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Hanford 241-A/AX Farm Leak Inventory Assessment Report

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Abstract: This report summarizes information on historical waste loss events associated with tanks and pipelines in the 241-A and 241-AX Tank Farms.

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Revision 2

HANFORD 241-A AND 241-AX TANK FARMS LEAK INVENTORY ASSESSMENT REPORT

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EXECUTIVE SUMMARY

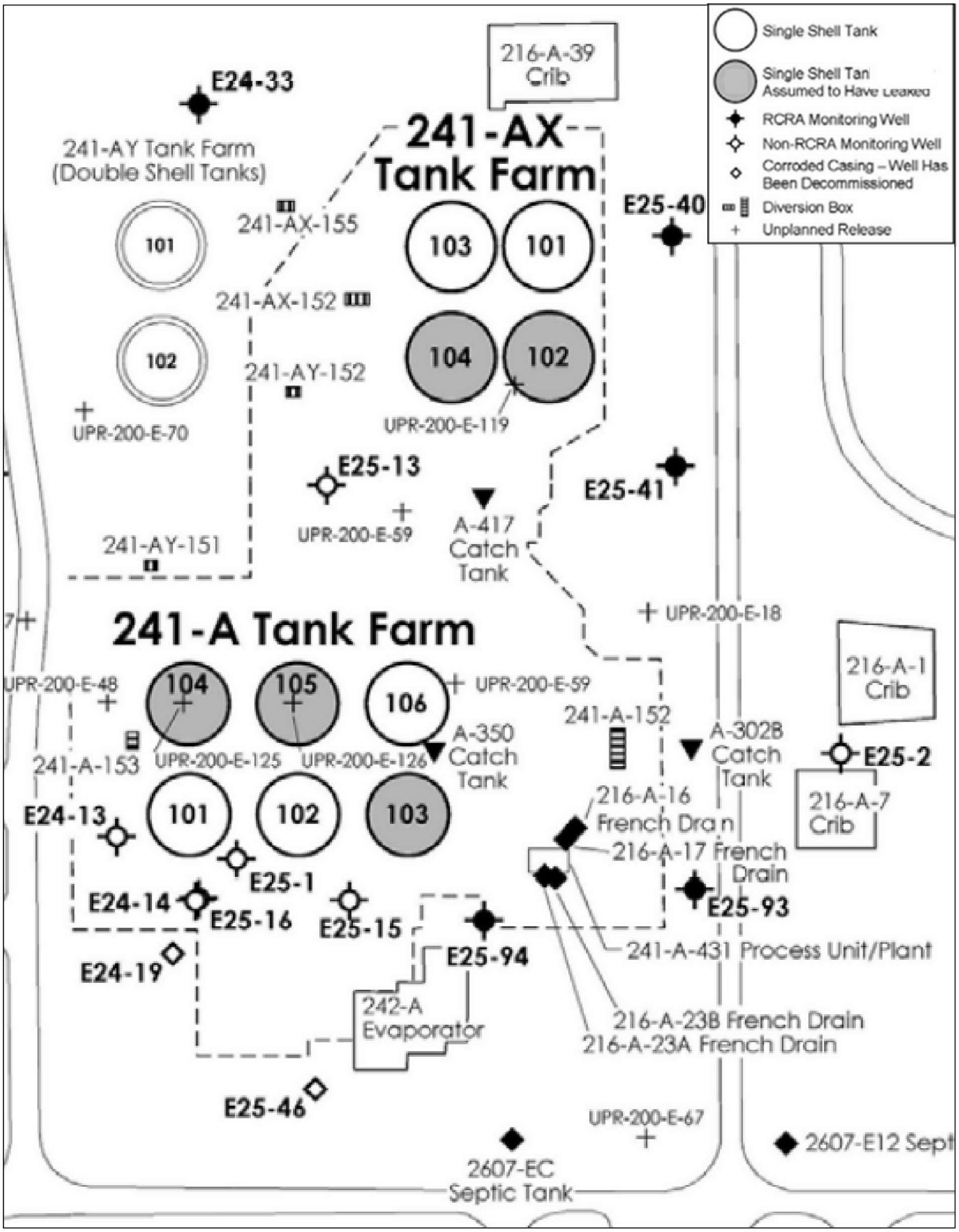
Washington State Department of Ecology, along with the Tank Farms Operating Contractor for the U.S. Department of Energy, developed a process to reassess selected tank leak estimates (volumes and inventories), and to update single-shell tank leak and unplanned release volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This process does not represent a formal tank leak assessment in accordance with procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process." This report documents a collaborative effort to reassess the inventory of past releases in the 241-A and 241-AX Tank Farms. This revision of the report should be considered a work in progress to be distributed for public review as appropriate. Comments will be incorporated as needed in a future revision.

Tank waste loss events were initially reassessed for single-shell tanks currently classified as "assumed leakers" ("the integrity classification of a waste storage tank for which surveillance data indicate a loss of liquid to the environment attributed to a breach of integrity", i.e., a tank leak) (HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014*, Revision 310). In this report the terminology will be that a loss of tank liner integrity will be referred to as a liner leak and a release of waste to the environment from any other source will be referred to as a release.

The initial 241-A and 241-AX Tank Farm leak assessment (Revision 1 of this report) was one of the first of a series of assessments for the 12 single-shell tank farms. Included in the reassessment and documented in this revised report were additional information and evaluations learned from development of other tank farm leak assessment reports; evaluations of "sound" tanks; reformatting of the report, incorporating the results of integrity assessments for 241-A and 241-AX Farm tanks that have been completed since Revision 1 was issued; and an estimate for the volume and inventory of waste releases from cascade lines, spare inlet overflows and pipeline leaks based on tank waste process data, ^{60}Co plumes in the vadose zone, and soil moisture content. Figure ES-1 shows major components of Waste Management Area A/AX (241-A and 241-AX Tank Farms) including: single-shell tanks used for waste retrieval and storage and catch tanks, pipelines, pits and diversion boxes used to transfer waste to and from the single-shell tanks.

Table ES-1 summarizes the results of tank waste loss reassessments for these tanks and provides a comparison to the waste loss estimates contained in HNF-EP-0182. The estimated volumes of waste lost and the waste composition (types) were evaluated to update the estimated inventory of constituents in RPP-26744, *Hanford Soil Inventory Model, Rev. 1.* Appendix D of RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report* provides a description of waste types and compositions and describes the rationale and logic used for assessments. In addition, tanks currently assumed as "sound" (the integrity classification of a waste storage tank for which surveillance data indicate no loss of liquid attributed to a breach of tank integrity) were reviewed to assess the potential for loss of waste containment. There was no conclusive indication of a tank liner failure and subsequent release of waste (leak) from any of the tanks classified as "sound" in the 241-A and 241-AX Tank Farms.

Figure ES-1. Waste Management Area A/AX and Surrounding Area



Note: Recent assessments concluded that tank 241-A-103 liner did not leak and recommend reevaluating the leak designation for tanks 241-AX-102 and 241-AX-104.

Table ES-1. Summary of Tank Waste Loss Events (2 sheets)

Tank	Description	HNF-EP-0182 Waste Loss Estimate (gal)	Revised Estimate[1]
241-A-103 (A-103)	From October 8, 1981 to March 5, 1987, the liquid level in tank A-103 was observed to have decreased an estimated 5,500 gal. However, the liquid waste level in tank A-103 would also slowly rise over a period of 9 to 12 months, then drop rapidly over a one to two day period. The liquid level decrease was likely due to release of retained gas and not a loss of waste from a liner leak. No increase in radioactivity was detected in drywells or laterals beneath this tank during these events.	5,500	0 gal Tank integrity assessment (RPP-ASMT-42278) reclassified tank as "sound"
241-A-104 (A-104)	The Hanford Site tank farm contractor in correspondence with the U.S. Energy Research and Development Administration reported an estimated waste loss of 700 to 1,500 gal in July 1975. In September 1975, the Hanford Site tank farm contractor conducted a study at tank A-104 to reevaluate the liner leak size and revised the estimated leak loss to ~2,000 gal. The waste type leaked from tank A-104 is PUREX HLW supernate (P1 waste) with 0.56 Ci/g ^{137}Cs.	500 to 2,500	2,000 gal ~1,100 Ci of ^{137}Cs Liner leak
241-A-105 (A-105)	At least three leak events occurred with tank A-105. PUREX HLW supernate (P1 waste) leaked from this tank in late 1963 and again in 1965. During sluicing in 1968 to 1970, 221-B Plant cesium ion exchange waste (waste type BIX) also leaked from this tank. In an effort to better quantify the inventory of waste leaked from tank A-105, a new conceptual model was devised to describe the leak. Based on this conceptual model, the range of waste volume leaked from tank A-105 was estimated to be between 2,000 gal (if all P1waste) or 40,000 gal (if all BIX waste). The actual volume of P1 and BIX waste is unknown.	10,000 to 277,000	2,000 to 40,000 gal 56,000 Ci of ^{137}Cs plus cooling water[2] Liner Leak
241-AX-102	An estimated waste loss of 3,400 gal from tank 241-AX-102 is inconsistent with the relatively low level of radiation detected in the leak detection pit and drywells associated with this tank. The likely source of radioactivity detected historically in drywells 11-02-11 and 11-02-12 is the leaking Dresser coupling associated with the tank off-gas piping and releases from the ventilation system. An integrity assessment concluded that the tank appears to be sound. 241-AX Farm tank leak pits will be swabbed to confirm the assessment conclusions.	3,000	0 gal Tank appears sound Tank integrity assessment (TFC-ENG-CHEM-D-42) in progress
241-AX-104	The likely source of radioactivity detected historically in drywells 11-04-01 and 11-04-11 is the leaking Dresser coupling associated with the tank off-gas piping and releases from the ventilation system.	---	0 gal Tank appears sound Tank integrity assessment (TFC-ENG-CHEM-D-42) recommended

Table ES-1. Summary of Tank Waste Loss Events (2 sheets)

Tank	Description	HNF-EP-0182 Waste Loss Estimate (gal)	Revised Estimate[1]
Other 241-A and AX Farm Single-Shell Tanks		0	0

[1] Except as noted, ^{137}Cs inventories are decayed to January 1, 2001.

[2] HNF-EP-0182 estimates 610,000 gal of cooling water were added to tank 241-A-105 from November 1970 to December 1978 to aid in evaporative cooling. Approximately 232,000 gal of added cooling water are potentially unaccounted for in the estimate of evaporative water. In accordance with Dangerous Waste Regulations [*Washington Administrative Code* 173-303-070, "Designation of Dangerous Waste," subsection (2)(a)(ii), as amended], any of this cooling water that has been added and subsequently leaked from the tank must be classified as a waste and should be included in the total leak volume.

HLW = high-level waste PUREX = Plutonium Uranium Extraction (Plant)

References:
HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014.*
RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*.
TFC-ENG-CHEM-D-42, Rev. B-7, "Tank Leak Assessment Process."

DOE/RL-88-30, *Hanford Site Waste Management Units Report* contains the official listing of unplanned releases identified at the Hanford Site. The operational histories for the 241-A and 241-AX Tank Farms were reviewed to determine if additional information exists for the unplanned releases within the 241-A and 241-AX Tank Farms that are not associated with tank waste loss events. Additional releases were identified through review of the operational histories for the 241-A and 241-AX Tank Farms. Nothing significant was identified in any of the new or existing documented unplanned releases information. However, during the review of the operational histories for the 241-T Tank Farm it was determined that there is a potential of newly identified unplanned releases as a result of pipeline failures or releases from overfilled tanks as summarized in Section 5.0. Except for the waste quantity estimates presented, there was insufficient information to estimate a volume or inventory of tank waste released to the soil for the identified unplanned releases. A rough estimate of surface releases was developed based on the most recent drywell data measurements.

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A1-Saltcake	saltcake from the first 242-A Evaporator campaign using 241-A-102 feed tank (1977-1980)
BDGRE	buoyant displacement gas release event
bgs	below ground surface
BIX	221-B Plant cesium ion exchange waste
Ci	Curies
cfm	cubic feet per minute
cm	centimeter
c/m	counts per minute
c/s or cps	counts per second
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
DWS	drinking water standard
Ecology	Washington State Department of Ecology
ESRB	Executive Safety Review Board
FIC	Food Instrument Corporation (gauge)
ft	feet
FY	fiscal year
gal	gallon
g or gm	gram
H or hr	hour
HLW	high-level waste
HPGe	high-purity germanium

HRLS	high rate logging system
HRR	high resolution resistivity
ILL	interstitial liquid level
in.	inch
kg	kilogram
LOW	liquid observation well
MT	manual tape
P1	PUREX HLW supernate
pCi	pico-curies
PNNL	Pacific Northwest National Laboratory
PSS	PUREX sludge supernate
PUREX	Plutonium Uranium Extraction (Plant)
r or rad	radiation absorbed dose
RAS	Radiation Assessment System
RCRA	*Resource Conservation and Recovery Act of 1976*
SIM	Soil Inventory Model
SGLS	spectral gamma logging system
SST	single-shell tank
TEDF	Treated Effluent Disposal Facility
TFPC	241-A and 241-AX Tank Farm Process Condensate
TWINS	Tank Waste Information Network System
UPR	Unplanned Release
W	Watts
WIDS	Waste Information Data System
WMA	Waste Management Area

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1.0 INTRODUCTION

Waste releases to the Hanford tank farms vadose zone are from many different sources, including tank liner leaks (a breach in tank liner, loss of integrity), cascade and spare inlet losses due to plugging of lines and overfilling the tanks, spills resulting from tank farm operations, and leaks in transfer pipelines. Vadose zone inventories are estimated by multiplying the release volume by the contaminant concentration in the solution released to the soil. The concentration of the solution released is based on process knowledge of the waste composition in the tank at the time the release occurred. For some major releases, historical records confirm the waste loss event and provide a strong technical basis for leak volume and inventory estimates. However, for many releases little data are available and there are varying degrees of uncertainty or differences in the available data.

