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Date:

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Author: C.L. Girardot, D.G. Harlow	
Purpose of Document: Identifies leak causes and locations for TX Farm tanks	

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Venetz, Theodore J

From:	Lawrence, Hugh K
Sent:	Monday, June 23, 2014 4:19 PM
To:	Venetz, Theodore J
Cc:	Harlow, Donald G; Girardot, Crystal L; Kunz, Ashley C
Subject:	RE: Safety review

Ted,
I have reviewed the photos contained in the document *RPP-RPT-54917*, as requested, from an industrial safety point of view. Based on that review the photos contained in this document are **approved** for use. Any question or comment, please ask.

Hugh Lawrence
WRPS Safety Programs

From: Venetz, Theodore J
Sent: Monday, June 23, 2014 3:54 PM
To: Lawrence, Hugh K
Cc: Harlow, Donald G; Girardot, Crystal L
Subject: Safety review

Hugh,
We need a safety review for external clearance of the attached report RPP-RPT-54917. There are only few photos, historical construction and some in-tank photos.
Thanks
Ted Venetz

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

C.L. Girardot, D.G. Harlow
Washington River Protection Solutions
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DRF UC: N/A
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Key Words: leak location, leak cause, tank, integrity assessment, TX Farm, TX-107, TX-114, leak assessment

Abstract: This document identifies 241-TX Tank Farm (TX Farm) leak causes and locations for the 100 series leaking tanks (241-TX-107 and 241-TX-114) identified in RPP-RPT-50870, Rev. 0, Hanford 241-TX Farm Leak Inventory Assessment Report. This document satisfies the TX Farm portion of the target (T04) in the Hanford Federal Facility Agreement and Consent Order milestone M-045-91F.

APPROVED
By Julia Raymer at 8:50 am, Jul 22, 2014

DATE:
Jul 22, 2014
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EXECUTIVE SUMMARY

This document identifies 241-TX Tank Farm (TX Farm) leak causes and locations for the 100-series leaking tanks in TX 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 (T04), in the Hanford Federal Facility Agreement and Consent Order milestone M-045-91F. The T04 target requires that the 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. 2, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*, leak assessment reports.

The leak assessment report for TX Farm, RPP-RPT-50870, Rev. 0, *Hanford 241-TX Farm Leak Inventory Assessment Report*, identified two 100-series leaking tanks in TX Farm, 241-TX-107 (TX-107) and 241-TX-114 (TX-114). All of the other sixteen 100-series tanks in TX Farm are classified as "sound" or are identified in RPP-RPT-50870 as requiring re-assessment of their classification per TFC-ENG-CHEM-D-42, *Tank Leak Assessment Process*. The TFC-ENG-CHEM-D-42 assessments are not part of the M-045-91-T04 target.

This TX 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.

The identification of TX Farm tank leak locations focused on the possible vertical location of a liner leak from liquid level decreases, radial transport in the soil indicated by radiation detected in drywells, and other possible factors such as liner bulging. The TX-107 liner leak occurred near the southern portion at or near the base of tank TX-107 based on radioactivity reported in drywell 51-03-12 in 1977. Tank TX-114 was first suspected of leaking in September 1974 based on radioactivity detected in drywell 51-14-04 between 39 and 42-ft below grade surface indicating the possibility of a sidewall leak. It is likely the leak location is in the tank's east quadrant based on 1997 Spectral Gamma Logging System evaluations. Liquid level decreases attributed to evaporation did not indicate the presence of a leak.

Tank TX-114 photos indicated a possible hole in the liner below the flashing. It is unclear whether this liner anomaly is a perforation of the liner; drywell data indicates a leak site in a different location. There may be unseen similar anomalies below the level of the solids.

Both tank TX-107 and TX-114 experienced liner failures that were detected by an increase in drywell radioactivity; however, liquid level decreases did not indicate a liner leak. Corrosion may have been a factor in each case as tanks TX-107 and TX-114 stored REDOX high level waste (HLW) and evaporator bottoms (EB) waste, respectively, both of which are conducive to pitting and stress corrosion cracking (SCC).

There appears to be very little contribution from tank design, construction temperatures, and thermal conditions. However, some or all of the factors can act serially or together to contribute to tank failure.

Basic information on the leaking and sound TX Farm tanks was reviewed to try and identify any differences between leaking and sound tanks related to liner failure. A number of the sound tanks contained REDOX HLW, EB waste, and even Tri-butyl phosphate waste, all of which are conducive to pitting and/or SCC. There does not seem to be any of the basic information that stands out as the reason sound tanks did not experience liner leaks. However, some other unknown factor influencing corrosion rate or other condition may have prevented a liner leak in the sound tanks.

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Acronyms and Abbreviations

221-B	B Plant
221-T	T Plant
241-TX	TX
241-TX Tank Farm	TX Farm
ALC	air lift circulator
BGS	below grade surface
$BiPO_4$	bismuth phosphate
cpm	counts per minute
c/s, cps	counts per second
DST(s)	double-shell tank(s)
ECOLOGY	State of Washington, Department of Ecology
FIC	Food Instrument Corporation
GM	Geiger-Mueller probe
LL	liquid level
MT	manual tape
NaI	sodium-iodide
NO_2^-	nitrite
NO_3^-	nitrate
OCP	open circuit potential
OH^-	hydroxide
OR	Occurrence Report
ORP	Office of River Protection
PCSACS	PC Surveillance Analysis Computer System
QI	questionable integrity
REDOX	Reduction Oxidation 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

°C	degrees Centigrade
Ci	curie
°F	degrees Fahrenheit
ft	feet
gal	gallon
K	1000
kgal	kilogallon (10^3 gallons)
in	inches
lb	pound
M	moles per liter

mm	millimeter
mR/hr	milliRoentgen per hour
pCi	picocurie (10^{-12} curies)
pCi/g	picocurie per gram
ppm	parts per million
R/hr	Roentgen per hour
yr	year

Waste Type Abbreviations

1C	first cycle decontamination waste (from fuels reprocessing plant)
BL	B Plant low-level waste
CPLX	complexed waste
CW	coating waste
DW	decontamination waste
EB	Evaporator Bottoms
Evap	Evaporator feed (post 1976)
HLW	high-level waste
IX	Ion Exchange
MW	Metal waste
NCPLX	non-complexed waste
OWW	Organic wash waste
R	REDOX HLW
TBP	Tri-butyl phosphate waste

Trademark Disclosure

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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-TX Tank Farm (TX Farm) tanks with a leak loss are addressed in this document. The TX Farm assessment, RPP-RPT-50870, Rev. 0, *Hanford 241-TX Farm Leak Inventory Assessment Report*, reported a leak loss for tanks 241-TX-107 (TX-107) and 241-TX-114 (TX-114). The report recommended that the status of tanks TX-104, TX-105, TX-110, TX-113, TX-115, TX-116, and TX-117 be further assessed using TFC-ENG-CHEM-D-42, *Tank Leak Assessment Process*, since the historical evidence suggests these tanks did not leak. The TFC-ENG-CHEM-D-42 assessments are not part of the M-045-91-T04 target.

The identification of TX Farm tank leak locations focused on the first indication of radiation detected in drywells as well as liquid level decreases as appropriate. Leak detection laterals were not installed underneath the TX Farm tanks.

Two meetings were held to review status of tanks TX-107 and TX-114 with the Office of River Protection (ORP) and the State of Washington, Department of Ecology (Ecology) personnel. A review on April 15, 2014, covered the information that had been generated on the location of the tank TX-107 leak and supporting data. A second meeting on May 27, 2014, provided a review of the tank TX-114 leak causes and locations document. Comments were received, responses developed, and additions/revisions were made to the document (see Appendix A).

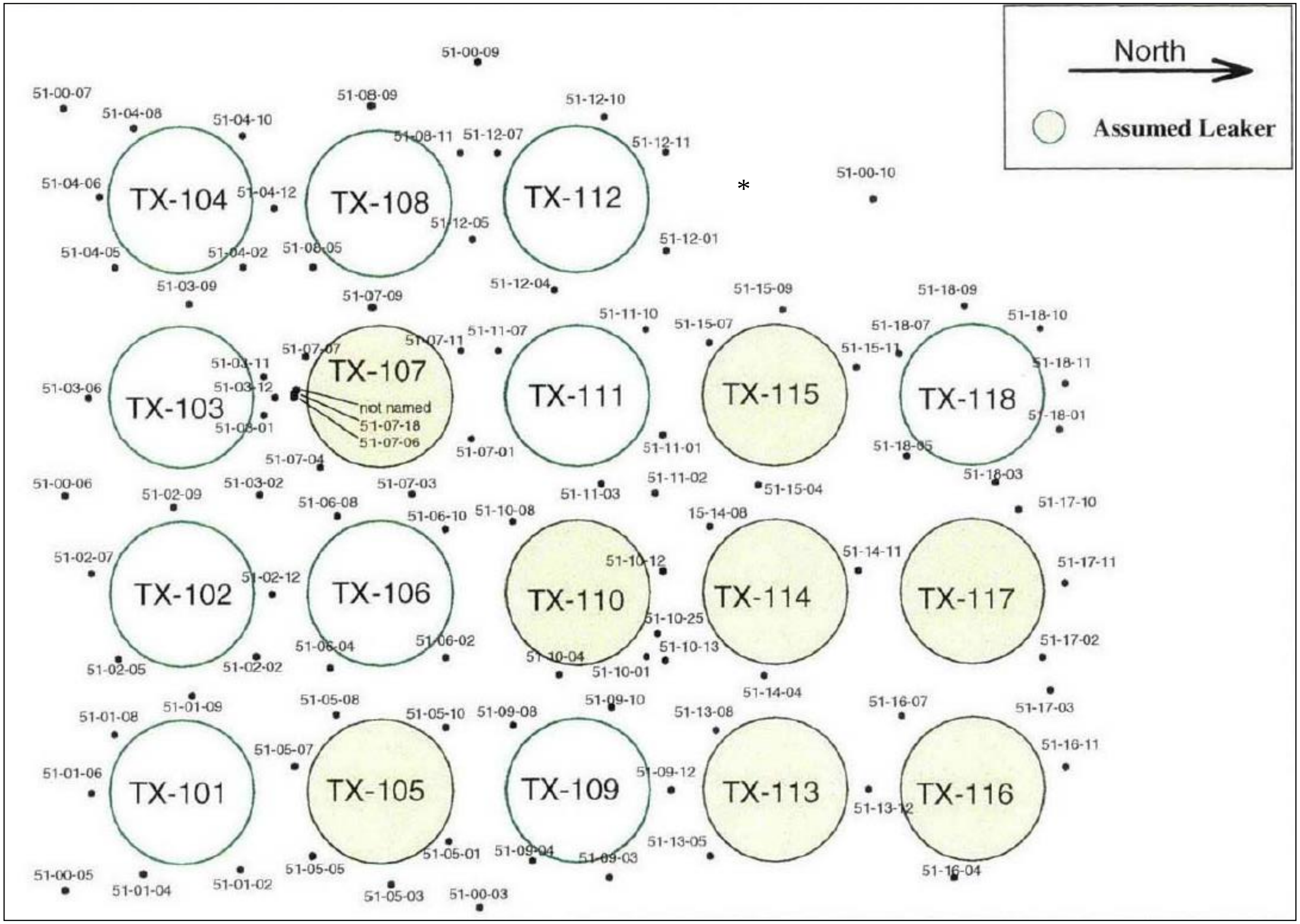
2.0 TX FARM BACKGROUND

The TX Farm was constructed between 1947 and 1948 and is located west of Camden Avenue and south of TY Farm in the 200 West Area. The farm contains eighteen 100-series dish bottom design single-shell tanks (SSTs). The tanks are 75-ft in diameter with an operating capacity of 758,000 gallons (WHC-SD-WM-ER-321, Rev. 1, *Supporting Document for the Historical Tank Content Estimate for TX-Tank Farm*). The original design for the 100-series tanks in the TX Farm contained thirteen risers ranging in size from 4-in to 42-in in diameter that provide grade-level access to the underground tank. There is one riser in the center of the tank dome and three each on opposite sides of the dome in each quadrant. Some of the tanks have had riser modifications since the original design.

The TX Farm has five cascades, three of four tanks each and two of three tanks. Tanks TX-101, TX-105, and TX-109 are the first tanks in the four tank cascade. Tanks TX-113 and TX-116 are the first tanks in the two three tank cascade. Each tank in a cascade is set 1-ft lower in elevation from the preceding tank. The cascade outlet height is ~23.6-ft from the tank bottom and 1-ft 4-in below the top of the steel liner (H-2-1747, *Tank Farm Riser and Nozzle Elevations*). The spare and cascade inlet nozzles are ~4.5-in higher in elevation than the cascade outlet. The last tank in each of the five cascades contained an overflow line extension and valve assembly (H-2-807, *18 Tank Farm General Layout)*.

Figure 2-1 shows a schematic of the TX Farm tanks with location of the drywells.

Figure 2-1. TX Farm 100-Series Tanks and Associated Drywells (RPP-RPT-50870, Rev. 1)



* Tanks TX-104, TX-105, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117 were recommended to be assessed using the TFC-ENG-CHEM-D-42 procedure as identified in RPP- RPT-50870. Therefore these tanks were not evaluated in this document.

Tanks TX-107 and TX-114 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 causes and locations. This is followed by the individual tank analyses of the possible leak locations and causes and a comparison of leaking and non-leaking tanks in the conclusion section. The sections contain excerpts from RPP-RPT-50870, Rev. 0.

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

Tank	Waste Type[1]
TX-107	MW, REDOX HLW, EB
TX-114	1C, MW, EB

Note: Waste types are listed in the List of Terms

3.0 TX FARM COMMONALITIES

3.1 TANK DESIGN/CONSTRUCTION

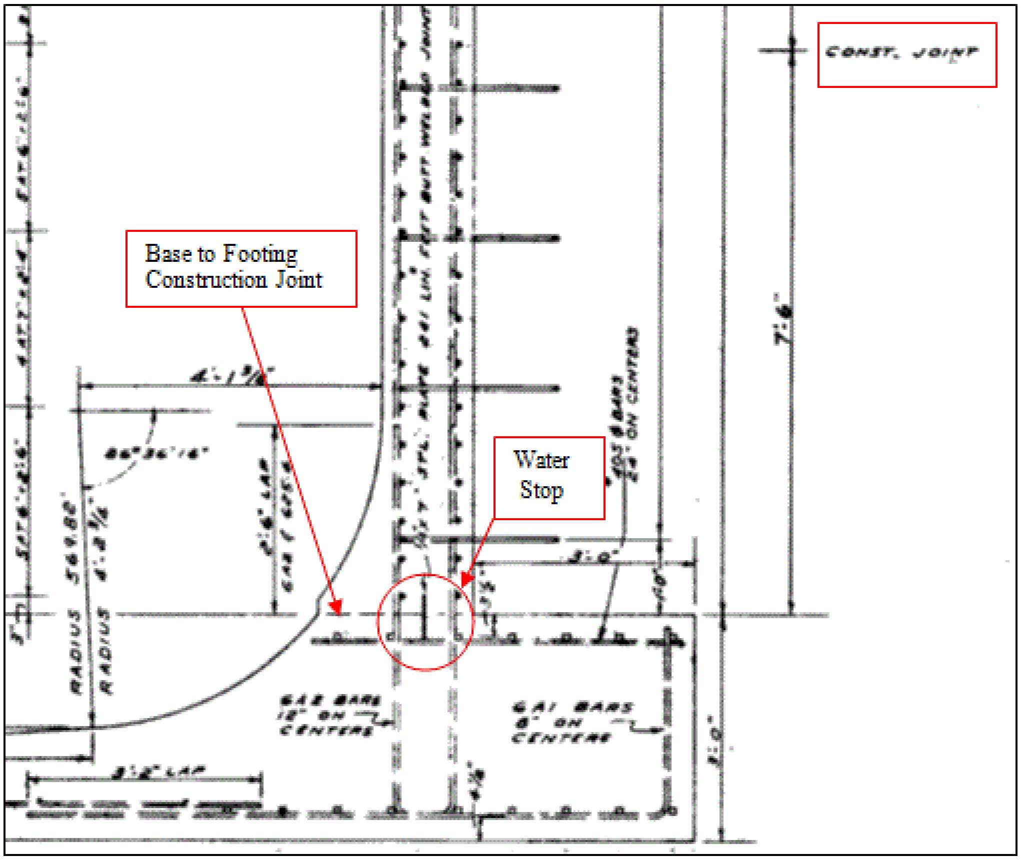
3.1.1 Tank Design

The TX Farm tanks are constructed of 1-ft thick reinforced concrete with a 0.25-in thick mild carbon steel liner (ASTM A295-46) on the bottom and sides with knuckle plates 0.375-in thick and a 1.25-ft thick domed concrete top. The tanks are set on a reinforced concrete foundation. A three-ply waterproofing was applied over the foundation and then coated with a 2-in thick layer of grout reinforced with wire mesh. A three-ply waterproof membrane was applied directly to the outside of the steel surface bottom and sidewalls. Two coats of primer paint were sprayed on interior steel tank liners. Tank ceiling domes were covered with three applications of magnesium zincfluorosilicate wash (HW-24800-35, *Design and Construction History, Project C-163, 241-TX Farm 200 West*). Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Each tank was covered with ~10-ft of overburden.

The steel bottom of the TX Farm tanks intersect the sidewall on a 4-ft radius similar to 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 TX Farm tank base footing is shown on Figure 3-1 from the bottom of the footing to the first keyed wall construction joint (H-2-812, *75- Foot Tank Base Footing and Wall Reinforcing, 241-TX*). This figure shows the concrete foundation and sidewall intersection between the dished bottom and the sidewall, water stop at the base footing to wall construction joint, the first wall construction joint, and other details. The 7-in wide water stop at the footing construction joint is 3½-in above the joint and 3½-in below the joint. The earlier 241-BCTU tanks notched footing construction joint does not incorporate a water stop.

Figure 3-2 shows the detail of the knuckle liner to the 55-lb roll roofing, grout/fabric, and three-ply asphaltic waterproof membranes between the bottom and sidewall intersection (H-2-808 TY Farm *75-Foot Tank Sections*, Section “D–D”). The three-ply asphaltic membrane waterproofing between the wall liner and the concrete shell continued the design from 241-BCTU Farms shown in Figure 3-3 which shows the rounded knuckle configuration and the bottom and sidewall three-ply water proofing. TX Farm used full penetration butt welds similar to 241-BCTU tank farms which are shown on BPF-73550.

Figure 3-1. TX Farm Base Footing and Wall Reinforcing (Drawing H-2-812)



The bottom of the outer footing is 49-ft BGS and the top of the outer footing is 46-ft BGS

Figure 3-2. TX Farm Tank Bottom Liner to Sidewall Transition Design Detail (Drawing H-2-808)

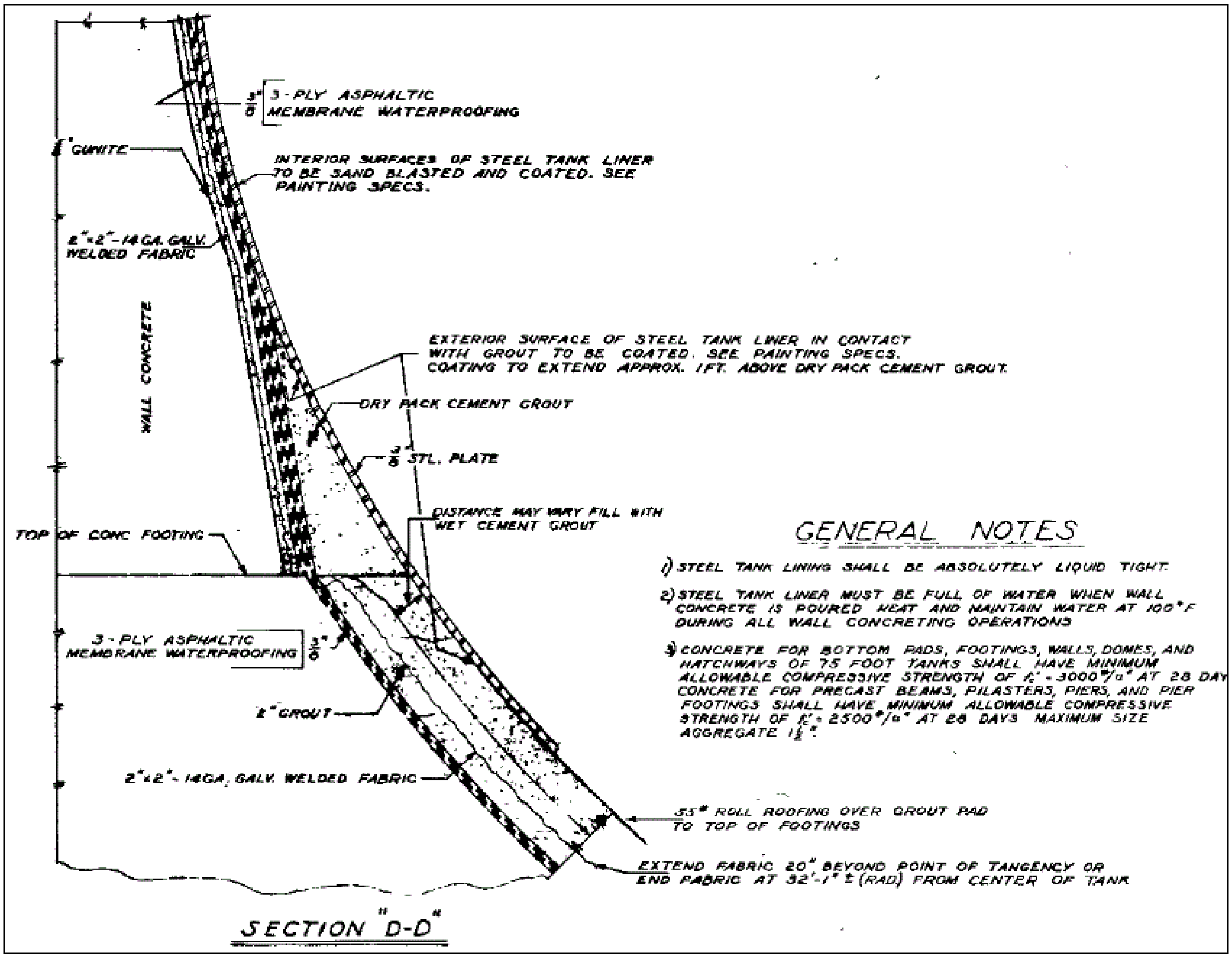
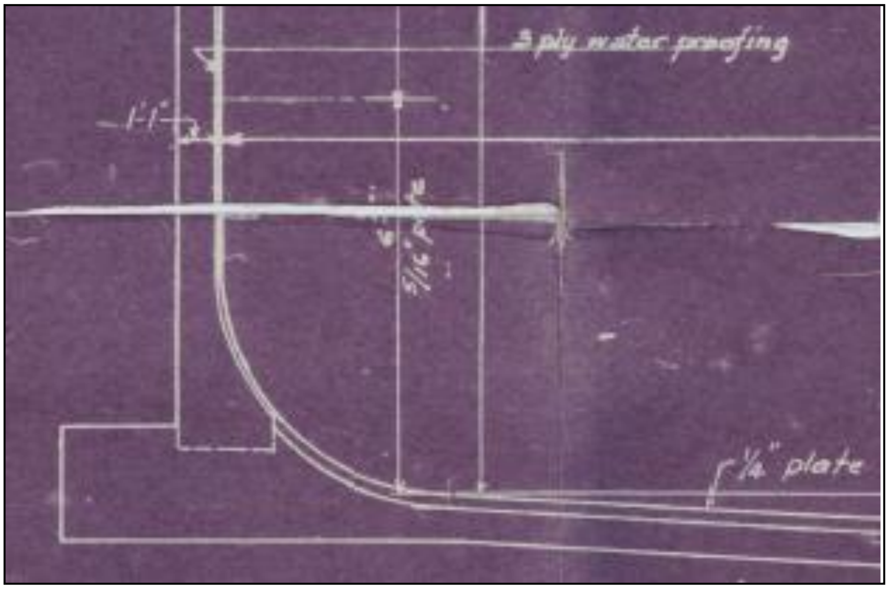


Figure 3-3. B C T U Tank Farm Knuckle Configuration with Three-Ply Waterproofing (BPF-73550, Sheet D5)

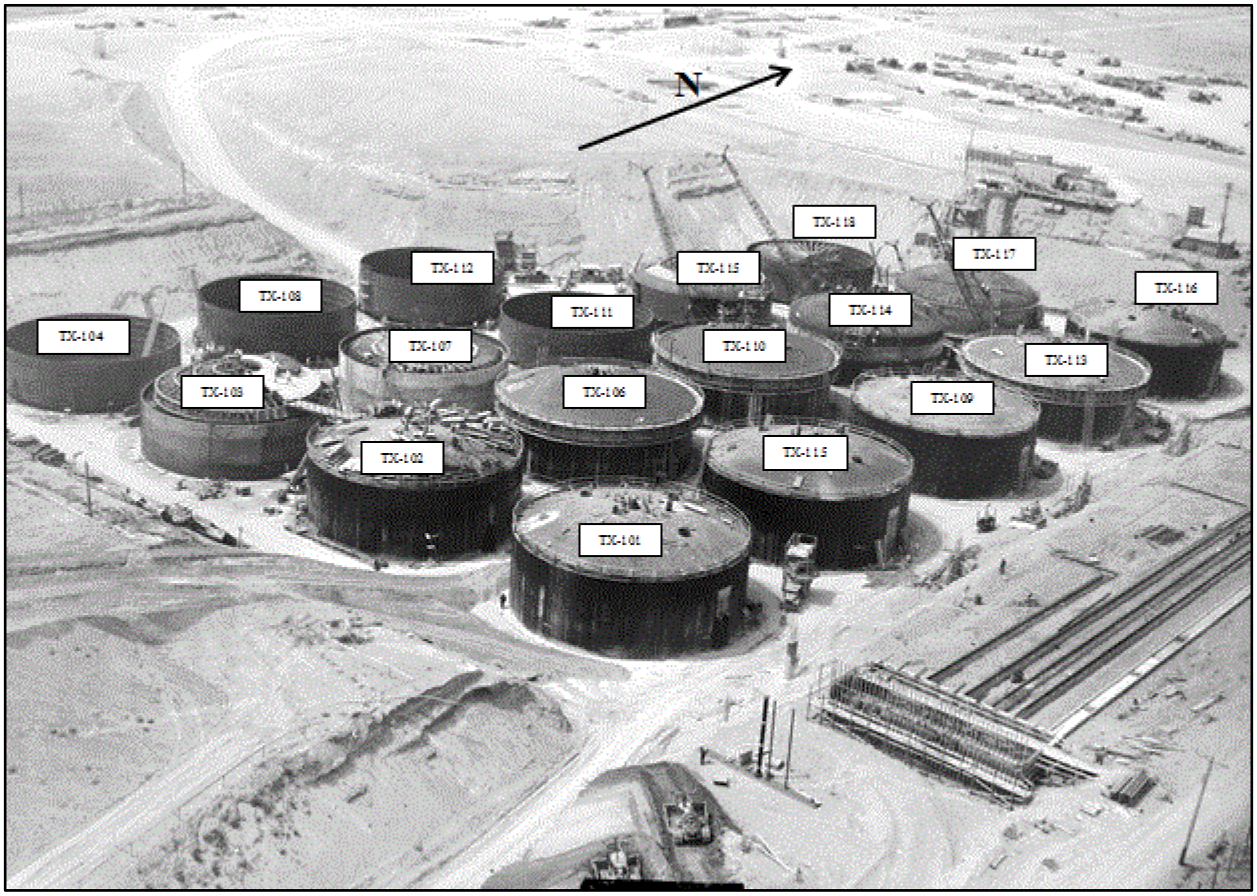


Improved methods of fabricating, welding and overall construction for tank liners were developed with marked improvements over methods previously used on similar installations (HW-24800-35). The re-weld averaged 4.19 percent. The subcontractor for TX Farm was Morrison-Knudsen Co. The X-Ray Products Corp. was responsible for the radiographic (X-Ray) inspection of all welded joints for the tank liners.

3.1.2 Tank Construction Conditions

The TX Farm construction temperatures were examined to determine if the tank liner fabrication occurred at or below the metal ductile-to-brittle temperature transition. The TX Farm tank steel liners were constructed between March 1948 and July 1948. The photograph in Figure 3-4 shows TX Farm under construction on June 18, 1948. From the start of the TX Farm tank construction through July 1948 there was one minimum temperature of 13°F with day time temperature of 40°F and one at 20°F with day time temperature at 50°F.

Figure 3-4. TX Farm Construction Photograph June 18, 1948 (1611 N1D0057600)



The metallurgical factors that limited carbon steel's ability to resist impact at low temperature were perhaps not well understood when TX Farm were constructed and were not specified for the 0.375-in thick ASTM A 285-46, *Standard Specifications for Low and Intermediate Tensile Strength Carbon-Steel Plates of Flange and Firebox Qualities*, 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 285-46 carbon steel at the time of TX Farm construction.

No chemical or physical test reports for the tank steel plates used were found. No other quality information for TX Farm was found during the search except for the re-welding of defective welds (see Section 3.5).

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 VIII low temperature service limit may be lower than what could be expected for steel of the vintage used in TX Farm construction. The concentrations of carbon and trace impurities and their effect on this property is 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 ductile-to-brittle transition 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. The TX Farm tank liners are A 285-46 carbon steel. The specifications for ASTM A 285 carbon steel have changed over time. TX Farm tank construction specification, HW-3061, *Paragraph D. "Steel Tank Lining" of Part II of Specifications for Construction of Composite Storage Tanks, Building 241-TX*, stated that the storage tank liner shall conform to ASTM A-285-46 grade A, B, or C or ASTM A-285-46 grade A, B, or C, with carbon composition of "0.25 % maximum."

Design, fabrication, and erection of the tank steel lining were required to be in accordance with current "Standards Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs" as promulgated by the "American Water Works Association" (HW-3061). Welding and inspection requirements were to conform to the American Welding Society's "Code for Arc and Gas Welding in Building Construction", Section 4.

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 FOR LEAKING TX FARM TANKS

The general information in this section is further developed and applied to the leaking tanks in Sections 4.4 and 5.4 for tanks TX-107 and TX-114, respectively, to understand implications of the conditions that could affect liner leaks and identify possible liner leak locations.

3.2.1 Liquid Level

The following is an excerpt from RPP-ENV-39658 (*Hanford SX-Farm Leak Assessments Report*) that highlights some of the early liquid level information:

> "Originally liquid levels were measured using pneumatic dip tubes (HW-10475-C, *Hanford Technical Manual Section C*, page 908). This practice was later replaced and a manual tape with a conductivity electrode was used to detect the liquid surface (H-2-2257, *Conductor Reel for Liquid Level Measurement*). The biggest limitations of the manual tape measurements were failures of the electrodes, solids forming on the

electrode and measurement precision. The statistical accuracy of the manual tape and electrode measurement technique was 0.75 in. (~2,060 gal), as determined in July 1955 (HW-51026, *Leak Detection – Underground Storage Tanks*, page 4). Later, liquid-level determinations were automated in many of the SSTs to provide more accurate and reliable measurements".

