55	1963	Purex waste	Boiling	1963	Soil radiation readings	Soil radiation readings	Yes	Small	
107-SX	1953-54	1956	Redox waste	Boiling	1964	Soil radiation readings	Soil radiation readings	Yes	Small	
109-SX	1953-54	1955	Redox waste	Boiling	1965	Soil radiation readings	No further evidence	No	Small	
115-SX	1953-54	1958	Redox waste	Boiling	1965	Liquid level measurements	Soil radiation readings		50,000***	40
112-SX	1953-54	1956	Redox waste	Boiling	1969	Liquid level measurements	Soil radiation readings	Yes	30,000	45

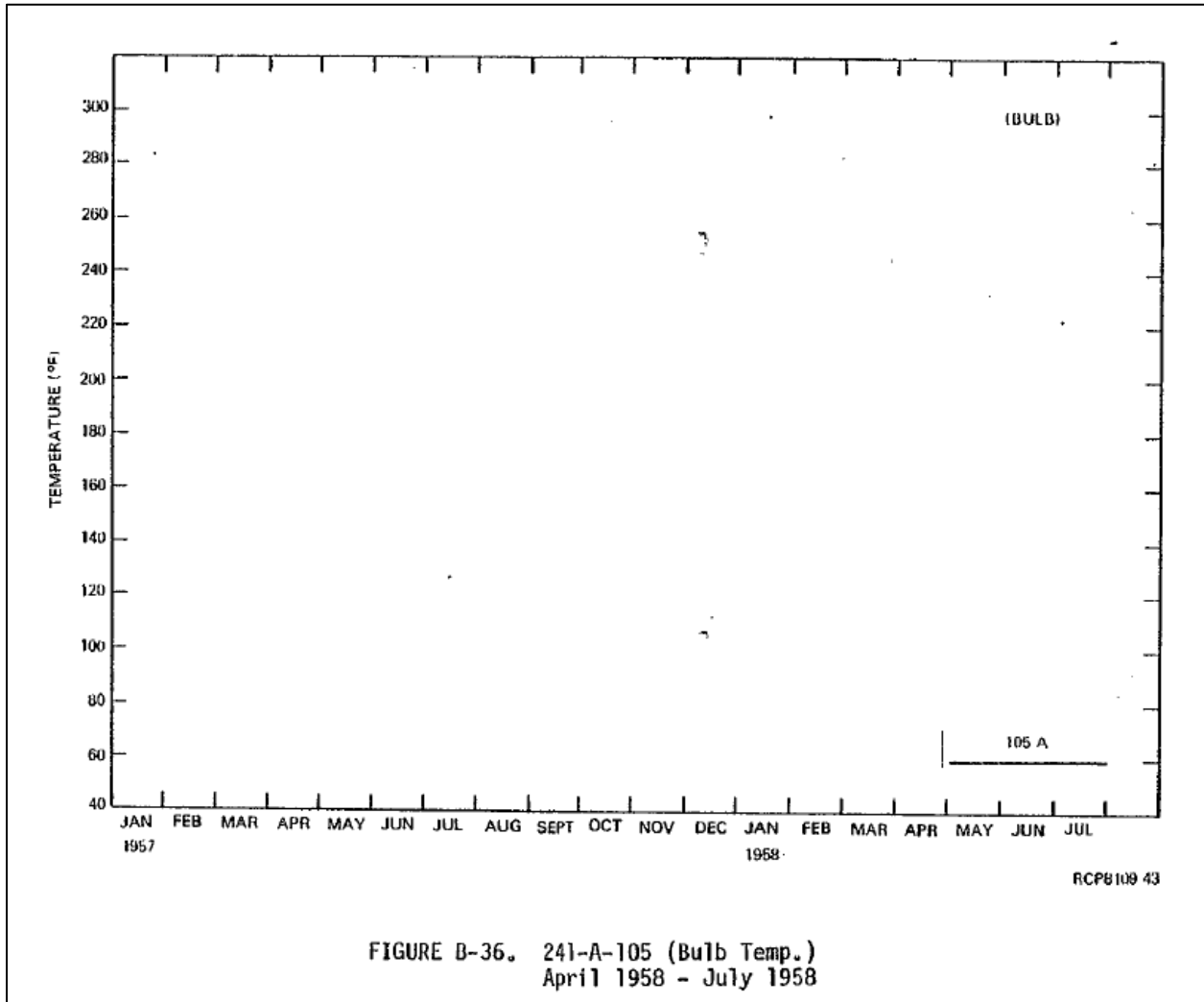
* Contained water at time of leak.
 ** Contained NaNO_3 solution at time of leak, also some residual supernatant solution.
 *** Contained NaNO_3 solution at time of leak.

Note: See tank farm segments for information on individual specific tanks

APPENDIX B2

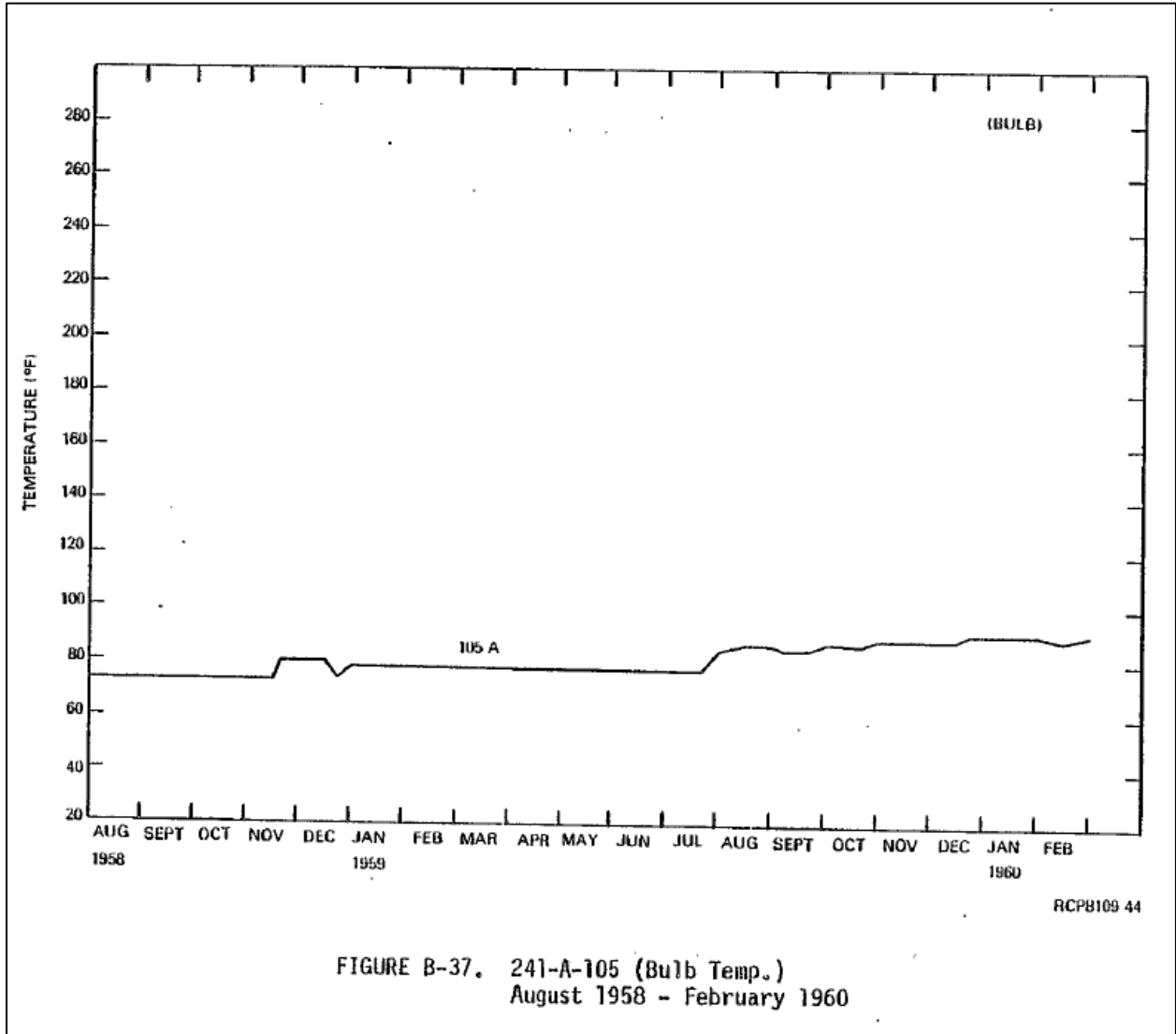
TANK A-105 TEMPERATURES APRIL 1958-JUNE 1970