Numerous studies and investigations have estimated the inventory of contaminants in the tank farms vadose zone. Document HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014* provides the current official tank leak volume estimates for tanks classified as "assumed leakers," but it does not provide associated inventory estimates, and tank leak volume estimates reported in HNF-EP-0182 have not been updated for many years. The Waste Tank Summary Reports were originally prepared for operational decisions, not to estimate the inventory released. It was not until the 1990s that the Waste Tank Summary Reports took on new meaning as the "official records" of leaking tanks—thereby assigning them a role different than originally intended. Document RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates* summarizes vadose zone tank leak characterization and investigations. The leak volume estimates presented in RPP-23405 are consistent with many of the estimates listed in HNF-EP-0182, but some estimates are much higher and others lower. RPP-23405 suggests that some releases attributed to tank leaks may have been from evaporation of waste, spare inlet overflows, line releases or spills during process operations. RPP-23405 also provides volume estimates for other unplanned releases (UPRs) in the single-shell tank (SST) farms.

Washington State Department of Ecology (Ecology) along with the Tank Farm Operations Contractor for the U.S. Department of Energy (DOE) developed a process to reassess selected tank leak estimates (volumes and inventories), and to update tank liner leaks, other waste releases, and UPR volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This report documents the results of applying the process described in RPP-32681 to reassess tank and UPR waste discharge estimates in the 241-A and 241-AX Tank Farms (A Farm and AX Farm). Current Hanford Soil Inventory Model (SIM) (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) estimates and leak/release volume estimates in the tank waste status report (HNF-EP-0182) should be updated to reflect revised estimates in this report.

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2.0 SCOPE AND CRITERIA

An assessment team comprised of representatives from Ecology, DOE's Office of River Protection and the Tank Farm Operations Contractor was assembled to review available information relating to waste loss events in 241-A and 241-AX Tank Farms (A and AX Farms). The assessment team membership is listed in Table 2-1. Team meeting summaries are included in Appendix A.

Table 2-1. Waste Loss Event Assessment Team

Name	Organization	Role
Jim Alzheimer	Washington State Department of Ecology	Regulatory oversight
Mike Barnes	Washington State Department of Ecology	Regulatory oversight lead (primary focus: tank retrieval and closure).
Joe Caggiano	Washington State Department of Ecology	Regulatory oversight (primary focus: vadose zone and groundwater data).
Jim Field	Washington River Protection Solutions	Leak Assessment lead Knowledge and experience with in-tank (i.e., surface liquid level and liquid observation well) data and vadose zone investigations.
Les Fort	Washington River Protection Solutions	Knowledge and experience in tank farm waste processing and operations and vadose zone characterization.
Paul Henwood	S. M. Stoller, Inc.	Knowledge and experience in gamma and spectral gamma logging and analyzing logging data.
Jeremy Johnson	U.S. Department of Energy Office of River Protection	Tank Farms Programs and Projects Division.
Jared Mathey	Washington State Department of Ecology	Regulatory oversight – Single-Shell Tank *Resource Conservation and Recovery Act of 1976* permit lead
Beth Rochette	Washington State Department of Ecology	Regulatory oversight (primary focus: closure, near-surface unplanned releases).

In accordance with RPP-32681, the following steps were conducted in reassessing waste losses within A and AX Farms.

- Collect information and data regarding past tank liner leaks in A and AX Farms (see RPP-32681).
- Collect information and data regarding waste releases (e.g., UPRs), including pipeline leaks, spills, and near-surface contamination in A and AX Farms.
- Compile information from previously reported waste tank liner leaks and UPRs to estimate the volume of tank waste which leaked to the vadose zone and the time at which these leaks occurred.

- Compile data regarding the waste composition at the time of a tank liner leak or UPR from the available sources, such as sample data, Tank Waste Information Network System, Best Basis Inventory, Hanford Defined Waste model, etc.

- Combine volume with waste composition to enable radionuclide and chemical inventory estimates for tank liner leaks and UPRs.

The initial 241-A and 241-AX Tank Farm leak assessment (Revision 1 of this report) was one of the first of a series of assessments for the 12 SST farms. Included in the reassessment and documented in this revised report were additional information and evaluations learned from development of other tank farm leak assessment reports; evaluations of "sound" tanks; reformatting of the report, incorporating the results of integrity assessments for A and AX Farm tanks that have been completed since Revision 1 was issued; and an estimate for the volume and inventory of waste releases from cascade lines, spare inlet overflows and pipelines based on tank waste process data, ^{60}Co plumes in the vadose zone, and soil moisture content. Figure ES-1 shows major components of Waste Management Area (WMA) A-AX including: SSTs used for waste retrieval and storage and catch tanks, pipelines, pits and diversion boxes used to transfer waste to and from the SSTs.

3.0 BACKGROUND

Approximately 57 million gal of radioactive waste from chemical processing and plutonium processing operations are stored in 177 underground storage tanks on the Hanford Site. Of these tanks, 149 are SSTs, which consist of a single steel liner inside a reinforced concrete tank. Nominal capacities range from 55,000 to 1,000,000 gal. For the immediate future, plans call for retrieval of waste from the SSTs and transfer to the 28 double-shell tanks (DSTs) with proven integrity, and eventual transfer for treatment in the Waste Treatment and Immobilization Plant.

3.1 241-A AND 241-AX TANK FARMS DESCRIPTION

The 241-A Tank Farm was constructed between 1954 and 1955. The SSTs in A Farm were operated as boiling waste tanks. The heat generated from the decay of radionuclides was sufficient to result in the evaporation of water from the wastes stored in these tanks. The water vapor and other off-gases from the A Farm SSTs were drawn from each tank through an underground 20-in.-diameter pipe that connects to an underground 24-in.-diameter pipe (i.e., vapor header). When AX Farm was constructed in 1963 and 1964, a similar vapor header was installed for these four SSTs. An underground 20-in.-diameter pipe connects from each SST to an underground 24-in.-diameter pipe. The underground 24-in.-diameter pipe runs to the 241-AX-152 diverter station. From the 241-AX-152 diverter station, the underground 24-in.-diameter pipe from the 241-AX vapor header connects to the A Farm vapor header.

The A Farm vapor header connects to underground condensers and de-entrainment vessels and then enters the 241-A-431 fan house and de-entrainment building. The 241-A and 241-AX Tank Farm Process Condensate (TFPC) was removed from the A and AX Farm off-gases and collected in tank 241-A-417. The off-gas was filtered and discharged through an exhaust stack. Initially, the condensate collected in tank 241-A-417 was either returned to one of the A or AX Farm SSTs or discharged to a crib. In January 1970, a prototype ion exchange system was installed to remove ^{137}Cs from the TFPC prior to discharge to cribs (PR-REPORT-JAN70, *Monthly Status & Progress Report January 1970*, pp. AV-2). Table 3-1 summarizes the analyses of the untreated TFPC waste located in reference documentation. The composition of the Plutonium Uranium Extraction (PUREX) high-level waste (HLW) supernate in tanks 241-A-101 (A-101), 241-A-104 (A-104), and 241-A-106 (A-106) in September 1964 are provided in Table 3-2 (RL-SEP-183-RD, *PUREX Tank Farm Supernatant Solution Composition*). In comparison with the TFPC, the ^{137}Cs concentration in the PUREX HLW supernate was ~100,000 times higher.

While not reported in these analyses, ^{60}Co was present in relatively small concentrations in the TFPC waste. The 216-A-8 crib received the TFPC waste from November 1955 through May 1956 and from April 1966 through April 1971. The 216-A-8 crib also received process condensate from 241-AY Tank Farm after April 1971. The 216-A-24 crib received TFPC waste from May 1956 through April 1966.

Table 3-1. 241-A Tank Farm Process Condensate Analyses

	241-A Tank Farm Process Condensate						
Constituent	**1959 Analyses[1]**	**1960 Analysis[2]**	**1969 Analyses[3]**			**1961 Analyses[4]**	**May 8, 1978[5]**
			#1	#2	#3		
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Tri-butyl or butyl phosphate	30 to 190	120	not reported			30 to 200	not reported
Shell spray base (or hydrocarbon)	< 10	not reported	not reported			10 to 70	not reported
Ammonium ion	not reported	not reported	630	430	156	35 to 200	not reported
Sodium	< 1.5	not reported	not reported			1 to 2	not reported
Nitrate	not reported	not reported	not reported			1 to 5	not reported
Nitrite	not reported	not reported	not reported			5 to 10	not reported
Iron	0.1	not reported	not reported			not reported	not reported
Nickel, chromium, copper, aluminum, zirconium, manganese, cobalt, calcium, and magnesium (each)	< 0.01	not reported	not reported			not reported	not reported
	µCi/ml	**µCi/ml**	**µCi/ml**			**µCi/ml**	**µCi/ml**
Cs-137	2.3E-02	3.2E-02	5E-3	7.4E-3	8.8E-3	1E-2	2.1E-4
Nb-95	2.5E-2	not reported				1E-2	not reported
Zr-95	1.2E-2	not reported				1E-2	not reported
Ru-106	7.2E-3	not reported				1E-3	2.2E-4
Ru-103	5.6E-3	not reported				not reported	not reported
Sr-89	3.7E-3	not reported				1E-3	not reported
Sr-90	4.4E-4					1E-4	not reported
Sr-89/90	not reported	8.4E-04				not reported	3.3E-4
Ce-144	5E-3	not reported				1E-3	1.45E-5
Y-91	3E-3	not reported				1E-3	not reported
I-131	not reported	not reported				1E-5	not reported
Gross beta	9.1E-2	not reported				not reported	not reported
Gross alpha	< 1.2E-6	not reported				not reported	not reported

[1] HW-63949, *Quarterly Progress Report Research and Development Activities Fixation of Radioactive Residues October – December 1959*, pp. 17.

[2] HW-66276, *The Removal of Cesium and Strontium from Condensate Wastes with Clinoptilolite*, pp. 14-17.

[3] Letter Mercer 1969, "Ion Exchange Treatment of 241-A and 241-AX Tank Farm Condensates." Values reported are for three separate experiments. Waste sluicing was being conducted during run #3.

[4] HW-79174, *Progress in Treatment of a Radioactive Condensate Waste*, pp. 16-17.

[5] Occurrence Report 78-47, *Radioactive Discharge Exceeding Specified Limits*.

Table 3-2. Plutonium Uranium Extraction High-Level Waste Supernate Analyses (September 2, 1964)

Constituent	241-A-101	241-A-104	241-A-106
	mg/L	mg/L	mg/L
Sodium	1.5E+05*	1.5E+05*	1.6E+05*
Nitrate	1.4E+04	4.1E+04	3.6E+04
Nitrite	1.55E+05	1.57E+05	1.54E+05
Sulfate	1.4E+04	1.8E+04	1.3E+04
Phosphate	5.4E+03	2.2E+03	9.0E+02
	µCi/ml	µCi/ml	µCi/ml
^{137}Cs	4.95E+03	3.34E+03	5.85E+03
^{95}Nb	not reported	not reported	not reported
^{95}Zr	81	37	1.58E+02
^{106}Ru	3.97E+02	58.5	1.89E+02
^{103}Ru	not reported	not reported	not reported
^{89}Sr	not reported	not reported	not reported
^{90}Sr	not reported	not reported	not reported
$^{89/90}$Sr	not reported	not reported	not reported
^{144}Ce	1.49E+02	94.5	1.71E+02

*These values are lower than the ^{137}Cs soil adsorption capacity and ^{137}Cs would be largely immobile in the soil (see RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report*, Appendix E).

In June 1963, the 216-A-24 crib (see Figure 6-1) was reported to have received 0.0124 Ci of ^{60}Co in 1.31E+06 liters of waste or ~9.5E-06 µCi/ml (HW-80877, *Radioactive Contamination in Liquid Wastes Discharged to Ground at the Separations Facilities Through 1963*, pp. 12). In December 1963, the 216-A-24 crib was reported to have received 0.0248 Ci of ^{60}Co in 1.36E+06 liters of waste or ~1.8E-05 µCi/ml (HW-80877, pp. 12). The TFPC was not reported as containing any ^{60}Co for the other months in 1963. In 1969, 0.058 Ci of ^{60}Co were reported to have been discharged in 6.37E+06 gal of TFPC to the 216-A-8 crib, or ~2.4E-06 µCi/ml. Also, the concentration of ^{60}Co was reported as 2.9E-05 µCi/cc in an April 1957 analysis of the condensate discharged to the 216-A-8 crib (HW-51399, *Calculation of PUREX A-8 Crib Capacity*, pp. 5). This information confirms that ^{60}Co was present in the TFPC as relatively small concentrations.

3.1.1 241-A Tank Farm Description

The 241-A tanks were designed for the storage of boiling waste generated from irradiated fuel reprocessing at the 202-A PUREX Plant. The 241-A tanks have three unique design features which are airlift circulators for cooling the boiling wastes, an underground vessel ventilation header to remove condensate and volatiles, and laterals 10 ft beneath the tank for leak detection.

The 241-A Tank Farm contains six nominally 1,000,000-gal capacity SSTs, as shown in Figure 3-1 (H-2-31880, *241-A Tank Farm Leak Detection System Plan-Section-Detail*) and Figure 3-2. The 241-A tanks consist of a 75-ft diameter, carbon steel liner inside a concrete tank. The tank steel bottoms intersected the sidewalls orthogonally (similar to 241-AX and 241-SX tanks), rather than the dished bottoms of earlier designed tank farms. The concrete thickness is 0.5 ft on the tank bottom, 2 ft to 1.25 ft on the side walls, and 1.25 ft for the tank dome. The concrete tank dome thickness increases to ~3.5 ft along the sidewalls. Each tank was originally equipped with 9 to 11 risers and a 20-in.-diameter vapor exhaust pipeline that penetrated the tank dome and 4 airlift circulators that were operated to suspend solids, mix the tank contents, and dissipate heat.

The 241-A tanks were originally designed to contain liquid and solid wastes at a maximum temperature of 280 °F (RPP-10435, *Single-Shell Tank System Integrity Assessment Report*, pp. A-42). After installation of airlift circulators, the operating temperature limit was revised to a maximum of 300 °F at the tank bottom (RPP-10435, pp. A-54). Wastes at higher temperatures could cause buckling of the steel liner and/or structural damage to the concrete shell.