It was stated in RPP-RPT-50870 (*Hanford 241-TX Farm Leak Inventory and Assessments Report*) that the accuracy for the manual tape can vary from 0.25-in to 2-in for different tanks depending on surface conditions (liquid/solids), boiling, air lift circulator (ALC) operation, and conductivity.

The in-tank repeatability limits for FIC liquid level gauges are ± 0.25-in (Letter 72730-80-097, "Review of Classification of Six Hanford Single-Shell "Questionable Integrity (QI)" Tanks").

Transfer discrepancies of greater than 1.5-in (4,125 gal) measured at the first hour and every two hours thereafter with an FIC, manual tape, or flowmeter required an orderly and immediate shutdown, investigation, and notification. The 1.5-in discrepancy requirement was a specification limit in ARH-1601, Section D, *Specifications and Standards for the Operation of Radioactive Waste Tank Farms and Associated Facilities.*

Liquid level measured by manual tape (MT) is calculated for B, C, T, and U Farm tanks with the formula: volume = (MT Reading X 2750 gal/in) + 12,500 gal (LET-082172, H.N. Raymond to C.J. Francis, August 21, 1972, *Maximum Operating Levels and Cascade Levels in 200-West area Tank Farms* [IDMS Accession D196208887]). The formula was confirmed to have been used as late as 1980 in RHO-CD-896, *Review of Classification of Nine Hanford Single-Shell "Questionable Integrity" Tanks*, page 76, for the then current tank T-111 volume (488,000 gal) and MT reading (173-in) which verified use of the formula. All half yearly and quarterly report ending volumes in this document were calculated with this formula. Original MT readings and the MT readings in PCSACS are all measured from the lower knuckle of the above tanks which is 12-in above the bottom inside center of the tanks. The ENRAF liquid level readings in PCSACS have been converted to read from the bottom inside center of the tank. Therefore, for the same reported liquid level the ENRAF reading is 12-in greater than the MT reading.

3.2.2 Temperature

Limited temperature data is available for the TX Farm tanks until the 1970's. Available waste temperatures starting in the 1970's can be found in WHC-SD-WM-ER-321, Rev. 0, and in PCSACS. Historical documents in the following two paragraphs can be used to infer probable upper tank temperatures for the storage of waste in the TX Farm tanks (see Sections 4.4.2 and 5.4.2 for individual tank waste temperature).

Only one section of the TX Farm tank construction specifications document HW-3061 is available and it does not address liquid storage temperature requirements. The earlier tank specifications indicated the temperature of the liquid contents would be (up to) 220°F (HW-1946, *Specifications for Composite Storage Tanks – Buildings #241 at Hanford Engineering Works*) which would probably also be applicable to the TX Farm.

The earliest operation limitations found for TX Farm are addressed in ARH-951, *Limitations for Use of Underground Waste Tanks*. The ARH-951 document was issued December 18, 1969 and indicated that tank temperatures for should be held below 230°F with a 5°F per day rise for liquid temperatures below 180°F and a 3°F per day rise for liquid temperatures above 180°F during waste addition to the tank.

Several of the TX Farm tanks were 242-T evaporator bottoms receivers which were retrofitted with exhaust systems, air inlets, and air lift circulators (ALC) for cooling (ARH-1845, *Design Criteria Waste Concentrate Facilities for the 241-T and 241-B Farm Complexes*).

3.2.3 Liner Observations

A bulge, typically caused by rapid vaporization of moisture under the 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 without producing a permanent bulge. 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.

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 PNNL-13571, *Expert Panel Recommendations for Hanford Double-Shell Tank Life Extension*.

Uniform corrosion rates for SSTs are reported to be generally less than 1 mil/year (HNF-3018, Rev. 0, *Single-Shell Tank Sluicing History and Failure Frequency*) 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 Slurry*). 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 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 double-shell tank (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 ($NO_3^- < 1M$) 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 diluted 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 3-1 (ARH-1601, Section D).

Table 3-1. 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 TX Farm prior to 1973. However, if the ARH-1601 specifications were in effect during prior TX Farm waste storage, the storage of undesirable concentrations of NO_2^-, NO_3^-, and OH^- could 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 none were recovered for tanks TX-107 and TX-114. 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 found in reports and other sources for the waste types listed. The reports may be based on limited data and/or values or were obtained from process flowsheets. Therefore, waste chemistry concentrations may not reflect the actual conditions when specific tank sample and temperature data is unavailable especially when multiple waste types are present in the tank. Individual tank sections provide information on the waste types stored in the tank.

3.2.5 Photographs

Available photographs of the TX Farm leaking tanks TX-107 and TX-114 were reviewed. Photographs were reviewed to identify beachlines possibly indicating previous operations of overfilling the tank, damaged equipment, possible liner bulges, and any other anomalies that could be indicative of a tank liner leak, and/or possible leak location. The photographs do not indicate a liner bulge for tanks TX-104 and TX-114; see Sections 4.4.5 and 5.4.5 for other details for tanks TX-107 and TX-114, respectively.

3.3 EX-TANK DATA FOR LEAKING TX FARM TANKS

The general information in this section is further developed and applied to the leaking tanks in Sections 4.5 and 5.5 for tanks TX-107 and TX-114, respectively, to understand implications of the conditions that could affect liner leaks and identify possible liner leak locations.

3.3.1 Laterals

Leak detection laterals were installed approximately 10-ft underneath some of the tanks containing self-boiling waste in 241-A and 241-SX Farms. Each lateral is 3-in pneumatic stainless steel tubing enclosed in 4-in carbon steel pipe. Probes were driven to the end of the lateral with compressed air then slowly withdrawn to gather a radiation profile below the bottom of the tank. Lateral leak detection systems were not installed under the TX Farm tanks.

3.3.2 Drywells

Eleven drywells are located around or near tank TX-107 and five drywells are located around or near tank TX-114. The earliest tank specific drywells were installed in 1970 through 1977; later one direct push was installed in 2002. All of the radiation readings in drywells are assumed to be maximum or peak readings unless otherwise noted. Drywells were drilled vertically from the surface and drywell coordinates and detailed drywell information, e.g., pipe dimensions and configuration, for tanks TX-107 and TX-114 are addressed in references cited in the individual tank segments. Drywells will not be useful to detect 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 a drywell.

The “00” series drywells were installed shortly after tank construction, usually around the periphery of the farm and most extend to 150-ft below grade surface (BGS). Others with tank numbers embedded in the drywell number (51-07-08, tank TX-107) were constructed later, sometimes after tank operations had ceased and generally to 100-ft BGS, with a few deeper than 100-ft BGS. The usual number of drywells surrounding a tank is one to four. If there are more, then there likely was some concern regarding a release which was being investigated. The last number corresponds to the clocked position of the drywell with respect to due north.

Four gamma ray probe types were used to monitor gamma in drywells to detect leaks (RPP-8321, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm 200 East Area*). The most widely used probe was the unshielded gross gamma sodium-iodide (NaI) probe (or probe 04; the shielded NaI probe was 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 (RHO-RE-EV-4P, *Supporting Information for the Scientific Basis for Establishing Dry Well Monitoring Frequencies*. 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, *Analysis Techniques and Monitoring Results, 241-SX Drywell Surveillance Logs*. A scintillation probe (SP) was also used to measure low levels of radiation in the drywells. 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 and initial migration.

Drywell sections (see Sections 4.5.1 and 5.5.1) contain gross gamma figures taken from RPP-6353, *Analysis and Summary Report of Historical Drywell Gamma Logs for 241-TX Tank Farm – 200 West*, showing continuing or new contamination in the drywells based on BGS depth from 1975 to 1994. Some of these gross gamma figures show anomalous data that appear to be unexplained detections that do not reflect radioactivity in the soil. In 1996, a baseline characterization of the gamma-ray-emitting radionuclides distributed in the vadose zone sediments beneath and around TX Farm was performed using the spectral gamma logging system (SGLS) and documented in GJO-HAN-16, *Vadose Zone Characterization Project at the Hanford Tank Farms TX Tank Farm Report*. Individual vadose zone characterization summary data reports were issued in 1996 and 1997 for the TX Farm tanks with results reported in the leaking tank segments. The gross gamma and the SGLS can detect equivalent Cs-137 at concentrations down to ~10 pCi/g and ~0.1 pCi/g respectively. Therefore, radioactivity ≤ 10 pCi/g does not appear on the gross gamma figures (GJO-HAN-8). SGLS logging can confirm both Cs-137 and/or Co-60 radioactivity which can assist in the leak location analysis, and the SGLS data is weighted more heavily on interpreting drywells. SGLS documents refer to processed U-235/U-238 which refers to irradiated isotopic distribution versus naturally occurring uranium found in the soil. 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 section and in some cases the more recent direct pushes installed to locate detailed soil radioactivity. The drywell summary section provides the analyses of the associated drywells and any direct pushes with the tank that is of concern.

3.4 LINER LEAK LOCATIONS

Drywell radioactivity when first detected can indicate a radial or depth location of a tank leak, migration of the tank leak, or the possible migration of an adjacent tank leak. The radial drywell radioactivity is also dependent on any possible flow paths from the actual tank liner leak location to the drywell itself as well as the waste viscosity and distance to the drywell. Drywells can also indicate the tank liner sidewall leak vertical location but the indication needs to be analyzed relative to non-tank liner leaks associated with pipe lines or other sources.

Liquid level decreases can be used for sidewall as well as bottom liner leaks but need to be analyzed in relationship with the vertical level of the tank drywell radioactivity, evaporation, and drywell contamination from pipe line leaks and other non-tank sources.

A liner leak may have penetrated the waterproof membrane at any location and followed concrete cracks or construction joints 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. Later indications of radioactivity in the drywells with improved detector capabilities could indicate additional leakage but the location of the leak could not be pinpointed without some additional information.

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 reach the effective detection radius of the probes used in the drywell, or did not contain radioisotopes detectable 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 of the TX Farm commonalities which centered on tank design/construction, in-tank data, and ex-tank data indicates that there was essentially one condition, chemistry-corrosion, that was the most likely to have contributed to a possible tank failed liner for tanks TX-107 and TX-114. There appears to be very little contribution from tank design (no inherent flaws have been documented in the literature reviewed), construction temperatures, and waste thermal conditions. However, some or all of the factors can act serially or together to contribute to tank liner failure. The following sections provide a tank TX-104 and TX-114 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. All TX Farm welded seams were inspected by radiograph including defective welds which were completely removed and refilled with new weld material (HW-24800-35). Defective welding, on an inch of weld basis, averaged 4.19% for the entire TX Farm with 4.56% and 3.45% for tanks TX-107 and TX-114, respectively. Some TX Farm tanks experienced four defective welding X-Ray reports while tank TX-107 was completed with two defective radiographic reports and tank TX-114 with three. Because no evidence has been found to substantiate quality defects, these are not included as a leak cause.

4.0 TANK 241-TX-107 SEGMENT

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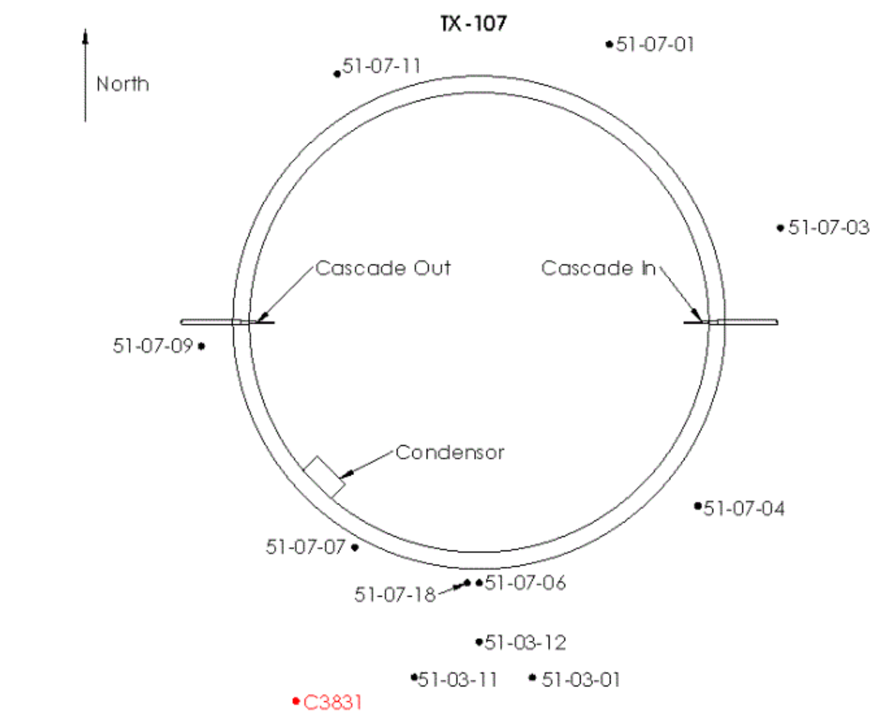
4.1 TANK TX-107 BACKGROUND HISTORY

This section provides information on the historical waste loss event associated with Single-Shell Tank (SST) 241-TX-107 (TX-107). There are eleven drywells located around tank TX-107 with specified distances from the drywell to the tank footing shown in Figure 4-1: 51-07-04, 51-07-09, 51-07-11, and 51-03-12, installed in 1971, 51-07-01 drilled in 1974, 51-07-03 drilled in 1976, and 51-07-06, 51-07-18, 51-07-07, 51-03-01, and 51-03-11 installed in 1977, in addition to one direct push installed in 2002.

The bottom of the tank footing is ~49-ft Below Grade Surface (BGS) with ~10-ft soil cover over the dome (WHC-SD-WM-TI-665, *Soil Load above Hanford Waste Storage Tanks*; H-2-808, *75 Foot Tank Sections, 241-TX*).

Figure 4-1. Tank TX-107 Associated Drywells
Tank inner ring is steel liner; outer ring is outer edge of tank footing



Drywell	Distance to Footing (ft)*	Date Installed
51-07-01	~10.0	1/31/1974
51-07-03	~12	3/29/1976
51-07-04	~6.6	12/31/1971
51-03-01	~19	6/9/1977
51-07-06	~2.3	June 1977
51-03-12	~12	11/30/1971
51-07-18	~2.4	7/31/1977
51-03-11	~19	5/31/1977
C3831	~29	July 2002
51-07-07	~1.75	5/31/1977
21-07-09	~5.5	11/30/1971
51-07-11	~6.7	11/30/1971

References:
H-2-36946 Rev. 6
H-2-808 Rev. 0

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3/24/2014

4.2 TANK TX-107 OPERATIONS SUMMARY

Tank TX-107 first began receiving metal waste (MW) from bismuth phosphate operations from 221-T Plant in the fourth quarter of 1951. The additions continued until the fourth quarter of 1952, with waste cascading to tank TX-108. Tank TX-107 is the third tank in a four-tank cascade series that consists of tanks TX-105 through TX-108.

Tank TX-107 was sluiced from August 1954 to April 1955 to remove waste for uranium recovery (SD-WM-TI-302, *Hanford Waste Tank Sluicing History*). The tank was refilled with MW from 221-T Plant during the second and third quarters of 1955. Sluicing was performed a second time from July 1956 to January 1957 (SD-WM-TI-302); the tank was declared empty in January 1957.

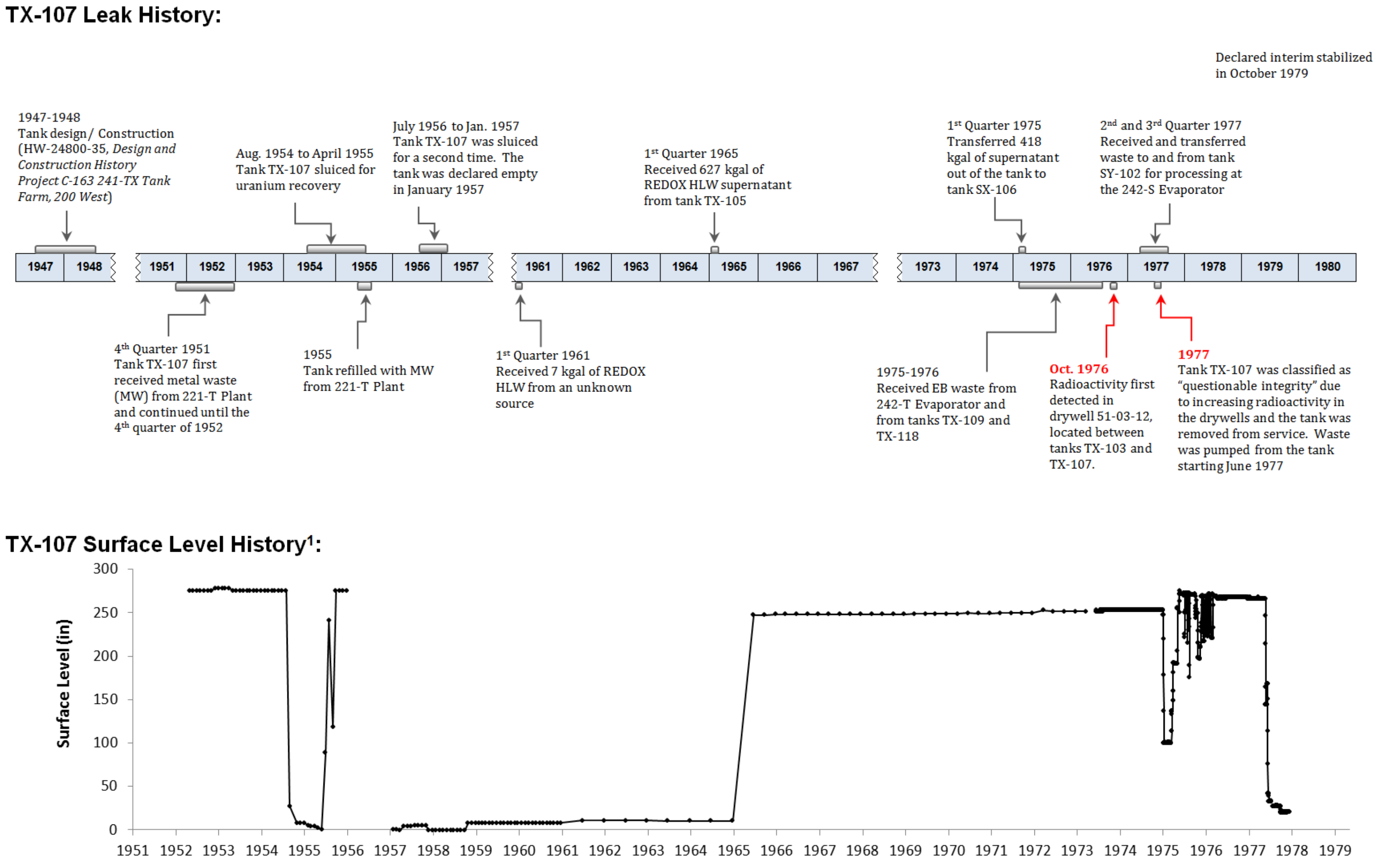
Beginning in the first quarter of 1961, tank TX-107 received 7 kgal of REDOX high-level waste (HLW) from an unknown source. No other transfers occurred until the first quarter of 1965 when 627 kgal of REDOX HLW supernatant from tank TX-105 was added to tank TX-107 (WHC-MR-0132). During the first quarter 1975, tank TX-107 transferred 418 kgal REDOX HLW to tank SX-106 and received 18 kgal of evaporator bottoms (EB) waste from tank TX-109. Tank TX-107 received 451 kgal of EB in the second quarter 1975 and provided evaporator feed and received EB until the second quarter 1976. Tank TX-107 received and transferred EB and evaporator feed from and to double-shell tank SY-102 for processing at the 242-S Evaporator in 1977.

In the second and third quarters of 1977, tank TX-107 EB waste was sent to tank SY-102 for processing in the 242-S Evaporator. Tank TX-107 was categorized as "questionable integrity" and removed from service in 1977 based on increasing activity in nearby drywells starting in April 1977 (OR 77-103, *Radiation Levels Exceeding Criteria in Drywells 51-07-06, 51-07-18, 51-03-12, 51-03-11, and 51-03-01*). Tank TX-107 was declared interim stabilized in October 1979 and classified as a confirmed leaker in 1984 (SD-WM-TI-356; HNF-EP-0182, Rev. 309, *Waste Tank Summary Report for Month Ending December 31, 2013*). Because the solids level was less than 2-ft, the tank was not jet pumped. After interim stabilization a supernatant pool covered about 10% of the waste surface. Document HNF-EP-0182, Rev. 309, reports a leak volume estimate of 2,500 gal for this tank. The basis for the 2,500 gal estimate could not be determined; however, the extent of the contamination attributed to this tank leak suggests that the estimate is low.

As of November 2013, tank TX-107 was estimated to contain 30 kgal of waste in the form of saltcake, which includes 7 kgal of interstitial liquid (HNF-EP-0182, Rev. 310, *Waste Tank Summary Report for Month Ending January 31, 2014*).

The operational history of tank TX-107 leak related details including liquid level is charted in Figure 4-2.

Figure 4-2. Operational Leak History of Tank TX-107



Notes:

1. Raw data from Hanford Engineer Works monthly reports. See Figure 4-3 for a plot of the quarterly liquid levels for the missing raw data.
2. No temperature data available for tank TX-107 prior to 1979. See PCSACS for temperature data from 1979 to present.

CL GIRARDOT
3/27/2014

4.3 TANK DESIGN/CONSTRUCTION

4.3.1 Tank Design

The TX Farm tank design continued important features of the earlier 241-BCTU tanks (BPF-73550). The steel bottom intersects the sidewall on a 4-ft radius. Full penetration butt welds with x-ray inspection and three ply asphaltic membrane waterproofing between the wall liner and the concrete shell continued those design features that were found later to be important for liner integrity during the 241-SX Farm leak assessment (see Section 3.1.1). The top of the tank footing is ~46 BGS and is 3-ft thick with the bottom of the footing at ~49-ft BGS.

4.3.2 Tank Construction Conditions

The TX Farm tank steel liners were constructed between March 1948 and July 1948. From the start of the TX Farm tank construction through July 1948 there was one minimum temperature of 13°F with day time temperature of 40°F and one at 20°F with day time temperature at 50°F.

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

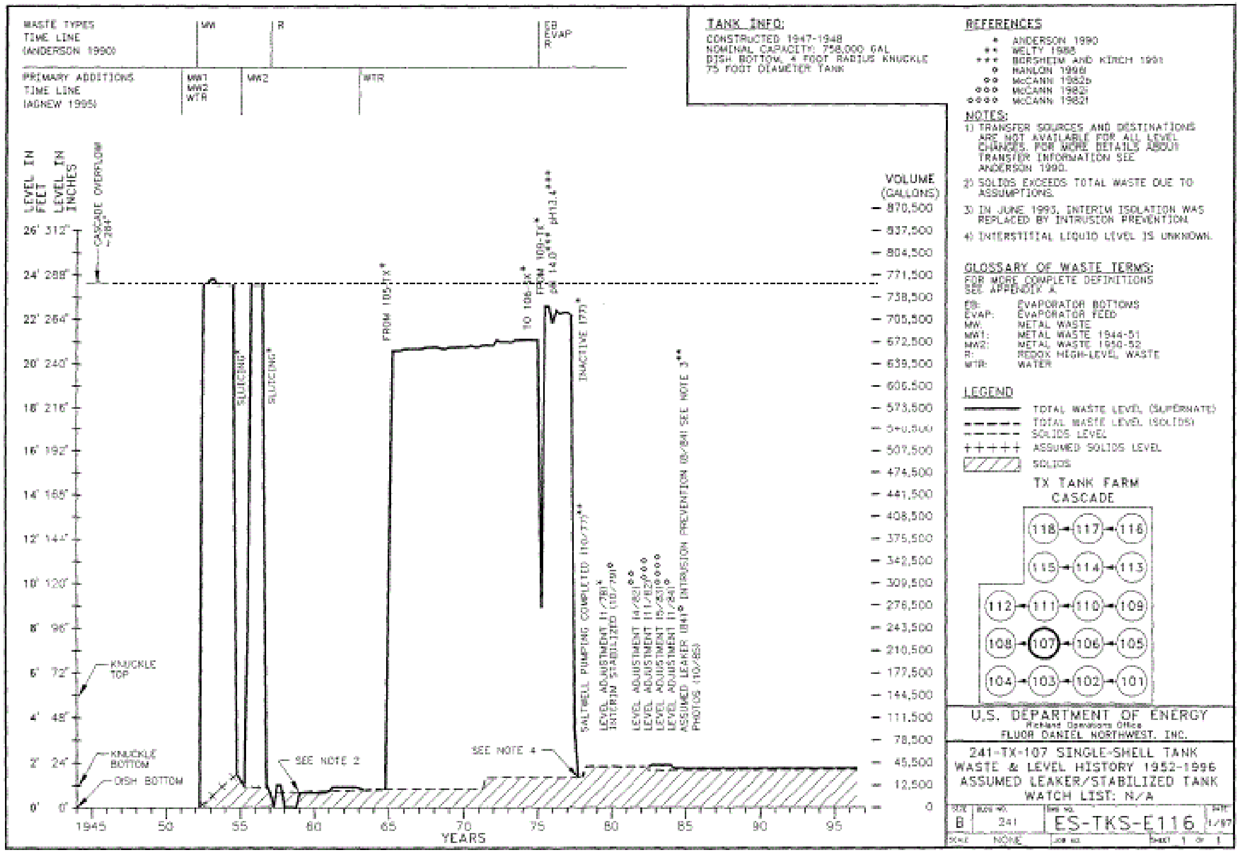
Design, fabrication, and erection of the tank steel lining were required to be in accordance with current “Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs” as promulgated by the “American Water Works Association” (HW-3061). Welding requirements were required to conform to the American Welding Society’s “Code for Arc and Gas Welding in Building Construction”, Section 4.

4.4 TANK TX-107 IN-TANK DATA

4.4.1 Liquid Level

The liquid level plot in Figure 4-3 indicates the transfer activity into and out of tank TX-107. The liquid levels are end of quarter levels so this figure may not reflect all transfers into and out of the tank that occurred during the operational history. See Figure 4-2 for historical monthly liquid level readings.

Figure 4-3. Tank TX-107 End of Quarter Surface Level



WHC-SD-WM-ER-321, Rev. 0, 1994, *Supporting Document for the SW Quadrant Historical Tank Content Estimate for TX-Tank Farm.*

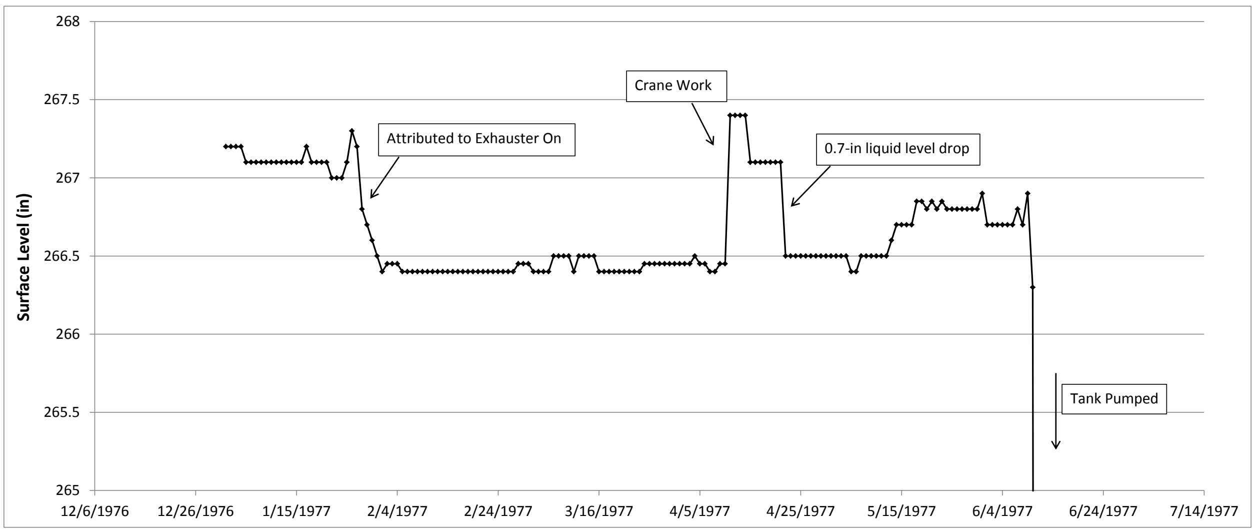
Tank TX-107 was first suspected of leaking in April 1977 after radioactivity increased to above the minimum criterion in drywell 51-03-12 after initially being detected in October 1976 (see Section 4.5.1.11). During this time, it was reported that both tanks TX-103 and TX-107 were "quarantined for a period of approximately five weeks" and there were no liquid level decreases observed with readings taken both manually (every four hours) and with the FIC (every two hours) (OR 77-103, *Drywell No. 51-07-06 Exceeding Criteria June 24, 1977*). The liquid level was reported to be stable in the preliminary, interim, and final OR 77-103. The liquid level was reported to be at 266-in on June 11, 1977 and pumping of the tank contents started June 26, 1977.

However, there was some earlier record of liquid level instability that was reported in five occurrence reports written between 1975 and 1977. Occurrence Report (OR) 75-57, *Decreasing Liquid Level In Tank 107-TX April 25, 1975*, reported a 0.8-in liquid level decrease in seven days with no change in the radiation of the five drywells around the tank. The decrease was attributed to increased exhauster flow and higher evaporation rates. An exhauster was put into operation on March 19, 1975 and flow was increased through tank TX-107 on April 21, 1975. Liquid level decreases reported in OR 75-101, *Liquid Level Drop in 107-TX August 9, 1975*, and OR 77-20, *Liquid Level Decrease Exceeding Criteria in 107-TX February 1, 1977*, were also attributed to exhauster operations (see Figure 4-4 for 1977 liquid level data).

Crane work on April 15, 1977 prompted an increase baseline change on April 18, 1977 from 266.4-in to 267.1-in, and the liquid level remained constant at 267.1-in until April 22, 1977. On April 22, 1977, the liquid level decreased from 267.1-in to near the original 266.4-in level (Occurrence Report 77-55, *Liquid Level Decrease Exceeding Criteria in Tank 107-TX April 22, 1977*). No explanation was determined for this 0.7-in liquid level change (see Figure 4-4) (OR 77-55). The liquid level was reported to be at 266-in on June 11, 1977 and pumping of the tank contents started June 26, 1977.

On July 6, 1977 (after most of the tank contents had been removed), it was reported that the liquid level dropped 0.5-in due to an inadvertent submersible pump startup (OR 77-115, *Liquid Level Decrease, Tank 107-TX July 6, 1977*).

Figure 4-4. Tank TX-107 Liquid Level January 1977 through June 1977



4.4.2 Temperature

No temperature data were recovered for tank TX-107 from when the tank was first put into service until November 1975 except for one data point measured on October 13, 1952 which reported the temperature of the supernatant to be 213°F (WHC-MR-0132). This data point appears to be high. Waste temperatures were likely lower in tank TX-107 based on facility transfer information and that tank TX-107 was the third tank in the cascade series. Tank TX-107 waste temperature plots from 1975 to 1984 and 1993 to 1996 can be found in WHC-SD-WM-ER-321 with a range between ~105°F and ~60°F. The plots carry a footnote that the data was obtained from SACS (PCSACS).