Figure B2-1. RHO-CD-1172 Tank A-105 Temperature April 1958 through July 1958



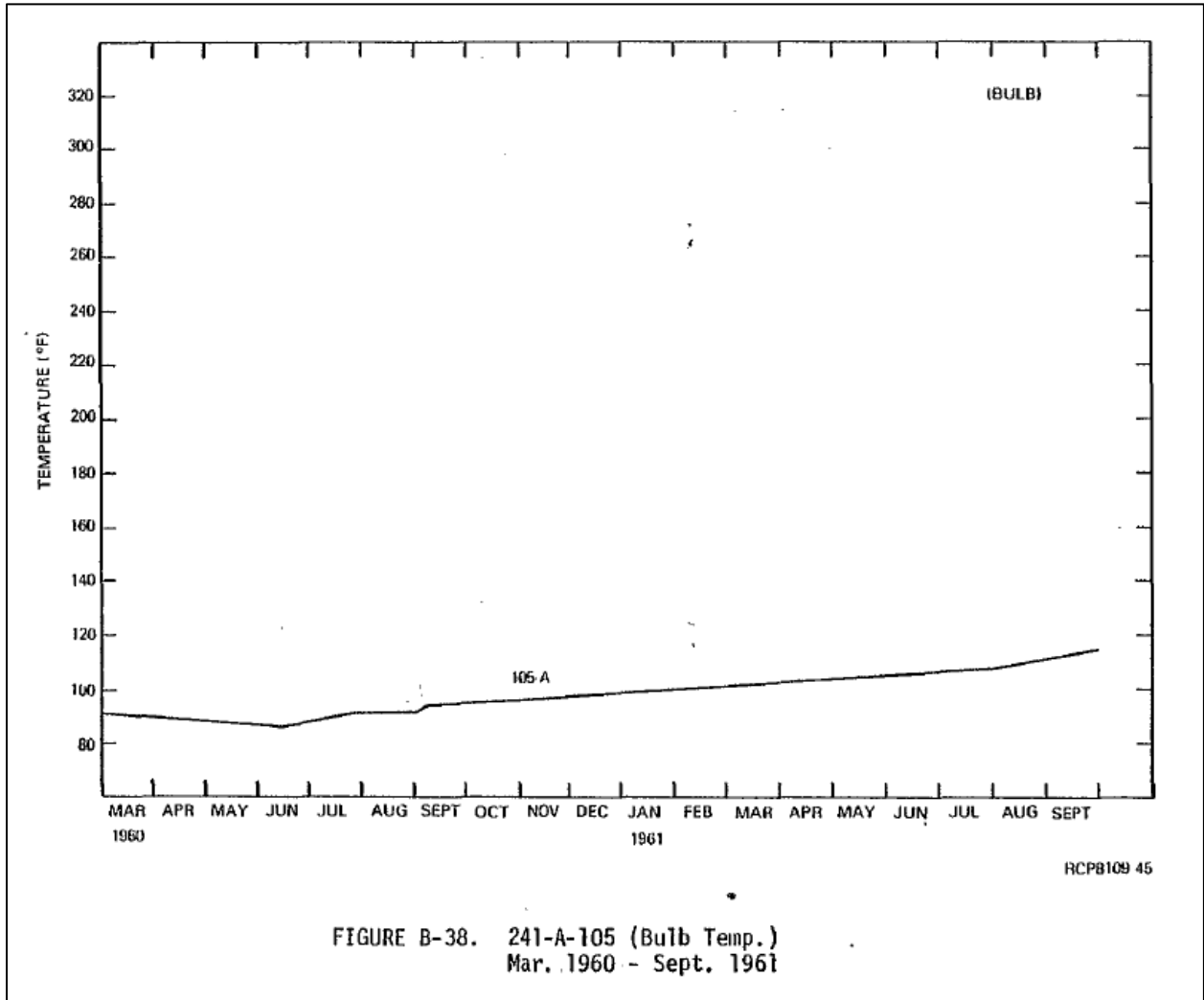
Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-2. RHO-CD-1172 Tank A-105 Temperature August 1958 through February 1960



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-3. RHO-CD-1172 Tank A-105 Temperature March 1960 through September 1961



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-4. RHO-CD-1172 Tank A-105 Temperature October 1961 through April 1963

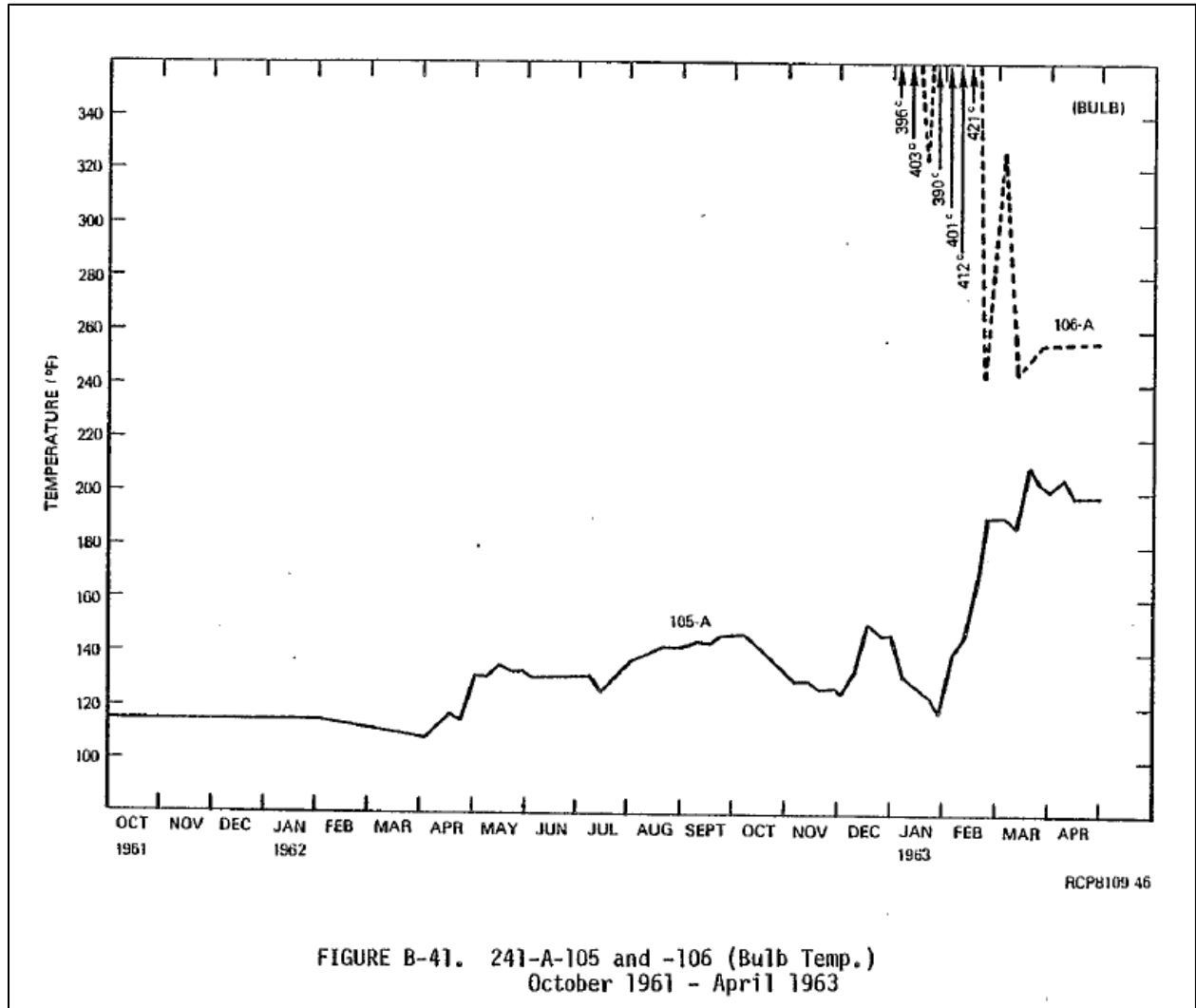
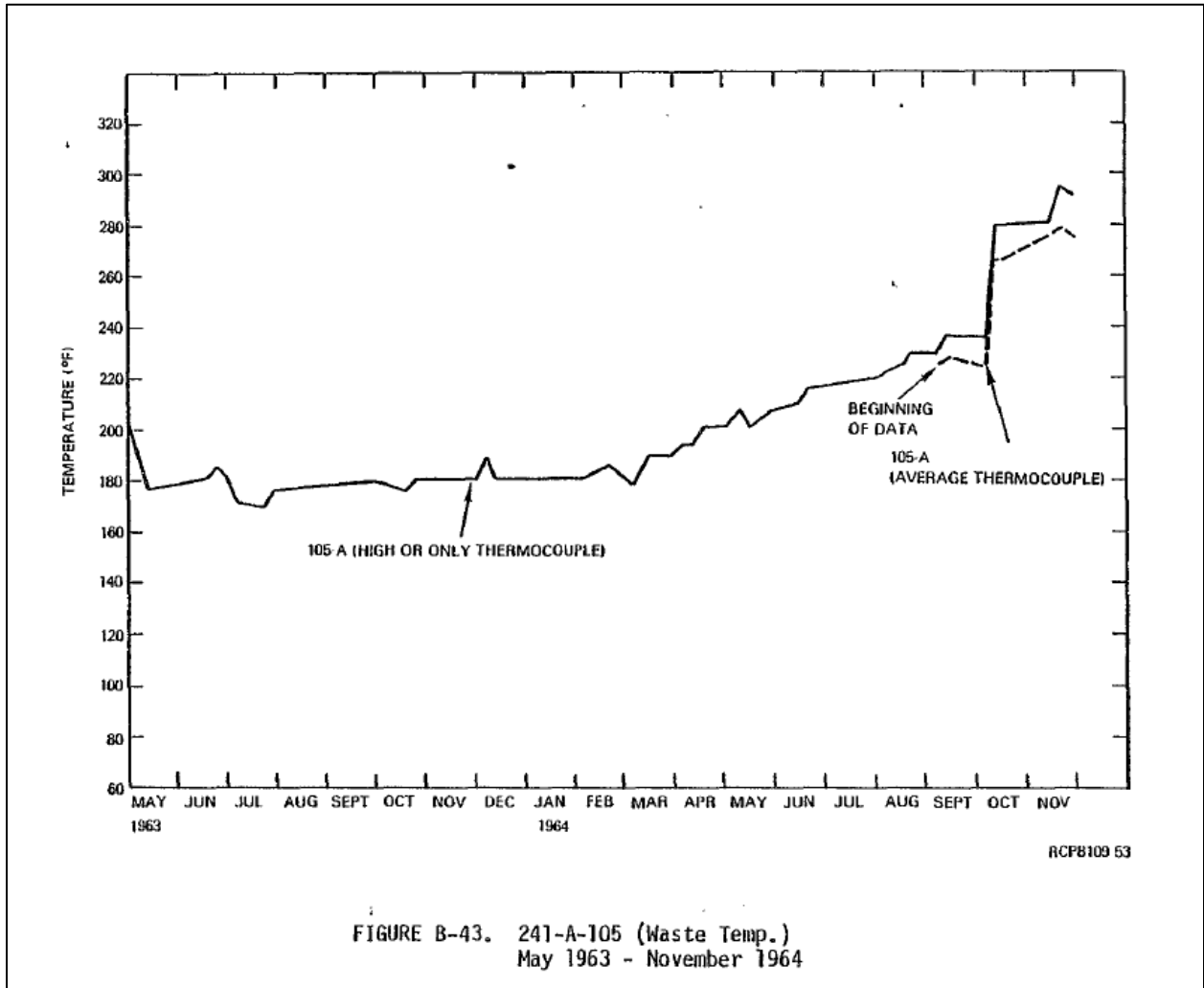