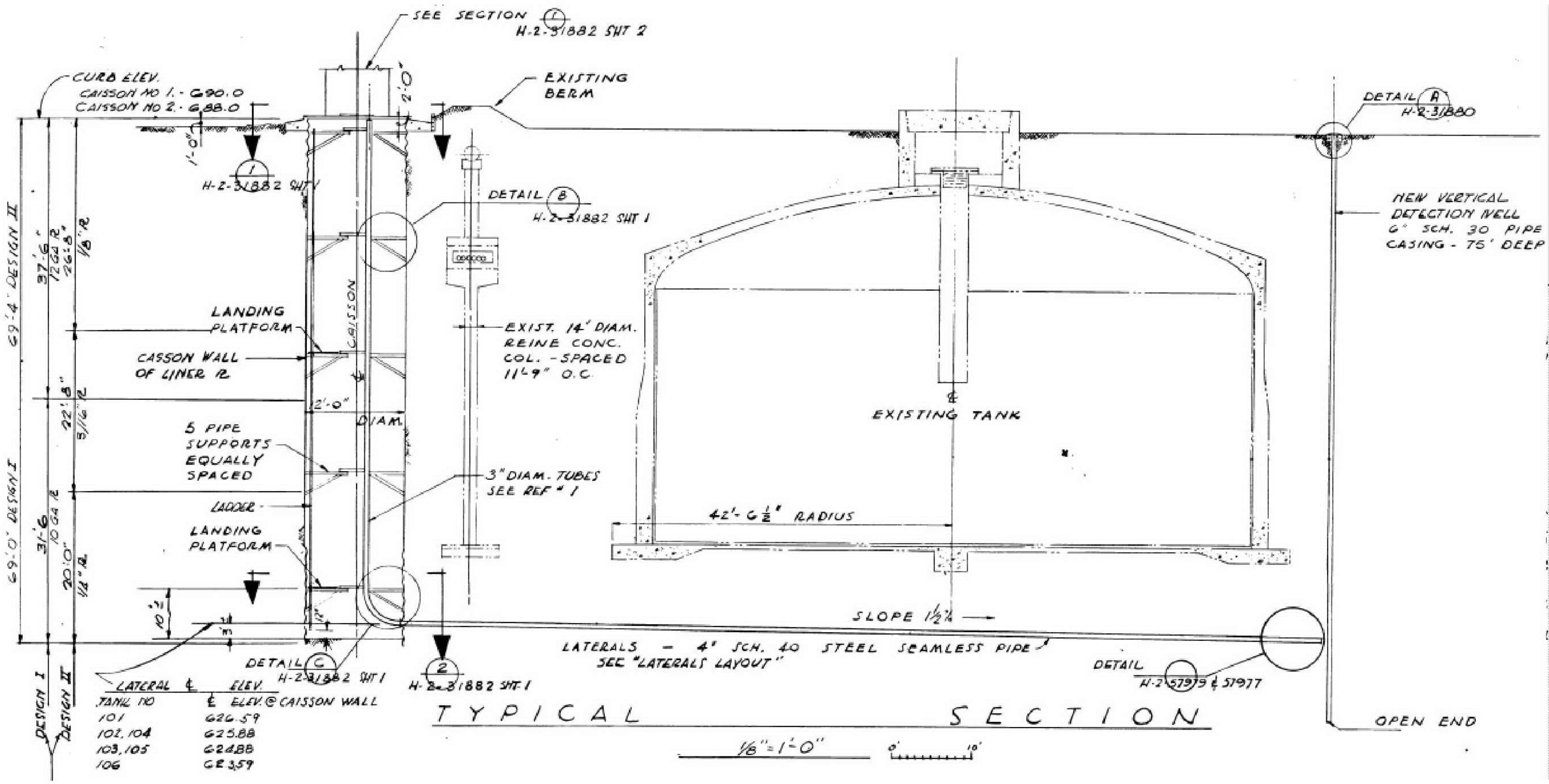
The 241-A tanks were vented to an underground vessel ventilation header that connected to AX Farm and later to the 241-AY Tank Farm. The purpose of this ventilation header was to remove off-gas and water vapor from these tanks, which were often operated with the wastes at boiling conditions. Section 4.5.2 includes further discussion on the vessel ventilation header and analyses of samples of condensate collected from this system. The 241-A and 241-AX tanks were isolated from this ventilation header in the early 1980s.

The design of this ventilation header included a baffled, 20-in.-diameter pipe inside each 241-A tank. The 20-in.-diameter pipe that exits the tank is connected to a 24-in.-diameter, stainless steel pipe header that is buried a minimum of 4 ft below grade. The 24-in. header ran between the tanks to the 241-A-431 ventilation building. Dresser couplings (see Figure 3-3) provide a compression seal on the outer surface of vapor header piping segments that are ~25 ft in length. A Dresser coupling is also used to seal the 20-in.-diameter pipe from each tank to the 24-in. main vapor header. The couplings provide for expansion and contraction of the vapor header pipe segments.

3.1.2 241-AX Tank Farm Description

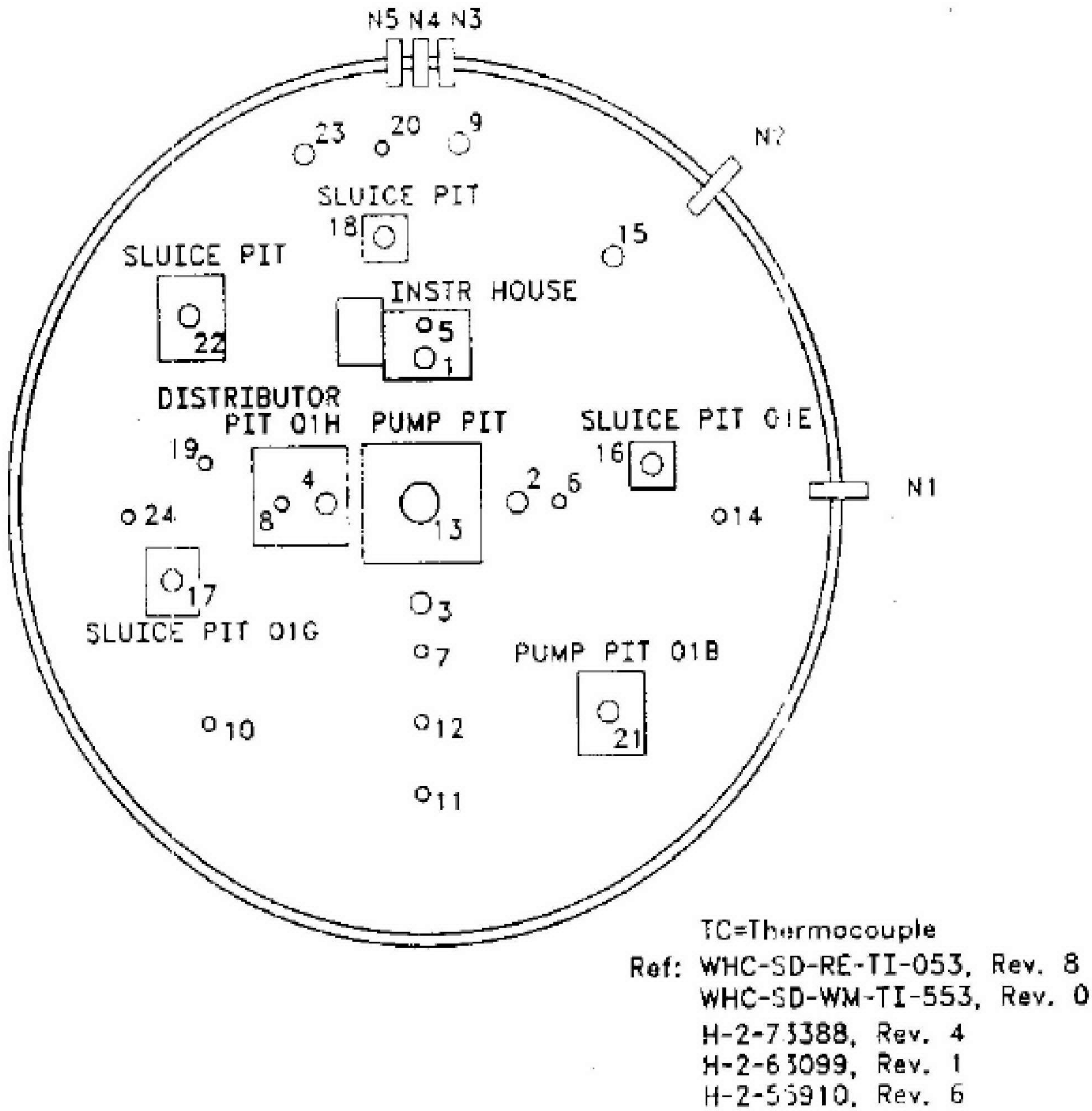
The 241-AX Tank Farm contains four 1,000,000-gal capacity SSTs. A cross section of a 241-AX tank is shown in RL-SEP-9, *PUREX 241-AX Tank Farm and Waste Routing System Information Manual* and Figure 3-4. The 241-AX tanks consist of a 75-ft-diameter carbon steel liner inside a concrete tank. The tank steel bottoms intersected the sidewalls orthogonally (similar to 241-AX and 241-SX tanks), rather than the dished bottoms of earlier designed tank farms. The concrete thickness is 1.5 ft on the tank bottom, 2 ft to 1.25 ft on the side walls, and 1.25 ft for the tank dome. The concrete tank dome thickness increases to ~5 ft along the sidewalls. Each tank was originally equipped with 54 risers that penetrated the tank dome and 22 airlift circulators that were operated to suspend solids, mix the tank contents, and dissipate heat (see Figure 3-5).

Figure 3-1. 241-A Farm Tank Showing Laterals



Reference: H-2-31880, *241-A Tank Farm Leak Detection System Plan-Section-Detail*.

Figure 3-2. Plan View of a Typical 241-A Farm Tank (Tank 241-A-101)

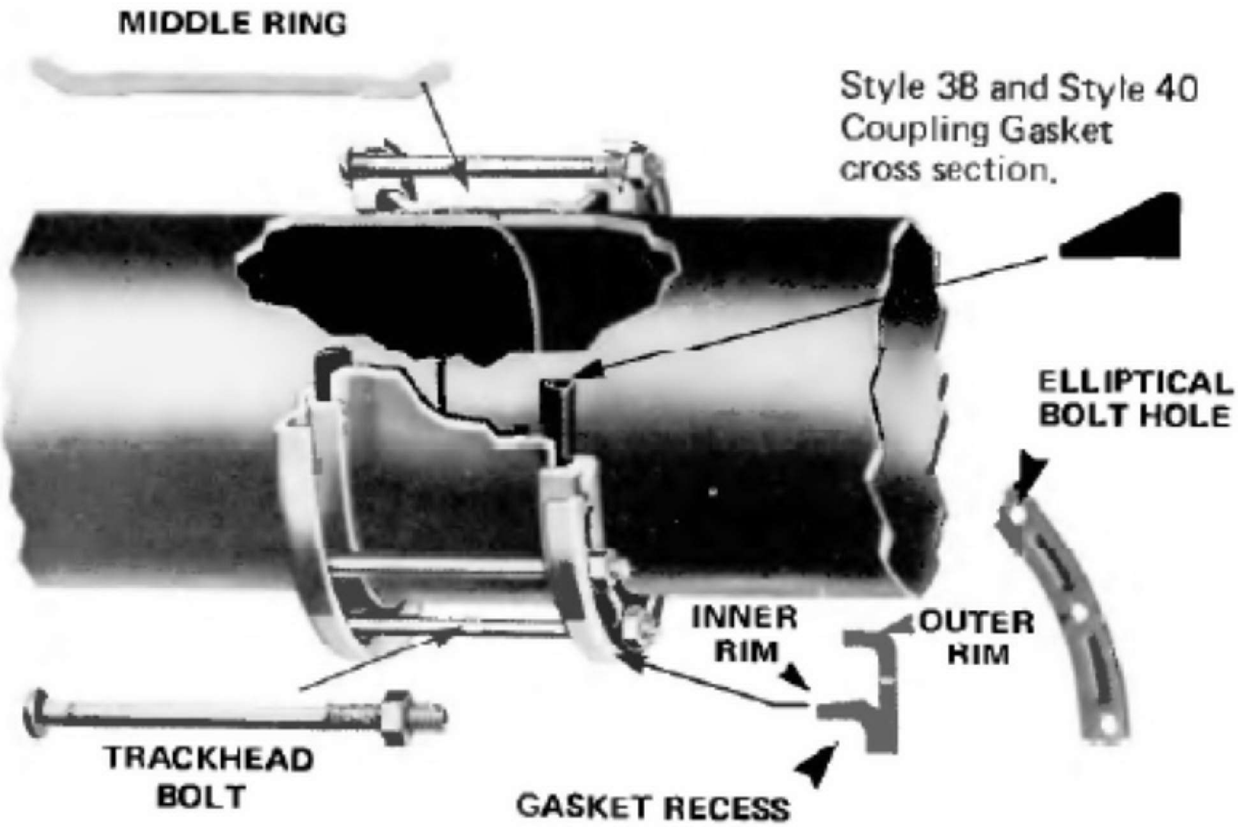


Note: Tank risers are numbered, side nozzles are distinguished with an identifier N before the number, and access pits are called out as to function/purpose.

References:

H-2-55910, *Waste Storage Tanks Dome Plan and Fixture Layout PUREX Waste Disposal Facility*.
H-2-63099, *105-A Tk. Arr'g't. As Built*.
H-2-73388, *Piping Waste Tank Isolation 241-A-101*.
WHC-SD-RE-TI-053, *Riser Configuration Document for Single-Shell Waste Tanks*.
WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.
WHC-SD-WM-TI-553, *Thermocouple Status Single Shell & Double Shell Waste Tanks*.