Condensers on the TX Farm tanks (tanks TX-101 through TX-108) were reported to be adequate for the waste temperatures and vapor loads for the original operations at approximately 180°F for supernatant and sludge (WHC-MR-0132).

Seven tanks in the B, C, T, and U Farms that contained metal waste (MW) ranged in temperature from 84°F to 174°F between 1945 and 1947 (HW-14946, *A Survey of Corrosion Data and Construction Details, 200 Area Waste Storage Tanks*). The temperature of T Farm tanks (tanks

T-101 and T-102) that contained MW waste ranged from 99°F to 165°F between 1945 and 1947 (HW-14946). Document HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil,* reports MW from the $BiPO_4$ process was cascaded into a 241-BX Farm series of tanks with temperatures recorded in the first tank of ~180°F, which contained the bulk of the uranium and fission products, and ~70°F in the last (third) tank of the cascade. Tank TX-107, the third tank in the tank TX-105 through tank TX-108 cascade would also experience low temperatures of ~70°F with cooling time and less fission product containing solids accumulation.

The REDOX HLW supernatant transferred to tank TX-107 in 1965 from tank TX-105 was originally transferred from tank SX-102 to tank TX-105. Tank SX-102 temperature was ~150°F, therefore with some cooling the waste in tank TX-107 probably started out less than 150°F during the REDOX HLW supernatant storage period and gradually ranged down to a waste temperature of ~105°F in 1975. The waste temperature then continued down to ~70°F with several transfers of EB into and out off by the time the tank was pumped.

The rate of temperature rise can result in increased vapor pressure under the bottom tank liner from moisture in the underlying grout and vapor from the asphalt membrane below the grout. Temperatures are not available so an actual rate of temperature rise is not available but the above temperature scenario would not likely result in bulging. There were no reports of bulging in tank TX-107.

4.4.3 Liner Observations

The photographs for tank TX-107 taken June 11, 1976 through October 31, 1985 were reviewed and no anomalies were indicated that relate to a liner failure. There is no documentation available indicating a liner bulge was present in tank TX-107.

4.4.4 Chemistry-Corrosion

Tank TX-107 began receiving waste in the fourth quarter of 1951 and received 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 TX-107 Waste Storage Chronology

Date	Waste Type	Length of Storage
4th Quarter 1951 to July 1956	MW	~ 4 years
1st Quarter 1961 to 1st quarter 1975	REDOX HLW	~ 14 years
1975 to June 1977	EB, REDOX HLW	~2 years

Note: Tank TX-107 was sluiced from August 1954 to April 1955 and again from July 1956 to January 1957. The tank was declared empty in January 1957. Reference RPP-RPT-50870, Rev. 0, for additional information on the waste types stored.

Table 4-2. Waste Chemistries for Waste Types Stored in Tank TX-107

Waste Type	$[NO_3^-]$	$[NO_2^-]$	$[OH^-]$	Meets Current DST Specification[2]
MW[1]	0.59	Not reported	1.16	Yes[3]
REDOX HLW[4]	4.83	0.74		No[5]
EB[4]	17.26	0.57		No[6]

1. Reference WHC-EP-0449, 1991, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups.*
2. Reference OSD-T-151-00007, Rev. 12, 2013, *Operating Specification for the Double-Shell Storage Tanks*.
3. Even with no reported value for nitrite, the ratio of nitrate to nitrite and hydroxide would still be less than 2.5 as stated in the current DST specification.
4. Reference WHC-EP-0772, 1994, *Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Site Single-Shell Tanks*.
5. Does not meet the current DST specification since the hydroxide and nitrite concentrations are not greater than or equal to 1.2M.
6. Reference WHC-EP-0772 assumes a density of 1.45 g/mL for molarity calculation. Does not meet the current DST specification since the nitrate concentration is greater than 5.5M.

Tank TX-107 first received MW and stored this waste type for approximately four years. Metal waste should not be a concern for either pitting or SCC under the tank TX-107 conditions. Tank TX-107 then received REDOX HLW and stored only REDOX HLW for approximately 14 years total. REDOX HLW does not meet the current DST specification for waste chemistry due to low concentrations of the nitrate-induced SCC inhibitors, nitrite and hydroxide. Thus, these conditions of the REDOX HLW would likely create an environment conducive to SCC and/or pitting (see Section 3.2.4). Tank TX-107 temperature is not available during storage of REDOX HLW; however, the temperature of the REDOX HLW from the transfer tank SX-102 through TX-105 was ~150°F in tank SX-102. Therefore, at least for some period of time the temperature was high enough to induce SCC and/or pitting.

Tank TX-107 then received EB with some existing REDOX HLW as shown in Table 4-1. Both EB and REDOX HLW are wastes that do not meet the current DST specification for waste chemistry. The temperature during storage of the EB waste combined with REDOX HLW was probably less than 105°F which should not increase the risk for SCC and/or pitting.

4.4.5 Photographs

The photographs for tank TX-107 taken June 11, 1976 through October 31, 1985 were reviewed and no anomalies were indicated that relate to a liner failure. There is no documentation available indicating a liner bulge was present in tank TX-107.

4.5 TANK TX-107 EX-TANK DATA

4.5.1 Drywells

There are eleven drywells located around tank TX-107: 51-07-04, 51-07-09, 51-07-11, and 51-03-12, installed in 1971, 51-07-01 drilled in 1974, 51-07-03 drilled in 1976, and 51-07-06, 51-07-18, 51-07-07, 51-03-01, and 51-03-11 installed in 1977, in addition to one direct push installed in 2002. 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 TX-107.

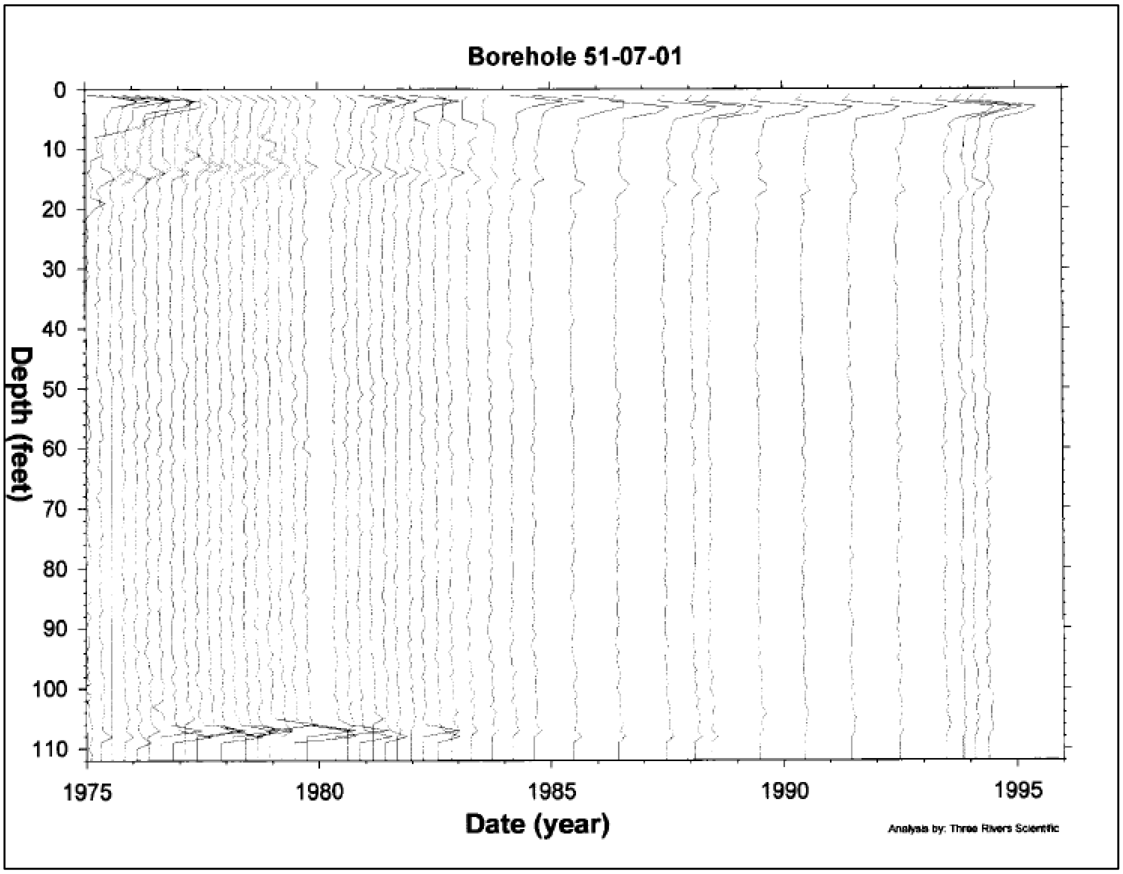
4.5.1.1 Drywell 51-07-01

Drywell 51-07-01 is located approximately 10-ft from the tank TX-107 footing. Drywell 51-07-01 was drilled in January 1974 with the first recoverable reading on January 25, 1974 reported as less than values (see Appendix A1). Readings continued to be reported as less than values through June 1986.

In December 1996, Cs-137 was the only man-made gamma-emitting radionuclide detected in this drywell (GJ-HAN-48, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank TX-107*). From the ground surface to 41.5-ft BGS, Cs-137 was detected continuously and intermittently to the bottom of the drywell (108-ft BGS). The maximum Cs-137 concentration was approximately 38.6 pCi/g at 2.5-ft BGS. Document GJ-HAN-48 reports, "*The small amount of Cs-137 at 20 ft may be the result of a breach in a subsurface pipeline that runs between the tanks. The contamination correlates well with other boreholes that are located near these pipelines. The near-surface contamination is probably the result of surface spills that have migrated down into the backfill surrounding the borehole or contamination that was carried down during the drilling of this borehole. The Cs-137 contamination at the bottom of the borehole is probably from particulate matter that has fallen down the inside of the casing.*"

Since historical radioactivity in this drywell is very low, and GJ-HAN-48 reported low levels of radioactivity, drywell 51-07-01 is not being included as part of the leak location for tank TX-107. Figure 4-5 shows the depths of radioactivity from 1975 to 1995 (RPP-6353, *Analysis & Summary Report of Historical Drywell Gamma Logs for 241-TX Tank Farm - 200 West*).

Figure 4-5. Tank TX-107 Drywell 51-07-01 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

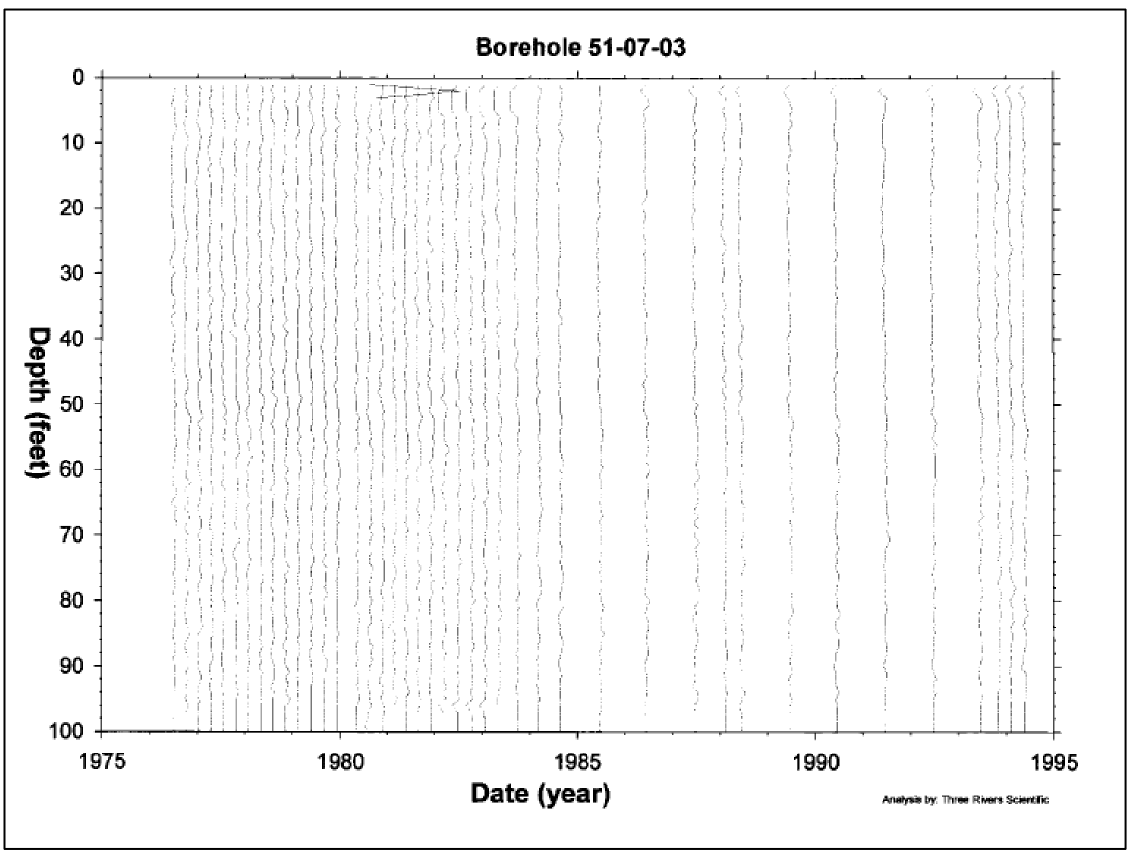
4.5.1.2 Drywell 51-07-03

Drywell 51-07-03 is located approximately 12-ft from the tank TX-107 footing. Drywell 51-07-03 was drilled in March 1976 with the first recoverable reading on May 13, 1976 reported as less than values (see Appendix A1). Readings continued to be reported as less than values through June 1986.

In December 1996, Cs-137 was the only man-made gamma-emitting radionuclide detected in this drywell (GJ-HAN-48). From the ground surface to 13.5-ft BGS, Cs-137 contamination was detected continuously and intermittently to the bottom of the drywell (96-ft BGS). The maximum concentration of 2.8 pCi/g was reported at 3-ft BGS (GJ-HAN-48). Document GJ-HAN-48 states, "*The near-surface contamination probably resulted from surface spills that have migrated down the backfill surrounding the borehole or contamination that was carried down during the drilling of this borehole. The Cs-137 contamination at the bottom of the borehole is probably from particulate matter that has fallen down the inside of the casing.*"

Since historical radioactivity in this drywell is very low, and GJ-HAN-48 reported low levels of radioactivity, drywell 51-07-03 is not being included as part of the leak location for tank TX-107. Figure 4-6 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 4-6. Tank TX-107 Drywell 51-07-03 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

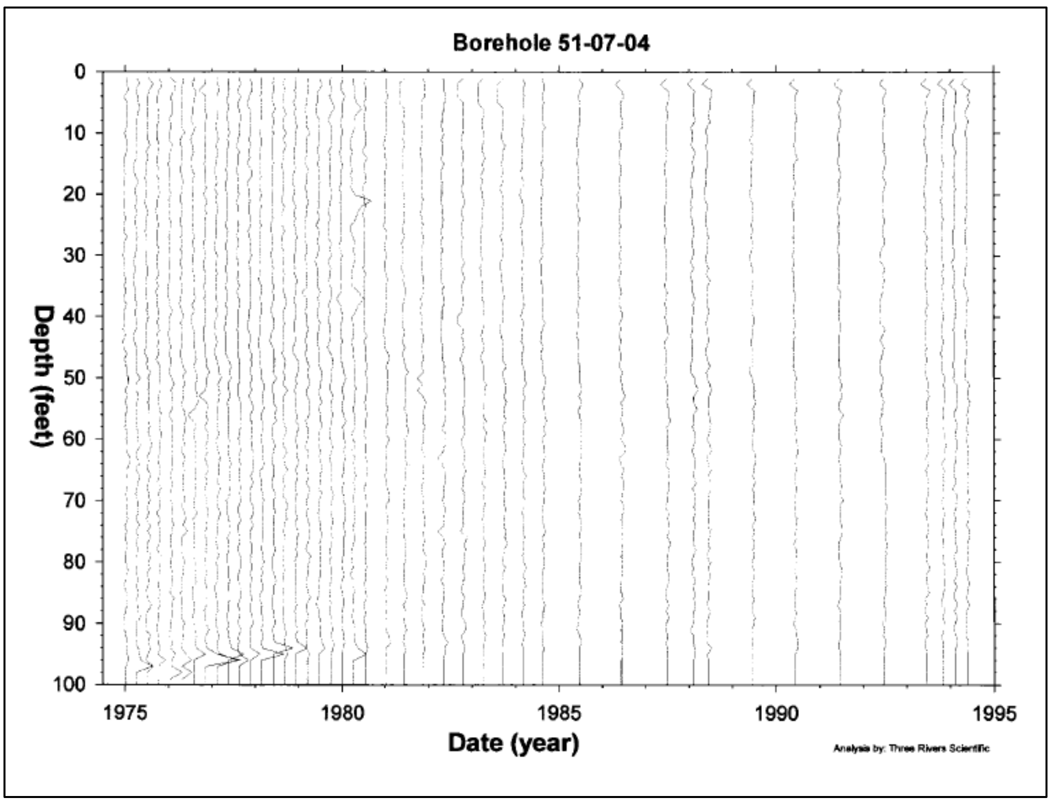
4.5.1.3 Drywell 51-07-04

Drywell 51-07-04 is located approximately 6.6-ft from the tank TX-107 footing. Drywell 51-07-04 was drilled in December 1971 with the first recoverable readings reported on July 9, 1973 reported as less than values (see Appendix A1). Readings continued to be reported as less than values through June 1986.

In December 1996, Cs-137 was the only man-made gamma-emitting radionuclide detected in this drywell (GJ-HAN-48). From the ground surface to 28-ft BGS, Cs-137 contamination was detected continuously and intermittently to the bottom of the drywell (96-ft BGS). The maximum concentration of 4 pCi/g was measured at the ground surface (GJ-HAN-48). Document GJ-HAN-48 states, "*The near-surface contamination probably resulted from surface spills that have migrated down the backfill surrounding the borehole or contamination that was carried down as the borehole was drilled. The Cs-137 contamination at the bottom of the borehole is probably from particulate matter that has fallen down the inside of the casing.*"

Since historical radioactivity in this drywell is very low, and GJ-HAN-48 reported low levels of radioactivity, drywell 51-07-04 is not being included as part of the leak location for tank TX-107. Figure 4-7 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 4-7. Tank TX-107 Drywell 51-07-04 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.4 Drywell 51-07-06

Drywell 51-07-06 is located approximately 2.3-ft from the tank TX-107 footing. Drywell 51-07-06 was drilled starting in June 1977 and was drilled to a depth of about 60-ft by June 24, 1977. The drywell was drilled as a result of increasing radioactivity detected in drywell 51-03-12. The drywell was logged with an unshielded scintillation probe (SP) prior to completing the drilling on this date. At this time, the drywell was abandoned after the core barrel and a Battelle probe were lost which prevented drilling it further.

The only data obtained for this drywell were reported in ten interim OR 77-103, *Radiation Levels Exceeding Criteria in Drywells: 51-07-06, 51-07-18, 51-03-12, 51-03-11, 51-03-01*, dated between June 24, 1977 and January 5, 1978. Only one logging of the drywell occurred on June 24, 1977, and radioactivity was reported to be greater than 30,000 cps (or 1,800K cpm) with the unshielded SP at 51-ft BGS (Interim OR 77-103, June 27, 1977). After this June 24, 1977 reading, the drywell was abandoned and drywell 51-07-18 (located 2-ft due west of drywell 51-07-06) was drilled on July 14, 1977 to replace this drywell (see Section below). Therefore, later SGLS was not performed in this drywell and it is not shown on the TX Farm figure in the GJ-HAN-48 document.

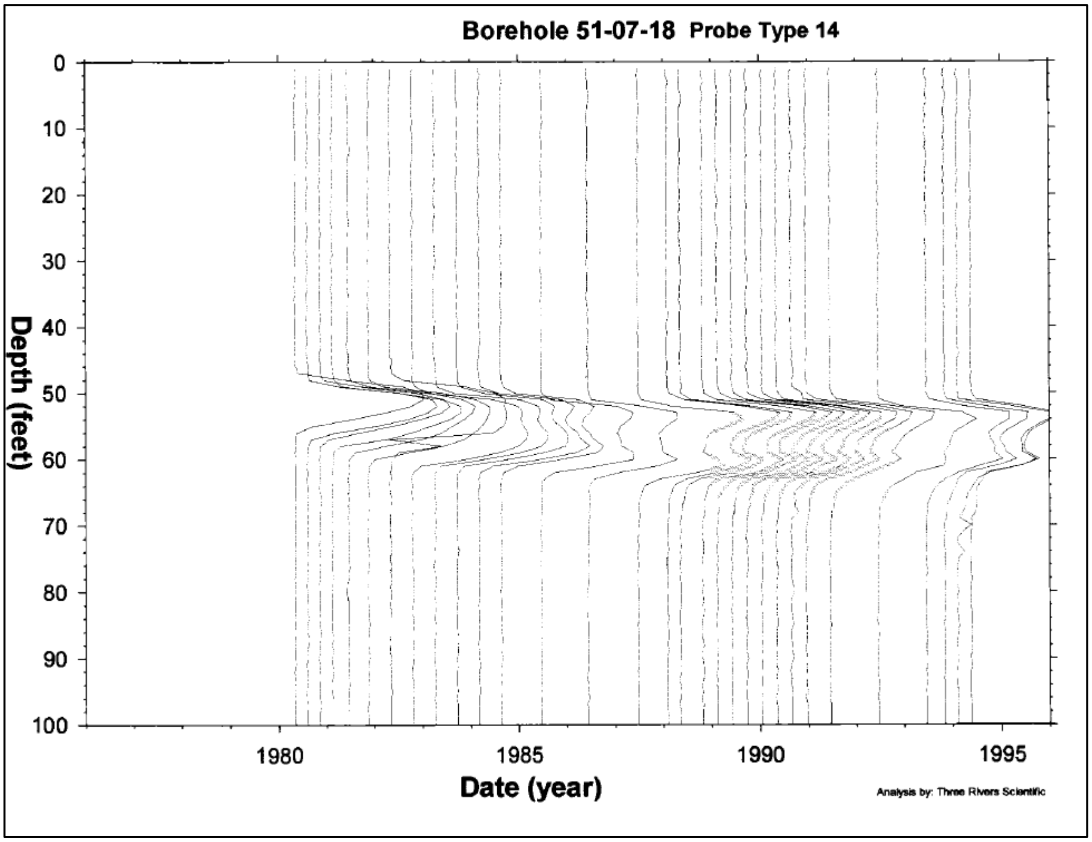
4.5.1.5 Drywell 51-07-18

Drywell 51-07-18 is located approximately 2.4-ft from the tank TX-107 footing. Drywell 51-07-18 was drilled on July 14, 1977, adjacent to drywell 51-07-06, to replace drywell 51-07-06 which was abandoned in June 1977. Drywell 51-07-18 was drilled as part of an investigation of increased radioactivity in drywell 51-03-12. The first recoverable reading on July 14, 1977 reported a peak with the unshielded SP of 1890.9K cpm at 51-ft BGS (see Appendix A1). The next recorded reading on July 29, 1977 reported the peak at 289.9K cpm at 50-ft BGS with a shielded scintillation probe (SSP). Radioactivity gradually increased to 610.6K cpm at 50-ft BGS by January 31, 1979. Readings remained relatively stable through 1981 and then decreased to 86.9K cpm by June 11, 1986 at 53-ft BGS.

In December 1996, Cs-137, Co-60, and Eu-154 were the only man-made gamma-emitting radionuclides detected in this drywell (GJ-HAN-48). Cs-137 was detected continuously from the ground surface to 16.5-ft BGS and intermittently to the bottom of the drywell (105-ft BGS). The maximum Cs-137 concentration of approximately 6.5 pCi/g was detected at 4-ft BGS. Co-60 was detected continuously from 49.5 to 74-ft BGS with a maximum concentration of 179 pCi/g at 59-ft BGS. Eu-154 was detected almost continuously from 49 to 60-ft BGS with the maximum concentration of 609 pCi/g at 52-ft BGS.

Document GJ-HAN-48 reported, "*Low Cs-137 concentrations measured near the ground surface probably originated from a near-surface spill that migrated downward into the formation around the outside of the casing or contamination that was carried down during the drilling of this borehole. The contamination"*...[i.e., Co-60 and Eu-154]…*"detected between 50 and 75 ft originated from a breach of the TX-107 tank structure.*" Figure 4-8 shows the depths of radioactivity from 1980 to 1995 (RPP-7729).

Figure 4-8. Tank TX-107 Drywell 51-07-18 (RPP-6353)



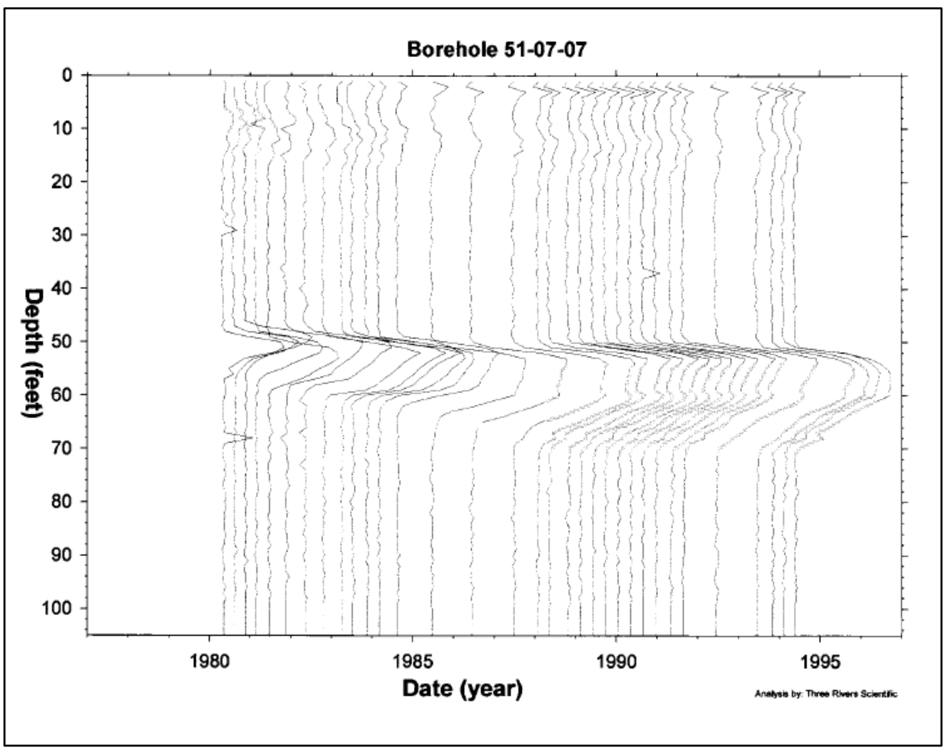
Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.6 Drywell 51-07-07

Drywell 51-07-07 is located approximately 1.75-ft from the tank TX-107 footing. Drywell 51-07-07 was drilled in May 1977 with the first recoverable reading on May 13, 1977 reported as less than values (see Appendix A1). The next recoverable reading on October 13, 1977 was also reported as less than values. The next reading on April 10, 1978 reported a peak of 3.1K cpm at 50-ft BGS. Readings gradually increased but still remained below 50K cpm through October 1980 at about the 50-ft BGS level. From March 1981 to July 1982 readings increased from about 50K cpm to 222.4K cpm and then remained relatively stable through June 1986 (see Appendix A1).

In December 1996, Cs-137, Co-60, and Eu-154 were the only man-made gamma-emitting radionuclides detected in drywell 51-07-07 (GJ-HAN-48). Cs-137 was detected continuously from the ground surface to 20-ft BGS, and intermittently to the bottom of the drywell (105-ft BGS). The maximum Cs-137 concentration of 10 pCi/g was detected at the ground surface. Co-60 was measured continuously from 50 to 78-ft BGS with a maximum concentration of 452 pCi/g at 59.5-ft BGS. Eu-154 was detected almost continuously from 51 to 57-ft BGS with a maximum concentration of 42 pCi/g at 52.5-ft BGS. Document GJ-HAN-48 reports, "*Low Cs-137 concentrations measured near the ground surface probably originated from a near-surface spill that has migrated downward around the outside of the casing or contamination that was carried down during the drilling of this borehole. The contamination"*…[i.e., Co-60 and Eu-154]…*"detected between 50 and 75 ft originated from a breach of the TX-107 tank structure*." Figure 4-9 shows the depths of radioactivity from 1980 to 1995 (RPP-6353).

Figure 4-9. Tank TX-107 Drywell 51-07-07 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

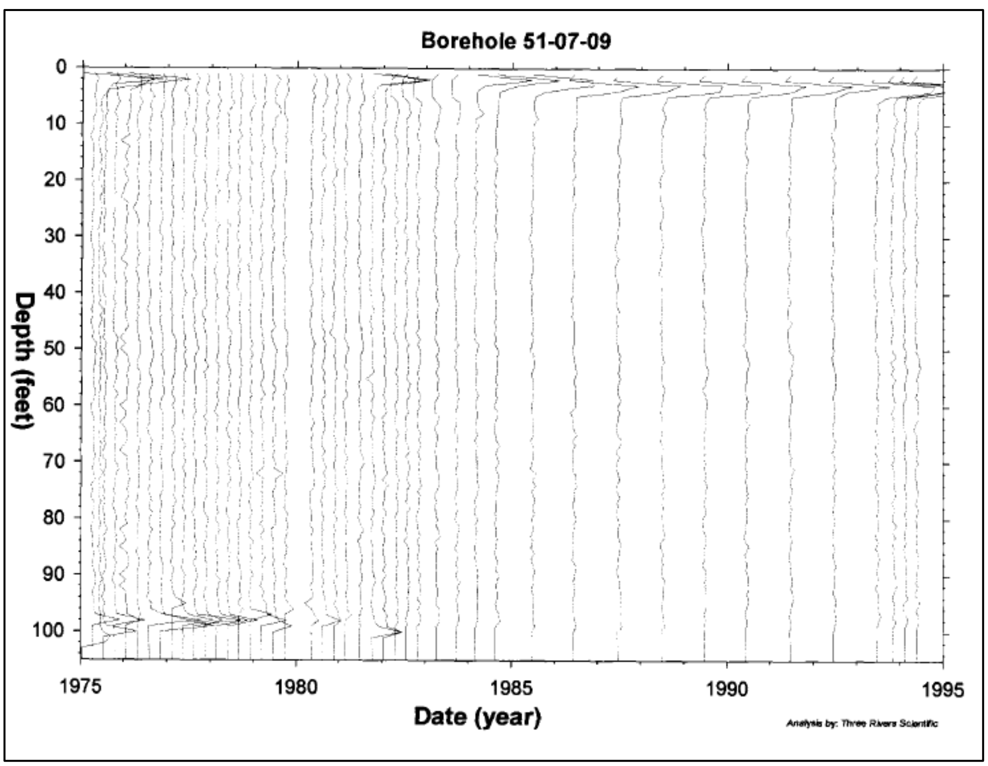
4.5.1.7 Drywell 51-07-09

Drywell 51-07-09 is located approximately 5.5-ft from the tank TX-107 footing. Drywell 51-07-09 was drilled in November 1971 with the first recoverable reading on August 24, 1973 reported as less than values (see Appendix A1). Readings continued to be reported as less than values through June 1986.