FIGURE B-41. 241-A-105 and -106 (Bulb Temp.)
October 1961 - April 1963

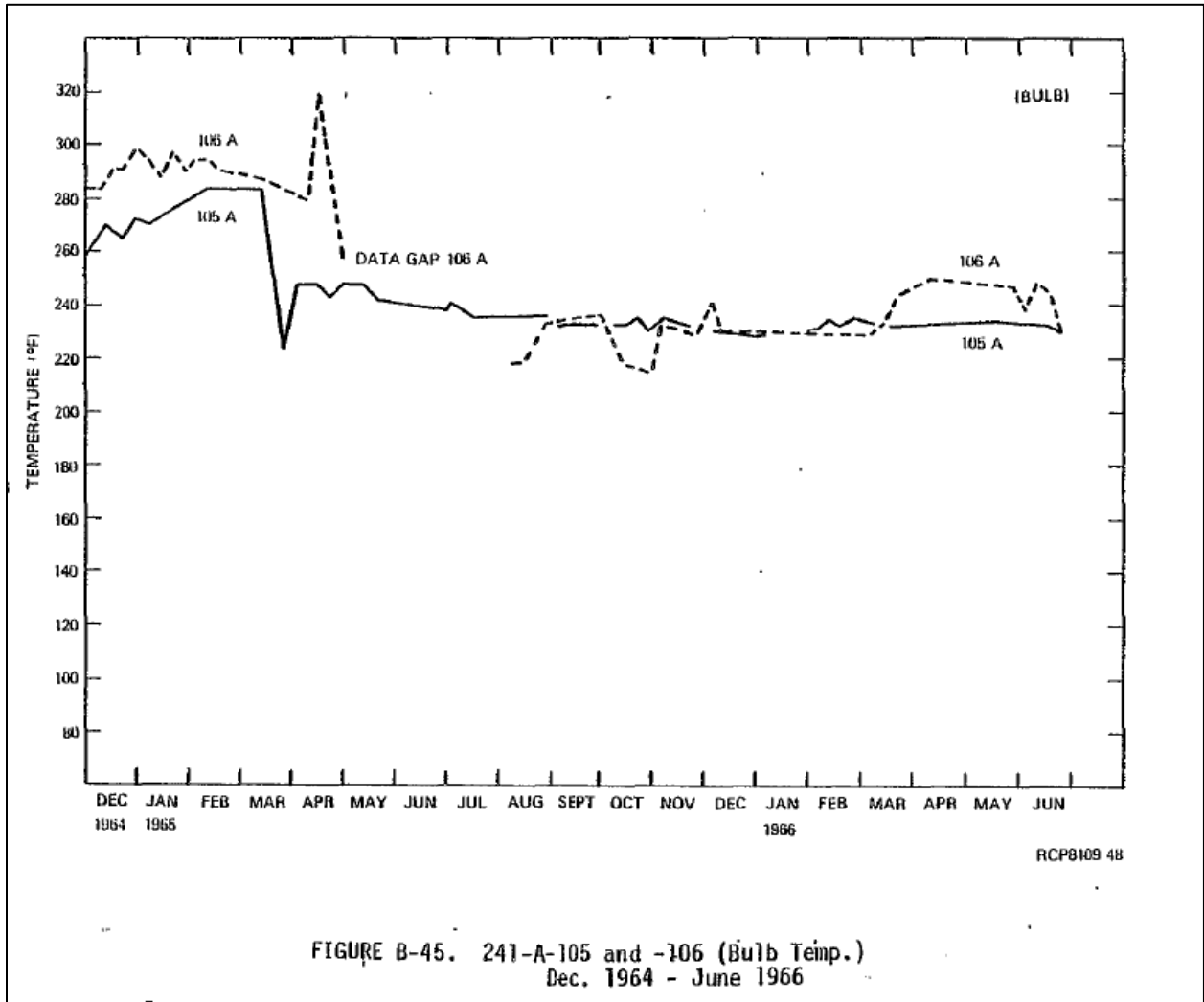
Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-5. RHO-CD-1172 Tank A-105 Temperature May 1963 through November 1964



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-6. RHO-CD-1172 Tank A-105 Temperature December 1964 through June 1966



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-7. RHO-CD-1172 Tank A-105 Temperature July 1966 through January 1968