Figure 3-3. Typical Dresser Coupling

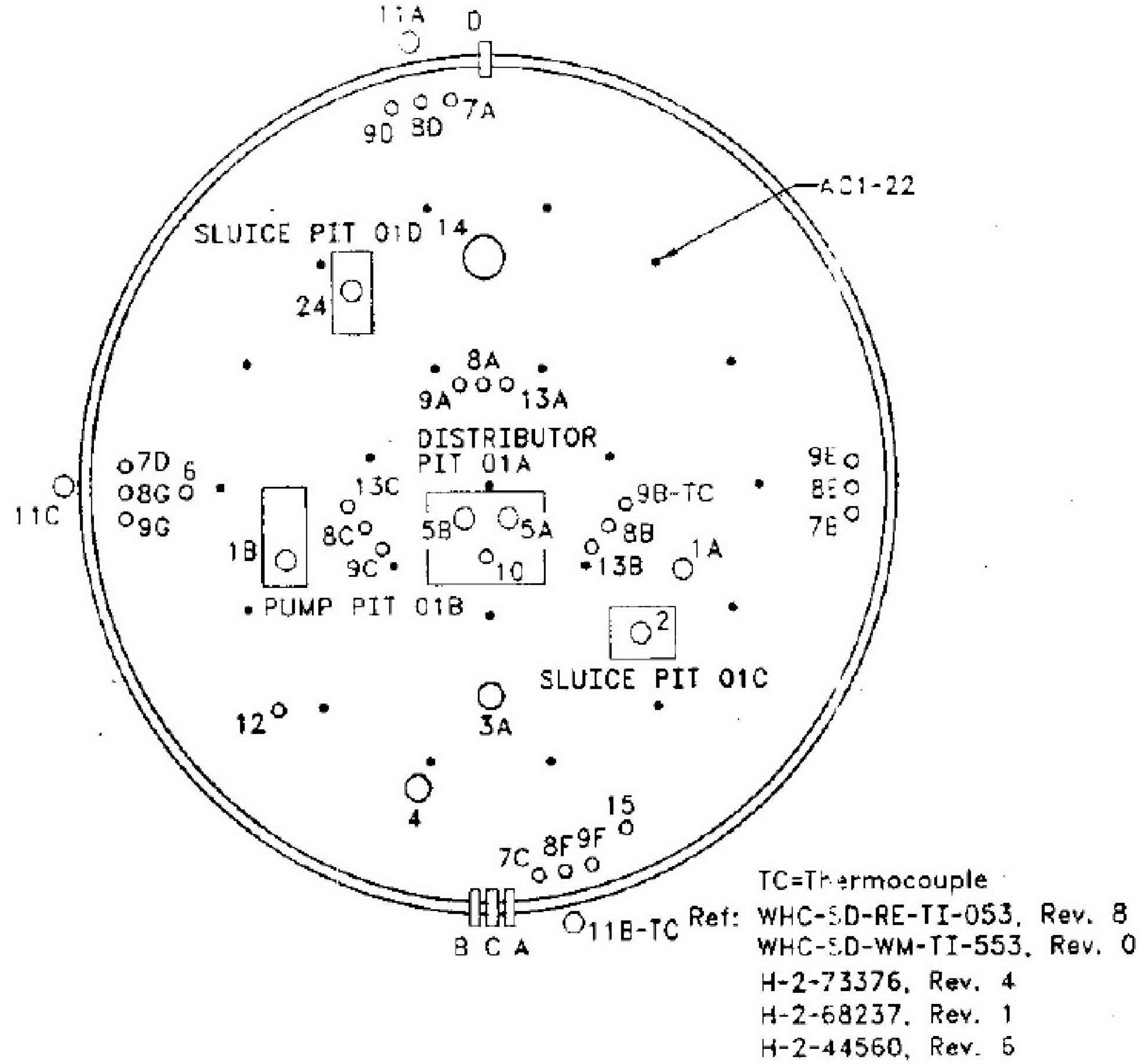


The 241-AX tanks were originally designed to contain liquid and solid wastes at a maximum temperature of 350 °F (RPP-10435, pp. A-43). Wastes at higher temperatures could cause buckling of the steel liner and/or damage to the concrete shell.

The 241-AX tanks were vented to an underground vessel ventilation header that connected to A Farm and later to the 241-AY Tank Farm. The purpose of this ventilation header was to remove offgas and water vapor from these tanks, which were often operated with the wastes at boiling conditions. Section 4.5.2 includes further discussion on the vessel ventilation header and analyses of samples of condensate collected from this system.

The 241-A and 241-AX tanks were isolated from this ventilation header in the early 1980s. The design of this ventilation header included a baffled, 20-in.-diameter pipe inside each 241-AX tank, as shown in Figure 3-3. The 20-in.-diameter pipe exiting the tank is connected to a 24-in.-diameter, stainless steel pipe header that is buried a minimum of 4 ft below grade. The 24-in. header ran between the tanks to the 241-AX-152 diverter station and then to A Farm to tie in to that farm's ventilation header. The 241-AX ventilation header slopes upward toward the A Farm tie-in. Dresser couplings provide a compression seal on the outer surface of vapor header piping segments that are ~25 ft in length. A Dresser coupling is also used to seal the 20-in.-diameter pipe from each tank to the 24-in. main vapor header. The couplings provide for expansion and contraction of the vapor header pipe segments.

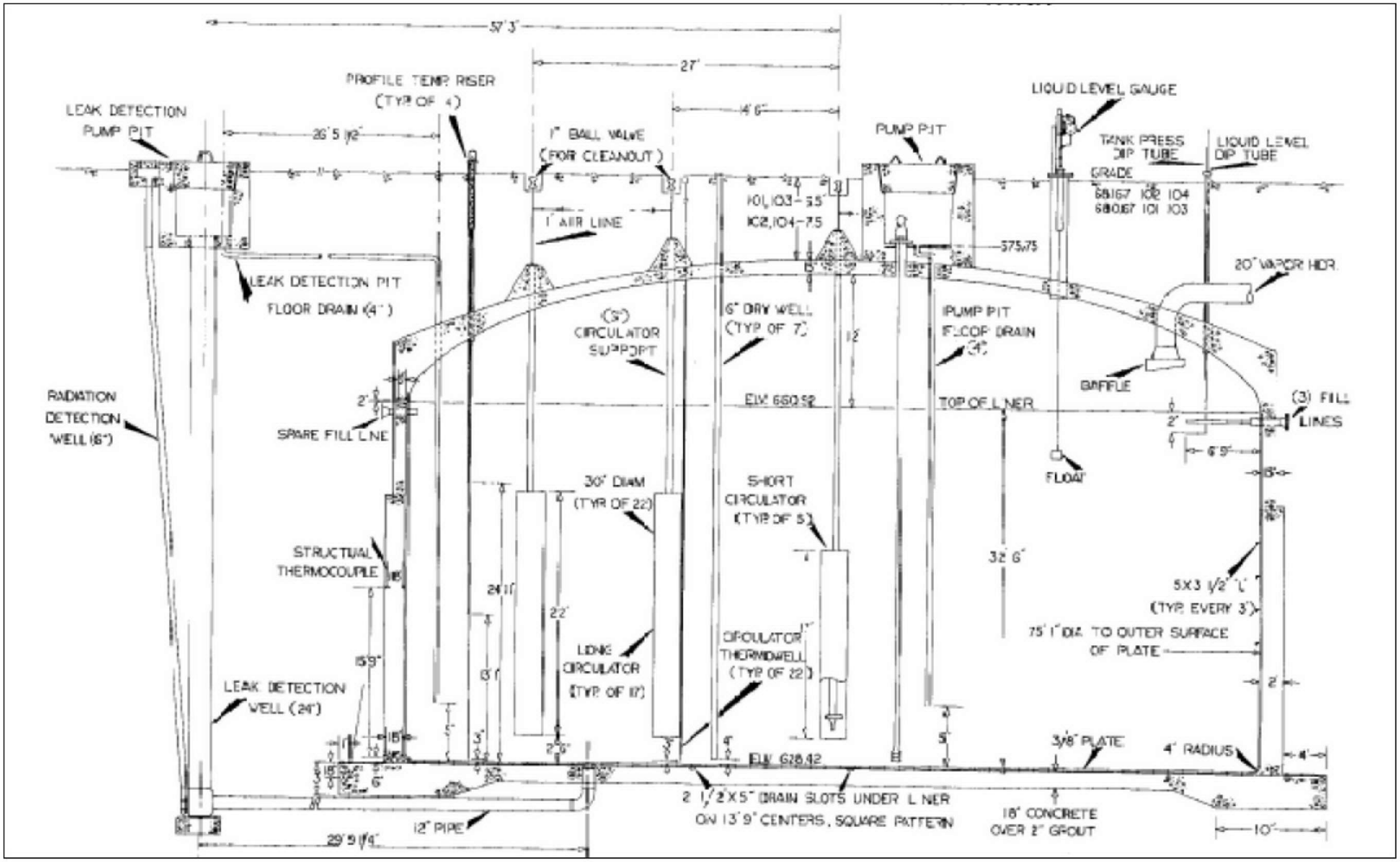
Figure 3-4. Typical 241-AX Farm Tank Plan View (Tank 241-AX-101)



Note: Tank risers are numbered, side nozzles are distinguished with an identifier N before the number, and access pits are called out as to function/purpose.

References:
H-2-55910, *Waste Storage Tanks Dome Plan and Fixture Layout PUREX Waste Disposal Facility*.
H-2-63099, *105-A Tk. Arr'g't. As Built*.
H-2-73388, *Piping Waste Tank Isolation 241-A-101*.
WHC-SD-RE-TI-053, *Riser Configuration Document for Single-Shell Waste Tanks*.
WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.
WHC-SD-WM-TI-553, *Thermocouple Status Single Shell & Double Shell Waste Tanks*.

Figure 3-5. 241-AX Farm Tank and Leak Detection Pit Composite Drawing



Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

3.2 TANK LEAK DETECTION MONITORING

Historically, SSTs were monitored by two independent methods: in-tank and ex-tank monitoring. From the beginning of Hanford Site tank farm operations, the primary leak detection system was routine monitoring of static liquid-surface levels within each tank. Routine monitoring of gross gamma activity in drywells near the SSTs provided the second leak detection method. The majority of the drywells in A Farm were drilled in the early 1960s to depths of ~75 ft and many of the drywells were deepened in the late 1970s to depths of ~125 ft. The drywells in AX Farm were drilled in 1974 and 1975 and are mostly ~100 ft deep. After the SSTs were pumped and interim stabilized, gross gamma monitoring was no longer required except as specified in tank waste retrieval work plans (RPP-9937, *Single-Shell Tank System Leak Detection and Monitoring Functions and Requirements Document*). Figures 3-6 and 3-7 show the location of drywells in A and AX Farms (Drywells 10-00-02 and 10-00-01, northeast corner of A Farm not shown). Table 3-3 shows A and AX Farm drywell numbers, ID, names, dates the drywells were drilled, and depth of the drywells.

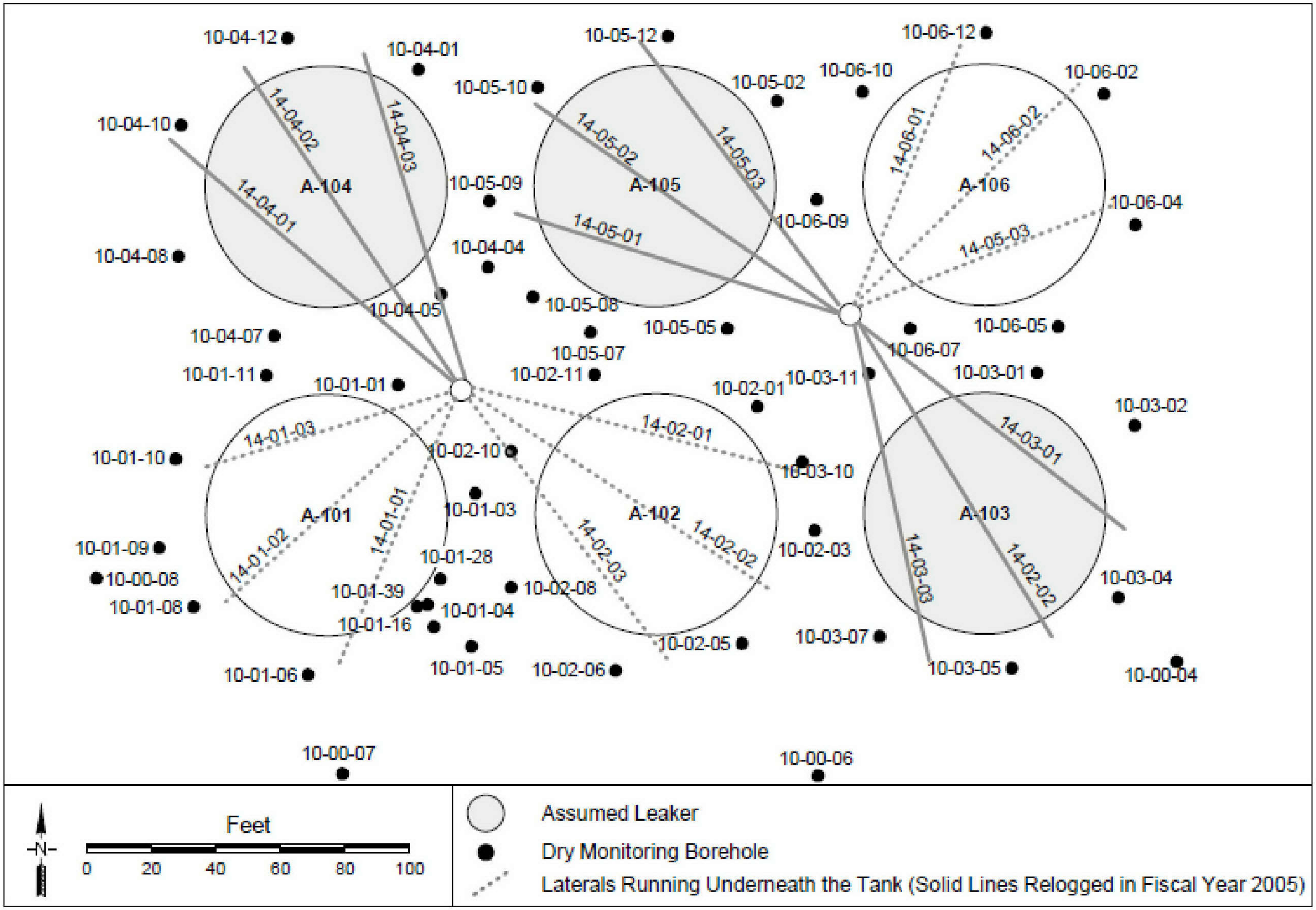
In addition to drywells, beneath each of the tanks in A Farm, three horizontal lateral pipes were installed in 1962 and 1963 (Figure 3-6). These laterals were installed after waste leakage from tank 241-SX-113 was suspected in 1958 and confirmed in 1962. Each lateral is ~10 ft beneath the tank concrete foundation. These laterals are 4-in. outer diameter, schedule 40 seamless steel pipe. The horizontal lateral pipes enter a caisson, transition to vertical orientation, and extend to an instrument enclosure at ground elevation. Probes can be inserted into each lateral to monitor for gamma radiation that could indicate waste leakage from a tank or pipeline.