In December 1996, Cs-137 and Co-60 were the only man-made gamma-emitting radionuclides detected in drywell 51-07-09 (GJ-HAN-48). Cs-137 was detected continuously from the ground surface to 12.5-ft BGS and from 68.5-ft BGS to the bottom of the drywell (100-ft BGS). The maximum Cs-137 concentration of 196 pCi/g was detected at a depth of 2.5-ft BGS. Co-60 was detected just above the minimum detection limit at 84.5-ft BGS. Document GJ-HAN-48 reports, "*The Cs-137 at the bottom of the borehole is probably from a subsurface source that is unrelated to the contaminant plume seen in the south quadrant of the tank TX-107. However, the contamination could be from particulate matter that has fallen down the inside of the casing or that was washed in during some type of surface flood event. The near-surface contamination probably resulted from surface spills migrating down into the backfill surrounding the borehole, or the contamination may have been in the backfill before the borehole was drilled and carried down as the borehole was drilled.*"

Since historical radioactivity in this drywell is very low, and the 1996 SGLS report low levels of radioactivity, drywell 51-07-09 is not being included as part of the leak location for tank TX-107. Figure 4-10 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 4-10. Tank TX-107 Drywell 51-07-09 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

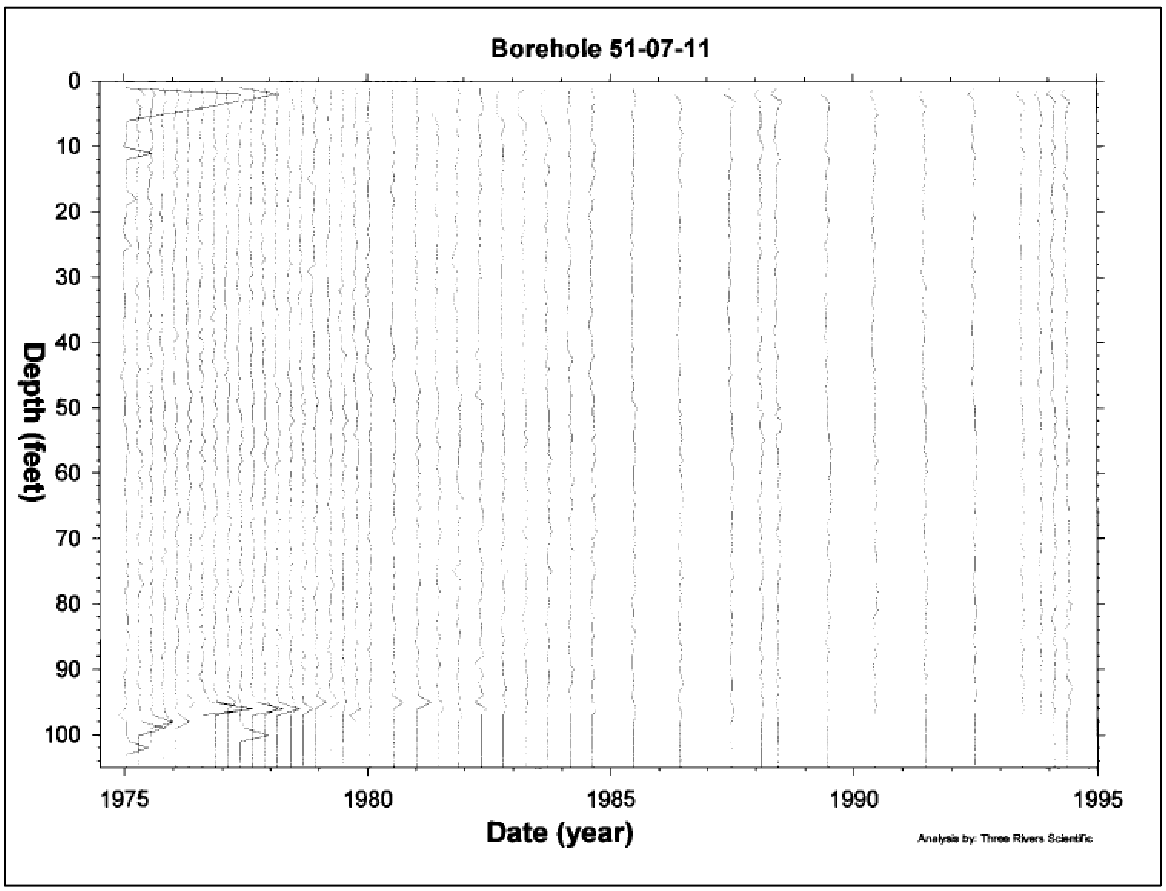
4.5.1.8 Drywell 51-07-11

Drywell 51-07-11 is located approximately 6.7-ft from the tank TX-107 footing. Drywell 51-07-11 was drilled in November 1971 with the first recoverable reading on July 6, 1973 reported as less than values (see Appendix A1). Readings continued to be reported as less than values through June 1986.

In December 1996, Cs-137 was the only man-made gamma-emitting radionuclides detected in drywell 51-07-11 (GJ-HAN-48). Cs-137 was detected continuously from the ground surface to 24-ft BGS, and intermittently to the bottom of the drywell. The maximum Cs-137 concentration of 4.1 pCi/g was detected at a depth of 2-ft BGS. Document GJ-HAN-48 reports, "*The near-surface contamination probably resulted from surface spills that have migrated down into the backfill surrounding the borehole, or the contamination may have been in the backfill before the borehole was drilled and carried down as the borehole was drilled. The Cs-137 at the bottom of the borehole is probably from particulate matter that has fallen down the inside of the casing*."

Since historical radioactivity in this drywell is very low, and the 1996 SGLS report low levels of radioactivity, drywell 51-07-11 is not being included as part of the leak location for tank TX-107. Figure 4-11 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 4-11. Tank TX-107 Drywell 51-07-11 (RPP-6353)



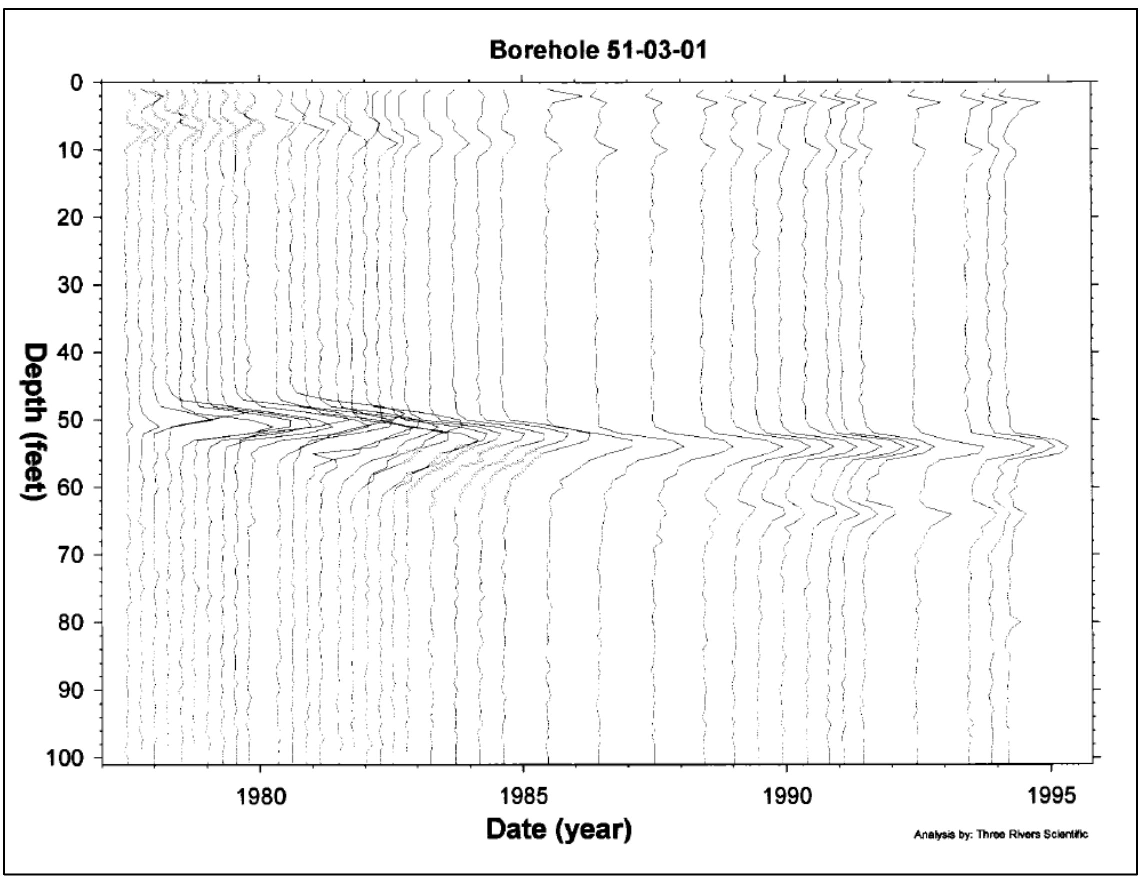
Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.9 Drywell 51-03-01

Drywell 51-03-01 is located approximately 19-ft from the tank TX-107 footing. Drywell 51-03-01 was drilled on June 8, 1977 with the first recoverable reading on June 8, 1977 reported as less than values through July 6, 1977 (see Appendix A1). Beginning on August 5, 1977, radioactivity was detected at about the 50-ft BGS level and gradually increased to 206.2K cpm by September 19, 1979. Readings then slowly declined from the 206.2K cpm peak reported in September 1979 to 49.7K cpm on June 11, 1986 at 54-ft BGS (see Appendix A1).

In November 1996, Cs-137, Eu-154, and Co-60 were the only man-made gamma-emitting radionuclides detected in drywell 51-03-01 (GJ-HAN-44, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank TX-103*). Cs-137 was detected continuously from the ground surface to 16.5-ft BGS, and intermittently at concentrations of 1 pCi/g or less between 19 and 49-ft BGS. The maximum Cs-137 concentration of 50 pCi/g was detected at a depth of 1-ft BGS. Co-60 and Eu-154 were detected from 51 to 68-ft BGS at concentrations ranging from 0.2 to 20 pCi/g for Co-60 and at concentrations less than 10 pCi/g for Eu-154. Document GJ-HAN-44 reports, "*The plume probably originated from a subsurface leak in tank TX-107 and will be discussed more fully in the TSDR for tank TX-107*." Figure 4-12 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 4-12. Tank TX-107 Drywell 51-03-01 (RPP-6353)



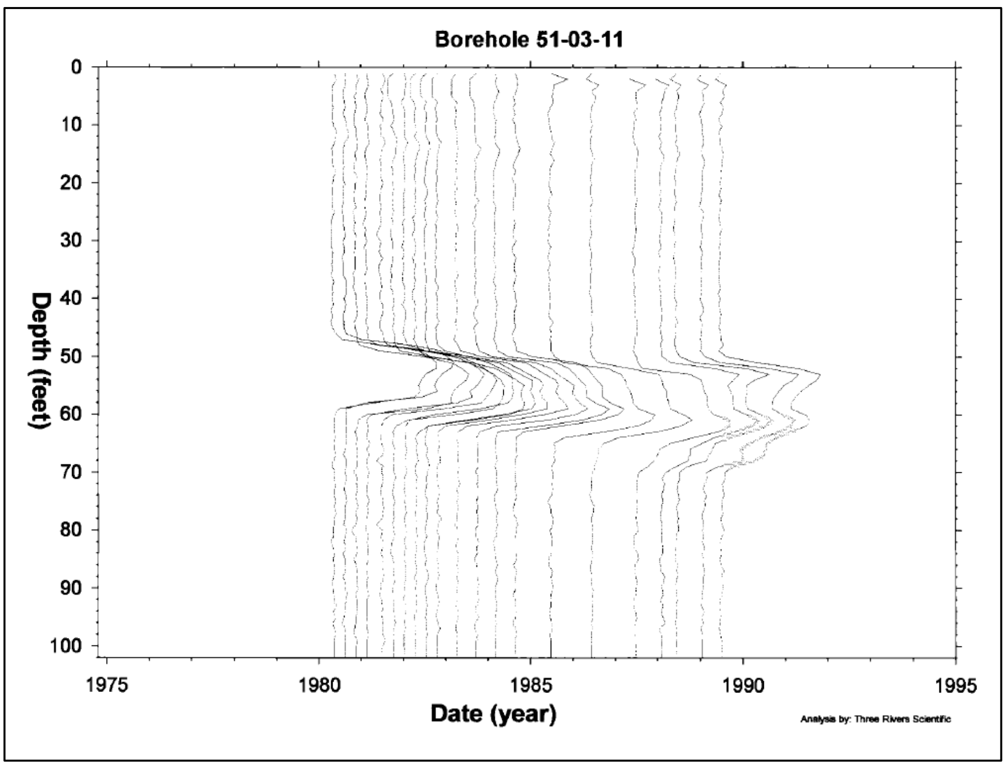
Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.10 Drywell 51-03-11

Drywell 51-03-11 is located approximately 19-ft from the tank TX-107 footing. Drywell 51-03-11 was drilled on May 25, 1977 with the first recoverable reading on May 25, 1977 reported a peak of 2.8Kcpm at 51-ft BGS (see Appendix A1). Radioactivity slowly increased to 37.9K cpm on October 17, 1977 and then increased to 133.2K cpm by March 8, 1978. On May 8, 1978 a separate peak was recorded at 56-ft BGS at 3.3K cpm. Readings continued to increase and reached 697.9K cpm by February 24, 1981 at 53-ft BGS. Radioactivity then slowly declined to 274.6K cpm by June 11, 1986 at depths ranging from 52 to 69-ft BGS (see Appendix A1).

In November 1996, Cs-137, Eu-154, Eu-152, and Co-60 were the only man-made gamma-emitting radionuclides detected in drywell 51-03-11 (GJ-HAN-44). Cs-137 was detected continuously from the ground surface to 23-ft BGS with the maximum concentration of 25 pCi/g detected at 1-ft BGS. Co-60 was detected from 51 to 68-ft BGS at concentrations ranging from 50 to 114 pCi/g, and from 68 to 100-ft BGS at concentrations ranging from 0.2 to 10 pCi/g. Eu-154 was detected between 51 and 60-ft BGS at concentrations ranging from 1.5 to 17 pCi/g. Document GJ-HAN-44 reports, "*The shallow Cs-137 contamination encountered in the borehole probably originated from a surface spill and is not indicative of a subsurface leak. The Co-60 in the zone below a depth of 61 ft probably originated from a subsurface leak; the top of the plume is well below the base of the tank. However, the leak did not originate from tank TX-103*"…"*The plume may have originated from a leak in tank TX-107*." Figure 4-13 shows the depths of radioactivity from 1980 to 1995 (RPP-6353).

Figure 4-13. Tank TX-107 Drywell 51-03-11 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.11 Drywell 51-03-12

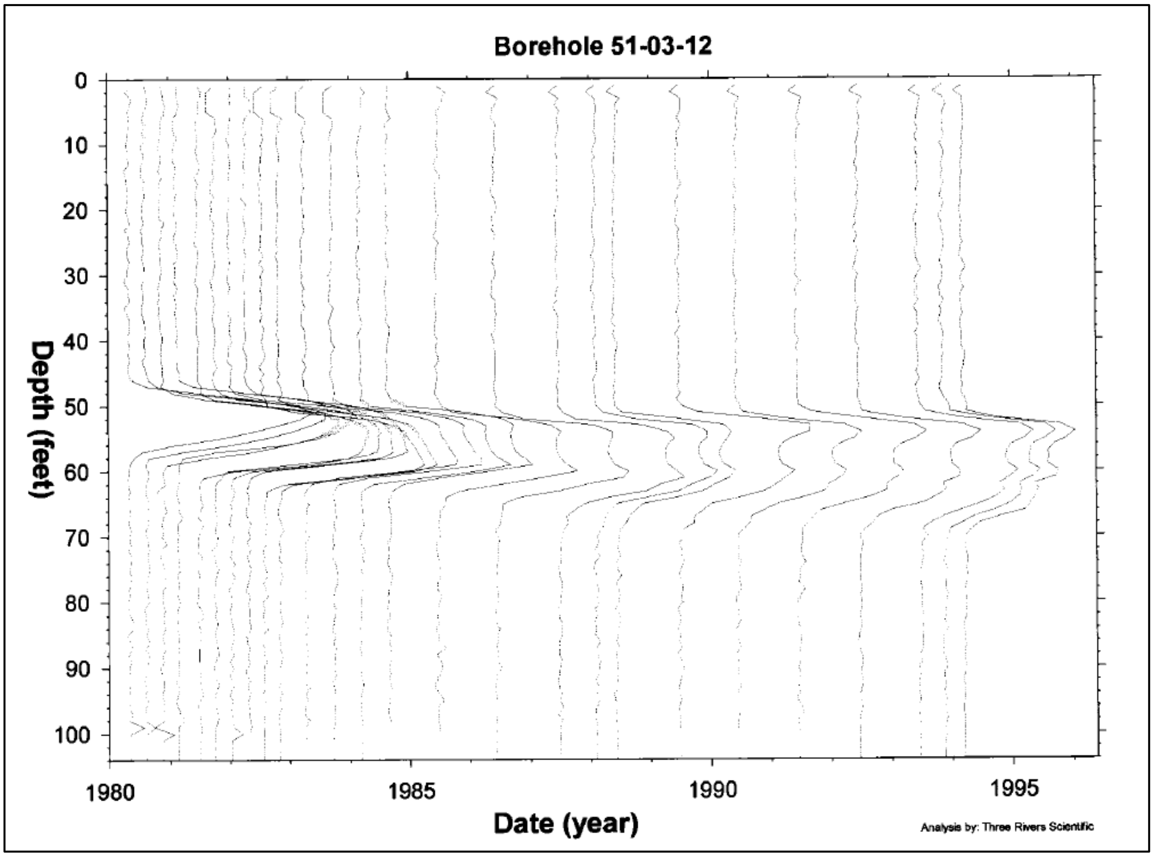
Drywell 51-03-12 is located approximately 12-ft from the tank TX-107 footing. Drywell 51-03-12 was drilled in November 1971 with the first recoverable reading on July 6, 1973 reported as less than values. Readings continued to be reported as less than values through May 1976. Beginning on October 21, 1976 a peak of 3.1K cpm was reported at 53-ft BGS (see Appendix A1).

On April 29, 1977, drywell 51-03-12 monitoring increased as the result of a radiation peak forming at approximately 53-ft BGS and the peak exceeded the minimum criterion on June 24, 1977 (OR 77-103). In June 1977, directional probing of drywell 51-03-12 indicated the strongest signal came from the north (or from tank TX-107) (OR 77-103, June 24, 1977). As a result, subsequent drywells were drilled near this drywell to determine the direction of the source. Readings in drywell 51-03-12 continued to increase to 1136.4K cpm at 51-ft BGS by October 1980. Radioactivity then slowly declined to 189.2K cpm at 60-ft BGS by June 11, 1986 (see Appendix A1).

In November 1996, Cs-137, Co-60, Eu-154, and Eu-152 were the only man-made gamma-emitting radionuclides detected in drywell 51-03-12 (GJ-HAN-44). Cs-137 was detected continuously from the ground surface to 20-ft BGS with the maximum Cs-137 concentration of 10 pCi/g detected at a depth of 1-ft BGS. Co-60, Eu-154, and Eu-152 were detected from about 51 to 69-ft BGS. Co-60 concentrations were about 0.2 to 10 pCi/g from 51 to 68-ft BGS and concentrations were generally less than 1 pCi/g from 75 to 100-ft BGS. Eu-154 concentrations ranged from 1.5 to 77 pCi/g at 51 to 60-ft BGS, and a single Eu-152 concentration was measured in this same zone at 53-ft BGS.

Document GJ-HAN-44 reports, "*The Co-60 and Eu-154 contaminants in the depth interval between 51 and 69 ft originated from a subsurface leak from a nearby tank. The contaminated zone begins well below the base of tank TX-103, and the contaminants are more or less uniformly distributed throughout a portion of the plume. The same plume has been encountered in several nearby boreholes associated with this tank and adjacent tank TX-104; the plume extends to at least tank TX-104 and appears to continue northeasterly to tank TX-107. The plume probably originated from a subsurface leak in tank TX-107 and will be discussed more fully in the TSDR for tank TX-107*." Figure 4-14 shows the depths of radioactivity from 1980 to 1995 (RPP-6353).

Figure 4-14. Tank TX-107 Drywell 51-03-12 (RPP-6353)



Note: Bottom of the tank footing is ~49-ft BGS

4.5.1.12 2002 Direct Push

In July/August 2002, one direct push (C3831) located approximately 29-ft from the tank TX-107 footing was installed near the tank to help determine the extent of the contamination and the composition of the waste released which are found in RPP-23752, Rev. 0A, *Field Investigation Report for Waste Management Areas T and TX-TY* (see Figure 4-1).

Results indicated elevated concentrations of several constituents (primarily Tc-99, Co-60, nitrate, and sodium) in the soil samples taken from direct push C3831 that are attributed to tank waste from tank TX-107. Document RPP-23752, Rev. 0A, indicates that direct push C3831 is located in the middle of the contaminant plume that has leaked from the southern portion of tank TX-107 as indicated by maximum Co-60 contamination (about 20 to 50 pCi/g) between 60 and 70-ft BGS.

Radioactivity detected in this direct push appears to be related to the drywell radioactivity detected in 1977 due to the similar depths where maximum concentrations were recorded.

4.5.1.13 Drywell Summary

Tank TX-107 was first suspected of leaking as the result of increased radioactivity detected in drywell 51-03-12 in April 1977, after low levels of radioactivity were initially detected in October 1976 (see Section 4.4.1). The radioactivity continued to increase in drywell 51-03-12, and additional drywells were installed near drywell 51-03-12 in an attempt to identify the source of radioactivity. In June 1977, drywell 51-07-06 was drilled and radioactivity was reported in excess of 30,000 cps (or 1,800K cpm). As a result, tank TX-107 waste contents were removed starting on June 26, 1977.

Tank TX-107 drywells 51-07-01, 51-07-03, 51-07-04, 51-07-09, and 51-07-11 do not indicate any radioactivity associated with a tank TX-107 leak. Therefore, these drywells are not included in the leak location for tank TX-107.

Drywell 51-03-12 initially reported radioactivity (3.1K cpm) at 53-ft BGS and monitoring of this drywell increased. Beginning in June 1977, radioactivity in drywell 51-03-12 increased to above the minimum criterion and thus five additional drywells were drilled between tanks TX-107 and TX-103 to try to determine the source of radioactivity. As a result of the amount of radioactivity detected in drywell 50-07-06 (located between drywell 51-03-12 and tank TX-107) shortly after drilling, it was concluded that the radioactivity detected in drywell 51-03-12 originated from tank TX-107.

Drywells 51-07-07, 51-07-18, 51-07-06, 51-03-11, and 51-03-01 were drilled in May to July 1977 to help determine the source of the radioactivity reported in drywell 51-03-12. Drywell 51-07-06 reported high levels of radioactivity at ~51-ft BGS in June 1977. This drywell was abandoned shortly after drilling and drywell 51-07-18 was drilled to replace drywell 51-07-06 (see Section 4.5.1.4). The first reading in July 1977 reported high levels of radioactivity in drywell 51-07-18 at 51-ft BGS. Radioactivity was reported to be higher in these two drywells compared to the other drywells located south of tank TX-107 which likely indicates the leak site is close to drywells 51-07-06 and 51-07-18. The low concentration of Cs-137 compared to Co-60, Eu-154, and Eu-152 indicates that either the Cs-137 concentration was low in the tank supernatant or the leak site was not sufficiently close to the drywells for the Cs-137 to be in the expected ratio with the more mobile Co-60, Eu-154 and Eu-152.

Drywell 51-07-07 readings were reported as less than values from May 1977 to October 1977. Beginning in April 1978, a small peak (~3.1K cpm) was reported at 50-ft BGS. Drywell 51-03-01 also reported less than values from June through July 1977. Beginning in August 1977, a small peak (3.1K cpm) was reported at 51-ft BGS. The radioactivity detected in these two drywells is likely migration from the leak site near drywells 51-07-06 and 51-07-18.

Drywell 51-03-11 first reported a peak (~2.8K cpm) of radioactivity in May 1977 at 51-ft BGS. Radioactivity detected in this drywell is likely associated with the tank TX-107 leak in the southern portion of the tank.

Direct push C3831, installed in 2002, appears to be related to the 1977 leak in the southern portion of the tank based on similar concentrations and BGS depths. Document RPP-23752, Rev. 0A, indicates that direct push C3831 is located in the middle of the contaminant plume that has leaked from the southern portion of tank TX-107.

4.6 POSSIBLE TANK TX-107 LINER LEAK LOCATION(S)

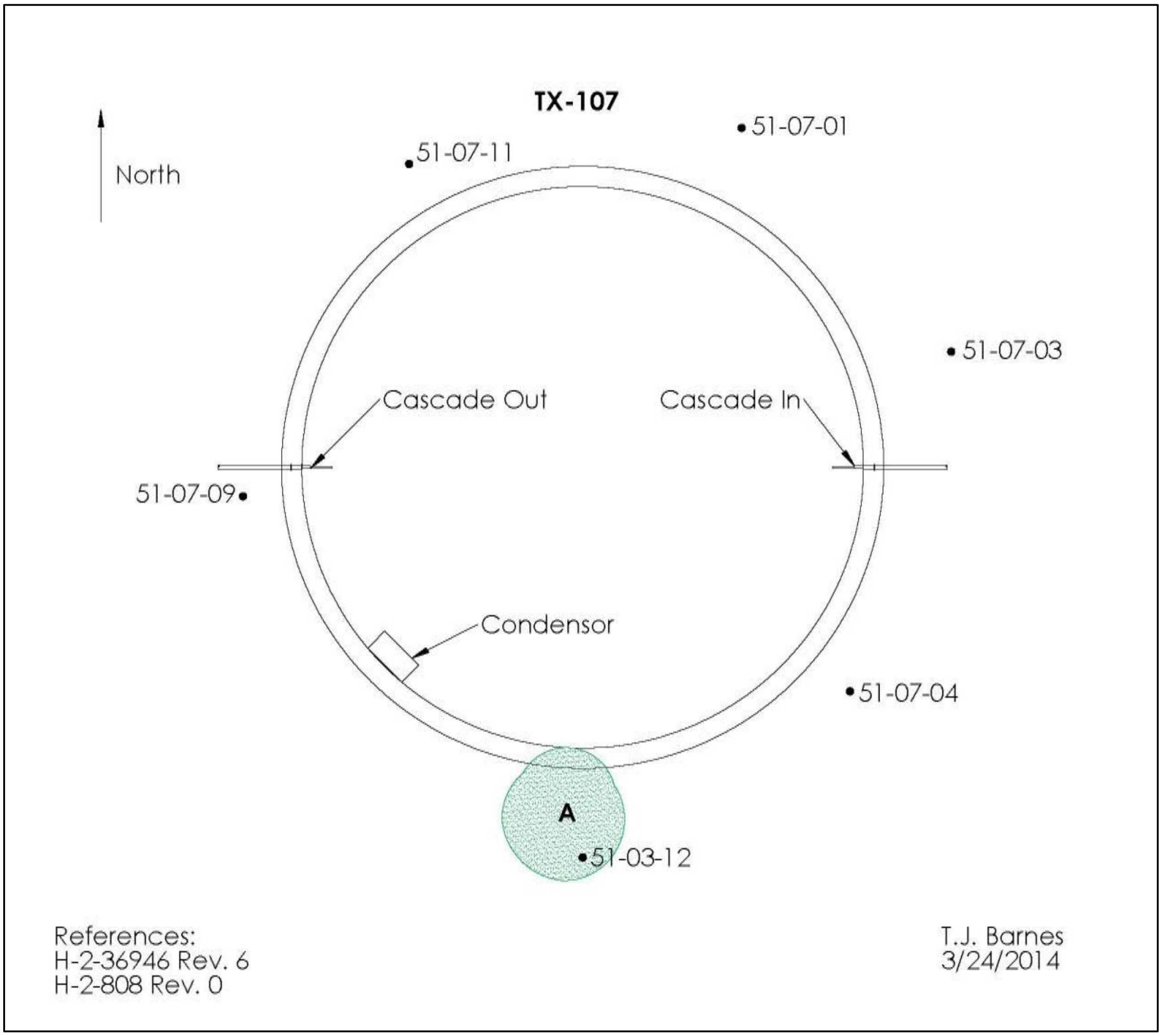
A liner leak may have penetrated the waterproof membrane at any location or pooled on the waterproof membrane and followed concrete cracks or construction joints to a different location for egress to the soil, including the top of the tank footing.

Tank TX-107 had at least one liner leak site based on radioactivity detected in six drywells and one direct push, likely at or near the bottom of the tank. Tank TX-107 was first suspected of leaking in April 1977 after radioactivity increased to above the minimum criterion in drywell 51-03-12 after initially detected in October 1976. Additional drywells were installed between tanks TX-107 and TX-103 to determine the source of radioactivity. Drywell 51-07-06, drilled in June 1977, reported high levels of radioactivity indicating tank TX-107 as the source and the tank was pumped shortly thereafter. In 2002, one direct push was installed near tank TX-107 and reported radioactivity which was likely migration from the earlier 1977 leak.

4.6.1 Leak Detected in 1976-1977

Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12, initially detected in October 1976 which increased to above the minimum criterion in April 1977. Tank TX-107 was later confirmed as the source in June 1977 after subsequent drywells were drilled (see Section 4.5.1.13). Drywell 51-03-12 was the only drywell located in the southern portion of tank TX-107 during this time (see Figure 4-15).