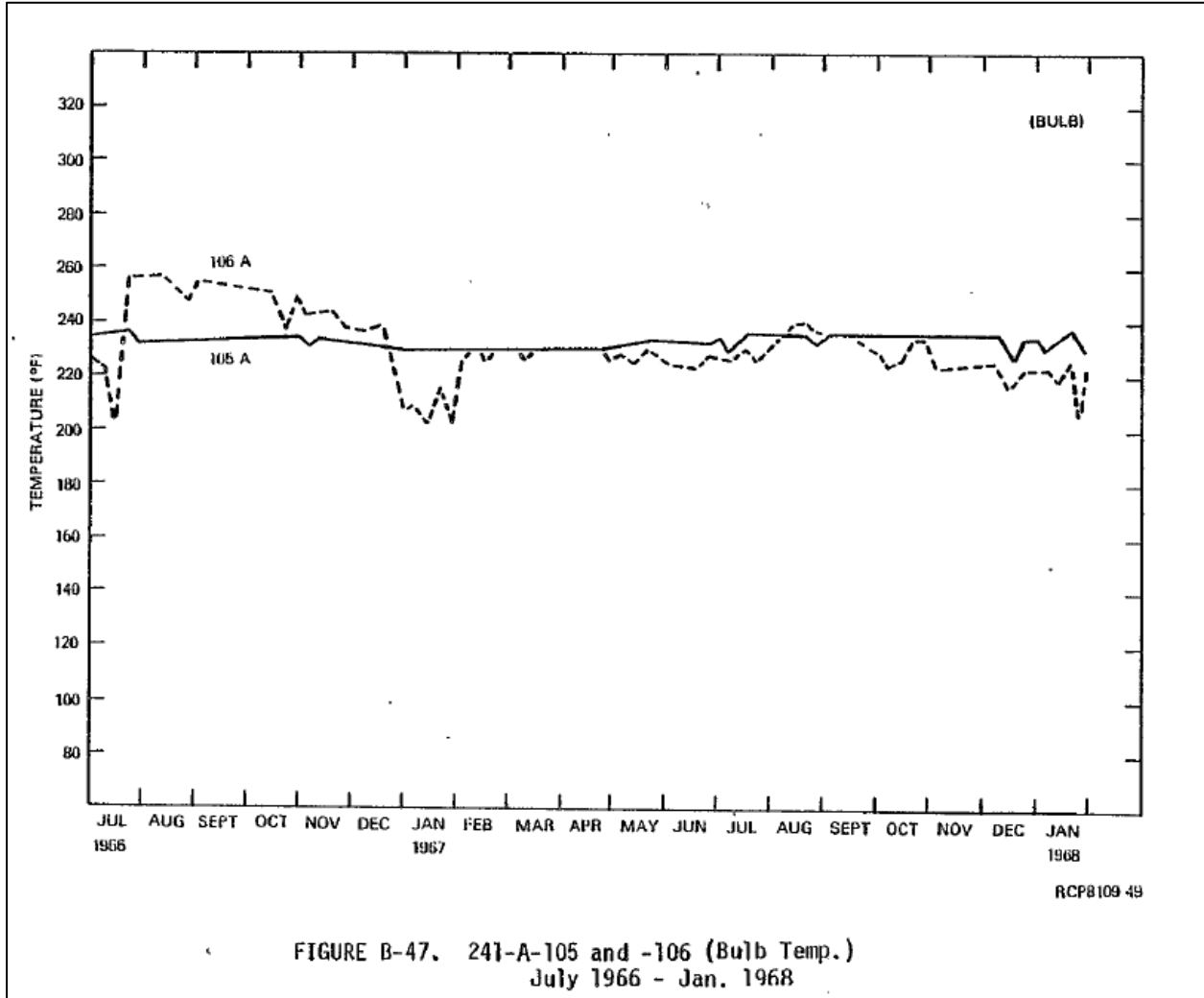
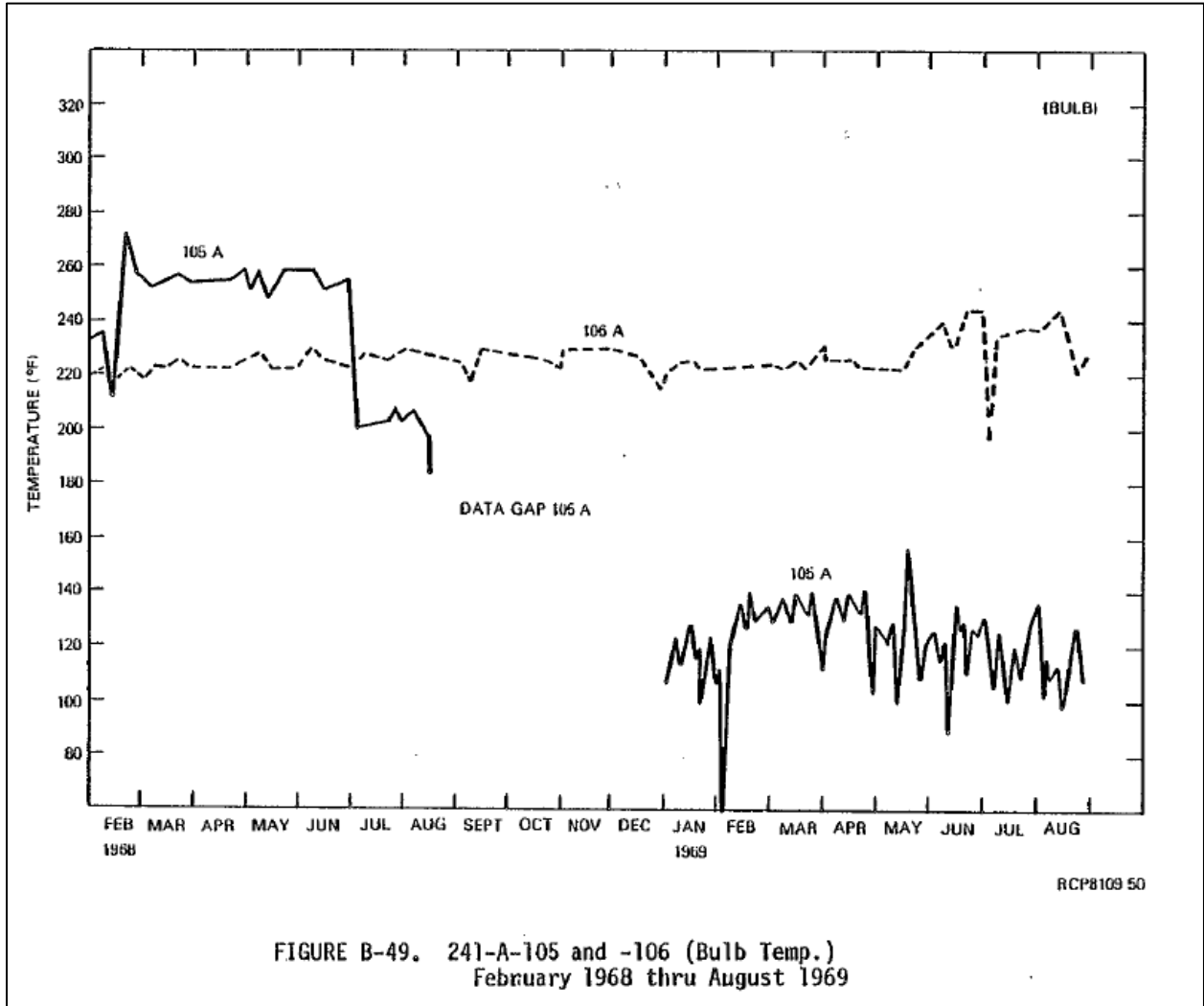
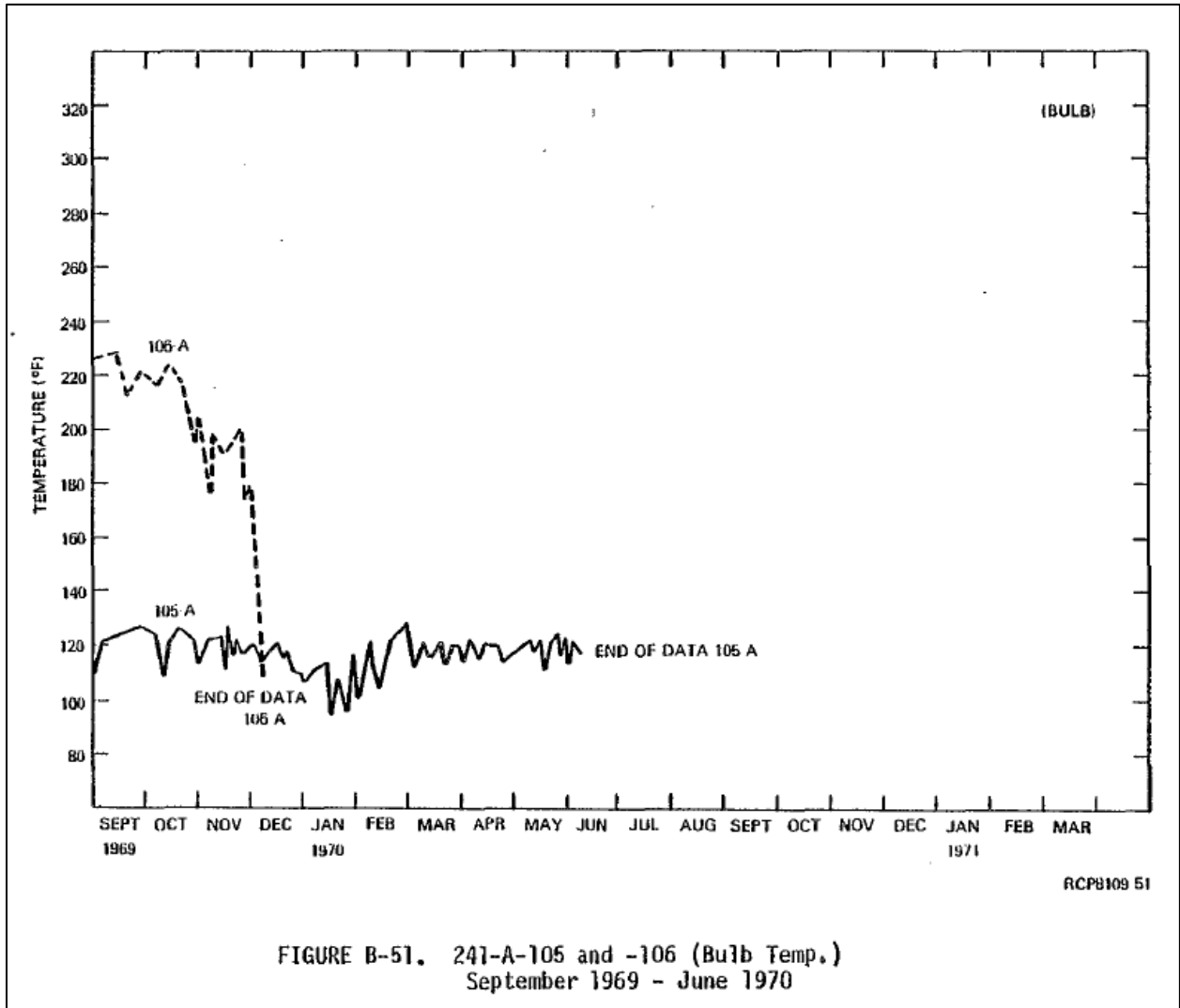