Each 241-AX tank has its own internal leak detection pit consisting of a network of drain slots in the concrete base immediately below the carbon steel liner (Figure 3-7). A 12-in. carbon steel pipe connects the drain network with a leak detection well. The 60-ft deep well consists of a 24-in., schedule 20 carbon steel pipe, surmounted by a concrete pump pit. A waste transfer line connects the leak detection pit with a pump pit atop the 241-AX tank. The leak detection well is vented to the main vent header through a water-filled seal pot. The leak detection pump pits drain into their respective storage tanks through a 4-in. line that extends 5 ft from the tank bottom. Each leak detection pit has a separate 6-in. “radiation detection well” (see Figure 3-5) that intersects the soil adjacent to the bottom of the leak detection pit. The radiation well is used as a cost-effective and non-invasive method to monitor changes in gamma activity within the leak detection pit.

3.2.1 In-Tank Monitoring

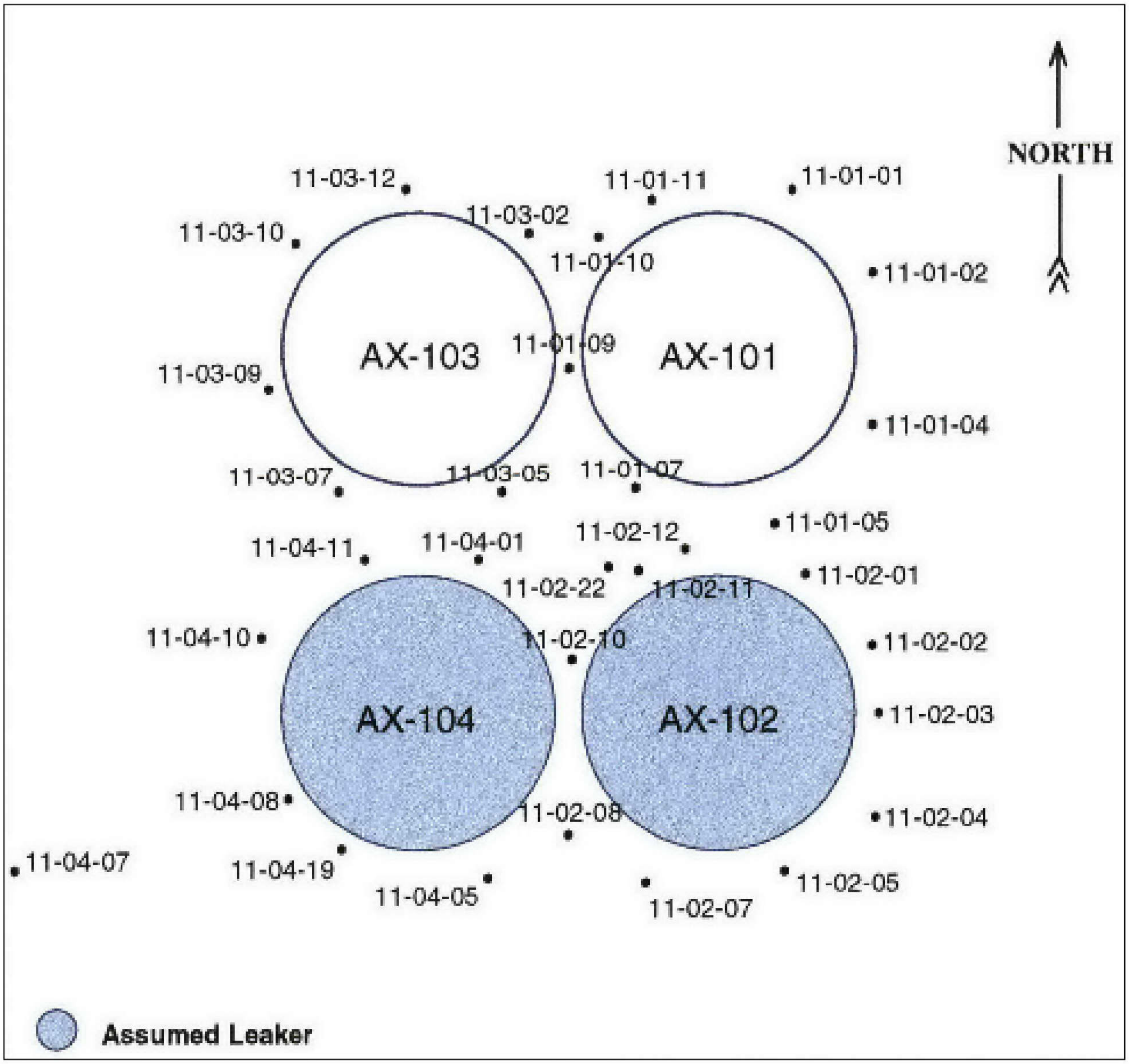
Originally, liquid levels were measured using pneumatic dip tubes (HW-10475 C-DEL, *Hanford Technical Manual Section C*, pp. 908). This practice was later replaced with a manual tape (MT) that had a conductivity electrode used to detect the liquid surface (H-2-2257, *Conductor Reel for Liquid Level Measurement*).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

Figure 3-6. Location of Drywells and Laterals in 241-A Tank Farm



Source: RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX.*

Figure 3-7. Location of Drywells in 241-AX Tank Farm



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

Surface level measurements remain highly uncertain in the waste tanks that contained boiling wastes (e.g., 241-A, 241-AX and 241-SX Tank Farms), when supernate has been removed from tanks leaving solids or precipitated salts, or where solid crusts have formed on the waste surfaces. In addition to uncertainty in measurements of liquid level, liquid level decreases may be caused by a liner leak, evaporation, barometric pressure changes or physical changes in waste surfaces (i.e., floating solids, surface collapse or gas release events). Liquid observation wells

(LOW) were installed in many of the tanks to measure interstitial liquid levels (ILL) using gamma and neutron probe measurements.

Table 3-3. 241-A and 241-AX Tank Farm Drywells (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Well Depth (feet)[1]
10-00-01	A6046	299-E25-57	30-Jun-55	150
10-00-04	A6047	299-E25-58	30-Jun-55	151
10-00-06	A4763	299-E25-15	3-Jul-69	340[2]
10-00-07	A4750	299-E24-14	1-Jul-69	340[2]
10-00-08	A4749	299-E24-13	10-Sep-69	340[2]
10-01-01	A6532	299-E25-97	28-Feb-62	125
10-01-03	A6530	299-E25-91	30-Apr-62	75
10-01-04	A6531	299-E25-92	30-Apr-62	125
10-01-05	A4759	299-E25-1	28-Feb-55	322[2]
10-01-06	A5925	299-E24-70	06-Apr-62	125
10-01-08	A5926	299-E24-71	13-Feb-62	125
10-01-09	B8052	10-01-09	1962 or 1978	75
10-01-10	A5927	299-E24-72	03-May-62	125
10-01-11	A5928	299-E24-73	02-May-62	125
10-01-16	A6567	299-E25-149	1981	51
10-01-28	A6608	299-E25-204	31-Jan-84	45
10-01-39	A6598	299-E25-192	31-Mar-82	46
10-02-01	A6529	299-E25-90	30-Apr-62	125
10-02-03	A6522	299-E25-83	30-Apr-62	125
10-02-05	A6524	299-E25-85	30-Apr-62	125
10-02-06	A6525	299-E25-86	30-Apr-62	85
10-02-08	A6526	299-E25-87	30-Apr-62	125
10-02-10	A6527	299-E25-88	28-Feb-62	125
10-02-11	A6528	299-E25-89	30-Apr-62	125
10-03-01	A6517	299-E25-78	31-May-62	125
10-03-02	A6518	299-E25-79	30-Apr-62	125
10-03-04	A6519	299-E25-80	30-Apr-62	125
10-03-05	A6520	299-E25-81	30-Apr-62	125
10-03-07	A6521	299-E25-82	30-Apr-62	125
10-03-10	A6044	299-E25-55	31-May-55	151
10-03-11	A6523	299-E25-84	30-Apr-64	85
10-04-01	A6500	299-E25-61	31-May-62	125
10-04-04	A6045	299-E25-56	3-Jun-55	151
10-04-05	A6502	299-E25-63	30-Apr-62	125

Table 3-3. 241-A and 241-AX Tank Farm Drywells (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Well Depth (feet)[1]
10-04-07	A5921	299-E24-66	31-May-62	120
10-04-08	A5922	299-E24-67	30-Apr-62	125
10-04-10	A5923	299-E24-68	31-May-62	125
10-04-12	A5924	299-E24-69	31-May-62	69
10-05-02	A6507	299-E25-68	31-May-62	125
10-05-05	A6509	299-E25-70	30-Apr-62	75
10-05-07	A6510	299-E25-71	30-Apr-62	75
10-05-08	A6533	299-E25-98	31-Jan-66	56
10-05-09	A6501	299-E25-62	30-Apr-62	75
10-05-10	A6505	299-E25-66	30-Apr-62	125
10-05-12	A6506	299-E25-67	30-Apr-62	75
10-06-02	A6513	299-E25-74	31-May-62	125
10-06-04	A6514	299-E25-75	31-May-62	125
10-06-05	A6515	299-E25-76	30-Apr-62	75
10-06-07	A6516	299-E25-77	28-Feb-62	125
10-06-09	A6508	299-E25-69	30-Apr-64	125
10-06-10	A6511	299-E25-72	30-Apr-62	125
10-06-12	A6512	299-E25-73	31-May-62	100[2]
11-01-01	A6534	299-E25-99	30-Nov-74	100
11-01-02	A6535	299-E25-100	31-Dec-74	100
11-01-04	A6537	299-E25-101	31-Jan-75	100
11-01-05	A6538	299-E25-102	31-Jan-75	100
11-01-07	A6539	299-E25-103	31-Jan-75	100
11-01-09	A6540	299-E25-104	31-Dec-74	100
11-01-10	B2896	299-E25-131	1978	73
11-01-11	A6541	299-E25-105	31-Dec-74	100
11-02-01	A6563	299-E25-132	30-Apr-78	125
11-02-02	A6542	299-E25-106	31-Jan-75	100
11-02-03	B2898	299-E25-133	1978	75
11-02-04	A6543	299-E25-107	28-Feb-75	100
11-02-05	A6544	299-E25-108	28-Feb-75	100
11-02-07	A6545	299-E25-109	28-Feb-75	99
11-02-08	A6546	299-E25-110	28-Feb-75	100
11-02-10	A6547	299-E25-111	28-Feb-75	100
11-02-11	A6548	299-E25-112	31-Jan-75	100
11-02-12	A6562	299-E25-128	31-May-75	52

Table 3-3. 241-A and 241-AX Tank Farm Drywells (3 sheets)

Well Number	Well ID	Well Name	Drill Date	Well Depth (feet)[1]
11-02-22	A6561	299-E25-127	31-May-75	125
11-03-02	A6549	299-E25-113	31-Jan-75	100
11-03-05	A6550	299-E25-114	31-Dec-74	100
11-03-07	A6551	299-E25-115	28-Feb-75	100
11-03-09	A6552	299-E25-116	31-Jan-75	120
11-03-10	A6553	299-E25-117	31-Jan-75	100
11-03-12	A6554	299-E25-118	31-Dec-74	100
11-04-01	A6555	299-E25-119	31-Dec-74	100
11-04-05	A6556	299-E25-120	28-Feb-75	100
11-04-07	A6557	299-E25-121	31-Mar-75	95
11-04-08	A6558	299-E25-122	28-Feb-75	100
11-04-10	A6559	299-E25-123	31-Mar-75	100
11-04-11	A6560	299-E25-124	31-Jan-75	125
11-04-19	A6565	299-E25-147	31-Mar-78	125

[1] Except as specified, the drywells have a 6- or 8-in. diameter steel casing. In 1978, many wells drilled to 75 ft in the 1960s and well numbers ≥ XX-XX-12 were extended. Extending a borehole usually involved installing a 15- to 20-ft length of temporary 8-in. overshot casing at the ground surface and extending the 6-in. casing to the desired depth. In the event that the 6-in. casing could not be driven to the completion depth, a 4-in. pipe was inserted into the original casing and the drywell was continued using this smaller casing. On reaching the planned depth, the temporary surface casing was removed and grout was usually placed in the annular space between the permanent casing and the portion of the drywell wall that was occupied by the overshot casing.

[2] Double cased with 6-in. or 8-in. casing and 4-in. casing and grouted between casings (referred to as Webster Completion wells).

References:

Environmental Dashboard Application, Queried 06/20/2013, [Well Reports/Document Lookup, provides multiple report formats for groundwater well information from Hanford Environmental Information System, Hanford Well Information System, and Waste Information Data System], http://environet.hanford.gov/EDA/index.cfm?regid=%23%2EP%28%22%0A&fwnavid=%23%2D%20%24%2F%0A&navMode=%28%3FT%3D%3A%28Y%3EJ%3B1%5C%20%0A.
GJ-HAN-1, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank T-110.*
GJ-HAN-2, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank T-107.*
GJ-HAN-49, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank AX-101.*
GJ-HAN-50, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank AX-102.*
GJ-HAN-51, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank AX-103*
GJ-HAN-52, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank AX-104.*
GJ-HAN-106, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-101.*
GJ-HAN-107, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-102.*
GJ-HAN-108, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-103.*
GJ-HAN-109, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-104.*
GJ-HAN-110, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-105.*
GJ-HAN-111, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-106.*

The A and AX Farm tanks were initially monitored using MT and/or Food Instrument Corporation (FIC) gauge surface level measurements. Between 1995 and 2002, FIC and MT gauges were removed and replaced by Enrafs®[1]. Liquid observation wells for neutron and gamma ILL measurements were installed in tanks A-101, 241-A-103 (A-103), 241-AX-101 (AX-101) and 241-AX-103 (AX-103).