Figure 4-15. Tank TX-107 Possible Leak Location (October 1976 to April 1977)
Tank inner ring is steel liner; outer ring is outer edge of tank footing

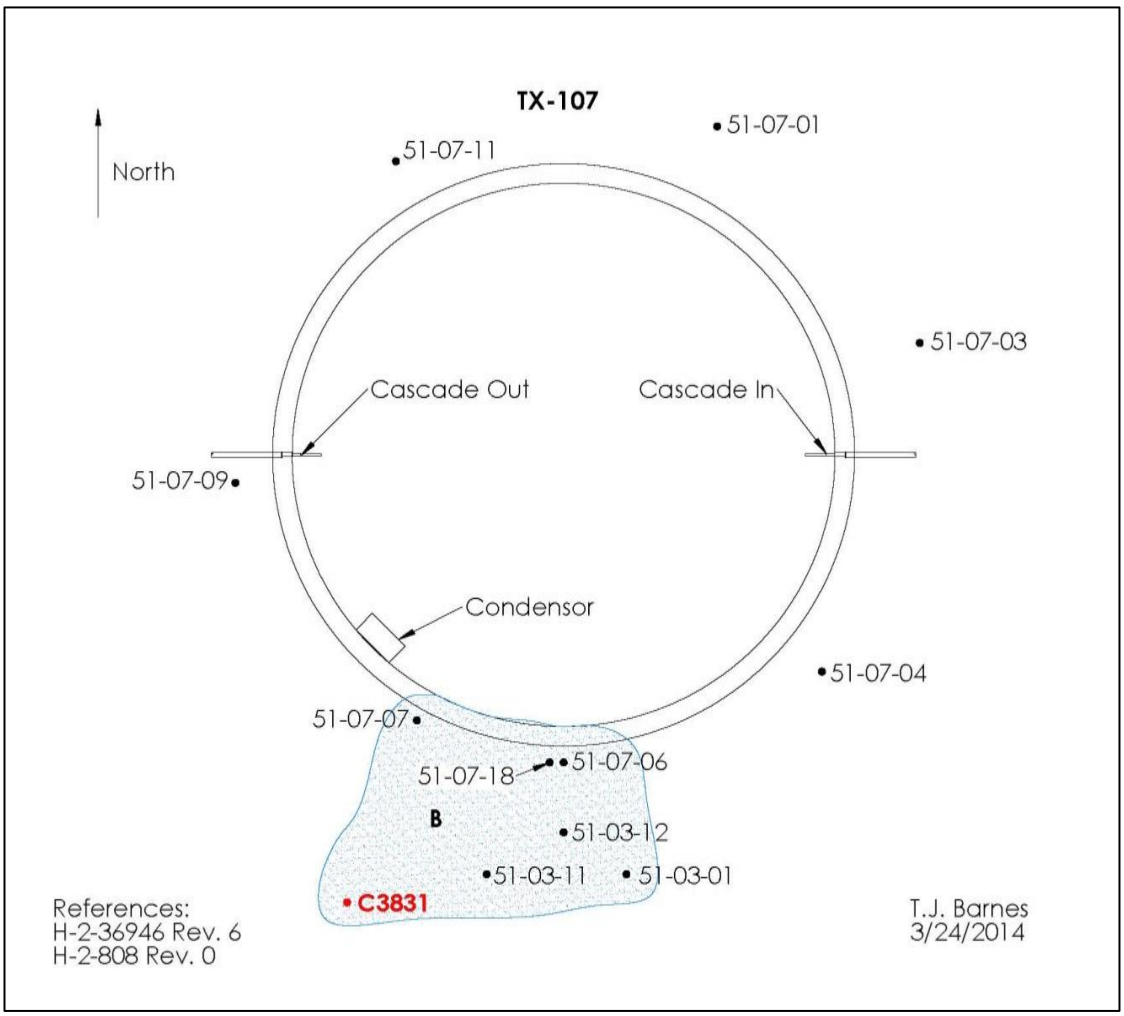


Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12, initially detected in October 1976 which increased to above the minimum criterion in April 1977. Tank TX-107 was later confirmed as the source in June 1977 after subsequent drywells were drilled (see Section 4.5.1.13).

4.6.2 Leak Detected in May 1977 to 2002

Drywells 51-07-06, 51-07-07, 51-07-18, 51-03-01, and 51-03-11 were drilled between May and July 1977 to help determine the source of radioactivity reported in drywell 51-03-12. During this time, drywells 51-07-07 and 51-03-01 were reported as less than values (but reported radioactivity later in 1977-1978). Drywell 51-07-06 was drilled in June 1977 and reported a peak of >1800K cpm at 51-ft BGS. Drywell 51-07-06 was abandoned shortly after drilling, and drywell 51-07-18 was drilled in July 1977 to replace drywell 51-07-06. As a result of the high levels of radioactivity in drywell 51-07-06, the tank TX-107 leak was confirmed in June 1977 and the tank was pumped shortly thereafter. It is likely the leak location is near drywells 51-07-06 and 51-07-18 as radioactivity was highest in these drywells with migration to the nearby drywells. In 2002, direct push C3831 was installed and is likely related to the 1977 leak due to similar concentrations and BGS depths measured. Thus, site B in Figure 4-16 is likely migration from the leak site near drywells 51-07-06 and 51-07-18.

Figure 4-16. Tank TX-107 Possible Leak Location (May 1977 to 2002)
Tank inner ring is steel liner; outer ring is outer edge of tank footing



Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12, initially detected in October 1976 which increased to above the minimum criterion in April 1977. Tank TX-107 was later confirmed as the source in June 1977 after subsequent drywells were drilled (see Section 4.5.1.13).

4.6.3 Leak Location Summary

Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12, initially detected in October 1976 which increased to above the minimum criterion in April 1977. Tank TX-107 was later confirmed as the source in June 1977 after subsequent drywells were drilled (see Section 4.5.1.13).

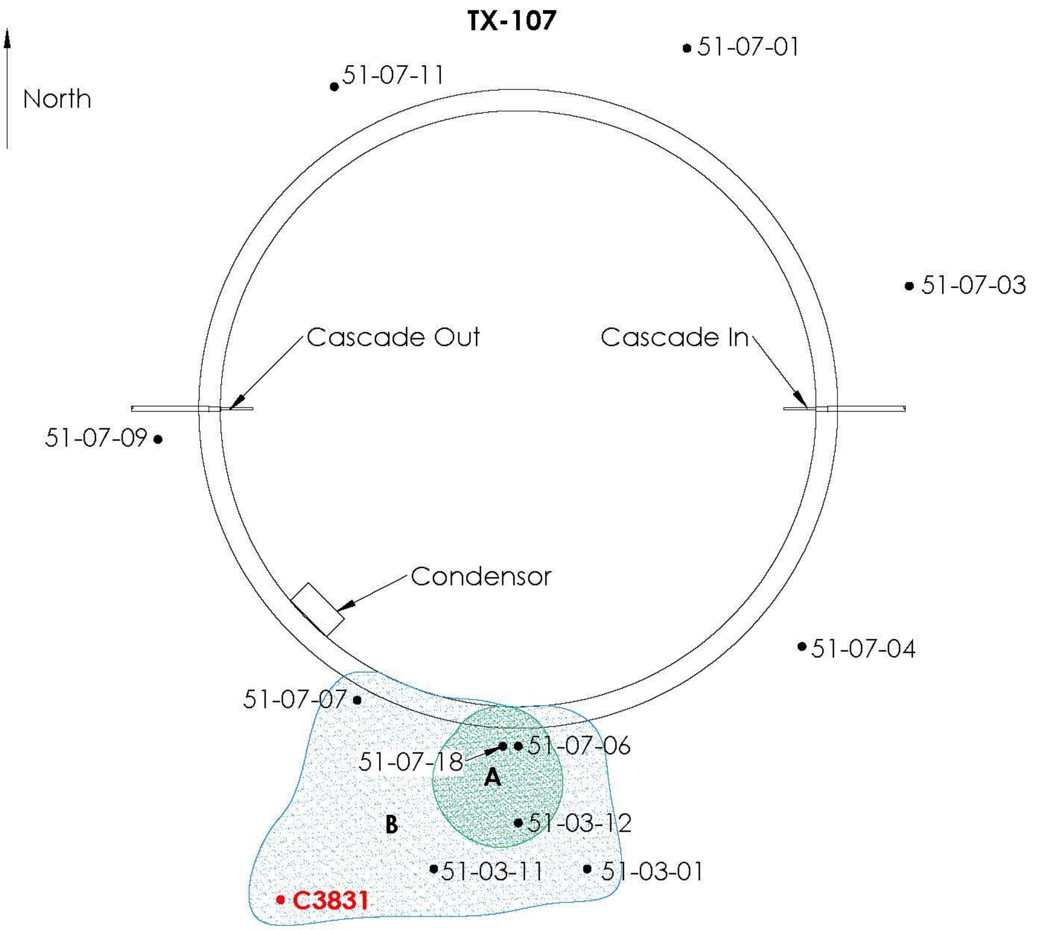
Drywell 51-03-12 first reported radioactivity in October 1976 at 53-ft BGS (see site A in Figure 4-17). Monitoring of this drywell was increased and in April 1977 radioactivity increased to above the minimum criterion.

As a result of the increasing radioactivity detected in drywell 51-03-12, five additional drywells were installed between tanks TX-103 and TX-107 to determine the source of radioactivity (see site B in Figure 4-17). In June 1977, drywell 51-07-06 reported a peak of >1800K cpm at 51-ft BGS, three orders of magnitude higher than what was detected in drywell 51-03-12. As a result, tank TX-107 was confirmed to be the source and the tank was pumped shortly thereafter. Radioactivity was higher in drywells 51-07-06 and 51-07-18 compared to the other drywells, likely indicating the leak location was near these two drywells.

Direct push C3831, installed in 2002, reported similar levels of concentrations of contaminants and similar BGS depth as measured in the nearby drywells (see site B in Figure 4-17). Therefore, it is likely radioactivity detected in this direct push is migration from the earlier 1977 leak. Document RPP-23752, Rev. 0A, indicates that direct push C3831 is located in the middle of the contaminant plume that has leaked from the southern portion of tank TX-107.

Tank TX-107 had at least one liner leak site based on radioactivity detected in six drywells and one direct push, likely at or near the bottom of the tank. Leak locations in Figure 4-17 are based on peak readings and are a representation of possible initial boundaries of radioactivity. No evidence of a liner bulge was indicated for tank TX-107.

Figure 4-17. Tank TX-107 Possible Radial Leak Locations
Tank inner ring is steel liner, outer ring is outer edge of tank footing



A	B
October 1976- April 1977	**May 1977 to 2002**
Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12. A peak of radioactivity was initially detected in drywell 51-03-12 in October 1976 at 53-ft BGS. This peak increased to above the minimum criterion by April 1977. Tank TX-107 was later confirmed in June 1977 as the source of the radioactivity detected in this drywell after subsequent drywells were drilled between tanks TX-103 and TX-107.	Drywells 51-07-06, 51-07-07, 51-07-18, 51-03-01, and 51-03-11 were drilled between May and July 1977 to help determine the source of radioactivity reported in drywell 51-03-12. During this time, drywells 51-07-07 and 51-03-01 were reported as less than values (but reported radioactivity later in 1977-1978). Drywell 51-07-06 was drilled in June 1977 and reported a significant peak at 51-ft BGS. As a result, the tank TX-107 leak was categorized as "questionable integrity" in June 1977 and the tank was pumped shortly thereafter. It is likely the leak location is near drywells 51-07-06 and 51-07-18 as radioactivity was highest in these drywells with migration to the nearby drywells. In 2002, direct push C3831 was installed and is likely migration of the 1977 leak due to similar concentrations and BGS depths measured.

References:
H-2-36946 Rev. 6
H-2-808 Rev. 0

T.J. Barnes
3/24/2014

4.7 POSSIBLE TANK TX-107 LINER LEAK CAUSE(S)

Tank TX-107 was evaluated for five conditions known to contribute to a failed liner.

4.7.1 Tank Design

The TX Farm tank design does not appear to be a factor contributing to a failed liner (see Section 3.1.1).

4.7.2 Thermal Conditions

No temperature data are available for tank TX-107, however, a transfer of REDOX HLW supernatant from tank SX-102 at ~150°F was likely the highest temperature of waste in tank TX-107. Thermal shock creates stress both from rapid temperature rise as well as waste-induced high temperatures. Since no detailed records are available, it is uncertain what the maximum temperature was in tank TX-107 during operation as well as the rate of temperature rise when waste was added. The thermal attributes of the waste and other information (see Section 4.4.2) would indicate that thermal stresses were likely minimal and should not have challenged the tank storage limits. It is unlikely that the rate of temperature rise would have resulted in vapor pressure under the liner overcoming the hydrostatic pressure.

Temperature requirements in ARH-951 issued December 18, 1969 indicated that tank temperatures should be held below 230°F.

4.7.3 Chemistry-Corrosion

Tank TX-107 initially stored MW for ~4 years. Metal waste should not have resulted in pitting and/or SCC under tank TX-107 conditions. After transfer of MW, tank TX-107 stored REDOX HLW for ~14 years from ~150°F down to ~105°F. Under these conditions, the REDOX HLW would likely create an environment conducive to SCC and/or pitting. The subsequent EB waste storage with REDOX HLW at temperatures less than 105°F is not conducive for SCC and/or pitting corrosion.

4.7.4 Liner Observations

A review of the available photographs for tank TX-107 does not contain any evidence pointing to a tank leak. There is no documentation available indicating a liner bulge was present in the tank.

4.7.5 Tank Construction Temperature

The TX Farm tank liners were constructed between January 1944 and September 1944. Only isolated minimum temperatures were experienced during tank construction at or below 18°F with day time temperatures between 41°F and 56°F (see Section 4.3.2). Impact occurrences could have occurred during cold temperatures that may have triggered fissures in the steel liner; however, the possibility seems much less than that which might have occurred during construction in other tank farms.

4.8 TANK TX-107 CONCLUSIONS

Tank TX-107 was first suspected of leaking based on radioactivity reported in drywell 51-03-12, initially detected in October 1976 which increased to above the minimum criterion in April 1977. Tank TX-107 was later confirmed as the source in June 1977 after subsequent drywells were drilled (see Section 4.5.1.13). Drywell evidence indicates that the tank TX-107 leaked near the southern portion of the tank at or near the bottom of the tank. No liquid level decreases were reported during this time.

There are several liner leak cause conditions that were examined but the most likely cause of the tank TX-107 liner leak was chemistry-corrosion as it relates to the storage of primarily REDOX HLW and possibly EB wastes. These waste types are conducive to pitting and/or SCC depending on storage temperature. There appears to be very little contribution from tank design, construction temperatures, and thermal conditions. However, some or all of the factors can act serially or together to contribute to tank liner failure.

APPENDIX A1

TANK TX-107 GROSS GAMMA DRYWELL DATA

Table A1-1. Tank TX-107 Drywell Radioactivity (K counts per minute) (August 1973 through June 1986) Sheet 1 of 2 (SD-WM-TI-356; Letter 65260-80-1286)

51-07-01 Drilled 01/1974		51-07-03 Drilled 03/1976		51-07-04 Drilled 12/1971		51-07-18 Drilled 07/14/1977			51-07-07 Drilled 05/1977			51-07-09 Drilled 11/1971		51-07-11 Drilled 11/1971	
Date	Peak (K cpm)	Date	Peak (K cpm)	Date	Peak (K cpm)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Date	Peak (K cpm)
N/A[1]		N/A[1]		7/9/1973	< 12	N/A[1]			N/A[1]			8/24/1973	< 12	7/6/1973	< 12
1/25/1974	< 18	N/A[1]				N/A[1]			N/A[1]			N/A[1]		N/A[1]	
5/7/1974	< 18	N/A[1]		4/30/1974	< 12	N/A[1]			N/A[1]			4/30/1974	< 12	4/24/1974	< 12
7/10/1974	< 6	N/A[1]		7/3/1974	< 3	N/A[1]			N/A[1]			6/29/1974	< 3	6/29/1974	< 3
2/17/1975	< 3	N/A[1]		1/23/1975	< 3	N/A[1]			N/A[1]			1/23/1975	< 3	1/23/1975	< 3
7/30/1975	< 3	N/A[1]		7/30/1975	< 3	N/A[1]			N/A[1]			7/30/1975	< 3	7/30/1975	< 3
1/22/1976	< 3	N/A[1]		1/8/1976	< 3	N/A[1]			N/A[1]			1/8/1976	< 3	1/8/1976	< 3
5/13/1976	< 3	5/13/1976	< 3	5/13/1976	< 3	N/A[1]			N/A[1]			5/13/1976	< 3	5/13/1976	< 3
9/30/1976	< 3	9/30/1976	< 3	9/30/1976	< 3	N/A[1]			N/A[1]			9/30/1976	< 3	9/30/1976	< 3
3/17/1977	< 3	3/17/1977	< 3	3/17/1977	< 3	7/14/1977	1890.9[2]	51	5/13/1977	< 3	N/A[1]	3/17/1977	< 3	3/17/1977	< 3
N/A[1]		N/A[1]		N/A[1]		N/A[1]			10/13/1977	< 3	N/A[1]	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		7/29/1977	289.9	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		8/19/1977	274.3	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		8/31/1977	291.9	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		9/19/1977	308.0	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		9/30/1977	303	50	N/A[1]			N/A[1]		N/A[1]	
10/12/1977	< 3	10/12/1977	< 3	10/17/1977	< 3	10/17/1977	339.3	51	N/A[1]			10/12/1977	< 3	10/12/1977	< 3
N/A[1]		N/A[1]		N/A[1]		10/31/1977	370.9	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		11/30/1977	327.8	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		12/30/1977	442.9	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		1/3/1978	416.8	49	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		1/30/1978	507.2	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		2/27/1978	423.5	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		3/29/1978	417.4	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		4/5/1978	439.4	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		4/28/1978	450.1	50	4/10/1978	3.1	50	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		6/30/1978	434.8	50	6/30/1978	4.4	52	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		6/30/1978	515.2	50	N/A[1]			N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		7/5/1978	519.1	50	7/10/1978	4.8	52	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		7/31/1978	494.0	50	7/31/1978	4.7	49	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		8/30/1978	448.6	50	8/30/1978	5.1	50	N/A[1]		N/A[1]	

Table A1-1. Tank TX-107 Drywell Radioactivity (K counts per minute) (August 1973 through June 1986) Sheet 2 of 2 (SD-WM-TI-356; Letter 65260-80-1286)

51-07-01 Drilled 01/1974		51-07-03 Drilled 03/1976		51-07-04 Drilled 12/1971		51-07-18 Drilled 07/1977			51-07-07 Drilled 05/1977			51-07-09 Drilled 11/1971		51-07-11 Drilled 11/1971	
Date	**Peak (K cpm)**	**Date**	**Peak (K cpm)**	**Date**	**Peak (K cpm)**	**Date**	**Peak (K cpm)**	**Depth (ft)**	**Date**	**Peak (K cpm)**	**Depth (ft)**	**Date**	**Peak (K cpm)**	**Date**	**Peak (K cpm)**
9/14/1978	< 3	9/6/1978	< 3	9/6/1978	< 3	9/11/1978	568.4	50	9/11/1978	6.6	51	9/7/1978	< 3	9/6/1978	< 3
N/A[1]		N/A[1]		N/A[1]		9/29/1978	474.1	50	9/29/1978	6	51	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		10/30/1978	584.8	50	10/30/1978	7.4	50	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		11/29/1978	579.1	50	11/29/1978	7.6	50	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		12/29/1978	652.0	51	12/29/1978	9.4	51	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		1/2/1979	597.7	50	1/3/1979	9.8	50	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		1/31/1979	610.6	50	1/31/1979	11.6	50	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		4/25/1979	484.6	50	5/24/1979	13.6	49	N/A[1]		N/A[1]	
9/27/1979	< 3	9/27/1979	< 3	9/27/1979	< 3	9/27/1979	578.8	49	9/27/1979	21.5	49	9/27/1979	< 3	9/27/1979	< 3
N/A[1]		N/A[1]		N/A[1]		6/5/1980	611.4	50	3/5/1980	34.1	51	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		6/19/1980	571.6	50	6/19/1980	36.5	50	N/A[1]		N/A[1]	
9/24/1980	< 3	10/9/1980	< 3	10/9/1980	< 3	10/9/1980	600.5	51	10/9/1980	47.1	51	9/24/1980	< 3	10/9/1980	< 3
N/A[1]		N/A[1]		N/A[1]		1/21/1981	590.9	50	3/11/1981	51.8	53	N/A[1]		N/A[1]	
9/9/1981	< 3	9/9/1981	< 3	8/27/1981	< 3	8/26/1981	489.5	51	8/26/1981	65.3	51	9/9/1981	< 3	8/27/1981	< 3
9/14/1982	< 3	9/22/1982	< 3	7/29/1982	< 3	7/29/1982	297.5	56	7/28/1982	222.4	51	9/22/1982	< 3	7/29/1982	< 3
N/A[1]		N/A[1]		N/A[1]		N/A[1]			7/5/1983	540.9	52	N/A[1]		N/A[1]	
9/22/1983	< 3	9/22/1983	< 3	9/22/1983	< 3	9/22/1983	249.5	57	9/27/1983	366.6	52	9/22/1983	< 3	9/22/1983	< 3
N/A[1]		N/A[1]		N/A[1]		N/A[1]			4/6/1984	234.6	53	N/A[1]		N/A[1]	
N/A[1]		N/A[1]		N/A[1]		N/A[1]			5/30/1984	266.4	52	N/A[1]		N/A[1]	
8/22/1984	< 3	8/21/1984	< 3	8/22/1984	< 3	8/21/1984	161.8	58	8/22/1984	363.1	52	8/22/1984	< 3	8/22/1984	< 3
N/A[1]		N/A[1]		N/A[1]		N/A[1]			11/15/1984	308.2	52	N/A[1]		N/A[1]	
6/25/1985	< 3	6/25/1985	< 3	6/25/1985	< 3	6/25/1985	97.3	60	6/25/1985	239.5	54	6/25/1985	< 3	6/25/1985	< 3
6/11/1986	< 3	6/11/1986	< 3	6/11/1986	< 3	6/11/1986	86.9	53	6/11/1986	268.0	54	6/11/1986	< 3	6/11/1986	< 3

Note: [1]N/A: Data not available

[2]Scintillation probe used

*Drywell 51-07-06 was drilled in June 1977 to a depth of about 60-ft. This drywell was abandoned after the core barrel and a Battelle probe were lost. When the drywell drilled reached 60-ft, a log was taken using a scintillation probe which identified a peak of greater than 30,000 cps (1,800K cpm) at 51-ft BGS (GJ-HAN-48). No other drywell data was recovered.

Table A1-2. Tank TX-107 Drywell Radioactivity (K counts per minute) (July 1973 through June 1986) (SD-WM-TI-356)

51-03-01			51-03-11			51-03-12		
Drilled 6/8/1977			Drilled 5/25/1977			Drilled 11/1971		
Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)
Drywell 51-03-01 drilled 6/8/1977			Drywell 51-03-11 drilled 5/25/1977			7/6/1973	< 12	N/A[1]
						4/24/1974	< 12	N/A[1]
						7/3/1974	< 3	N/A[1]
						1/23/1975	< 3	N/A[1]
						7/23/1975	< 3	N/A[1]
						1/8/1976	< 3	N/A[1]
						5/13/1976	< 3	N/A[1]
						10/21/1976	3.1	53
						4/25/1977	3.7	53
			5/25/1977	2.8	51	5/23/1977	6.4	52
6/8/1977	< 3	N/A[1]	6/2/1977	3.4	50	6/22/1977	11.4	51
7/6/1977	< 3	N/A[1]	7/1/1977	6.3	50	7/22/1977	16.1	51
8/5/1977	3.1	51	8/3/1977	8.9	50	8/19/1977	25.6	52
9/6/1977	4.3	51	9/6/1977	16.1	51	9/19/1977	50.1	51
10/7/1977	5.6	51	10/3/1977	27.0	50	N/A[1]		
10/17/1977	7.1	51	10/17/1977	37.9	51	10/17/1977	71.4	52
1/3/1978	15.2	50	3/8/1978	133.2	50	1/3/1978	214.4	49
4/3/1978	30.8	51	5/8/1978	258.8	50	4/3/1978	521.5	49
				3.3	56	7/3/1978	715.4	50
9/5/1978	81.6	50	N/A[1]			9/1/1978	854.9	52
1/2/1979	120.2	50	1/17/1979	516.7	50	1/10/1979	975.2	51
				15.6	57			
5/2/1979	161.5	51	5/24/1979	390.5	49	4/10/1979	1055.2	51
9/19/1979	206.2	50	10/3/1979	318.2	50	10/3/1979	1102.1	51
10/15/1980	167.5	51	10/9/1980	515.0	52	10/15/1980	1136.4	52
				204.0	57			
N/A[1]			2/24/1981	697.9	53	2/10/1981	1049.0	53
4/17/1981	103.5	52	6/3/1981	622.4	54	5/31/1981	854.3	54
9/1/1981	95.6	51	9/1/1981	517.6	55	9/1/1981	726.6	54
N/A[1]			3/9/1982	455.3	57	N/A[1]		
9/15/1982	75.5	52	9/14/1982	499.5	59	9/8/1982	512.3	58
9/21/1983	58.5	53	9/21/1983	505.9	59	9/21/1983	365.7	59
8/22/1984	53.4	52	8/22/1984	448.0	59	8/22/1984	307.7	59
6/25/1985	47.9	53	6/25/1985	338.8	69	6/25/1985	247.4	60
6/11/1986	49.7	54	6/11/1986	274.6	61	6/11/1986	189.2	60

Note: [1]N/A: Data not available

5.0 TANK 241-TX-114 SEGMENT

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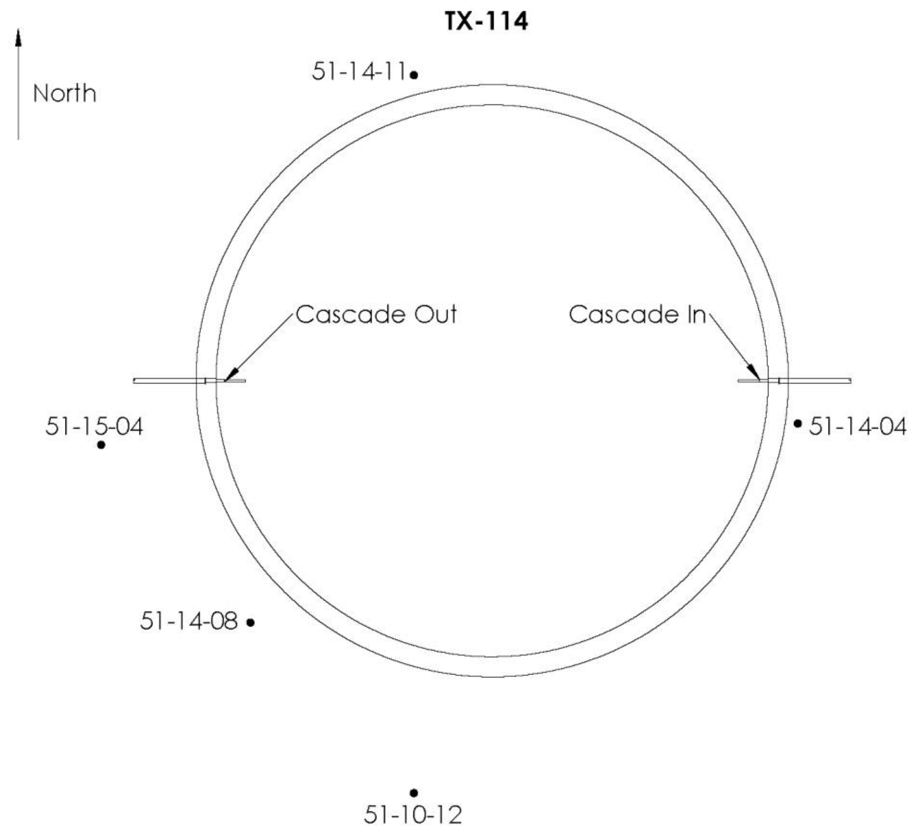
5.1 TANK TX-114 BACKGROUND HISTORY

This section provides information on the historical waste loss event associated with Single-Shell Tank (SST) 241-TX-114 (TX-114). There are five drywells located around tank TX-114 with specified distances from the drywell to the tank footing shown in Figure 5-1: 51-14-11, 51-14-04, 51-10-12, 51-14-08, and 51-15-04, all installed in 1970.

The bottom of the tank footing is ~48-ft 2-in Below Grade Surface (BGS) with ~9.1-ft soil cover over the dome (WHC-SD-WM-TI-665; H-2-808).

Figure 5-1. Tank TX-114 Associated Drywells
Tank inner ring is steel liner; outer ring is outer edge of tank footing



Drywell	Distance to Footing (ft)*	Date Installed
51-14-04	~1.8	9/30/1970
51-10-12	~17	9/30/1970
51-14-08	~6.4	9/30/1970
51-15-04	~14	10/31/1970
51-14-11	~2.7	9/30/1970

References:
H-2-36946 Rev. 6
H-2-808 Rev. 0

T.J. Barnes

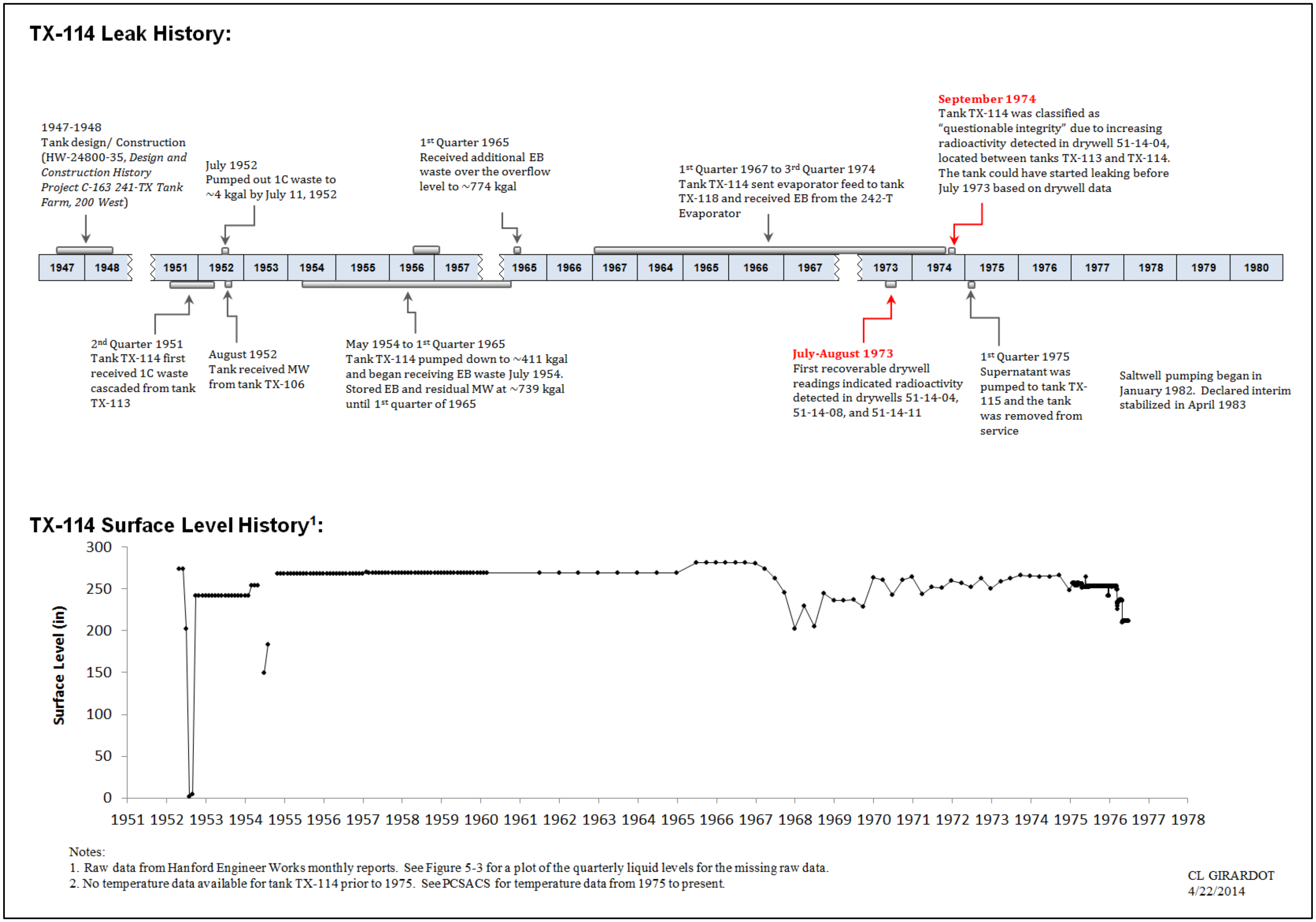
5.2 TANK TX-114 OPERATIONS SUMMARY

Tank TX-114 was first filled with first cycle decontamination (1C) waste in the second quarter 1951 cascaded from tank TX-113 (WHC-SD-WM-TI-669, Rev. 1, *Waste Status and Transaction Record Summary for the Northwest Quadrant of the Hanford 200 Area).* The 1C waste was pumped down to ~4 kgal by July 11, 1952 (HW-27839, *Waste Status Summary Period 07/1952 Thru 09/1952)* to reclaim space. Tank TX-114 then started receiving metal waste (MW) from tank TX-106 on August 29, 1952 (HW-27839). Beginning in May 1954, the tank was pumped down to ~411 kgal and began receiving EB waste July 7, 1954 and stored EB with residual MW at ~739 kgal until the first quarter of 1965 when additional EB was added over the overflow level to ~774 kgal. In the first quarter 1967 tank TX-114 shipped evaporator feed to tank TX-118 and received EB from the 242-T Evaporator until the third quarter of 1974 (WHC-SD-WM-TI-669, Rev. 1). Supernatant was pumped to tank TX-115 in the first quarter 1975, the tank was removed from service in 1975, and declared inactive in 1976 (WHC-MR-0132). The solids component of the tank contents began rising in 1967, and by 1972 the level of solids had reached about 257-in (WHC-SD-WM-ER-351).