Figure B2-8. RHO-CD-1172 Tank A-105 Temperature February 1968 through August 1969



Note: Bulb (sludge) temperature 2-in to 3-in off the tank bottom (see Section 3.2.2)

Figure B2-9. RHO-CD-1172 Tank A-105 Temperature September 1969 through June 1970



APPENDIX C2
TANK A-105 LATERAL ACTIVITY

**Table C2-1. Tank 241-A-105 Lateral Radioactivity (K counts per minute)
(September 1972 through June 1986)
(SD-WM-TI-356) (1 of 2 sheets)**

14-05-01			14-05-02			14-05-03		
Date	Peak (K cpm)	Length (ft) ⁵	Date	Peak (K cpm)	Length (ft) ⁵	Date	Peak (K cpm)	Length (ft) ⁵
	N/A ²			N/A ²		11/19/63	17 ¹	44.6 ⁶
	N/A ²			N/A ²		11/26/63	150 ¹	44.6 ⁶
	N/A ²			N/A ²		3/8/65	195 ¹	95.6 ⁶
	N/A ²			N/A ²		01/31/66	225 ⁷	N/A ²
	N/A ²			N/A ²		02/28/66	225 ⁷	N/A ²
	N/A ²			N/A ²		03/31/66	225 ⁷	N/A ²
	N/A ²			N/A ²		4/30/66	225 ⁷	N/A ²
	N/A ²			N/A ²		5/31/66	225 ⁷	N/A ²
	N/A ²		10/2/67	2 ⁸	N/A ²	N/A ²		
	N/A ²		8/25/68	150	100	N/A ²		
	N/A ²		9/1/68	380	100	N/A ²		
	N/A ²		9/8/68	410	N/A ²	N/A ²		
10/29/68 ⁹	20 ¹	N/A ²	10/29/68 ⁹	190 ¹	N/A ²	10/29/68 ⁹	120 ¹	N/A ²
8/70	40 ¹	N/A ²	8/70	375 ¹	N/A ²	8/70	960 ¹	N/A ²
9/13/72	16.6	98	9/8/72	198	40	9/11/72	580	93
4/26/74	11.6	98	4/26/74	175	40	4/26/74	485	93
1/3/75	4.4	98	1/6/75	77	50	1/10/75	192	93
5/12/75	3.9	98	5/12/75	51	35	6/2/75	202.5	93
8/15/75	6.2	98	8/15/75	54	48	8/18/75	199.5	93
1/7/76	6.3	98	1/21/76	54	48	1/5/76	198	96
6/4/76	5.8	94	8/30/76	79.3	49	8/30/76	273	94
9/10/76	7.5	94	N/A ²			10/4/76	347	94
12/6/76	7.7	94	12/8/76	82	49	12/8/76	356	93
3/28/77	7.3	94	3/28/77	80.7	49	3/28/77	310	93
6/9/77	23	89.6	N/A ²			N/A ²		
6/17/77	24 ³	88.6	6/17/77	195 ³	35.6	6/16/77	720 ³	97.6
9/5/77	27	89.6	9/5/77	180	28.6	9/5/77	648	95.6

**Table C2-1. Tank 241-A-105 Lateral Radioactivity (K counts per minute)
(September 1972 through June 1986)
(SD-WM-TI-356) (2 of 2 sheets)**

14-05-01			14-05-02			14-05-03		
Date	Peak (K cpm)	Length (ft) ⁵	Date	Peak (K cpm)	Length (ft) ⁵	Date	Peak (K cpm)	Length (ft) ⁵
12/9/77	26	89.6	12/9/77	162	28.6	12/9/77	570	95.6
	N/A ²			N/A ²		3/29/78	387	95.6
	N/A ²			N/A ²		5/8/78	516 ¹	N/A ²
12/20/78	26	92.6		N/A ²		5/15/78	1,080 ¹	N/A ²
	N/A ²		6/5/78	180	28.6	6/26/78	810	95.6
	N/A ²			N/A ²		9/27/78	660	95.6
	N/A ²			N/A ²		12/20/78	870	95.6
12/25/79	23	92.6	12/25/79	138	28.6	12/25/79	192	96.6
12/16/80	14 ⁴	92.6	12/16/80	136	38.6	12/16/80	222 ⁴	88.6
				136 ⁴	28.6			
12/28/81	18	92.6	10/28/81	159	28.6	10/28/81	434	87.6
12/15/82	22	92.6	12/15/81	149	27.6	12/15/82	398	87.6
8/26/83	14	93.6	8/26/83	103	40.6	8/26/83	126	88.6
9/1/83	19	96.6	9/1/83	164	41.6	9/1/83	527	86.6
11/18/83	9	94.6	11/18/83	132	40.6	11/18/83	236	88.6
10/15/84	10	94.6	10/15/84	147	41.6	10/15/84	400	88.6
9/26/85	14	94.6	9/26/85	122	42.6	9/26/85	394	89.6
6/20/86	16	97.6	6/20/86	136	41.6	6/20/86	480	89.6

Note: ¹Referenced from WHC-MR-0264

²N/A: Data not available

³New monitoring equipment

⁴New measuring method

⁵Length is distance from the caisson

⁶Referenced from WHC-MR-0250

⁷Referenced from HAN-93855

⁸Referenced from ARH-78 and HAN-98918

⁹Activity measuring instrument repaired which corrected these values from previous readings

APPENDIX D2

TANK A-105 GROSS GAMMA DRYWELL DATA

**Table D2-1. Tank 241-A-105 Drywell Radioactivity (K counts per minute) (March 1969 to November 1986)
(Drywell Data Sheets Retrieved on March 15, 2011 and SD-WM-TI-356) (1 of 3 sheets)¹**

10-06-09			10-05-02			10-05-05			10-05-07			10-05-08		10-04-04			10-05-09			10-05-10			10-05-12										
Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)								
1/3/65	45	18	N/A ³			1/3/65	10	50	N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			1/3/65	250	5								
	10	50					7	50																									
	10	80					8	70																									
	45	83					110	75																									
1/7/65	40	20	1/7/65	7	50	N/A ³			1/7/65	6	50	N/A ³		N/A ³			1/7/65	15	15	1/7/65	6	50	N/A ³										
	6	50		8	70					7	70							6	50		6	70											
	7	80		40	74					21	74							6	70		8	74											
	100	84																7	73														
11/3/65	8	17	11/3/65	7	70	11/3/65	8	70	11/3/65	6	70	N/A ³		N/A ³			11/3/65	6	16	11/3/65	6	20	11/3/65	210	5								
	45	20		39	76		62	75		8	75							25	19		5	70		7	70								
	8	80																5	70		22	75		110	75								
	130	84																9	74														
11/12/65	48	20	N/A ³			11/12/65	6	50	N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			11/12/65	96	6								
	7	50					17	73																66	75	6	50	9	74	130	76		
	8	82																															
	150	84																															
11/18/65	7	50	N/A ³			11/18/65	6	50	N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			11/18/65	200	5								
	6	80					10	73																60	76	7	50	7	70	110	76		
	110	84																															
11/22/65	6	16	11/22/65	6	25	11/22/65	7	25	11/22/65	6	25	N/A ³		N/A ³			11/22/65	6	25	11/22/65	5	25	11/22/65	250	6								
	45	19		8	50		6	50		7	50							5	50		7	25											
	7	25		9	74		10	72		9	75							5	70		12	75		6	50								
	6	50		54	77		22	74		32	76													10	73								
	8.5	82					62	76																32	75								
	150	84																						120	77								
1/21/66	40	19	N/A ³			1/21/66	9	50	N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			1/21/66	220	6								
	9	50					10	70																60	76	8	50	10	70	68	76		
	10	80																															
	36	83																															
1/27/66	40	19	1/27/66	7	50	1/27/66	8	50	1/27/66	6	50	N/A ³		N/A ³			1/27/66	15	15	1/27/66	6	50	1/27/66	230	5								
	10	50		8	70		10	70		7	70							6	50		6	70		10	50								
	12	82		40	74		64	75		22	74							6	70		8	74		10	70								
	80	84																7	73					110	76								