Following is a description of in-tank monitoring instrumentation summarized from RPP-9645, *Single-Shell Tank System Surveillance and Monitoring Program.*

Enraf®. The Enraf® gauge is the most accurate level gauge currently used in the tank farms. This gauge tracks level changes in tank waste by using a load cell to monitor the weight of a displacer. For the purposes of leak detection, the Enraf® gauge needs a free liquid surface below the displacer. The vendor quotes an Enraf® precision of ± 0.004 in. and an accuracy of ± 0.04 inches. However, in-tank Enraf® instruments are calibrated to an accuracy of ± 0.1 in. and the 2-decimal readout on the gauge provides a precision of ± 0.01 inch.

The condition providing the highest sensitivity to a potential liner leak is a smooth, pure liquid waste surface combined with the most accurate gauge (Enraf®). These measurements are impacted very little by day-to-day variation from either the waste surface or gauge error. If the waste surface becomes more irregular or a gauge with lower resolution is used, the measurement data becomes more scattered (increases) during the normal day-to-day readings. For a heavy slurry waste with a highly irregular surface and a low-resolution instrument, the day-to-day readings exhibit a higher degree of nominal data scatter. Surface level gauges are not used for leak detection if the waste has a solid surface, since the level would not decrease in response to a leak. Liquid levels cannot be measured accurately during waste transfer operations or in self-boiling tanks with a dynamic surface (resulting that at certain times tank waste surface levels were uncertain when the surface was dynamic [as in boiling tanks] or a transfer was occurring).

Manual Tape. The MT is still used in a few tanks. It relies on a metal tape with a plummet contacting an electrically conductive waste surface. An MT in good working order on a highly conductive surface should be accurate and repeatable to ~0.25 inch. As the waste dries out, the device becomes less accurate, until ultimately no signal is received. Uncertainty for different tanks varied from 0.25 in. to 2 inches. The drying out of the waste surface is typically observed as increasing levels of data scatter during routine data reviews. Most DSTs use the MT as a backup to the Enraf®.

The FIC conductivity gauge is no longer used. The FIC was functionally equivalent to the MT, except that the tape and plummet were raised and lowered by a motor rather than manually. All FICs have now been replaced by Enraf® gauges.

Interstitial Liquid Level. Levels of waste phases can be measured by using geophysical techniques deployed inside an LOW placed in a tank. The LOWs were installed in tanks containing permeable waste (i.e., tanks containing saltcake versus sludge) and/or tanks with a solid waste surface. Originally, the uncertainty of waste surface level measurements varied from 1 to 3 in. depending on the waste and barometric pressure changes. Interpreting LOW measurements is complicated, especially for a low permeability waste or when the liquid level is

[1] Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

between two waste layers with different permeability (e.g., saltcake and sludge). Updated methods have improved the accuracy of current LOW measurements. Such actions include calibrating the waste depth measuring system daily before going to the field to ensure measurements are within ± 0.25 in. of its known value; verifying the neutron and gamma probes before each use; and comparing all of the measurement scans to a “reference scan” to identify any spikes, drifting, dead zones, or other anomalous problems (assuming a uniform waste porosity).

3.2.2 Ex-Tank Monitoring

Total gamma logging was initially performed in the drywells using NaI and Green and Red total gamma monitoring detectors (Geiger Mueller detectors) (Figure 3-8). Gross gamma logging detects only the cumulative sum of all radioactive gamma-emitting isotopes and does not distinguish the isotopes creating the gamma energy. Gross gamma logs were used to detect relative changes in the drywell profile as an indicator of change—either decay or movement toward or away from a drywell. The total gamma logs were digitized starting in 1975. Some pre-1975 archive strip chart data (1967 to 1971) were located for drywells in A Farm and were reviewed as part of these analyses; the AX Farm drywells were installed in December 1974 or later.

Between 1995 and 2000, all of the drywells in all of the farms were logged using a spectral gamma logging system (SGLS). The SGLS uses a high-purity germanium (HPGe) detector and provides isotope-specific gamma measurements (e.g., cesium, europium, cobalt and uranium isotopes). Detection and quantification of low specific activity radionuclides such as $^{238/235}U$, and other transuranics or radionuclides that have experienced significant decay such as ^{60}Co, generally require an SGLS. For areas of higher activity (> 2,000 pCi/g), a high rate logging system (HRLS) employing an HPGe is used to quantify activity levels as high as 1E8 pCi/g.

The Radiation Assessment System (RAS) truck was designed for routine gamma monitoring against the baseline established from the SGLS data in 1999. The RAS uses a series of three interchangeable NaI(Tl)-based scintillation detectors (RAS-L, RAS-M, and RAS-S) for measurement over the range from background levels to $\sim 10^5$ pCi/g ^{137}Cs. The size of a leak that can be detected by RAS depends on the radioactivity level of the waste leaked, the leak rate, proximity of a dry borehole to the leak, and subsurface soil properties controlling flow rate and direction. Consequently, there is no single value that can be stated as the maximum leak that could go undetected by drywell monitoring for an SST. Figure 3-8 shows approximate measurement ranges of different types of gamma radiation detectors.

As with the in-tank measurements, there are uncertainties associated with the ex-tank geophysical logging. Three sources of uncertainty are as follows.

1. Number and location of wells / laterals / leak detection pits: There were rarely more than six drywells surrounding the 100-series SSTs (circumference ~235 ft) and often fewer. These drywells are generally 6-in.-diameter steel casings that extend vertically 75 to 125 ft below ground surface (bgs) (groundwater is between 245 and 300 ft bgs) and allow access of geophysical probes. Because the holes had to be steel cased to prevent collapse and loss of

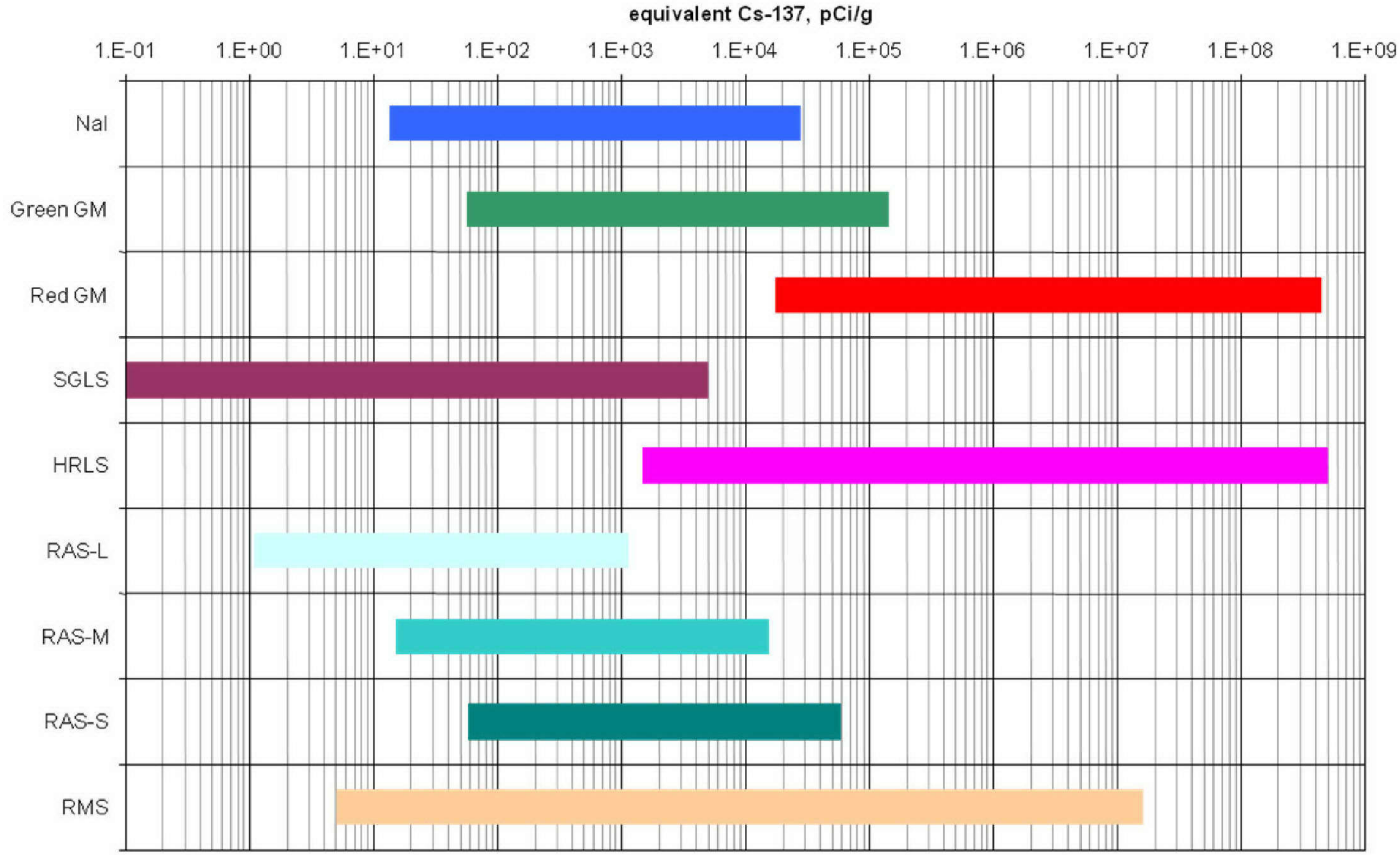
the drywell, only gamma-emitting radionuclides within about a 12-in. radius of a drywell are detected. Geologic conditions at the Hanford Site require that monitoring drywells (drywells) must be cased to prevent collapse. Alpha and beta radiation are blocked by the casing; only gammas (and neutrons) can penetrate to the detector. With HPGe detectors, it is possible to collect gamma energy spectra with sufficiently good energy resolution to identify characteristic decay gammas, and to calculate concentration based on net counts for specific photopeaks. Table 3-4 lists prominent gamma decay "lines" for various man-made and naturally-occurring radionuclides. Typical minimum detection limits are provided for HPGe detectors; these detection limits will be significantly higher for detectors such as NaI, which has poorer energy resolution capability.

The presence of steel borehole casing and the steel housing of the logging sonde restrict the minimum detectable gamma energy to about 180 keV. At lower energies, gamma attenuation becomes severe, but very high concentrations may still be detectable. "Pure" beta emitters such as ^{90}Sr can be qualitatively detected on the basis of bremsstrahlung radiation resulting from beta interactions in the casing. In other cases, radionuclides with few or no detectable gamma lines may be intimately associated with other, more detectable radionuclides. Examples include ^{240}Pu (^{239}Pu), ^{241}Pu (^{237}U), and ^{233}U (^{232}U/^{208}Tl). It is also possible that mobile, readily detectable radionuclides such as ^{60}Co may serve as surrogates or indicators for other, less detectable radionuclides such as ^{99}Tc.

Laterals beneath the A and 241-SX Farm tanks provided a gamma monitoring system as a means to compare drywell readings. However, the absence of gamma activity in a well, lateral, or leak detection pit (AX Farm only) does not necessarily indicate that a tank did not leak. Nevertheless, the leak detection pits are considered the most effective method to detect a low-volume leak, with laterals as the second most effective.

A few drywells were installed within the tank farms when they were constructed, but most were not installed until the 1970s. During the Hanford operational period, data collection technology evolved from manual records of detector readings to strip charts to digital data collection. Probe types, detectors and logging practices also changed. From 1974 to 1994, total gamma data are available in electronic format, and these detectors have been reasonably well characterized. Although most leaks and releases occurred prior to 1973, careful evaluation of available drywell data can be used to reconstruct contaminant distribution and migration patterns over a period of 20 years. Chemical contaminants as well as alpha- and beta-emitting isotopes are not detected during logging and can only be found through soil sampling and analyses. However, the existence of short-lived mobile gamma-emitting radionculides deep in the vadose zone may be an indicator of pathways for mobile chemical contaminants such as nitrates.

Figure 3-8. Measurement Ranges of Tank Farm Gamma Detectors



Notes:

NaI: Sodium iodide or scintillation detector used to measure total gamma in lower activity wells
Green GM: Geiger Mueller tube used to measure moderate gamma activity.
Red GM: Geiger Mueller tube used to measure high gamma activity
SGLS: Spectral gamma logging system, uses a high purity germanium detector to measure gamma energy spectra for separate gamma radionuclides (i.e., ^{137}Cs, ^{60}Co, ^{154}Eu, ^{238}U)
HRLS: High rate logging system, uses shielding to investigate gamma activity too intense for the spectral gamma logging system.
RAS-L: Radionuclide Assessment System – large NaI detector
RAS-M: Radionuclide Assessment System – medium NaI detector
RAS-S: Radionuclide Assessment System – small NaI detector
RMS: Radionuclide monitoring system (not used at Hanford)

Table 3-4. Radionuclides Detectable with High-Purity Germanium Equipment (2 sheets)

Man-made Gamma-Emitting Radionuclides Detectable with High-Purity Germanium Equipment						
Radionuclide	Half life (years)	Primary Gamma Rays		Secondary Gamma Rays		Typical MDL, pCi/g
		E, keV	Y	E, keV	Y	
^{60}Co	5.2714	**1,332.50**	**0.9998**	**1,173.24**	**0.9990**	0.15
^{106}Ru	1.0238	511.86	0.2040	621.93	0.0993	
^{125}Sb	2.7582	427.88	0.2960	600.60 635.95 463.37	0.1786 0.1131 0.1049	
^{126}Sn	2.07E+05	414.52	0.977	666.16 694.83	0.999 0.959	
^{137}Cs	30.07	**661.66**	**0.851**			0.2
^{152}Eu	13.542	1,408.01	0.2087	344.28 964.13 1,112.12 778.90	0.2658 0.1434 0.1354 0.1296	
^{154}Eu	8.593	**1,274.44**	**0.3519**	723.31 1,004.73 873.19	0.2022 0.1801 0.1227	0.2
^{235}U	7.04E+08	185.72	0.5720	205.31	0.0501	0.6
^{238}U (^{234m}Pa)[1]	4.47E+09	**1,001.03**	**0.0084**	766.36	0.0029	10-15
(^{233}Pa)	2.14E+06	**311.90**	**0.385**	300.13 340.48 415.76	0.0662 0.0445 0.0173	1
^{239}Pu	24,110	**375.05** 413.71	**1.554E-5** 1.466E-5	203.55 345.01 332.85	5.69E-6 5.86E-6 5.48E-6	20,000
^{241}Pu (^{237}U)	14.3	**208.005**	**5.19E-6**[2]	164.61 332.35	4.56E-7[2] 2.94E-7[2]	
^{241}Am[2]	432.2	208.01 335.37 **662.40** **722.01**	7.91E-6 4.96E-6 **3.64E-6** **1.96E-6**	368.05 376.65 322.52 332.35	2.17E-6 1.38E-6 1.52E-6 1.49E-6	50,000