Tank TX-114 drywell 51-14-04, located between tanks TX-114 and TX-113, indicated a slight increase in radioactivity in September 1974 (OR 74-129, *Increasing Drywell Radiation Levels between Waste Tanks 113-TX and 114-TX*) which was reported to be more associated with tank TX-114 than tank TX-113. This resulted in salt well pumping priority for tank TX-114 and also TX-113. A decrease in the tank TX-114 liquid level in December 1975 was reported to have resulted from a dry salt clump on the plummet hanging up on a wire or tape (OR 75-146, *Violation of Liquid Level Decrease Criteria*). Drywell 51-14-04 showed increases in December 1976 (OR 76-164, *Drywell Radiation Increase Exceeding Criteria*) and January 1977 (OR 77-06, *Drywell Radiation Increase Exceeding Criteria*). A liquid level decrease was reported in August 1977 and was attributed to liquid seeping from voids into the depression left following salt well pumping (OR 77-138, *Tank 114-TX Liquid Level Exceeding Increase Criterion*). This occurrence report (OR) mentioned that drywells 51-14-04, 51-14-08, and 51-14-11 have long shown significant radiation peaks at the level of the bottom of the tank. An exploratory augering to a depth of 22-ft performed January 31, 1977 along with additional analysis indicated there was no proof that the spare inlet lines had leaked due to past overfill of the tank (OR 77-06). An increase in drywell 51-10-01 in August 1977 (OR 77-144, *Radiation Peak in Drywell 51-10-01 Exceeding Increase Criterion*) prompted two additional tank TX-110 drywells to be drilled between drywell 51-10-01 and tank TX-114 which along with directional probe data indicated movement of radioactivity from the vicinity of tank TX-110.

Tank TX-114 was classified as "questionable integrity" in 1974, based on increasing gamma activity in drywell 51-14-04 (SD-WM-TI-356). The Waste Tank Summary Report (HNF-EP-0182) does not report a leak volume estimate for this tank other than assigning an 8,000 gal leak based on the average leak volume estimate for 19 tanks (8901832B R1 – Letter). Jet salt well pumping began in January 1982 and was completed in November 1982. Pumping stopped due to failure of the jet pump. The tank was declared interim stabilized April 5, 1983 with an estimated 15,000 gal of drainable liquid remaining and 4,000 gal of pumpable liquid (HNF-SD-RE-TI-178). The operational history of tank TX-114 leak related details including liquid level is charted in Figure 5-2.

Figure 5-2. Operational Leak History of Tank TX-114



5.3 TANK DESIGN/CONSTRUCTION

5.3.1 Tank Design

The TX Farm tank design continued important features of the earlier 241-BCTU tanks (BPF-73550). The steel bottom intersects the sidewall on a 4-ft radius. Full penetration butt welds with x-ray inspection and three ply asphaltic membrane waterproofing between the wall liner and the concrete shell continued those design features that were found later to be important for liner integrity during the SX Farm leak assessment (see Section 3.1.1). The top of the tank footing is ~45 BGS and is 3-ft thick with the bottom of the footing at ~48-ft BGS.

5.3.2 Tank Construction Conditions

The TX Farm tank steel liners were constructed between March 1948 and July 1948. From the start of the TX Farm tank construction through July 1948, there was one minimum temperature of 13°F with day time temperature of 40°F and one at 20°F with day time temperature at 50°F.

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

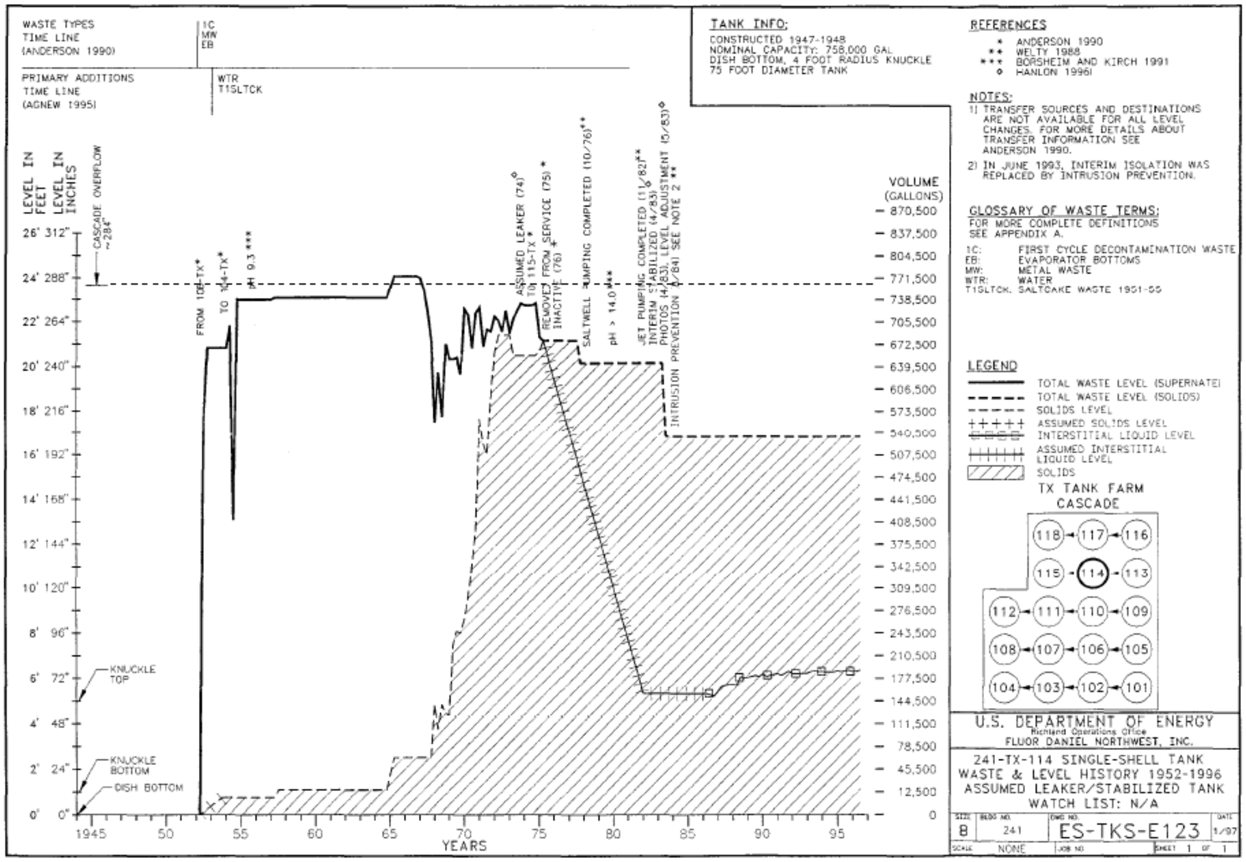
Design, fabrication, and erection of the tank steel lining were required to be in accordance with current "Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs" as promulgated by the "American Water Works Association" (HW-3061). Welding requirements were required to conform to the American Welding Society's "Code for Arc and Gas Welding in Building Construction", Section 4.

5.4 TANK TX-114 IN-TANK DATA

5.4.1 Liquid Level

The liquid level plot in Figure 5-3 indicates the transfer activity into and out of tank TX-114 with overfilling 1965 through 1967. The liquid levels are end of quarter levels so this figure may not reflect all transfers into and out of the tank that occurred during the operational history. See Figure 5-2 for historical monthly liquid level readings.

Figure 5-3. Tank TX-114 End of Quarter Surface Level



WHC-SD-WM-ER-321, Rev. 0, 1994, *Supporting Document for the SW Quadrant Historical Tank Content Estimate for TX-Tank Farm.*

Tank TX-114 first reported a decreasing liquid level in 1975 which was attributed a clump of salt on the plummet hanging up on wire or tape. In general, this and the other liquid level ORs do not indicate the presence of a tank leak or an intrusion. The following ORs were written for liquid level changes in tank TX-114 between 1975 and 1980 (see Appendix A2).

- Occurrence Report 75-146, *Violation of Liquid Level Decrease Criteria*
- Occurrence Report 76-50, *Liquid Level Increase Exceeding Criteria for Tank 114-TX*
- Occurrence Report 76-101, *Liquid Level Increase Exceeding Criteria for Tank 114-TX*
- Occurrence Report 77-138, *Tank 114-TX Liquid Level Exceeding Increase Criterion*
- Occurrence Report 77-160, *Tank 114-TX Liquid Level Exceeding Maximum Operating Limits*
- Operating Limit Deviation Report 80-14, *114-TX Manual Tape Measurement Increase Exceeding the Criteria*

5.4.2 Temperature

Seven tanks in the B, C, T, and U Farms that contained metal waste (MW) ranged in temperature from 174°F to 84°F between 1945 and 1947 (HW-14946). Document HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*, reports MW was cascaded into a 241-BX Farm series of tanks with temperatures recorded in the first tank of ~180°F, which contained the bulk of the uranium and fission products, and ~70°F in the last tank of the cascade. The MW contains approximately 90% of the fission products from the Bismuth Phosphate ($BiPO_4$) process at both 221-T Plant and 221-B Plant.

Tank TX-114, the second tank in the tank TX-113 through tank TX-115 cascade, first received 1C waste, which would have experienced much lower temperatures as the fission product content was much lower than MW. The 1C waste was typically neutralized with CW (acidic 1C waste from 221-T Plant neutralized with the basic CW waste in 221-T Plant), and this 1C/CW waste contained approximately 10% of the $BiPO_4$ process fission products with approximately 90% in the MW. Metal waste was then added to the tank after emptied of 1C waste, and this would have been less than 180°F as tank TX-114 was the second tank in the cascade series.

Tank TX-114 was used to store EB waste with MW until 1967. The tank was then used to transfer supernatant to the evaporator feed tank TX-118 and subsequently receive, cool, and precipitate EB waste from the 242-T Evaporator on a cyclic basis through 1974. Temperatures found for the 242-T Evaporator and other EB tank receivers indicate that the temperature at the beginning of the cooling period in the EB receiving tank would have been close to 200°F. The EB receiving tank was then cooled down to < 150°F to precipitate solids before transferring the next batch of supernatant to tank TX-118 for further volume reduction in 242-T Evaporator (Monthly Report for February 1973, M.C. Frazer to R.L. Walser, February 1973).

No temperature data were recovered for tank TX-114 from the second quarter 1951 when the tank was first put into service until 1975. The maximum waste temperature from 1975 through 1982 was about 110°F which decreased to less than 90°F in May 1982.

5.4.3 Liner Observations

One of the tank TX-114 photographs was captioned to indicate a hole in the liner below the flashing by seepage of what appears to be asphalt coming through the liner in addition to seepage of asphalt around the tank near the flashing (see Section 5.4.5). The liquid level was filled over the cascade lines with EB waste in the mid 1960's. No other liner observations relating to a tank TX-114 leak have been found.

5.4.4 Chemistry-Corrosion

Tank TX-114 began receiving waste in the second quarter 1951 and received various waste types throughout operation as shown in Table 5-1. The typical concentration for nitrite, nitrate, and hydroxide for waste is 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 TX-114 Waste Storage Chronology

Date	Waste Type	Length of Storage
Second quarter 1951 to July 1952	1C	~ 1 year
September 1952 to June 1954	MW	~ 1.75 years
July 1954 to 1975	MW/EB	~ 20 years

Reference RPP-RPT-50870, Rev. 0, for additional information on the waste types stored.

Table 5-2. Waste Chemistries for Waste Types Stored in Tank TX-114

Waste Type	$[NO_3^-]$	$[NO_2^-]$	$[OH^-]$	Meets Current DST Specification[2]
1C[1]	1.54	0.26	0.28	No[3]
MW[1]	0.59	Not reported	1.16	Yes[4]
EB[5]	17.26	0.57		No[6]

1. Reference WHC-EP-0449, 1991, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups.*
2. Reference OSD-T-151-00007, Rev. 12, 2013, *Operating Specification for the Double-Shell Storage Tanks*.
3. Waste type 1C does not meet the current DST specification for waste chemistry; however, 1C was mixed with CW prior to adding to the tank. Depending on this ratio, the resulting waste may have met the DST specification.
4. Even with no reported value for nitrite, the ratio of nitrate to nitrite and hydroxide would still be less than 2.5 as stated in the current DST specification.
5. Reference WHC-EP-0772, 1994, *Characterization of the Corrosion Behavior of the Carbon Steel Liner in Hanford Site Single Shell Tanks.*
6. Reference WHC-EP-0772 assumes a density of 1.45 g/mL for molarity calculation. Does not meet the current DST specification since the nitrate concentration is greater than 5.5M.

Tank TX-114 stored 1C waste for approximately one year which could have resulted in pitting or SCC. However, the 1C waste was typically neutralized with CW (acidic 1C waste from T Plant neutralized with the basic CW waste in T Plant) prior to pumping to the storage tanks. Depending on this ratio of 1C to CW, the resulting waste may have met the DST specification for waste chemistry since CW by itself meets the DST specifications.

Tank TX-114 stored MW for ~1.75 years. The MW was not a concern for either pitting or SCC under the tank TX-114 conditions. Tank TX-114 then received EB with some existing MW as shown in Table 5-1, and subsequently received EB and transferred supernatant to the 242-T Evaporator feed tank between 1967 and 1974 at elevated temperatures. The EB waste receipt and supernatant transfer conditions would likely create an environment conducive to SCC and/or pitting.

5.4.5 Photographs

Photographs of tank TX-114 taken before and after pumping the tank in 1975 were reviewed and a photo out of the photo sets was captured to indicate a hole in the liner below the flashing. The anomaly showed what looks like asphalt seeping through the liner. See Figure 5-4 for a view of this anomaly in April 1983. This liner anomaly is located in the southern portion of tank TX-114. Asphalt seepage near the flashing can be seen in several locations around the tank (see Figure 5-5). Drywell data (see Section 5.5.1) indicates a leak site in the eastern portion of the tank due to high radioactivity detected in drywell 54-14-04. It remains unclear whether this liner anomaly is a perforation of the liner; however, drywell data indicates a leak site in a different location.

Figure 5-4. Tank TX-114 Photograph #106996-10CN
April 11, 1983

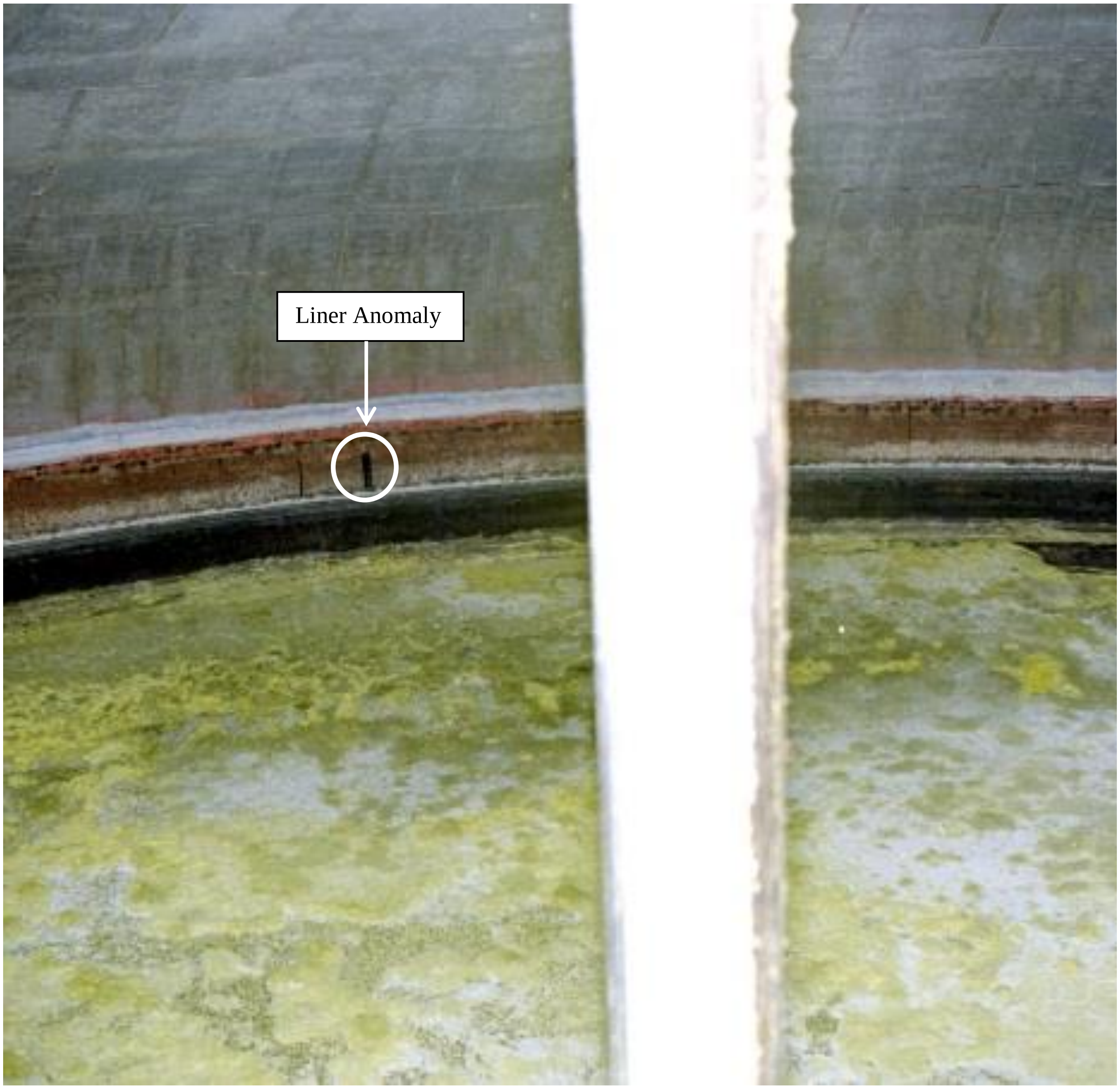


Figure 5-5. Tank TX-114 Photograph #106996-4CN
April 11, 1983

The photograph in Figure 5-5 indicates a possible beach line from overfilling 1965 to 1967 above the spare inlet lines. The spare inlet lines are at the same level as the cascade inlet line.

5.5 TANK TX-114 EX-TANK DATA

5.5.1 Drywells

There are five drywells located around tank TX-114 with specified distances from the drywell to the tank footing shown in Figure 5-1: 51-14-11, 51-14-04, 51-10-12, 51-14-08, and 51-15-04, all installed in 1970. 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 TX-114.

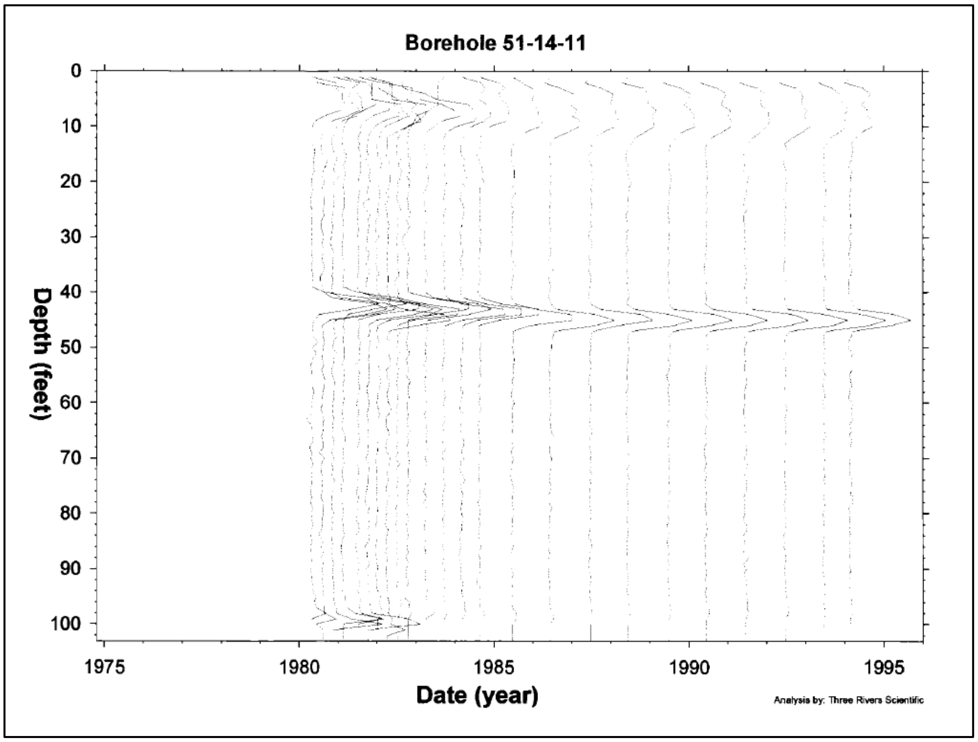
5.5.1.1 Drywell 51-14-11

Drywell 51-14-11 is located approximately 2.7-ft from the north side of tank TX-114. Drywell 51-14-11 was drilled in September 1970 with the first recoverable reading on August 30, 1973 with a peak of 342K cpm at 39-ft BGS (see Appendix B2). Readings were relatively stable at this BGS depth through May 1974. Beginning in June 1974, radioactivity declined to 70.8K cpm at 45-ft BGS and continued to slowly decrease to 53.2K cpm in June 1986.

In March 1997, Cs-137 was the only man-made gamma-emitting radionuclide detected continuously in drywell 51-14-11 from the ground surface to 49-ft BGS, intermittently between 49 and 95-ft BGS and near the bottom of the drywell (100-ft BGS) (GJ-HAN-59, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank TX-114*). Higher zones of Cs-137 concentrations were detected from 0 to 11-ft, 15.5 to 22-ft, 44 to 46-ft, 90 to 91-ft, and 95.5 to 99.5-ft BGS. The maximum Cs-137 concentration of 53 pCi/g was detected at 44-ft BGS.

Document GJ-HAN-59 reports, "*The Cs-137 contamination detected by the SGLS and historical data suggest a subsurface source such as a leak from either tank TX-113 or TX-114. The proximity of borehole 51-14-04 to tank TX-114, as well as the "extensive tar leakage" and "possible cracks in the liner" identified in 1976 (Jensen 1976b), suggest that tank TX-114 is the most likely source of this contamination. However, tank TX-113 cannot be ruled out as a potential source of contamination. Unfortunately, detailed records that could identify and quantify tank leaks prior to 1973 are not available.*" Drywell 51-14-11 was reported to be more associated with tank TX-114 than tank TX-113 (OR 74-129). Tank TX-117 cannot be ruled out as a possible source of radioactivity from drywell 51-14-11 as there are no other intervening drywells to eliminate tank TX-117 being a source. Therefore, tanks TX-113 and TX-117 cannot be ruled out as possible sources. The RPP-32681 process recommended both of these tanks be further assessed using TFC-ENG-CHEM-D-42 since historical data suggest they are misclassified as assumed leakers. If they are determined to be sound then they would be eliminated as possible leak sources affecting drywell 51-14-11. Figure 5-6 shows the depths of radioactivity from 1980 to 1995 (RPP-6353).

Figure 5-6. Tank TX-114 Drywell 51-14-11 (RPP-6353)



Note: Bottom of the tank footing is ~48-ft 2-in BGS

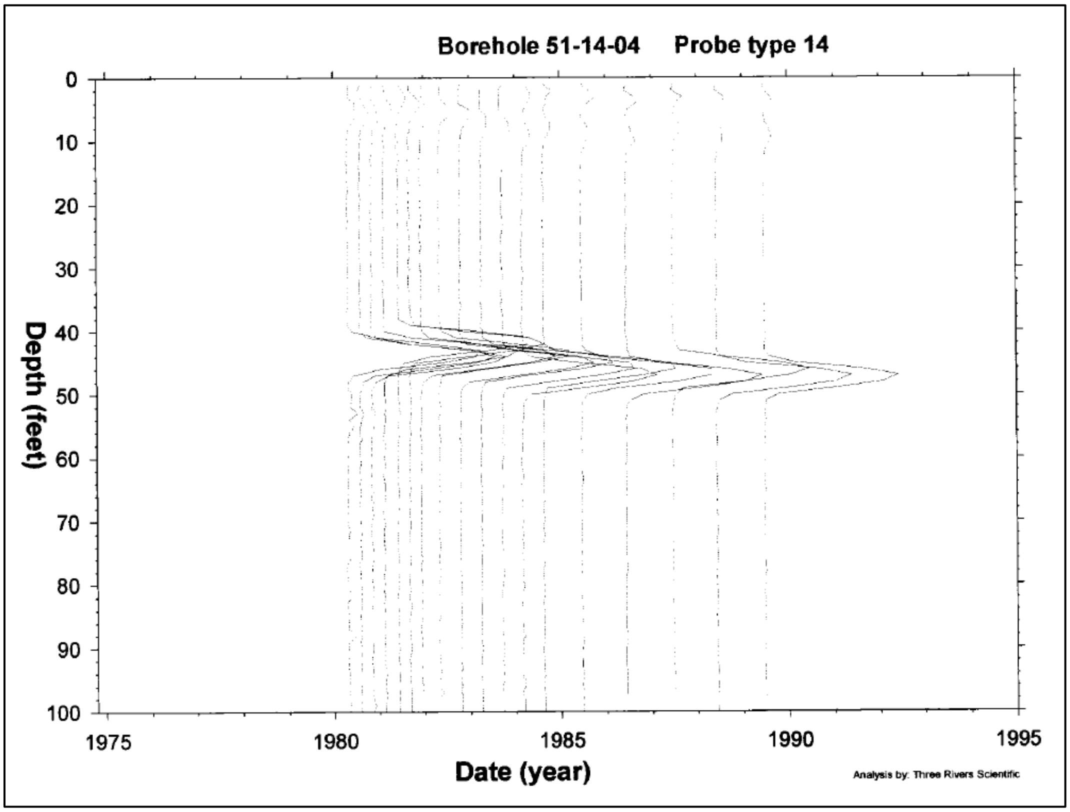
5.5.1.2 Drywell 51-14-04

Drywell 51-14-04 is located approximately 1.8-ft from the east side of tank TX-114 and 17-ft 2-in from tank TX-113. Drywell 51-14-04 was drilled in September 1970 with the first recoverable reading on August 27, 1973 with a peak of 2.1K cpm at 42-ft BGS (see Appendix B2). Readings continued to be reported at roughly the same intensity through May 1974 between 42 and 48-ft BGS. On July 26, 1974, a peak of 972.8K cpm, which increased significantly from the May 1974 reading, was reported at 47-ft BGS. This dramatic increase in levels from May to July 1974 was the result of usage of new monitoring equipment in the drywells. Radioactivity remained relatively stable through June 1986 between 42 and 47-ft BGS.

In March 1997, Cs-137 was the only man-made gamma-emitting radionuclide detected almost continuously in drywell 51-14-04 from the ground surface to 97.5-ft BGS (GJ-HAN-59). The highest contamination levels (1,843 pCi/g) were observed at a depth of 47-ft BGS. However, higher concentrations are probable between 45 and 46.5-ft BGS since the detector became saturated and radionuclide concentrations could not be calculated. Document GJ-HAN-59 reports, "*The Cs-137 contamination between 42 and 50 ft is probably from a subsurface source (i.e., a leak from tank TX-113 or TX-114).*"

It was suggested tank TX-114 is the more probable source; however, tank TX-113 cannot be ruled out. Figure 5-7 shows the depths of radioactivity from 1980 to 1995 (RPP-6353).

Figure 5-7. Tank TX-114 Drywell 51-14-04 (RPP-6353)



Note: Bottom of the tank footing is ~48-ft 2-in BGS

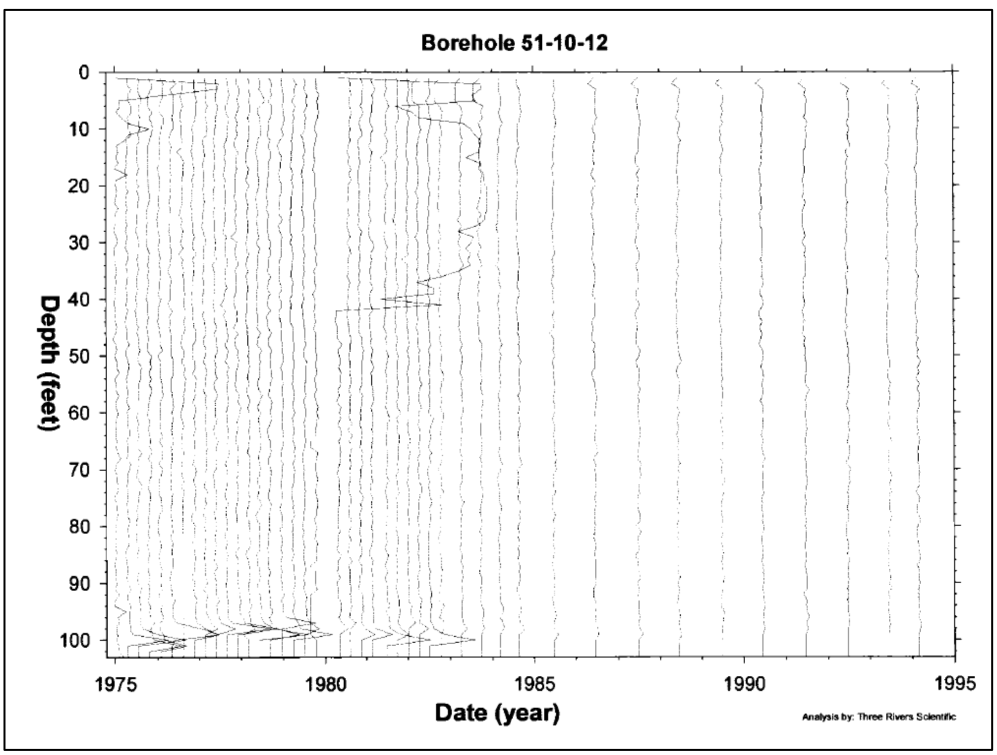
5.5.1.3 Drywell 51-10-12

Drywell 51-10-12 is located approximately 17-ft from the south side of tank TX-114. Drywell 51-10-12 was drilled in September 1970 with the first recoverable readings reported on July 6, 1973 as a less than values (see Appendix B2). Readings continued to be reported as less than values through June 1986.