**Table D2-1. Tank 241-A-105 Drywell Radioactivity (K counts per minute) (March 1969 to November 1986)
(Drywell Data Sheets Retrieved on March 15, 2011 and SD-WM-TI-356) (2 of 3 sheets)¹**

10-06-09			10-05-02			10-05-05			10-05-07			10-05-08		10-04-04			10-05-09			10-05-10			10-05-12				
Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)		
2/4/66	40	19	N/A ³	N/A ³	N/A ³	2/4/66	7	50	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	2/4/66	200	6	N/A ³	N/A ³	N/A ³	
	9	50					10	70														7	50				
	10	80					63	75														8	70				
	52	84																				100	76				
5/12/66	8	50	N/A ³	N/A ³	N/A ³	5/12/66	8	50	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	5/12/66	15	6	N/A ³	N/A ³	N/A ³	
	8	80					8	70														8	70				
	130	83					50	74														58	76				
5/20/66	23	17	N/A ³	N/A ³	N/A ³	5/20/66	8	50	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	N/A ³	5/20/66	130	6	N/A ³	N/A ³	N/A ³	
	8	50					8	70														8	70				
	8	80					50	73														88	76				
	120	83																									
5/25/66	25	19	5/25/66	8	50	5/25/66	8	50	5/25/66	8	50	N/A ³	N/A ³	5/26/66	8	50	5/25/66	8	50	5/25/66	8	50	5/25/66	120	5	N/A ³	N/A ³
	8	50		8	70		8	70		8	70				8	70											
	8	80		50	76		30	75		60	75				20	75											
	120	83																90	76								
8/26/66	24	18	8/26/66	8	50	8/26/66	8	50	8/26/66	8	50	N/A ³	N/A ³	8/26/66	8	50	8/26/66	8	50	8/26/66	8	50	8/26/66	64	6	N/A ³	N/A ³
	8	50		8	73		8	73		8	70				8	70											
	8	80		60	74		35	75		15	74				20	75											
	120	84																100	76								
9/13/72	< 6	N/A ³	9/13/72	12	N/A ³	9/13/72	< 6	N/A ³	9/13/72	< 6	N/A ³	9/13/72	< 6	9/13/72	< 6	N/A ³	9/13/72	< 6	N/A ³	9/13/72	28	60	9/13/72	9	76		
N/A ³			N/A ³			4/6/72	< 6	N/A ³	N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
N/A ³			5/1/73	12	N/A ³	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
N/A ³			10/8/73	12	N/A ³	N/A ³			N/A ³			N/A ³		N/A ³			10/22/73	19	59	N/A ³			N/A ³				
N/A ³			11/12/73	12	N/A ³	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
4/4/74	< 6	N/A ³	4/16/74	12	N/A ³	N/A ³			4/6/74	< 6	N/A ³	4/6/74	< 6	4/6/74	< 6	N/A ³	4/6/74	< 6	N/A ³	4/10/74	11	61	4/10/74	< 6	N/A ³		
N/A ³			1/20/75	101 ²	73	7/14/75	< 3	N/A ³	7/14/75	< 3	N/A ³	7/14/75	< 3	7/14/75	< 3	N/A ³	7/14/74	< 3	N/A ³	7/14/75	6	60	7/14/75	< 3	N/A ³		
7/14/75	< 3	N/A ³	7/7/75	79	73	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
1/5/76	< 3	N/A ³	1/5/76	60	70	1/5/76	< 3	N/A ³	1/5/76	< 3	N/A ³	1/5/76	< 3	1/5/76	< 3	N/A ³	1/5/76	< 3	N/A ³	1/5/76	5	56	1/5/76	< 3	N/A ³		
N/A ³			6/1/76	45	71	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
12/6/76	< 3	N/A ³	12/6/76	32	71	12/6/76	< 3	N/A ³	12/6/76	< 3	N/A ³	12/6/76	< 3	11/22/76	< 3	N/A ³	12/6/76	< 3	N/A ³	12/6/76	3	59	12/6/76	< 3	N/A ³		
6/13/77	< 3	N/A ³	6/27/77	21	71	6/13/77	< 3	N/A ³	6/13/77	< 3	N/A ³	6/13/77	< 3	6/13/77	< 3	N/A ³	6/15/77	< 3	N/A ³	3/14/77	3	61	6/13/77	< 3	N/A ³		
N/A ³			N/A ³			N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			8/1/77	3	58	N/A ³				
11/28/77	< 3	N/A ³	11/28/77	18	71	11/28/77	< 3	N/A ³	11/28/77	< 3	N/A ³	11/28/77	< 3	11/28/77	< 3	N/A ³	11/28/77	< 3	N/A ³	11/28/77	< 3	N/A ³	11/28/77	< 3	N/A ³		
7/17/78	< 3	N/A ³	7/10/78	11	71	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
N/A ³			7/21/78	91	71	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			N/A ³			N/A ³				
N/A ³			9/25/78	41	71	N/A ³			N/A ³			N/A ³		N/A ³			N/A ³			8/18/78	8	74	N/A ³				
12/18/78	< 3	N/A ³	12/19/78	26	71	12/18/78	< 3	N/A ³	12/18/78	< 3	N/A ³	12/19/78	< 3	12/19/78	< 3	N/A ³	12/19/78	< 3	N/A ³	12/18/78	9	76	12/19/78	< 3	N/A ³		

**Table D2-1. Tank 241-A-105 Drywell Radioactivity (K counts per minute) (March 1969 to November 1986)
(Drywell Data Sheets Retrieved on March 15, 2011 and SD-WM-TI-356) (3 of 3 sheets)¹**

10-06-09			10-05-02			10-05-05			10-05-07			10-05-08		10-04-04			10-05-09			10-05-10			10-05-12		
Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)	Date	Peak (K cpm)	Depth (ft BGS)
12/3/79	< 3	N/A ³	12/31/79	12	71	12/19/79	< 3	N/A ³	12/19/79	< 3	N/A ³	12/19/79	< 3	12/19/79	< 3	N/A ³	12/19/79	< 3	N/A ³	12/3/79	8	75	12/19/79	< 3	N/A ³
12/16/80	< 3	N/A ³	12/15/80	5	71	12/15/80	< 3	N/A ³	12/15/80	< 3	N/A ³	12/15/80	< 3	12/15/80	< 3	N/A ³	12/15/80	< 3	N/A ³	12/15/80	9	75	12/15/80	< 3	N/A ³
12/14/81	< 3	N/A ³	10/19/81	4	71	10/19/81	< 3	N/A ³	10/19/81	< 3	N/A ³	10/19/81	< 3	10/19/81	< 3	N/A ³	10/19/81	< 3	N/A ³	10/19/81	8	76	10/19/81	< 3	N/A ³
11/29/82	< 3	N/A ³	12/13/82	3	71	12/13/82	< 3	N/A ³	12/13/82	< 3	N/A ³	12/13/82	< 3	12/13/82	< 3	N/A ³	12/13/82	< 3	N/A ³	12/13/82	9	77	12/13/82	< 3	N/A ³
11/15/83	< 3	N/A ³	11/15/83	2	71	11/15/83	< 3	N/A ³	11/15/83	< 3	N/A ³	11/15/83	< 3	11/15/83	< 3	N/A ³	11/15/83	< 3	N/A ³	11/15/83	7	78	11/15/83	< 3	N/A ³
10/17/84	< 3	N/A ³	10/17/84	2	71	10/17/84	< 3	N/A ³	10/17/84	< 3	N/A ³	10/17/84	< 3	10/15/84	< 3	N/A ³	10/17/84	< 3	N/A ³	10/17/84	7	78	10/17/84	< 3	N/A ³
9/16/85	< 3	N/A ³	9/16/85	2	71	9/16/85	< 3	N/A ³	9/16/86	< 3	N/A ³	9/16/85	< 3	9/20/85	< 3	N/A ³	9/16/85	< 3	N/A ³	9/16/85	8	79	9/16/85	< 3	N/A ³
11/13/86	< 3	N/A ³	11/13/86	2	71	11/13/86	< 3	N/A ³	11/13/86	< 3	N/A ³	11/13/86	< 3	11/13/86	< 3	N/A ³	11/13/86	< 3	N/A ³	11/13/86	8	79	11/13/86	< 3	N/A ³

Note: ¹If Depths were not available, the column was omitted from the table

²New Probe

³N/A: Data not available

6.0 CONCLUSIONS

Five conditions may have contributed to A Farm tank liner failure including thermal conditions, tank design, bulging, chemistry- corrosion and tank construction conditions. The A Farm tanks continued with the same basic design features as the 241-SX Farm with the fillet welded orthogonal intersection between the bottom and sidewall, less rigorous weld inspection testing and partial asphaltic membrane waterproofing. The A Farm tanks had a flat tank bottom vice the 3.3% sloped 241-SX Farm tank bottoms.