Table 3-4. Radionuclides Detectable with High-Purity Germanium Equipment (2 sheets)

Naturally-Occurring Radionuclides Detectable with High-Purity Germanium Equipment						
	Primary Gamma Rays			Secondary Gamma Rays		
Radionuclide	Daughter	E, keV	Y	Daughter	E, keV	Y
^{40}K	^{40}Ar	**1,460.83**	**0.1067**			
^{232}Th[3]	**^{208}Tl** ^{212}Pb ^{208}Tl	**2,614.53** 238.63 **583.19**	**0.3534** 0.433 **0.3011**	^{228}Ac ^{228}Ac ^{228}Ac	911.21 968.97 338.32	0.266 0.1617 0.1125
^{238}U[4]	^{214}Pb **^{214}Bi** **^{214}Bi**	351.92 **609.31** **1,764.49**	0.358 **0.4479** **0.1536**	^{214}Pb ^{214}Bi ^{214}Pb ^{214}Bi ^{214}Bi	295.21 1,120.29 241.98 1,238.11 2,204.21	0.185 0.148 0.0750 0.0586 0.0486

E = Energy level
MDL = Minimum detection limit, based on routine analysis with Spectral Gamma Logging System
Y = Yield; gammas per decay or fractional probability of a gamma ray emission

[1] Protactinium-234m is a short-term daughter of ^{238}U. The yield is relatively low, and these gamma lines are generally not seen in "natural" uranium. Within the uranium decay series, secular equilibrium is achieved slowly, and gamma activity from ^{214}Pb or ^{214}Bi will not reach significant levels in less than several hundred thousand years. Hence, the presence of gamma activity originating from ^{234m}Pa without much higher levels of activity from ^{214}Pb and ^{214}Bi is an indication of the presence of anthropogenic ^{238}U, which has been chemically separated from its decay products.

[2] Yield corrected for branching ratio of 0.0000245.

[3] Thorium-232 occurs naturally in geologic materials. At Hanford, "background" values are generally in the range of 0.5 to 1 pCi/g. Thorium-232 will establish secular equilibrium throughout the decay series relatively quickly. Hence, anomalous values may indicate the presence of anthropogenic ^{232}Th. Concentrations above 2 pCi/g warrant further evaluation.

[4] Uranium-238 occurs naturally in geologic materials. At Hanford, "background" values are generally in the range of 0.5 to 2.5 pCi/g. For anthropogenic ^{238}U, the decay series will not be in secular equilibrium, and the peaks shown above will not be elevated. Elevated ^{214}Bi and ^{214}Pb concentrations may be an indication that ^{222}Rn may be present.

2. Waste type: The overall effectiveness of gross gamma logging in drywells as a leak detection system depends on the waste type in the tank. It can be used to evaluate the approximate time period when tank waste may have entered the sediments. Early gross gamma logging can indicate the nature of waste streams by considering the decay rate of gamma activity. The gross gamma logging system is most effective with waste types containing high concentrations (activities) of gamma-emitting radionuclides (e.g., ^{137}Cs or ^{60}Co at the present time and short-lived radionuclides in the past) and large releases, and less effective with lower activity waste types such as aluminum cladding waste or waste that contains transuranics. In addition to limitations on the effectiveness of gamma measurements for different waste types, there were lags of months to years between release and detection where multiple waste transfers in the adjacent tank may have occurred. Consequently, the type of waste in the nearest tank when a leak/release was detected may not be the same as the waste released. This contributes to uncertainty in inventory and leak volume estimates.

3. Other contamination sources: Gamma activity observed in drywells may also have originated from near-surface waste loss events, transfer line releases or tank overfills, in which case there is no loss of integrity of the steel liner in the tank. However, all releases contribute to the soil inventory, regardless of whether the liner failed.

Geophysical techniques can also be used outside of a tank to measure increased moisture and gamma-emitting contaminants. Dry borehole neutron moisture and/or RAS total gamma leak detection monitoring is performed during retrieval in accordance with tank waste retrieval work plans. The accuracy of dry borehole logging count rate is roughly the square of the total number of counts (*Radiation Detection and Measurement* [Knoll 2000], pp. 94-96). The correlation between counts per second (c/s) and radioactivity or moisture measurements varies by detector.

Leak detection monitoring for retrieval is conducted by observing changes in neutron readings (c/s) compared to an established baseline for the detector being used. Therefore, for a given detector, accuracy of calibration is not a factor. The level of moisture change that triggers additional RAS monitoring is specified in tank waste retrieval work plans. Some of the drywells in A Farm are double cased with grout between casings (see Table 3-3) and cannot be used to measure soil moisture.

In addition to monitoring data, one-time readings are often obtained during the installation of wells and/or push holes as part of characterization efforts to determine the nature and extent of contaminants in the vadose zone.

Ex-Tank High Resolution Resistivity. High Resolution Resistivity (HRR) leak detection monitoring is used during retrieval operations and measures changes in resistivity against baseline conditions as specified in tank waste retrieval work plans. Because tank waste is high in sodium and nitrate, changes in resistivity/conductivity are a potential indicator of a tank leak. In leak injection tests in 241-S Tank Farm, where 13,000 gal of saline solution were injected to the soil near tank 241-S-102 it was determined that HRR could detect a leak of 2,100 gal or more with 95% accuracy. Initial tests showed responses after only a few hundred gallons of saline solution were injected (RPP-30121, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and Monitoring Test Report*). In comparison, drywell neutron moisture measurements showed negligible changes during leak injection tests. The HRR system does not quantify leak volume or rate, but provides a continuous measure of resistivity during retrieval as compared to weekly moisture measurements and provides three-dimensional spatial measurements compared to measurements indicating conditions within a radius of ~1 ft from a drywell. Furthermore, HRR senses a much larger volume than a drywell, including beneath a tank. However, HRR is affected by the presence of steel infrastructure and corrections must be made for such facilities. Retrieval has not started in the A and AX Farms and HRR has not been used for leak detection monitoring in these farms.

3.3 RETAINED GAS

Many radioactive wastes generate and retain hydrogen, nitrogen, nitrous oxide, ammonia, methane, and other volatile organic compounds. Retained gas is defined as that gas held in the waste predominately by yield strength, producing particle displacing bubbles. The generation rates of the major fuel (hydrogen, ammonia, methane) and diluent species (nitrogen) aid in assessing the long-term behavior of tank wastes (surface level measurements) and support analyses of potential changes in waste storage conditions (to assess postulated gas release events). The presence of such gases as ammonia, methane, and nitrous oxide can have a significant influence on the flammability characteristics of a gas mixture. Increases in retained gas may result in ILL rise or an increase in the measured surface level. Gas release events may result in the tank head space exceeding flammability limits and a sudden decrease in the ILL, complicating interpretation of the ILL data. For some tanks containing retained gas, the ILLs may also increase and decrease with changes in barometric pressure.

Any original wastes that were discharged to the waste tanks from an evaporator were essentially free of retained gas. The gases retained in the wastes were generated during waste storage as a result of radiolytic degradation of organic products and water within the waste. Non-convective layers and crusts retain large quantities of the entrained and underlining gases. In contrast, convective layers do not retain significant amounts of such gases. The principal soluble gas, ammonia, is widely distributed throughout the liquid phases of the waste. Retained gas sampling observations and other findings show the gases that have been retained in the waste for long intervals are enriched in hydrogen. An evaluation of the empirically measured rates of gas generation results from the slow decomposition of nitrogen and ammonia, and differences in transportation rates (RPP-6664, *The Chemistry of Flammable Gas Generation*).

Tanks A-101, A-103 and AX-101 were high in flammable gas (WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*); tanks A-101, AX-101 and AX-103 were on the flammable gas watchlist due to high retained gas hydrogen content and tanks A-101 and 241-AX-102 (AX-102) were on organics watchlists (RPP-7771, *Flammable Gas Safety Issue Resolution*). Tanks A-101 and AX-101 were sampled using a retained gas sampler and contained an average of 18 ± 9 and 17 ± 1 % by volume of flammable gas respectively in the nonconvective layer (PNNL-13000, *Retained Gas Sampling Results for the Flammable Gas Program*). Estimated retained gas fractions based on surface level rise and barometric pressure correlations for these and other SSTs are reported in WHC-SD-WM-ER-526.

3.4 TANK LEAKS

HNF-EP-0182 defines "assumed leaker" as "The integrity classification of a waste storage tank for which surveillance data indicate a loss of liquid attributed to a breach of integrity" (i.e., a breach in the tank liner). By inference, a "questionable integrity" tank is a tank for which the liner integrity is in question. Conversely, a "sound" tank is classified as "The integrity classification of a waste storage tank for which surveillance data indicate no loss of liquid attributed to a breach of integrity." Other types of releases from tanks or near tanks such as cascade and transfer line leaks or spare inlet releases are UPRs and should not be considered tank leaks, but are included in the tank farm soil inventory.

During the active operation of the SST farms, either an anomalous liquid-level measurement of 0.5 to 2 in. (depending on the type of waste in a tank and the accuracy of measurement techniques) or a significant increase in gamma activity in a drywell, lateral or leak detection pit was generally a sufficient reason for the tank to be listed as “questionable integrity” or an “assumed leaker” (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). When a tank was designated as “questionable integrity” it was pumped to a “minimum heel” and taken out of service. In some cases the “questionable integrity” designation was followed up with additional investigations which concluded that a tank did not leak or identified an overflow or transfer line release source and the tank was returned to operation. In some instances, a tank that indicated liquid level loss or increased drywell activity would have the liquid level lowered 2 to 3 ft. If the indications of liquid loss stabilized, the tank continued to be used with an administrative control not to exceed the new liquid level. However, in many cases no additional investigations were performed. In the late 1980s, all SSTs that had been flagged as “questionable integrity,” “assumed leakers” or “confirmed leakers” were combined into the list contained in the monthly waste tank summary report (HNF-EP-0182) and flagged as “confirmed or assumed leakers.” Because of the uncertainty associated with the measurements, unexplained waste level decreases were generally considered an inadequate basis for designating a tank as a “confirmed leaker.” The “confirmed leaker” designation required an observed waste level decrease combined with increasing gamma activity in a nearby drywell. The “assumed leaker” designation could be assigned based on either measurement (an observed waste level decrease or increasing gamma activity in a nearby drywell, in particular laterals or the leak detection pits in AX Farm which are considered the most sensitive leak detection methods), without confirmation from the other measurement. As shown in this report, some gamma activity in drywells appears to be the result of UPRs rather than a breach in a tank liner and the tank may not have leaked. However, all waste releases add to the contaminant inventory in the soil.

3.5 INTERIM STABILIZATION

Uncertainties associated with both the primary and secondary leak detection systems for the SSTs led to a number of decisions. By the early 1960s, decisions were made to move from an SST design to a DST design for construction of new tanks. The double-shell design provided both secondary containment and reliable leak detection systems between the two liners.
A decision was also made to pump liquids stored in the SSTs into the DSTs. This process was referred to as interim stabilization of the SSTs.

A Consent Decree (*Washington v. DOE*, Case No. CT-99-5076-EFS [September 9, 2003]) was established that set a timetable and specified criteria to complete interim stabilization, and by 2003 all of the SSTs were interim stabilized except two that went directly to retrieval without undergoing interim stabilization (HNF-EP-0182). A tank was considered interim stabilized when it contained less than 50,000 gal of drainable interstitial liquid and less than 5,000 gal of supernate. If the tank was jet pumped to achieve interim stabilization, then the jet pump flow or saltwell screen inflow must have been at or below 0.05 gpm. Due to equipment failure in some jet pumps, tanks were administratively stabilized before reaching the 0.05 gpm criteria (see HNF-EP-0182).

Although some tanks met interim stabilization administrative procedure at the time they were stabilized, they no longer meet the updated administrative procedure. In 2005, it was determined that tank A-103 no longer met the Interim Stabilization Drainable Interstitial Liquid criterion. Also, in February 2001, tank A-104 was determined to be missing original interim stabilization data (see HNF-EP-0182, *Waste Tank Summary Report for Month Ending October 31, 2013*, Revision 307).