In March 1997, Cs-137 was the only man-made gamma-emitting radionuclide detected continuously in drywell 51-10-12 from the ground surface to 28-ft BGS, intermittently from 28 to 60-ft BGS, and semi-continuously from 60 to 99.5-ft BGS (GJ-HAN-59). The maximum Cs-137 concentration of 7.7 pCi/g was reported at 99.5-ft BGS. Document GJ-HAN-59 reports, "*The increased Cs-137 concentrations between 19 and 24 ft suggest a subsurface source (i.e., a pipeline leak or a breach in the tank structure).*"…"*On the basis of the intermittent nature of the contamination from 24 to 60 ft, it is likely that the contamination from 24 to 99.5 ft is the result of contamination being carried down during drilling activities. It is also possible that contamination migrated down the outside of the casing from a higher zone in the borehole or the contamination was in the formation near the borehole.*"

Since historical radioactivity in this drywell is very low, and the GJ-HAN-59 report indicated low levels of radioactivity below the surface level, drywell 51-10-12 is not being included as part of the leak location for tank TX-114. Figure 5-8 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 5-8. Tank TX-114 Drywell 51-10-12 (RPP-6353)



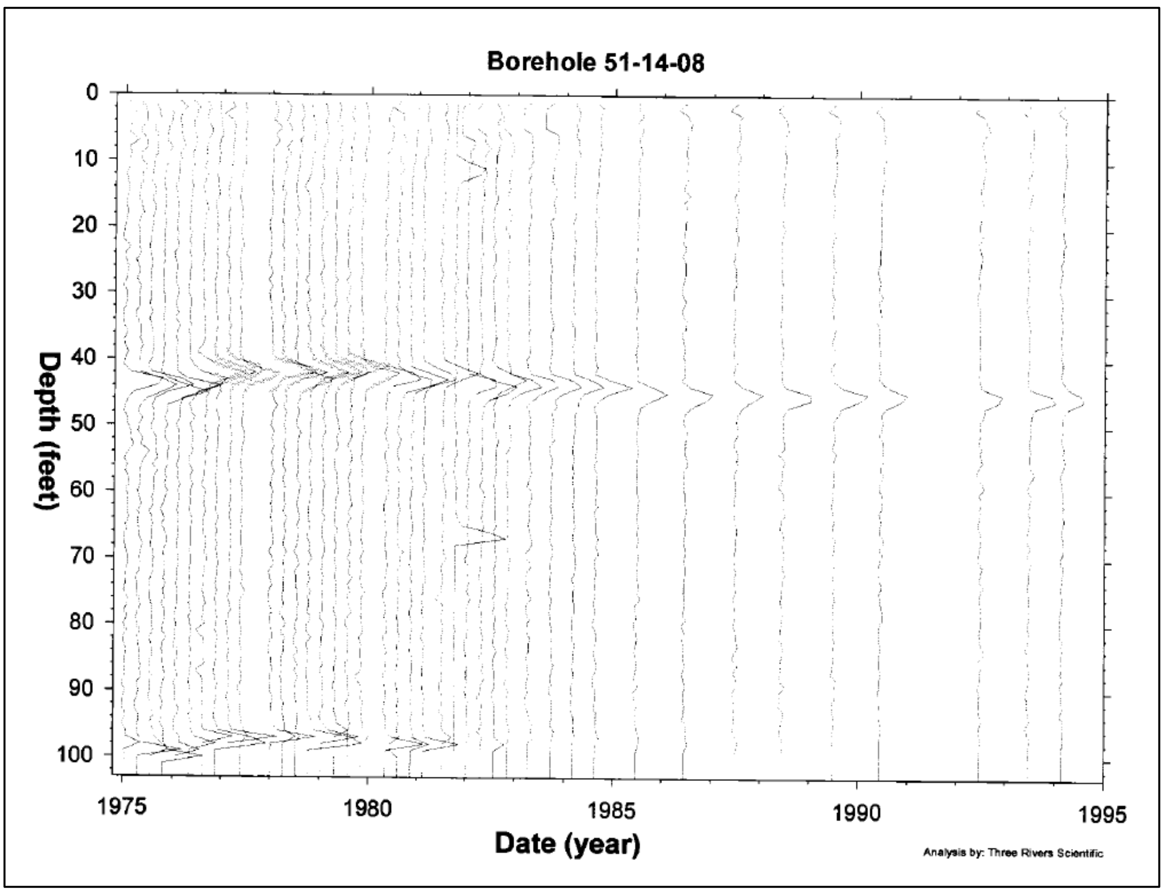
Note: Bottom of the tank footing is ~48-ft 2-in BGS

5.5.1.4 Drywell 51-14-08

Drywell 51-41-08 is located approximately 6.4-ft from the southwest side of tank TX-114. Drywell 51-14-08 was drilled in September 1970 with the first recoverable reading on July 6, 1973 with a peak of 21K cpm at 40-ft BGS (see Appendix B2). Readings then doubled to 45K cpm by the end of August 1973. Radioactivity remained relatively stable between 40 and 47-ft BGS through June 1986.

In March 1997, Cs-137 was the only man-made gamma-emitting radionuclide detected almost continuously in drywell 51-14-08 from the ground surface to 98-ft BGS (GJ-HAN-59). The maximum concentration of about 10 pCi/g was reported at 3-ft BGS. A distinctive peak was identified at 44-ft BGS with a maximum concentration of 1.9 pCi/g. Document GJ-HAN-59 states, "*The Cs-137 contamination between 43 and 47 ft is probably from a subsurface source such as a leak from tank TX-113 or TX-114.*" However, tanks TX-110 and TX-115 cannot be ruled out as a possible source of radioactivity from this drywell. The RPP-32681 process recommended both of these tanks be further assessed using TFC-ENG-CHEM-D-42 since historical data suggest they are misclassified as assumed leakers. If they are determined to be sound then they would be eliminated as possible leak sources affecting drywell 51-14-08. Figure 5-9 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 5-9. Tank TX-114 Drywell 51-14-08 (RPP-6353)



Note: Bottom of the tank footing is ~48-ft 2-in BGS

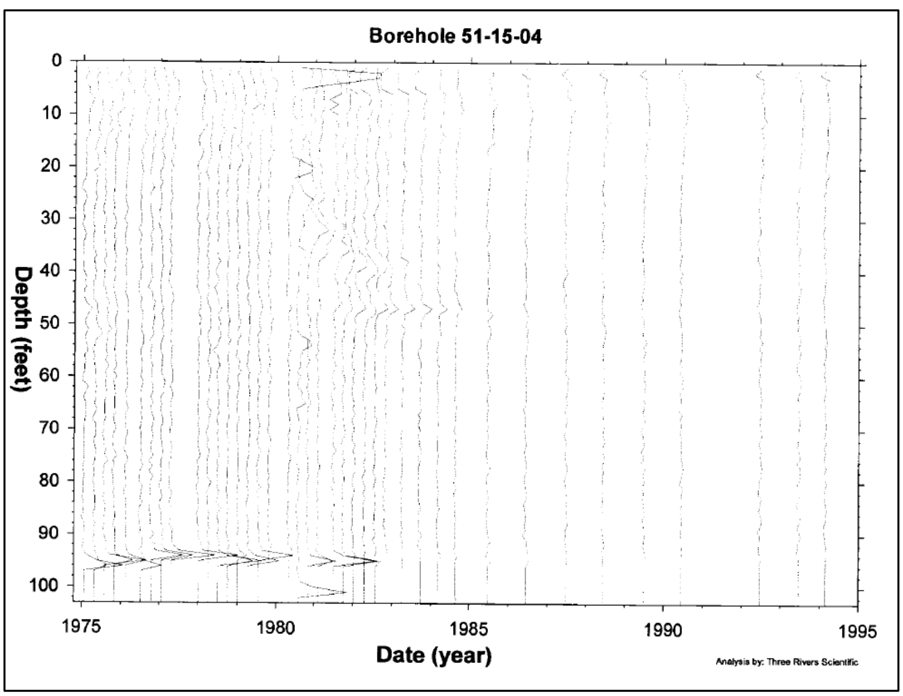
5.5.1.5 Drywell 51-15-04

Drywell 51-15-04 is located approximately 14-ft from the west side of tank TX-114. Drywell 51-15-04 was drilled in October 1970 with the first recoverable reading on July 6, 1973 reported as a less than values (see Appendix B2). Readings continued to be reported as less than values through June 1986.

In March 1997, Cs-137 and Co-60 were the only man-made gamma-emitting radionuclides detected in drywell 51-15-04 (GJ-HAN-59). Cs-137 was detected continuously from the ground surface to 40-ft BGS, intermittently from 40 to 57-ft BGS, and continuously from 57 to 94.5-ft BGS with the maximum concentration of 10.1 pCi/g reported at 7.5-ft BGS. Co-60 was detected at 29, 47.5, and 52-ft BGS with a maximum concentration of 0.3 pCi/g reported at 52-ft BGS. Document GJ-HAN-59 states, "*The Cs-137 and Co-60 contamination between 0 and 40 ft probably resulted from surface and subsurface spills that have migrated down into the backfill material surrounding the borehole or contamination that was carried down during the drilling of this borehole.*"…"*The Cs-137 and Co-60 contamination detected between 45 and 54 ft coincides with the location of the small plume shown on the historical gross gamma time-sequence plot. This contamination may be from longer-lived radionuclides that remained after the shorter-lived radionuclides in this plume decayed away.*"…"*The Cs-137 contamination from about 57 to 94.5 ft may be from a plume that intercepted the borehole at about 57 ft.*"

Since historical radioactivity in this drywell is very low, and the GJ-HAN-59 report indicated low levels of radioactivity below the surface level, drywell 51-15-04 is not being included as part of the leak location for tank TX-114. Figure 5-10 shows the depths of radioactivity from 1975 to 1995 (RPP-6353).

Figure 5-10. Tank TX-114 Drywell 51-15-04 (RPP-6353)



Note: Bottom of the tank footing is ~48-ft 2-in BGS

5.5.1.6 Drywell Summary

Tank TX-114 was first reported to be leaking in September 1974 based on radioactivity detected in drywell 51-14-04.

Tank TX-114 drywells 51-10-12 and 51-15-04 low level of activity are not useful for determination of as leak location for tank TX-114.

The first recoverable reading for drywell 51-14-11 reported a peak of 342K cpm at 39-ft BGS on August 30, 1973. Readings remained relatively stable through May 1974 and then slowly declined to 53.2K cpm by June 1986. The most likely source of this radioactivity is tank TX-114; however, tanks TX-113 and TX-117 cannot be ruled out as possible sources since both of these tanks have been recommended to be further assessed using TFC-ENG-CHEM-D-42 to determine correct leak integrity status and/or eliminate possible drywell contribution.

Drywell 51-14-04 (located 1.8-ft from tank TX-114 and 17-ft from tank TX-113) first recoverable reading reported a peak of 2.1K cpm at 42-ft BGS on August 27, 1973. Readings continued to be reported at roughly the same intensity through May 1974 between 42 and 48-ft BGS. Due to the usage of new monitoring equipment, the peak increased to 972.8K cpm at 47-ft BGS on July 26, 1974. The source of this radioactivity is likely from tank TX-114. It is likely the tank TX-114 leak was near drywell 51-14-04 based on later SGLS data (see Figure 5-11 and Figure 5-12) and proximity to tank TX-114. However, tank TX-113 cannot be ruled out as a possible source since this tank has been recommended to be further evaluated using TFC-ENG-CHEM-D-42 to eliminate possible drywell contribution.

Tank TX-114 was overfilled 1965 through 1967. A packing leak from the cascade inlet line which is near drywell 51-14-04 as well as a leak from the capped spare inlet lines seem unlikely sources of radioactivity in the drywell. The cascade and spare inlet lines are located 23-ft 6-in BGS and the first recoverable reading in 51-14-04 reported a peak at 42-ft BGS. The relative distance of a potential cascade or inlet line leak to the point of detection would seem to favor a lower sidewall leak as opposed to the higher cascade line packing leak or capped leaking spare inlet lines.

Figure 5-11. 1996 and 1999 Spectral Gamma Logging Results for Drywells near Tank TX-114 (GJO-HAN-11)

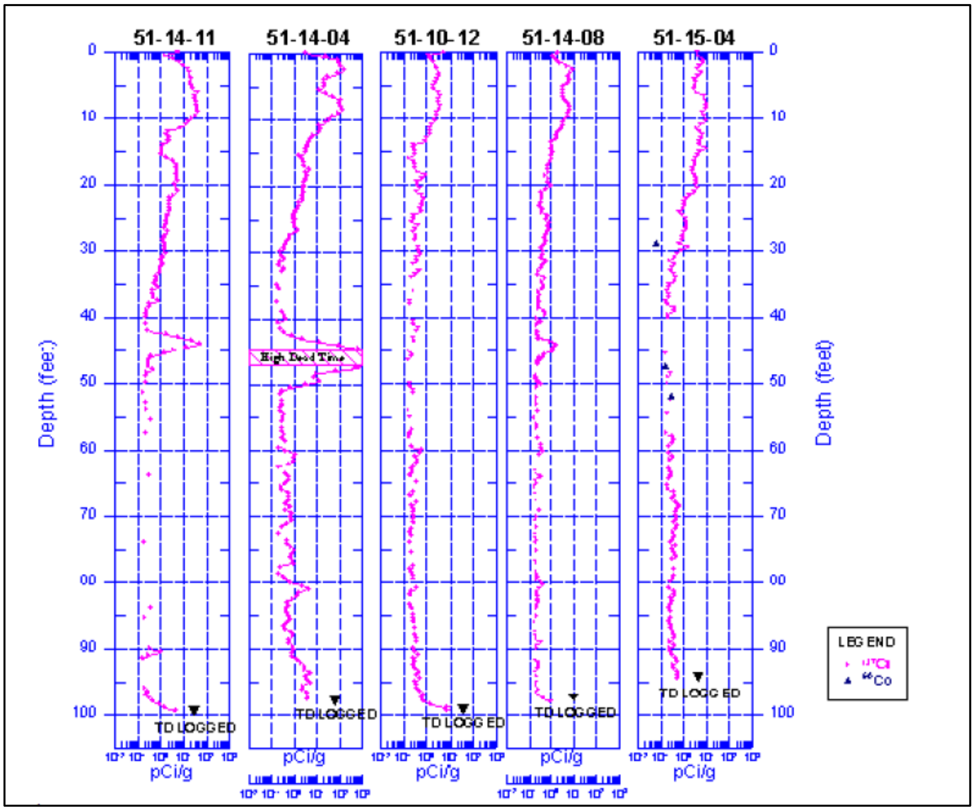
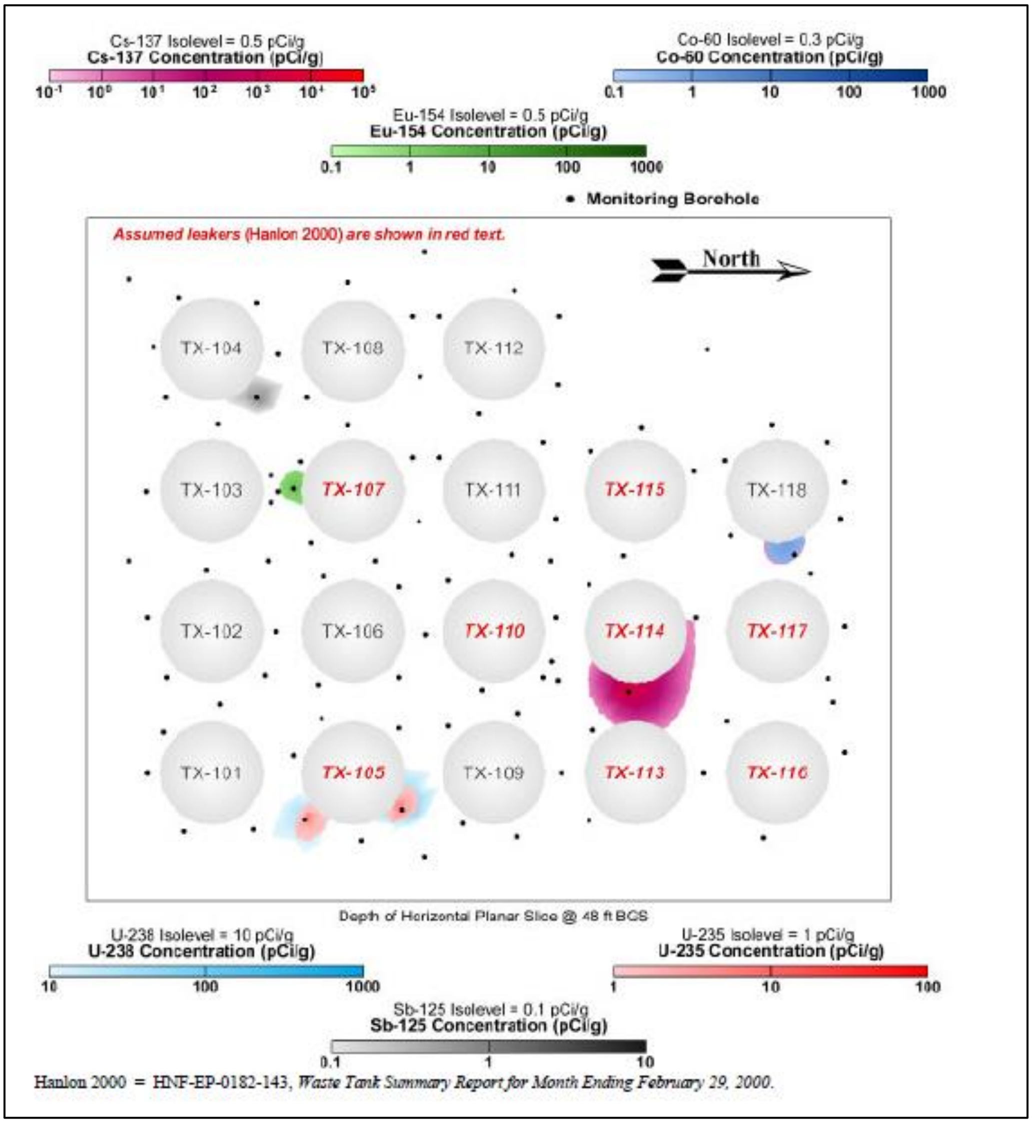


Figure 5-12. Tank TX-114 Drywell Logging Plume Visualization (GJO-HAN-11)



Drywell 51-14-08 first recoverable reading reported a peak of 21K cpm at 40-ft BGS on July 6, 1973. Readings then doubled to 45K cpm by the end of August 1973, and then remained relatively stable through June 1986. The source of this radioactivity is likely tank TX-114; however, tanks TX-110 or TX-115 cannot be ruled out as possible sources.

5.6 POSSIBLE TANK TX-114 LINER LEAK LOCATION(S)

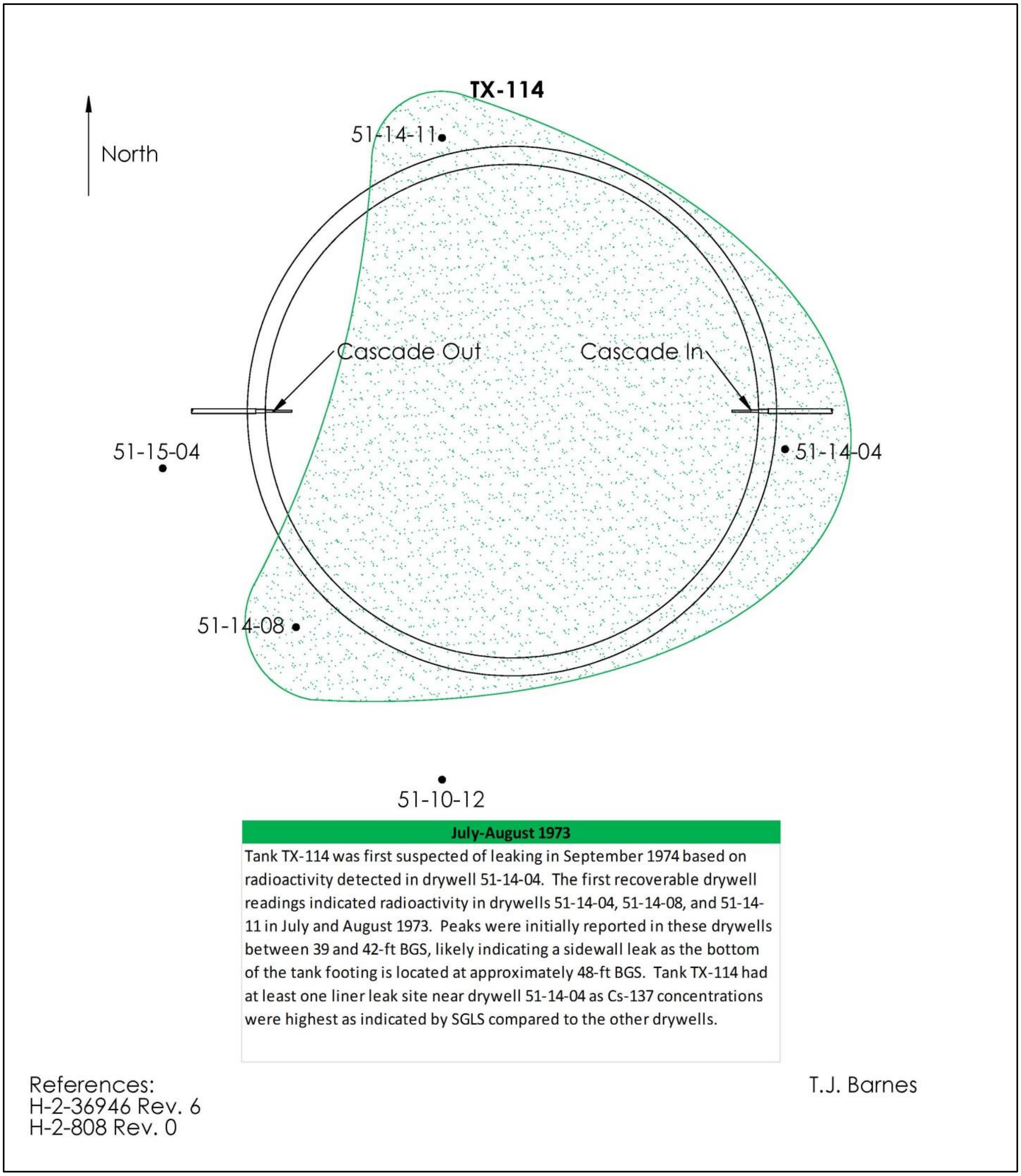
A liner leak may have penetrated the waterproof membrane at any location or pooled on the waterproof membrane and followed concrete cracks or construction joints to a different location for egress to the soil, including the top of the tank footing.

Tank TX-114 had at least one liner leak site based on radioactivity detected in three drywells, likely a sidewall leak since radioactivity in the drywells was detected at a higher BGS depth than the bottom of the tank footing. Tank TX-114 was first suspected of leaking in September 1974 based on radioactivity detected in drywell 51-14-04. No direct pushes were installed near tank TX-114.

5.6.1 Leak Detected in July-August 1973

Tank TX-114 was first suspected of leaking in September 1974 based on radioactivity detected in drywell 51-14-04. The first recoverable drywell readings indicated radioactivity in drywells 51-14-04, 51-14-08, and 51-14-11 in July and August 1973 (see Figure 5-13). Peaks were initially reported between 39 and 42-ft BGS in these three drywells, likely indicating a sidewall leak as the bottom of the tank footing is located at approximately 48-ft BGS. Tank TX-114 had at least one liner leak site. The leak site is likely near drywell 51-14-04 as Cs-137 concentrations were the highest as indicated by SGLS in this drywell compared to drywells 51-14-08 and 51-14-11.

Figure 5-13. Tank TX-114 Possible Leak Location (July-August 1974)
Tank inner ring is steel liner; outer ring is outer edge of tank footing



5.7 POSSIBLE TANK TX-114 LINER LEAK CAUSE(S)

Tank TX-114 was evaluated for five conditions known to contribute to a failed liner.

5.7.1 Tank Design

The TX Farm tank design does not appear to be a factor contributing to a failed liner (see Section 3.1.1).

5.7.2 Thermal Conditions

No direct temperature data are available for tank TX-114 during storage of 1C and MW; however, indirect temperature data indicates that temperature would be less than 150°F. The temperature during EB waste storage probably ranged between ~200°F and ~150°F as the tank received EB and was cooled to precipitate solids then transferred supernatant back to the evaporator.

Thermal shock creates stress both from rapid temperature rise as well as waste-induced high temperatures. Since no records are available during the period of EB waste storage, it is uncertain what the maximum temperature was in tank TX-114 during operation as well as the rate of temperature rise when waste was added. The thermal attributes of the waste and other information (see Section 5.4.2) would indicate that thermal stresses were likely minimal and should not have challenged the tank storage limits.

Temperature requirements in ARH-951 (*Limitations for Use of Underground Waste Tanks*) issued December 18, 1969 indicated that tank temperatures should be held below 230°F.

5.7.3 Chemistry-Corrosion

Tank TX-114 stored 1C waste for approximately one year and MW for ~1.75 years which should not have resulted in pitting or SCC. Tank TX-114 then received EB with some existing MW and subsequently received more EB and shipped supernatant evaporator feed, gradually building up layers of salt cake. The EB waste receipt and supernatant transfer conditions would likely create an environment conducive to pitting or SCC especially at the elevated temperatures of ~200°F.

5.7.4 Liner Observations

A review of the available photographs for tank TX-114 indicates seepage of asphalt possibly through a hole in the liner and around the tank near the flashing. There may be unseen similar anomalies below the solids level. No other liner observations relating to a tank TX-114 leak have been found.

5.7.5 Tank Construction Temperature

The TX Farm tank liners were constructed between January 1944 and September 1944. Only isolated minimum temperatures were experienced during tank construction at or below 18°F with day time temperatures between 41°F and 56°F (see Section 5.3.2). Impact occurrences could have occurred during cold temperatures that may have triggered fissures in the steel liner;

however, the possibility seems much less than that which might have occurred during construction in other tank farms.

5.8 TANK TX-114 CONCLUSIONS

Tank TX-114 was first suspected of leaking in September 1974 based on radioactivity detected in drywell 51-14-04. The first recoverable drywell readings indicated radioactivity in drywells 51-14-04, 51-14-08, and 51-14-11 in July and August 1973 (see Appendix B2). Peaks were reported between 39 and 42-ft BGS in these three drywells which indicates the probability of a sidewall leak. The leak site is likely near drywell 51-14-04 in the east quadrant as Cs-137 concentrations were the highest as indicated by SGLS in this drywell compared to drywells 51-14-08 and 51-14-11.

There are several liner leak cause conditions that were examined but the most likely cause of the tank TX-114 liner leak was chemistry-corrosion as it relates to the storage of EB wastes. The EB waste type is conducive to pitting and/or SCC at the likely storage temperature. The possible perforation in the liner below the flashing may be an indicator of corrosion. There appears to be very little contribution from tank design, construction temperatures, and thermal conditions. However, some or all of the factors can act serially or together to contribute to tank liner failure.

APPENDIX A2

TANK TX-114 LIQUID LEVEL OCCURRENCE REPORTS

(Excerpt from RPP-RPT-50870)

The following is a list of the liquid level occurrence reports for tank TX-114 with quotes from the ORs

Occurrence Report 75-146, *Violation of Liquid Level Decrease Criteria*:

"The liquid level took a sharp drop on December 26, 1975, dropping from a level of 253.25 inches to 242.0 inches from one data input to the next. The reading was rechecked and confirmed."

"The sharp, drop suggests a shift of the surface being contacted by the liquid level sensing probe. Dry wells monitoring this tank have long term stable radiation peaks at depths equal to or below tank bottom. Photographs will be taken as soon as possible to evaluate waste surface for evidence of shifts or faulty gauge operation.

Photographs were taken January 2. They reveal not only extensive quantities of liquid – 80 percent of surface is liquid with salt surfacing on isolated floes. The pictures also depict extensive tar leakage - much of it from levels below the lead flashing indicating possible liner penetrations. The photographs also display what may be cracks in the liner but this assessment is difficult to confirm. Dry wells remain stable. The liquid level gauge appears to have salt buildup and appears tangled with a wire or tape.

The gauge was relocated and tank levels established per January 31, 1976 revised report and attached discussion."

Occurrence Report 76-50, *Liquid Level Increase Exceeding Criteria for Tank 114-TX*:

"Liquid level increase exceeding action criteria of 1.00 inch increase. Tank liquid level is currently reported at 236.75 inches which provides a 2.25 inch rise above the base line of 234.50 inches established for this tank on March 25, 1976.

The apparent cause is judged to be slow drain down of liquid from higher elevations across the surface of the waste contents following the salt well pumping which concluded March 24, 1976."

Occurrence Report 76-101, *Liquid Level Increase Exceeding Criteria for Tank 114-TX*:

"The liquid level registered a sudden increase exceeding the criteria for tank 114-TX. The increase occurred after repair of the gauge tape housing which had apparently lost circuit continuity allowing the gauge to be lowered through the liquid until a solid surface was contacted. This situation had taken place May 8, at which time a sudden 26 inch level decrease was thought to be a shift or collapse of the salt cake following salt well pumping. Photographs were finally obtained and indicated the possible problem of poor gauge contact. When conductivity was reestablished, the surface level returned to a reading slightly higher than the level registered before the May 8 decrease. This occurrence report is used as a vehicle to reestablish the tank levels."

Occurrence Report 77-138, *Tank 114-TX Liquid Level Exceeding Increase Criterion*:

"A liquid level baseline of 239.5 inches was established for Tank 114-TX on July 17, 1976. On August 13, 1977, the liquid level measurement was 241.75, exceeding the baseline by more than the allowed increase criterion of two inches. The tank is equipped with a manual liquid level tape only.

Tank Farm Surveillance Analysis indicates the increase is due to liquid seeping from voids into the depression left following salt well pumping."