No tank bottom bulging was reported in tank A-104, however ALC guy rods had become detached which is a possible indicator of bulging. Tank A-104 was preheated at 158°F for five months but the temperature rate of rise with initial transfer of waste is not available. It is therefore unknown if any water remaining in the grout was removed or upon heating may have increased the vapor pressure under the tank bottom to a point that resulted in a bulge and weakening of the tank bottom steel.

Tank A-105 was reported to have been preheated up to ~115°F; however, there were indications in September 1963 of possible initial bulging of the tank A-105 bottom with large fluctuations in the liquid level including increases up to 12-in equivalent to a 33 kgal volume increase. The tank was pumped to 10-in of liquid which if there was any remaining water in the grout could have resulted in vapor pressure under the bottom liner overcoming the hydrostatic pressure for a period of time resulting in cracks in the bottom liner. Moisture could then have been transferred to the grout through cracks in the liner which re-sealed as waste was added to the tank. PUREX HLW continued to be accumulated up to an equivalent 11,000 tons of uranium production. At that point a steam eruption bulged the tank bottom 8½-ft resulting in a separation of the wall liner from the bottom of the tank.

Corrosive conditions in tank A-104 may have existed during a total of ~4 years of water storage. The storage in tank A-104 of PSS for three years would have created an environment conducive to SCC based on flowsheet conditions. Tank A-105 does not appear to have been exposed to corrosive waste storage; however, water of unknown quality was stored in the tank from 1955 – 1962 prior to receiving waste.

The A Farm tank construction temperature conditions were not as severe as experienced during 241-SX Farm construction or even during 241-BY and 241-TY Farm construction. There were, however, at least four instances where the temperature dropped below the ductile-to-brittle transition temperature of 18°F which could have caused fissures in the steel liner should an impact occur. A contribution to eventual failure of the two tanks is considered unlikely.

It is possible that no one characteristic of the A Farm leaking tanks in isolation from the others have resulted in failure. However, thermal conditions appear to play a primary role with tank design being a contributing factor as well as liquid level control in the case of tank A-105. All or combinations of these characteristics resulted in bulging of the tank liner which in the case of tank A-105 set up possible conditions for the steam eruption. Corrosion and tank constructions conditions could be secondary contributors to liner failure.

The A Farm leaking tank information (see Table 6-1) was compared to the sound A Farm tanks (see Table 6-2) where similar information was available. All of the A Farm tanks were filled with 6-in of water initially and some contained water for several years before waste was first transferred to the tank. No single design or operating characteristic is highly correlated with the failure of tanks A-104 and A-105.

Table 6-1. A Farm Leaking Tanks

Leaking Tank	Initial Waste Details				Leak Status		Water Addition		Evidence of a Bulging Liner		Thermal Conditions				
	First Filled	First Boiling	Waste Type	Tank Pre-heated	Leak Detected	Indication of leak	Water added	Duration of Water Storage	Bulge Present	Failed ALCs	Rate of Rise	Max Temp	Temp Duration	Bumping	Maximum pressurization
A-104	8/9/1958 ¹	August 1959 ¹	P, OWW, AR, B, PSS	–	March 1975	Laterals	- 1/24/1956 to Aug. 1958 - 1969-1972 ⁶	~ 32 months ~ 2 years	No ⁴	Yes	4.9°F/day ⁷ 1/2/1963 to 2/6/1963	437°F Feb. 1963	17 months >300°F	–	–
A-105	May 1962 ²	3/5/1963 ³	P	~115°F ²	Nov. 1963 March 1965	Laterals	1955-1962	~ 7 years	Yes- 8.5 ft with liner tear from sidewall ³	Yes	3.3°F/day ⁷ 1/29/1963 to 3/1/1963	285°F Jan. 1965	10 months >250°F	Yes- Jan. 1965 ⁵	–

Note: Reference HW-41791 Pt 1, *PUREX Waste Storage. Part 1- 241-A Waste Storage Facilities 3/7/56 General Electric*, States that 6-in of water was added to all A Farm tanks 1/24/56. Where dashes are used in the cell, information was not known or not available.

Waste Type: P: PUREX HLW; OWW: Organic wash waste; AR: 244-AR Vault waste; B: B Plant HLW; PSS: PUREX Sludge supernatant

- 1 Reference HWN-1991- First filled with PUREX HLW supernatant
- 2 LL – Temp Plots (see Figure 4-2)
- 3 Reference ARH-78 and TRAC-0022
- 4 Reference RHO-R-39 reports no bulge present in tank A-104. However, see Sections 4.4.3 and 4.4.5 for additional information
- 5 Reference ARH-78 with a release of steam, ground trembling
- 6 Test water was stored in the tank from 1956-1958. At the end of 1969, refilled with water for a leak test and stored until 1972
- 7 Initial temperature rate of rise unknown

Table 6-2. A Farm Sound Tanks

Sound Tank	Initial Waste Details				Leak Status		Water Addition		Evidence of a Bulging Liner		Thermal Conditions				
	First Filled	First Boiling	Waste Type	Tank Pre-heated	Leak Detected	Indication of leak	Water added	Duration of Water Storage	Bulge Present	Failed ALCs	Rate of Rise	Max Temp	Temp Duration	Bumping	Maximum pressurization
A-101	1/24/1956	7/16/1957	P, OWW, B, PL, RESD	~144°F	No	No	1/24/1956	< 1 month	No ²	Yes	8.3°F/day ³ 7/2/1957 to 7/16/1957	399°F June 1961	17 months >300°F	–	–
A-102	3/22/1956	3/13/1958	P, OWW, B, AR, PSS	–	No	No	1/24/1956	~2 months	–	Yes	6°F/day ³ 8/1/1961 to 8/12/1961	380°F Aug. 1961	3 months >300°F	–	–
A-103	5/17/1956	7/5/1956	P, OWW, B, AR, IX, PSS	–	D-42 Concluded Sound Tank ⁴	No	1/24/1956	~4 months	–	Yes	4.5°F/day 5/28/1956 to 6/28/1956 (initial)	446°F April 22, 1957	1 month >300°F	Yes-July 5 to 12, 1956 ¹	1-12 in. Water ¹
A-106	July 1961	Before 12/31/1961	P, OWW, B, AR	–	No	No	1/24/1956	~68 months	–	Yes	6.3°F/day ³ 4/3/1963 to 5/16/1963	594°F May 16, 1963	76 months >300°F	–	–

Note: Reference HW-41791 Pt 1, *PUREX Waste Storage. Part 1- 241-A Waste Storage Facilities 3/7/56 General Electric*, States that 6-in of water was added to all A Farm tanks 1/24/56. Where dashes are used in the cell, information was not known or not available.

Waste Type: P: PUREX HLW; OWW: Organic wash waste; AR: 244-AR Vault waste; B: B Plant HLW; PL: PUREX low-level waste; RESD: Residual Evaporator Liquor; IX: Ion Exchange Waste

- 1 Reference HW-41791 Pt 2
- 2 Reference RHO-R-39
- 3 Initial temperature rate of rise unknown
- 4 Reference RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*

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APPENDIX A

MEETING MINUTES

December 3, 2012

January 15, 2013



MEETING SUMMARY

From: C. L. Girardot
Phone: 376-0528
Location: Ecology Office,
Date: December 3, 2012
Subject: Tank Farm Leak Integrity Assessments

Crystal girardot

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY	Jeff Luke, WRPS
Mike Barnes, ECOLOGY	Jeff Lyon, ECOLOGY
Crystal Girardot, WRPS	Ted Venetz, WRPS
Don Harlow, WRPS	Dennis Washenfelder, WRPS
Jeremy Johnson, ORP	

PURPOSE:

The purpose of this meeting was to:

- 1) Kick off Fiscal Year (FY) 2013 Leak Location and Cause status meetings with ORP and ECOLOGY
- 2) Summarize Leak Location and Cause status and outline FY 2013 schedule
- 3) Discuss Tank A-105 Leak Location and Cause preliminary summary

Leak Location and Cause Status and Schedule

To date, the Leak Location and Cause reports for SX Farm, BY Farm, and TY Farm have been prepared, reviewed, and comments from ECOLOGY and ORP have been incorporated. This work was completed at the end of FY 2011.

For FY 2013, a Leak Location and Cause report will be completed for the following tanks: A-104, A-105, B-107, C-101, C-105, T-106, T-107, U-104, U-110, and U-112. There is a possibility of more tanks to be added to this list once the T Farm and TX Farm assessment reports are completed per RPP-RPT-32681.

SX Farm

SX Farm was discussed briefly and it was asked if welding maps were available for SX Farm as well as additional information about hydrostatic testing procedures of the SX Farm steel liners during construction and if there are any available photographs of the bottom of the tank liner after hydrostatic testing. The condition of the bottom of the steel liner after hydrostatic testing was questioned and what deformations if any were in evidence. This will be looked into in more detail and the SX Farm report will be updated as required.

Tank A-105 Leak Location and Cause Summary

The preliminary results from the tank A-105 analysis were discussed. It was determined that the leak from tank A-105 was first detected in lateral 14-05-03 in November 1963. However, since radioactivity in the lateral stabilized and then started to decline shortly after, the tank was kept in service.

In January 1965, a steam eruption occurred in tank A-105 resulting in the bottom liner tearing approximately $\frac{3}{4}$ the way around the tank. Tank A-105 was declared a confirmed leaker in March 1968, supernatant was removed from the tank, and sluicing campaigns occurred in 1968 and 1970.

One possible leak cause could have occurred when tank A-105 aged HLW supernatant was pumped out of the tank in January 1963 leaving the liquid level at 10-in. If adequate time was not allowed for dissipation of grout moisture under the tank bottom liner before pumping, this may have resulted in an initial bulged tank bottom liner if the vapor pressure below the tank bottom liner exceeded the hydrostatic pressure. Unexplained liquid level fluctuations occurred in September 1963, some as large as 12-in, further supporting a compromised liner. A bulged liner failure may have allowed subsequent condensate and/or concentrated HLW to be trapped below the tank bottom liner. Any trapped liquid coupled with the increased hydrostatic pressure and temperature of the concentrated 11,000 tons equivalent HLW in the tank, ultimately resulted in the January 1965 steam eruption and ripped liner.

A tank leak cause matrix (blame button chart) was presented with tank design being the primary contributor to a tank A-105 leak with a bulging liner being the next likely contributor. It was suggested to add an additional category to this chart for tank A-105 to account for the January 1963 pump out of the supernatant as explained above. It was suggested that the blame button chart needs to be reviewed for possible revision. A preliminary draft of the tank A-105 segment was distributed at the meeting.

A final draft of the tank A-105 segment will be completed and distributed prior to the next meeting.

ACTIONS:

1. All: Review meeting summary for discussion in the next meeting.
Status: Completed
2. C. Girardot: Prepare and distribute December 3, 2012 Meeting Summary.
Status: Completed
3. C. Girardot/D. Harlow: Complete Tank A-105 Leak Location and Cause report and distribute (incorporate any comments as appropriate).
Status: Report completed with comment(s) incorporated, see attached.
4. C. Girardot/D. Harlow: Find information on SX Farm plates including photos and construction and update SX Farm report as required.
Status: Completed. Additional boxes have been searched and no information was found.
5. C. Girardot/D. Harlow: Review the tank leak cause matrix (blame button chart).
Status: Completed. Added additional category to both the blame button chart and the attendant Leak Cause Matrix.

6. All: Meet to review the Leak Loss status (RPP-RPT-32681) and identify what needs to be revised/updated.

Status: Completed. Passed on to the Closure & Corrective Measures group.

NEXT MEETING:

Tuesday January 15, 2013

A Farm Report, RPP-RPT-54912, Rev. 0, Tank A-105, Comments and Resolutions – J. A. Caggiano

January 24, 2013

1. There are unconfirmed reports of tank liner bulging where the bulged liner returned to the normal configuration. In some cases the bulging steel may have remained within elastic limits and did not reach the failure point. Would multiple bulging events weaken the bottom such that it might contribute to ultimate failure? Consider addressing this possibility.

Response: Added multiple bulging effects to section 3.2.3 and the individual tank segment sections 4.4.3 and 5.4.3.



MEETING SUMMARY

From: C. L. Girardot
Phone: 376-0528
Location: Ecology Office
Date: January 15, 2013
Subject: Tank Farm Leak Integrity Assessments

Crystal girardot

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS

Crystal Girardot, WRPS
Don Harlow, WRPS
Ted Venetz, WRPS
Dennis Washenfelder, WRPS

PURPOSE:

The purpose of this meeting was to discuss the Tank A-104 Leak Location and Cause summary.

Tank A-104 Leak Location and Cause Summary

The results from the tank A-104 analysis were discussed. It was determined that the leak from tank A-104 was first detected in lateral 14-04-02 in the northern portion of the tank in March 1975 shortly after the start of sluicing the tank in September 1974. This was the first indication of a tank A-104 leak. Radioactivity in lateral 14-04-02 continued to increase a week later. In April 1975, radioactivity was first detected in lateral 14-04-01 underneath the southern edge of the tank possibly due to a new leak site. A couple of weeks later, radioactivity was first detected in lateral 14-04-03 underneath the northern portion of the tank, likely due to migration from the earlier leak detected in lateral 14-04-02. During this time, no radioactivity was detected in the surrounding drywells that could be indicative of a tank leak.

At the end of 1969, tank A-104 was filled with 957 kgal of water for a leak test to confirm integrity and the tank was declared a spare. The reason for this leak test remains unknown.

Possible leak causes that were identified for tank A-104 included: tank design, liner bulging, thermal conditions, chemistry-corrosion, and tank construction conditions. No one cause was identified that could be the primary contributor to the tank leak.

It was suggested to investigate the waste transfers into and out of tank A-104 during the time when the maximum temperature spike occurred in 1963 and update the report. It is unclear why there was a spike in temperature in February 1963 as Organic Wash Waste (OWW) was being added to the tank to control temperature from January 30, 1963 through February 15, 1963. The PUREX Plant outage in December 1962 through January 1963 resulted in the lack of OWW for

tank A-104 temperature control. Portable compressors were used to supply additional air to the air lift circulators which reduced the tank A-104 temperature.

One observation was made about the lateral radioactivity detected from March to May 1975 and the relatively fast spread of radioactivity detected during this time. It was asked if a leak rate would be able to be calculated from the lateral data. Information will be made available for the calculation of leak rates to be provided in a separate document.

The question of whether sluicing could be a contributor to a tank liner leak was also asked or if sluicing could unplug previously undetected leak sites. It was concluded that these possibilities may be more evident as further analyses are performed on the remaining leaking single-shell tanks. A note was suggested to be added to the tank leak cause matrix table regarding the possible linkage between sluicing and leaks.

A draft tank leak cause matrix table was presented showing a summary of causal factors contributing to leaks of all tanks assessed thus far and updated to include tank A-104. This matrix will be revisited as each tank is assessed.

The conclusions for the 241-A Farm Leak Cause and Locations report will be distributed prior to the next meeting. The draft Tank B-107 report will be discussed in the next meeting.

ACTIONS:

7. All: Review meeting summary for discussion in the next meeting.
Status: Completed
8. C. Girardot: Prepare and distribute January 15, 2013 Meeting Summary.
Status: Completed
9. C. Girardot/D. Harlow: Complete A Farm Leak Location and Cause report including Tank A-104 segment and distribute (incorporate any comments as appropriate).
Status: Report completed with comment(s) incorporated, see attached.
10. C. Girardot/D. Harlow: Find information on SX Farm plates including photos and construction and update SX Farm report as required.
Status: Completed. Additional boxes have been searched and no information was found.
11. D. Harlow: See about tank T-111 and if this needs to be added to the list of tanks to be analyzed for Leak Location and Cause.
Status: Not currently listed. The RPP-RPT-32681, T Farm Leak Assessment, will address all T Farm tanks.
12. C. Girardot/D. Harlow: Prepare the tank B-107 Leak Location and Cause report to be discussed in the next meeting.
Status: Completed.

NEXT MEETING:

Part 1. TX Farm Leak Assessment. Part 2. Review tank B-107 leak location and causes.
Date: February 5 (Part 1 and Part 2)
Time: 2:30-4:00
Location: ECOLOGY Office

A Farm Report, RPP-RPT-54912, Rev. 0 Comments and Resolutions – J. A. Caggiano

January 24, 2013

2. Figure 2-1 shows A-103 as an assumed leaker, as it does in the Hanlon report. Other places discuss the two leakers in A Farm A-104 and A-105. Should either label Figure 2-1 or correct the figure to be consistent with what is said in the text.

Response: Added a footnote to Figure 2-1 to address the recommendation to change the Tank A-103 designation from “Assumed Leaker” to “Sound Tank” in RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*.