Occurrence Report 77-160, *Tank 114-TX Liquid Level Exceeding Maximum Operating Limits*:

"On September 14, 1977, the liquid level measurement was 242.25 inches, exceeding the maximum operating limits by .25 inch. The apparent cause is water entering the tank from pressure testing a line to this tank. The tank is equipped with a manual liquid level tape only."

OLDR 80-14, *114-TX Manual Tape Measurement Increase Exceeding the Criteria*:

"The 114-TX manual tape measurement increased over the allowed 2-inch increase from the baseline value (207.00" – 12/29/78) by .75 inches on 9/18/80. The level then decreased back to within the 2-inch criterion during the next 4 days (9/22/80). The level has been erratic. The measurements have been in and out of the increased criteria since the initial increase.

The investigation revealed that the increase was the result of a measurement anomaly. The investigation recommends the establishment of a common grounding point for all future measurement readings and the establishment of a new liquid level baseline value."

APPENDIX B2

TANK TX-114 GROSS GAMMA DRYWELL DATA

Table B2-1. Tank TX-114 Drywell Radioactivity (K counts per minute) (July 1973 through June 1986) (SD-WM-TI-356) (1 of 2 pages)

51-14-04			51-14-08			51-14-11			51-10-12		51-15-04	
Drilled 09/1970			Drilled 09/1970			Drilled 09/1970			Drilled 09/1970		Drilled 10/1970	
Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Depth (ft)	Date	Peak (K cpm)	Date	Peak (K cpm)
N/A[1]			7/6/1973[3]	21.0	40	N/A[1]			7/6/1973[3]	< 12	7/6/1973[3]	< 12
8/27/1973	2.1	42	8/30/1973	45.0	40	8/30/1973	342.0	39	N/A[1]		N/A[1]	
9/27/1973	2.1	44	N/A[1]			9/25/1973	327.5	39	N/A[1]		N/A[1]	
10/31/1973	2.5	45	10/26/1973	40.5	40	10/29/1973	302.5	44	N/A[1]		N/A[1]	
11/30/1973	1.7	44	N/A[1]			11/28/1973	332.5	42	N/A[1]		N/A[1]	
12/28/1973	1.3	45	12/1/1973	43.0	40	12/24/1973	275	42	N/A[1]		12/4/1973	< 12
1/5/1974	1.4	44	1/26/1974	37.5	41	1/29/1974	267.5	40	N/A[1]		N/A[1]	
2/22/1974	2.4	44	N/A[1]			2/28/1974	312.5	44	N/A[1]		N/A[1]	
3/22/1974	1.6	45	3/2/1974	42.0	44	3/29/1974	360	40	N/A[1]		N/A[1]	
4/17/1974	2.6	48	4/26/1974	12.0	42	4/9/1974	348.0	42	4/23/1974	< 12	N/A[1]	
5/31/1974	2.4	43	5/23/1974	16.2	42	5/22/1974	350	45	N/A[1]		N/A[1]	
N/A[1]			6/28/1974	9.8[2]	47	6/27/1974	70.8[2]	45	6/29/1974	< 3	6/29/1974	< 3
7/26/1974	972.8[2]	47	7/23/1974	11.4	44	7/23/1974	91.2	45	N/A[1]		N/A[1]	
8/16/1974	1055.0	46	8/27/1974	12.0	41	8/3/1974	84.9	45	N/A[1]		N/A[1]	
9/19/1974	2796.1	44	9/26/1974	10.8	41	9/19/1974	64.9	44	N/A[1]		N/A[1]	
10/10/1974	1168.2	45	10/18/1974	12.0	41	10/31/1974	65.1	43	N/A[1]		N/A[1]	
11/8/1974	1101.8	44	11/29/1974	11.4	44	11/29/1974	102.1	64	N/A[1]		N/A[1]	
12/30/1974	1113.0	47	12/18/1974	9.6	44	12/18/1974	126.7	44	N/A[1]		N/A[1]	
1/29/1975	1078.0	44	1/24/1975	9.9	44	1/24/1975	74.2	44	1/22/1975	< 3	1/30/1975	< 3
7/31/1975	1023.2	45	7/31/1975	11.1	44	7/31/1975	66.8	43	7/31/1975	< 3	7/31/1975	< 3
1/12/1976	1036.6	46	1/22/1976	10.2	44	1/8/1976	74.0	44	1/8/1976	< 3	1/9/1976	< 3
5/9/1976	1012.9	44	5/12/1976	10.6	43	5/9/1976	68.0	43	5/13/1976	< 3	5/12/1976	< 3
9/23/1976	1020.6	43	11/11/1976	10.7	43	10/7/1976	65.3	42	9/30/1976	< 3	9/29/1976	< 3
3/10/1977	998.4	43	4/14/1977	9.4	42	4/20/1977	69.3	43	3/17/1977	< 3	3/17/1977	< 3

Table B2-1. Tank TX-114 Drywell Radioactivity (K counts per minute) (July 1973 through June 1986) (SD-WM-TI-356) (2 of 2 pages)

51-14-04			51-14-08			51-14-11			51-10-12		51-15-04	
Date	**Peak (K cpm)**	**Depth (ft)**	**Date**	**Peak (K cpm)**	**Depth (ft)**	**Date**	**Peak (K cpm)**	**Depth (ft)**	**Date**	**Peak (K cpm)**	**Date**	**Peak (K cpm)**
10/13/1977	1059.5	42	10/13/1977	9.9	42	10/6/1977	61.1	41	10/13/1977	< 3	10/13/1977	< 3
4/13/1978	1159.2	43	4/20/1978	9.0	42	4/6/1978	65.0	42	N/A[1]		N/A[1]	
9/14/1978	1165.3	43	9/14/1978	8.4	42	9/21/1978	67.9	43	9/6/1978	< 3	9/7/1978	< 3
4/26/1979	1174.7	43	4/11/1979	9.5	43	N/A[1]			N/A[1]		N/A[1]	
9/12/1979	1176.3	44	9/26/1979	8.9	42	9/26/1979	61.2	41	9/27/1979	< 3	9/27/1979	< 3
10/9/1980	1037.7	43	10/15/1980	8.3	42	9/25/1980	52.6	41	10/15/1980	< 3	10/15/1980	< 3
9/9/1981	1085.4	42	9/9/1981	9.5	41	9/9/1981	41.5	41	9/9/1981	< 3	9/9/1981	< 3
7/30/1982	1144.9	45	9/23/1982	8.3	44	9/23/1982	47.8	43	9/23/1982	< 3	9/23/1982	< 3
9/23/1983	903.5	46	9/23/1983	7.9	44	9/23/1983	41.8	44	9/22/1983	< 3	9/22/1983	< 3
N/A[1]			3/7/1984	7.9	44	N/A[1]			N/A[1]		N/A[1]	
N/A[1]			5/30/1984	7.6	44	N/A[1]			N/A[1]		N/A[1]	
8/21/1984	924.4	46	8/21/1984	9.2	44	8/21/1984	37.6	44	8/21/1984	< 3	8/21/1984	< 3
N/A[1]			N/A[1]			11/15/1984	40.0	44	N/A[1]		N/A[1]	
6/25/1985	840.7	47	6/25/1985	7.8	45	6/25/1985	39.5	44	6/24/1985	< 3	6/25/1985	< 3
6/12/1986	1146.2	47	6/12/1986	7.4	45	6/12/1986	53.2	45	6/12/1986	< 3	6/12/1986	< 3

Note: [1]N/A: Data not available
[2]New monitoring equipment
[3]First recoverable data

6.0 CONCLUSIONS

Liner leaks probably occurred near the southern portion at or near the base of tank TX-107 based on radioactivity reported in drywell 51-03-12 in 1977. Tank TX-114 was first suspected of leaking in September 1974 based on radioactivity detected in drywell 51-14-04 between 39 and 42-ft below grade surface. The SGLS radioactivity, 3 to 6-ft above the top of the tank base, indicates the probability of a sidewall leak in the tank's east quadrant.

There are several liner leak cause conditions that were examined for tanks TX-107 and TX-114 which include tank design, construction conditions, thermal conditions, and chemistry-corrosion. Chemistry-corrosion, relating to storage of REDOX HLW in tank TX-107 and EB waste in tank TX-114 at elevated temperatures could have created an environment conducive to pitting and/or SCC.

Tank TX-114 photographs indicated a possible hole in the liner below the flashing. It is unclear whether this liner anomaly is a perforation of the liner; drywell data indicates radioactivity in a different location. There may be unseen similar anomalies below the level of the solids.

Both tanks TX-107 and TX-114 experienced liner failures that were detected by drywell radioactivity. Liquid level decreases which were attributed to evaporation did not indicate the presence of a tank leak. Corrosion may have been a factor in each case as tank TX-107 stored REDOX HLW and TX-114 stored EB waste which are both conducive to pitting and/or SCC.

There appears to be very little contribution from tank design, construction temperatures, and thermal conditions. However, some or all of the factors can act serially or together to contribute to tank failure.

Basic information on the leaking TX Farm tanks and the TX Farm sound tanks are listed separately in Table 6-1 and Table 6-2. The information was reviewed to identify any differences between leaking and sound tanks related to liner failure. A number of the sound tanks contained REDOX HLW, EB waste, and even TBP waste all of which are conducive to pitting and SCC. There doesn't seem to be any of the basic information that stands out as the reason sound tanks did not experience liner leaks.

Table 6-1. TX Farm Leaking Tanks

Leaking Tank	Waste Details		Leak Status		R Waste Storage		Thermal Conditions
	First Filled	Waste Type	Leak Detected	Indication of leak	Stored R Waste	R Only Storage Length	Estimated Max. Temp.
TX-107	4th Quarter 1951	MW, R, EB	October 1976	Drywells	Yes	~ 14 years	< 180°F
TX-114	2nd Quarter 1951	1C, MW, EB	July/August 1973	Drywells	No	-	< 150°F

Notes: Waste Types: MW: Metal Waste; R: REDOX HLW; 1C: first cycle decontamination waste; EB: Evaporator bottoms

Table 6-2. TX Farm Sound Tanks

Sound Tank	Waste Details[1]		Leak Status[2]		R and/or TBP Waste Storage[1]		Thermal Conditions[3]
	First Filled	Waste Type	Leak Integrity Classification	Basis for Formal Leak Assessment	Stored R or TBP Waste	R or TBP Only Storage Length	Estimated Max. Temp.
TX-101	July 1949	MW, R, BL-IX-EB-CW, BL-IX-1C-TBP, BNW-N-LW-PL-RIX, Evap. Feed, NCPLX	Sound	-	R/TBP	R: ~ 22 years	128°F
TX-102	February 1950	MW, R, EB, Evap. Feed	Sound	-	R	~ 13 years	136°F
TX-103	August 1950	MW, TBP, EB, Evap. Feed, NCPLX	Sound	-	TBP	~ 17 years	112°F
TX-104	November 1950	MW, R, BL-OWW-RIX-R-TBP, EB, Evap. Feed, CPLX	"Sound" but TFC-ENG-CHEM-D-42	Drywells show high uranium activity	R/TBP	R: ~ 15 years	128°F
TX-105	May 1952	MW-TBP, R, EB, Evap. Feed	"Assumed leaker" but TFC-ENG-CHEM-D-42	Additional logging of drywells recommended	R/TBP	R: ~ 14 years	210°F[4]
TX-106	May 1952	MW, R, EB, Evap. Feed	Sound	-	R	~ 14 years	138°F
TX-108	May 1952	MW, R, TBP, EB, Evap. Feed	Sound	-	R/TBP	R: ~ 4 years TBP: ~ 3 years	116°F
TX-109	January 1949	1C, 1C-TBP, Evap. Feed	Sound	-	TBP	-	168°F
TX-110	September 1949	1C, 1C-TBP, EB, Evap. Feed	"Assumed leaker" but TFC-ENG-CHEM-D-42	Gamma activity in drywell 51-10-12 may be from TX-114 or TX-110	TBP	-	153°F
TX-111	March 1950	1C, 1C-TBP, EB, Evap. Feed, NCPLX	Sound	-	TBP	-	147°F
TX-112	August 1950	1C, EB, Evap. Feed, NCPLX	Sound	-	-	-	126°F
TX-113	May 1952	EB, 1C-EB	"Assumed leaker" but TFC-ENG-CHEM-D-42	Drywell 51-14-04 source could be from TX-113	-	-	120°F
TX-115	May 1952	TBP, MW, R, DW-CW, EB	"Assumed leaker" but TFC-ENG-CHEM-D-42	Drywell data shows low activity attributed to migration from another source	R/TBP	TBP: ~ 1 year R: ~ 9 years	123°F

Sound Tank	Waste Details[1]		Leak Status[2]		R and/or TBP Waste Storage[1]		Thermal Conditions[3]
	First Filled	**Waste Type**	**Leak Integrity Classification**	**Basis for Formal Leak Assessment**	**Stored R or TBP Waste**	**R or TBP Only Storage Length**	**Estimated Max. Temp.**
TX-116	May 1952	EB	"Assumed leaker" but TFC-ENG-CHEM-D-42	Drywell data shows low activity attributed to migration from another source	-	-	117°F
TX-117	May 1952	EB, 1C-EB	"Assumed leaker" but TFC-ENG-CHEM-D-42	Drywell data shows low activity attributed to migration from another source	-	-	191°F
TX-118	May 1952	1C, TBP, 1C-EB, EB-TBP-DW, CW, EB, Evap. Feed, NCPLX	Sound	Likely cascade line or transfer line leak	TBP	~ 1.5 years	145°F

Notes: Waste Types: TBP: Tri-butyl phosphate waste; 1C: First-cycle decontamination waste; CW: coating waste; MW: metal waste; EB: Evaporator bottoms; R: REDOX HLW; Evap: Evaporator feed (post 1976); NCPLX: Non-Complexed waste; CPLX: complexed waste; DW: decontamination waste

1. Reference: WHC-MR-0132, *A History of the 200 Area Tank Farms*
2. Reference: RPP-RPT-50870, Rev. 0, *Hanford 241-TX Farm Leak Inventory Assessment Report*.
3. Reference: WHC-SD-WM-TI-591, Rev. 0, *Maximum Surface Level and Temperature Histories for Hanford Waste Tank*. All of these temperatures except for tank TX-105 were reported to have occurred in the 1970's or later.
4. Reference ARH-780. January 22, 1952 HW-23140 states that the sludge temperature is 238°F and 210°F for the supernatant.

7.0 REFERENCES

ARH-951, 1969, *Limitations for Use of Underground Waste Tanks*, Richland, Washington.

ARH-1601, 1974, *Specifications and Standards for the Operation of Radioactive Waste Tank Farms and Associated Facilities*, Atlantic Richfield Hanford Company, Richland, Washington.

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ASTM A285, 1946, American Society for Testing and Materials, *Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates*

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Appendix A

Meeting Minutes

April 15, 2014

May 27, 2014

MEETING SUMMARY

From:	C. L. Girardot
Phone:	376-0528
Location:	Ecology Office
Date:	April 15, 2014
Subject:	Tank Farm Leak Integrity Assessments
To:	Distribution

Jim Alzheimer, ECOLOGY*
Dan Baide, WRPS*
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY*
Alan Carlson, WRPS
Jim Field, WRPS
Les Fort, WRPS*
Crystal Girardot, WRPS*
Don Harlow, WRPS*
Jeremy Johnson, ORP*
Ted Venetz, WRPS*
Dennis Washenfelder, WRPS

*Attended Meeting

PURPOSE:

The purpose of this meeting was to discuss portions of the Tank TX-107 Leak Causes and Locations report. Handed out to those who attended the meeting were draft copies of the tank TX-107 segment of the TX Farm report, the TX-107 Summary sheet, and Tank Leak Cause matrix table.

Tank TX-107 Leak Causes and Locations Status

The results from the tank TX-107 leak loss analysis were discussed. Tank TX-107 was first suspected of leaking in April 1977 as a result of increased radioactivity detected in drywell 51-03-12 (at 53-ft BGS), after low levels of radioactivity were initially detected in October 1976. Radioactivity continued to increase in drywell 51-03-12, and five additional drywells were drilled between May and July 1977 between tanks TX-103 and TX-107 to determine the source. High levels of radioactivity were detected in drywells 51-07-06 and 51-07-18 (at ~51-ft BGS), and tank TX-107 was determined to be the source. Tank TX-107 was categorized as "questionable integrity" and most of the supernatant was removed in May 1977. No liquid level decreases were reported during this time. Tank TX-107 was declared interim stabilized in October 1979 with an estimated leak volume of 2,500 gal.

Tank TX-107 was put into service in the 4th quarter of 1951 and received metal waste (MW) from 221-T Plant and stored MW for about four years total probably around 70°F or less. Tank TX-107 also stored REDOX HLW for about 14 years total from ~150°F down to ~105°F likely creating an environment conducive to pitting and/or SCC. The subsequent evaporator bottoms

(EB) waste stored with REDOX HLW (at temperatures probably less than 105°F) is not conducive for SCC and/or pitting.

From the drywell information it was concluded that the predominant leak site was in the southern portion of the tank at or near the tank base. The most likely cause of the tank TX-107 liner failure was chemistry-corrosion as it relates to the storage of primarily REDOX HLW and possibly EB wastes. These waste types are conducive to pitting and/or SCC depending on storage temperature. There appears to be very little contribution from tank design, construction temperatures, and thermal conditions. No evidence of a liner bulging was found.

A tank leak cause matrix table was addressed containing thermal conditions and waste chemistry as contributors to the tank TX-107 leak. With the information available there was not a dominant design or waste tank construction identified as the cause of the tank TX-107 leak.

Discussed was the reported weld re-work rates for TX Farm and the rate that was reported for tank TX-107. It was stated that the rate for tank TX-107 was less compared to other tanks in TX Farm. These weld re-work rates will be added to the report in the general TX Farm background information.

The next meeting will discuss tank TX-114 Leak Causes and Locations report, the last tank to be discussed out of the 25 SSTs with liner leaks.

ACTIONS:

1. All: Review the April 15, 2014 tank TX-107 meeting summary and provide comments by April 29, 2014.
   Status: Complete.
2. All: Provide comments on the draft report on Leak Causes and Locations for tank TX-107 by April 29, 2014.
   Status: Complete. See Attachment 1.

NEXT MEETING:

Review Tank TX-114 Leak Location and Cause report.

Date: Tuesday, May 27, 2014
Time: 3:00 pm
Location: Ecology Room 31

ATTACHMENT 1:

Review Comments with Responses
J.A. Caggiano April 22, 2014
RPP-RPT-54917, Rev. 0 (Draft TX-107 Segment of Leak Causes Report)

GENERAL COMMENTS:

1. It would really beneficial to these reports to tabulate as much information as possible so as to minimize repetition. Reading the same information several times about one tank gets tedious and adds to the length of the report.

   Response: As feasible, information will be tabulated in the final TX Farm report to reduce redundancy and simplify reading.

2. The reader would benefit from a table of waste types that were stored in the SSTs to include the major constituents, their concentration/activity, and process(es) of origin. This can be key in interpreting drywell logs.

   Response: A table is provided of the major waste types stored in each SST (see Section 4.4.4. Chemistry-Corrosion for tank TX-107) along with a chronology of when the SST stored each waste type as well as the length of storage. A separate table in the Chemistry-Corrosion section of each individual SST segment provides concentrations of the species interested in terms of corrosion. Additional information on the waste types stored in the SSTs is provided in applicable tank farm leak inventory reports. This applicable reference will be added as a footnote to Table 4-1 in the report.

SPECIFIC COMMENTS:

1. Pg. 4-5, para 5. Minor point, but 30 kgals sludge plus 7 kgals interstitial liquid doesn't total 30 kgal, at least by the old math that I learned in school.
   Response: Revised this paragraph to: "As of November 2013, tank TX-107 was estimated to contain 30 kgal of waste in the form of saltcake, which includes 7 kgal of interstitial liquid (HNF-EP-0182, Rev. 310, *Waste Tank Summary Report for Month Ending January 31, 2014*)."

2. Pg. 4-6, Fig. 4-2. TX-107 was declared "empty" in January 1957 and wasn't refilled until 1961. As the tank was sluiced, there likely was some residual waste in the tank for about 4 years. Could this have effected corrosion for the tank bottom? Please consider.

   Response: The residual waste that was left in the tank for about 4 years was metal waste. It is stated in Section 4.4.4, Chemistry-Corrosion, that metal waste should not be a concern for either pitting or stress corrosion cracking under the tank TX-107 conditions. The ratio of nitrate to nitrite and hydroxide is less than 2.5 as stated in the current DST specification for waste chemistry. Therefore, it appears corrosion should not be a concern during this time.

3. Pg. 4-11, Sect. 4.5.1. If you look up the Stoller report for TX-107, it shows only 7 drywells. Some explanation should be offered for this apparent discrepancy.

Response: The Stoller report for tank TX-107, GJ-HAN-48, shows eight drywells around TX-107: 51-07-01, 51-07-03, 51-07-04, 51-07-06, 51-07-18, 51-07-07, 51-07-09, and 51-07-11. The TX Farm report, GJ-HAN-46, figure does not include drywell 51-07-06 because it was abandoned in 1977 and not logged by SGLS. However, the well was logged in 1977. This will be clarified in the report.

4. Pg. 4-25, para 2. How do you account for the high Co-60 and Eu-154 in drywells 51-07-07 and 51-07-18 at near the base of the tank? What's the source of these isotopes? Please clarify.

   Response: The source of these isotopes is from a tank TX-107 liner leak. In the Stoller GJ-HAN-48 report, contamination was detected near the base of the tank and this contamination was Co-60 and Eu-154. This will be clarified in the appropriate sections of the report.

MEETING SUMMARY

From:	C. L. Girardot
Phone:	376-0528
Location:	Ecology Office
Date:	May 27, 2014
Subject:	Tank Farm Leak Integrity Assessments

To: Distribution

Jim Alzheimer, ECOLOGY*	Les Fort, WRPS
Dan Baide, WRPS	Crystal Girardot, WRPS*
Mike Barnes, ECOLOGY*	Don Harlow, WRPS*
Joe Caggiano, ECOLOGY*	Jeremy Johnson, ORP*
Alan Carlson, WRPS	Ted Venetz, WRPS*
Jim Field, WRPS	Dennis Washenfelder, WRPS

*Attended Meeting

PURPOSE:

The purpose of this meeting was to discuss portions of the Tank TX-114 Leak Causes and Locations report. Handed out to those who attended the meeting were draft copies of the TX Farm report including the tank TX-114 segment, the TX-114 Summary sheet, the Tank Leak Cause matrix table, the path forward to the Single-Shell Tank Integrity Program Leak Integrity Milestones (M-045-91F), and a draft (maybe preliminary) outline of the summary document for Leak Causes and Locations.

Tank TX-114 Leak Causes and Locations Status

The results from the tank TX-114 leak loss analysis were discussed. Tank TX-114 was first suspected of leaking in July and August 1973 as a result of increased radioactivity detected in drywells 51-14-04, 51-14-08, and 51-14-11 between 39 and 42-ft below grade surface (BGS). The bottom of the tank footing is approximately 48-ft BGS. Tank TX-114 was categorized as "questionable integrity" due to increasing radioactivity in drywell 51-14-04 (located between tanks TX-113 and TX-114), and most of the supernatant was removed in 1975.

Tank TX-114 was put into service in the 2nd quarter of 1951 and received first cycle decontamination (1C) waste cascaded from tank TX-113 and stored MW for about one year total probably around 180°F or less. Tank TX-114 also stored only MW for about 1.75 years total probably around 180°F or less. Tank TX-114 then stored MW combined with evaporator bottoms (EB) waste for about 20 years total at temperatures around 200°F likely creating an environment conducive to pitting and/or SCC. The storage of MW was not a concern for either pitting or SCC under the tank TX-114 conditions. The storage of 1C waste could have resulted in pitting and/or SCC since 1C does not meet the current DST specification for waste chemistry;

however, 1C waste was typically neutralized with coating waste (CW) prior to pumping to the storage tanks. Depending on this ratio of 1C to CW, the resulting waste may have met the current DST specifications.

From the drywell information it was concluded that the predominant leak site was a sidewall leak in the eastern portion of the tank near drywell 51-14-04. The most likely cause of the tank TX-114 liner failure was chemistry-corrosion as it relates to the storage of primarily EB wastes. This waste type is conducive to pitting and/or SCC at the elevated tank TX-114 storage temperature. There appears to be very little contribution from tank design and construction temperatures. No evidence of a liner bulging was found.

A tank leak cause matrix table was addressed containing thermal conditions and waste chemistry as contributors to the tank TX-114 leak. With the information available there was not a dominant design or waste tank construction condition identified as the cause of the tank TX-114 leak.

Tank TX-114 is the last SST with a reported liner leak to be discussed in regards to leak causes and locations (M-045-91F-T04). Discussed were the leak integrity milestone (M-045-91F) and the current status of the four targets as well as path forward. The Leak Causes and Locations portion includes eight individual reports. A summary document is being drafted that includes highlights of these eight reports as well as a summary of the leak rate analysis of the 25 SSTs with liner leaks.

Future meetings will be coordinated to discuss progress of the targets and reports prepared to satisfy Milestone M-045-91F.

ACTIONS:

3. All: Review the May 27, 2014 tank TX-114 meeting summary and provide comments by June 10, 2014.
   Status: Complete.
4. All: Provide comments on the draft report on Leak Causes and Locations for tank TX-114 by June 10, 2014.
   Status: Complete. See Attachment 1.

ATTACHMENT 1:

Review Comments with Responses
J.A. Caggiano June 3, 2014
RPP-RPT-54917, Rev. 0 (Draft TX-114 Segment of Leak Causes Report)

1. Pg. 5-5, para 2. Could you please expand on the statement, "Augering and additional analyses indicated there was no proof that the spare inlet lines had leaked…..". How many holes, to what depth, what date(s), and how many samples were taken and analyzed? Were these just temporary holes, or were they converted to drywells and/or monitoring holes? Please expand and provide a reference.

   Response: OR 77-06 indicated an augering (one) down to 22-ft on January 31, 1977 and additional undefined analysis indicated no proof that the spare inlet lines had leaked. No information on conversion to drywell or monitoring holes. Added clarification and reference to the document.

2. "Blame button" table. You have a column entitled "other than a liner leak" which I think should list any tanks, including TX-114, that have been overfilled for a period of time. For TX-114, LLs remained pretty constant (from the data provided) until the tank was overfilled. Pumping and other operations "post-overfill" don't provide a clear picture. The overfilling is not discussed in the Conclusions, but should at least be mentioned. Overfilling doesn't necessarily lead to releases, but can. Whether overfilling leads to a release or not is a function of the height of overfilling (i.e., hydraulic head) and the nature of the seal around the spare inlet ports. One plausible mechanism for the drywell hits at the base of the tank is a slow "dribble" from a leaky spare inlet line (close to where the first drywell hits were registered at 51-14-04) that flows slowly down the tank wall and then spreads to the drywell when the released fluid hits the tank base. Please revise the table to indicate overfilling for those tanks that were filled above tank capacity and consider an overflow mechanism for a release from TX-114.

   Response: The blame button table includes 6 instances where there seemed to be the possibility of some other reason for the drywell radioactivity or liquid level decrease other than or in conjunction with a tank liner leak. Overfills have not been added to the table unless there is a reason. The first recoverable peak radioactivity in the 51-14-04 drywell at 42-ft BGS was 3-ft above the top of the tank base (45-ft 2-in BGS). Any leaking nozzles during the ~2 year overfill period are 18-ft 6-in above the first recoverable peak radioactivity in the drywells at 42-ft and don't seem to be a reasonable source of the drywell radioactivity.

3. Pg. 5-19, para 2. There is Cs-137 contamination in both of these boreholes, but it is at or very close to the limit of detection and is not useful as an indicator of proximity to a possible source/breach. I would avoid, to the extent possible, the use of bold generalizations such as "TX-114 drywells 51-10-12 and 51-15-04 do not indicate any radioactivity associated with a TX-114 leak." Please consider rephrasing this statement and others like it.

   Response: Rephrased to indicate low levels of radioactivity are not useful for determination of leak location.

4. Pgs. A2-2, 2-3. The ORs mostly indicate increasing liquid level in tank TX-114 which casts doubt a liner leak from TX-114, unless the rate of fluid addition (likely intrusion) were greater than the rate of leakage. Should this enter the discussion as part of the liner evaluation? Please consider.

   Response: Each one of the appendix OR's documenting increasing liquid level contains the explanation for the increase. The explanation indicates the increases shouldn't affect the overall leak cause and location scenario. This was noted in Section 5.4.1.

5. Pg. B2-2, Table B2-1. What is the explanation for the delay in logging these wells constructed in 1970, but not logged for the first time (according to the table) until 1973? Please provide.

   Response: Added a footnote to the table indicating the 1973 data was the first recoverable data.

6. Pg. 6-1, para 3. You seem to have concluded that there was a breach of the liner and a release due to a failed liner. However, there are other possible mechanisms for the release other than a liner breach. I would qualify this statement which sounds as if you have reached this conclusion with certainty. Please revise.

   Response: Added in the tank overfill and cascade line packing and capped spare leak potential. The cascade line and capped spares at 23-ft 6-in BGS and the drywell first recoverable peak indication of radioactivity at 42-ft BGS which is above the top of the tank base (45-ft 2-in) seemed to point to a sidewall leak with only the remote possibility of a leak from one of the lines.

GENERAL COMMENT:

7. The term "leak" should be replaced with "release". "Leak" generally implies a breach in the liner, but a release may also occur from a pipeline, overfilling, cascade/transfer line that doesn't mean a loss of the integrity of the steel liner. All releases count in the soil inventory for a particular tank (to be used in risk/performance analyses), but loss of integrity has other significance—especially for selection of a retrieval technology. Please consider this change here and throughout these reports.

   Response: The term "leak" has been generally used throughout the series of leak causes and locations documents to indicate release from containment whether from the tank itself or the supporting equipment. The "leaks" have usually been qualified by indicating where they came from within the text. The present document will continue to use the terminology contained in the previous documents.

DISTRIBUTION SHEET

To	From	Page 1 Of 1
Distribution	Technical Integration	Date 06/16/2014
Project Title/Work Order		EDT No. N/A
RPP-RPT-54917, Rev. 0, Hanford Single-Shell Tank Leak Causes and Locations - 241-TX Tank Farm		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
T.J. Barnes	R2-53	X			
K.D. Boomer	R2-53	X			
R.A. Burk	S7-83	X			
C.A. Burke	S7-75	X			
A.B. Carlson	R2-53	X			
K.G. Duncan	R2-53	X			
J.G. Field	S7-90	X			
L.A. Fort	H6-13	X			
C.L. Girardot	R2-53	X			
R.E. Gregory	S7-68	X			
D.G. Harlow	R2-53	X			
D.B. Little	R2-58	X			
T.J. Venetz	R2-53	X			
J.A. Voogd	R1-51	X			
D.J. Washenfelder	R2-53	X			
T.W. Fletcher	H6-60	X			
E.M. Mattlin	H6-60	X			
J.M. Johnson	R6-60	X			
S.E. Killoy	H6-14	X			
M.R. Greene	R1-51	X			
J.J. Luke	H6-14	X			