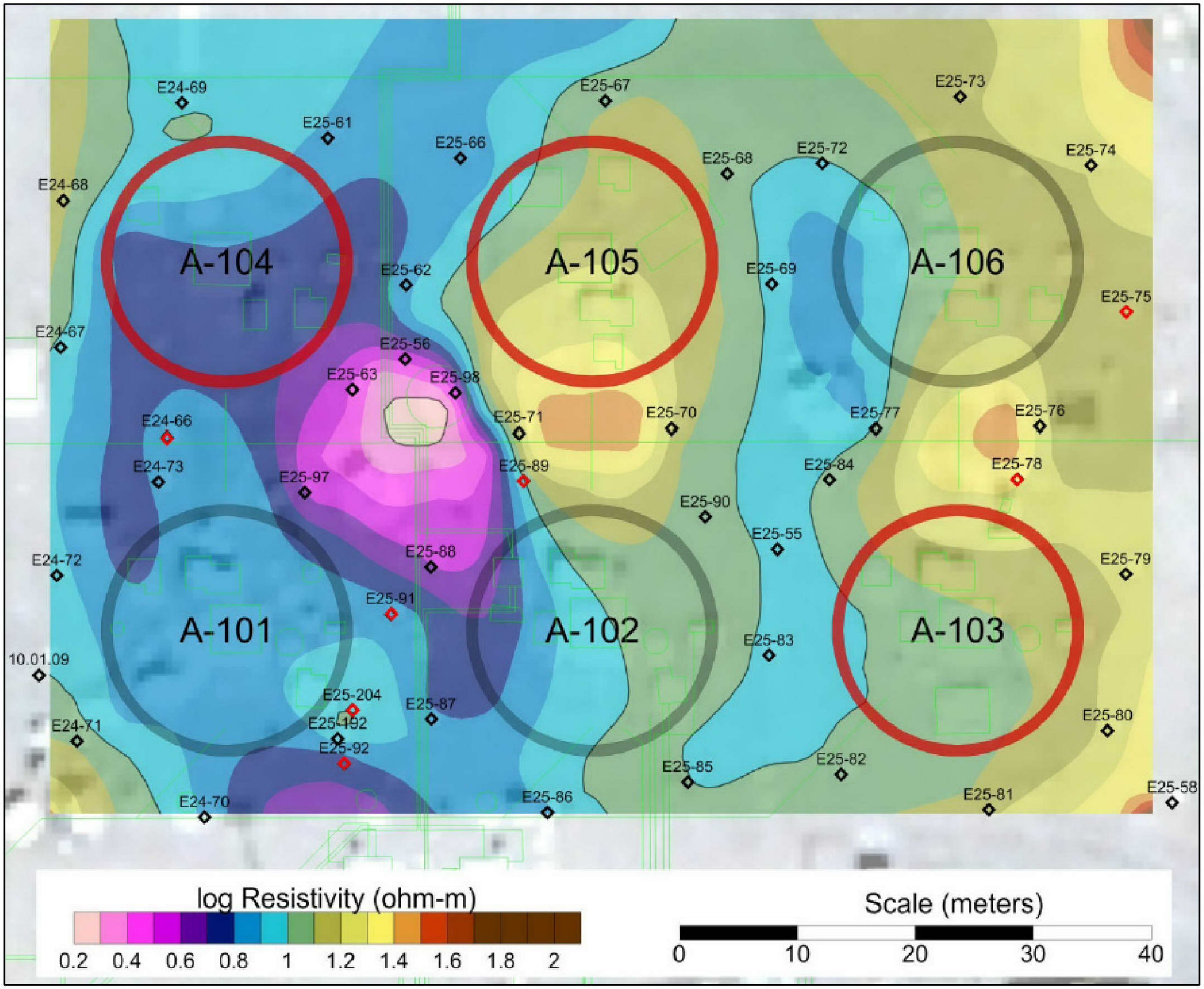
3.6 SURFACE GEOPHYSICAL EXPLORATION IN 241-A AND 241-AX TANK FARMS

A surface geophysical exploration survey was conducted in January 2010 to collect and analyze soil electrical resistivity data as a means to identify and locate low resistivity regions in and around the A and AX Farm areas. This was done to identify potential areas of high nitrate or sodium contamination. The results of this effort were reported in RPP-RPT-46613, *Surface Geophysical Exploration of the A and AX Tank Farms*. The initial part of the survey effort integrated ground penetrating radar and electrical resistivity. High-resolution electrical resistivity data were collected in a well-to-well survey using existing groundwater and vadose zone wells in the A and AX Farm areas.

Figures 3-9 and 3-10 display well-to-well survey results in A and AX Farms. It should be noted that both A and AX Farms display very low resistivity values in general, when compared to other Hanford tank farm sites. Typically, the high end of the log resistivity scale extends to ~4 log ohm-m, which represents dry background Hanford sediments. However, these results have a high end of 2 and 1.5 log ohm-m for A and AX Farms, respectively. The high end value of 1.5 log ohm-m for AX Farm is still within the range typically reported as low resistivity values associated with increased salts and moisture. These values can be influenced by increased metallic infrastructure. Thus, the results presented show variations within this very low resistivity range. The A Farm results extend just beyond the very low resistivity range and into values associated with saturated sands; once again, these results display variations within a very low to low resistivity range.

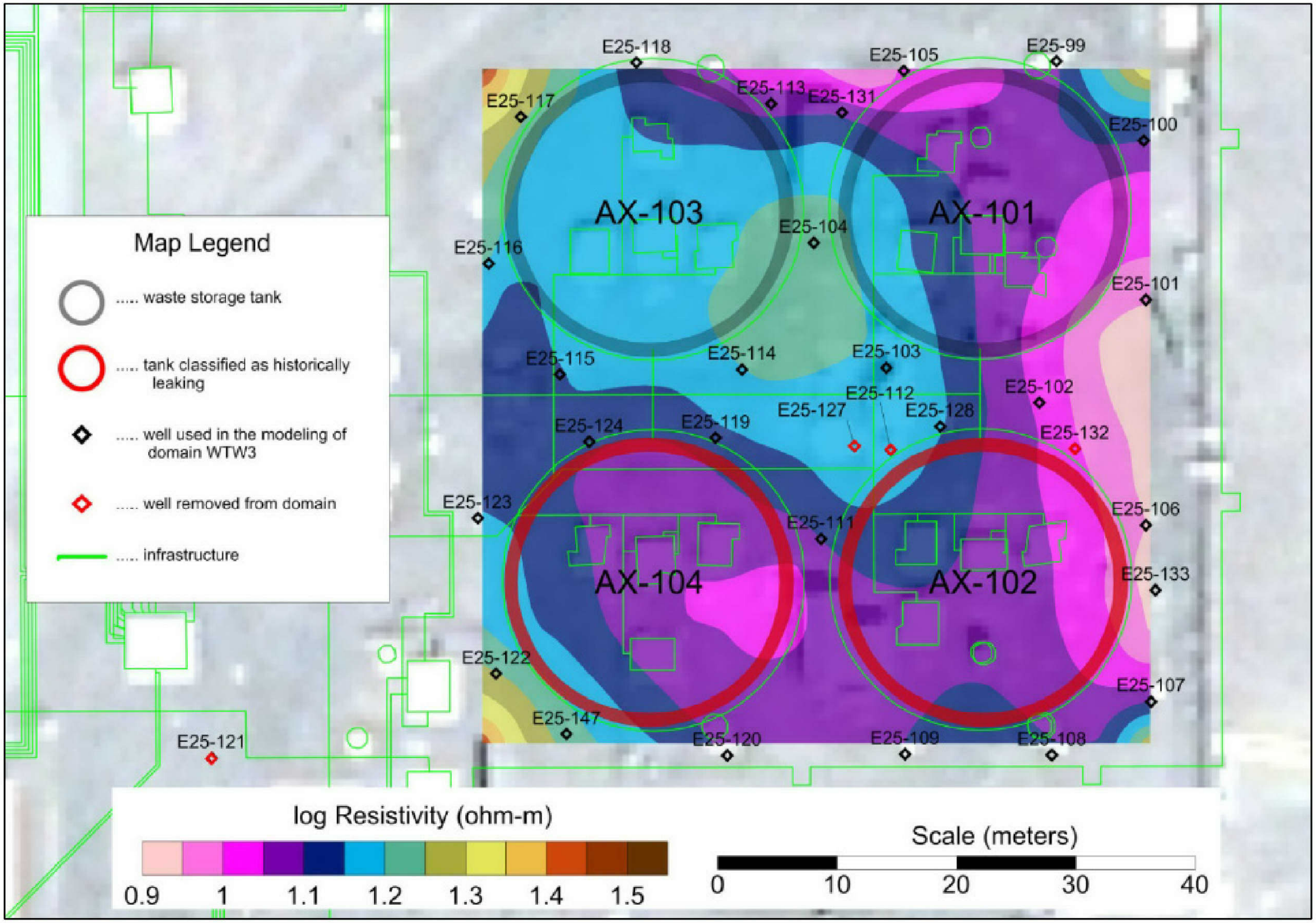
In general, the well-to-well model for A Farm shows the lowest resistivity areas southeast of tank A-104, southwest of tank 241-A-105 (A-105) and south-southeast of tank A-101. Low resistivity is also observed throughout the east side of A Farm and west of tank A-106. There is some indication of a low resistivity area near tank A-103, but not to the extent seen in other areas. Low resistivity areas were shown throughout AX Farm and were lowest to the north of tank AX-101, east of tanks AX-101 and AX-102 and on the east side of tank 241-AX-104 (AX-104). The well-to-well analysis provides only a two-dimensional image for low resistivity and does not indicate the depth of the resistivity anomalies. The results are consistent with observed drywell logging results, as well as the level losses associated with this evaluation. Vertical electrode resistivity arrays and direct push sample results in these areas are needed to determine the depth and corroborate the existence of anomalies observed. Consequently, for the purposes of this report the resistivity data were not considered to determine whether a tank leaked, nor the leak location, leak volume, or inventory.

Figure 3-9. 241-A Tank Farm Well-to-Well Surface Geophysics Exploration Results



Source: RPP-RPT-46613, *Surface Geophysical Exploration of the A and AX Tank Farms*.

Figure 3-10. 241-AX Tank Farm Well-to-Well Surface Geophysics Exploration Results



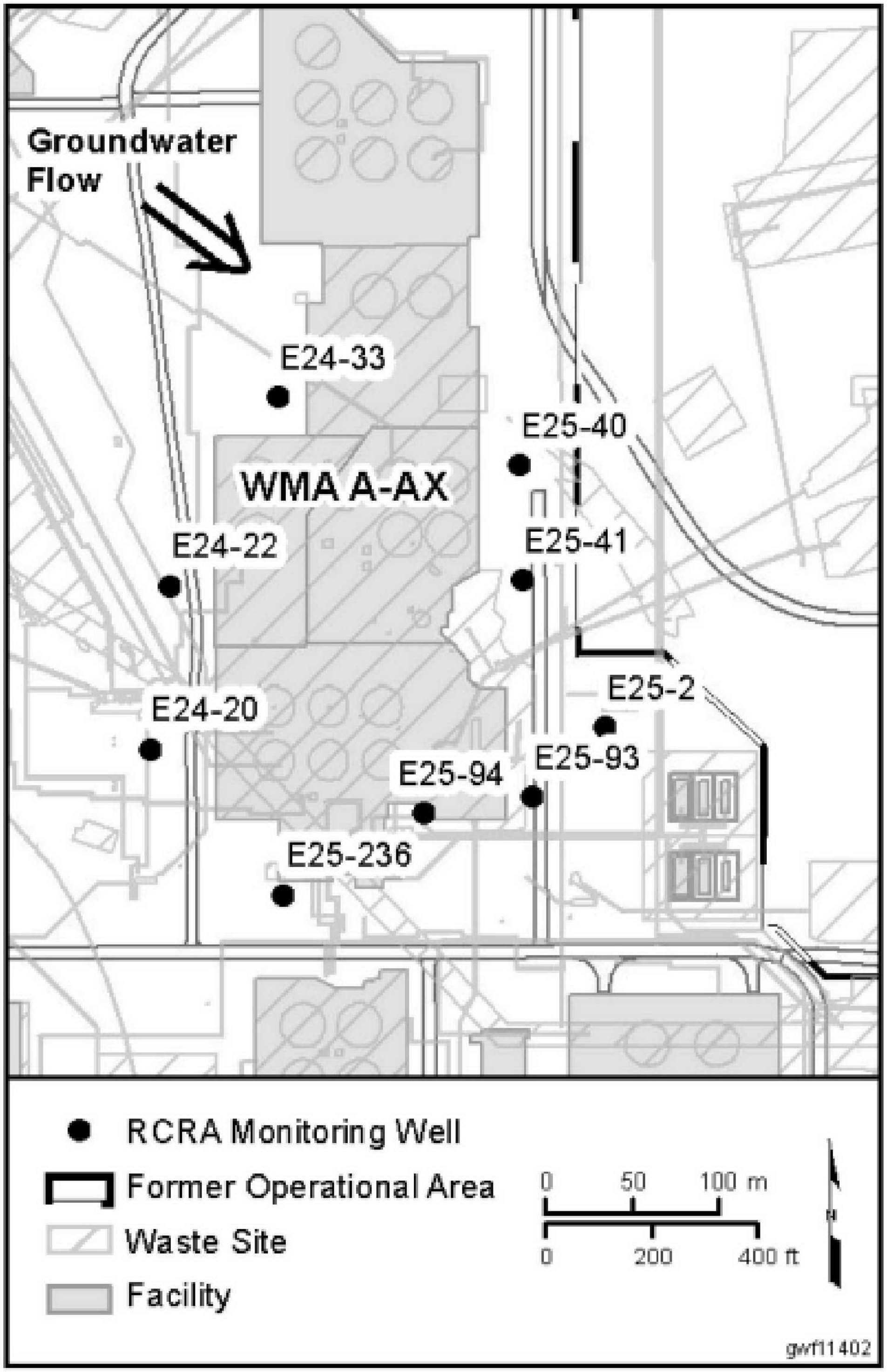
Source: RPP-RPT-46613, *Surface Geophysical Exploration of the A and AX Tank Farms.*

3.7 GROUNDWATER CONTAMINATION FROM RELEASES AT WASTE MANAGEMENT AREA A-AX

The primary contaminants observed in groundwater monitoring wells at WMA A-AX (Figure 3-11) are nitrate and ^{99}Tc. In 2013, nitrate exceeded the drinking water standard (DWS) in 299-E24-20 and 299-E25-93. Since *Resource Conservation and Recovery Act of 1976* (RCRA) assessment monitoring began in 2006, these are the only two wells that have exhibited nitrate concentrations above the DWS. The nitrate concentrations in well 299-E25-93 have been detected above the DWS since 2006 (Figure 3-12). Although nitrate is increasing regionally as displayed in wells 299-E24-22 (up-gradient well), 299-E25-2 (down-gradient well), and 299-E25-40 (down-gradient well), concentrations remain below the DWS (Figure 3-13). Thus, the elevated nitrate at well 299-E25-93, a down-gradient WMA A-AX well, indicates a local source of nitrate contributions to groundwater in the vicinity of WMA A-AX. Note that nitrate concentrations in well 299-E24-20 also exceeded the DWS once in 2008, and again throughout 2013 (Figure 3-12). A relatively large regional nitrate plume above the DWS is located south of the WMA A-AX.

In 2013, ^{99}Tc was detected above the DWS in three WMA A-AX wells: 299-E24-22, 299-E25-236, and 299-E25-93. Techentium-99 in well 299-E24-22, an upgradient WMA A-AX well, has been detected above the DWS since June 2013. The ^{99}Tc at well 299-E24-22 appears to be associated with sources to the north because of the regional southeast groundwater flow direction and location of this well with respect to WMA A-AX. However, ^{99}Tc activity at well 299-E25-93, located downgradient of WMA A-AX, has historically greater activity as compared to the upgradient wells including well 299-E24-22 indicating a source in the vicinity of WMA A-AX (Figures 3-14 and 3-15).

Figure 3-11. Location of the 241-A and 241-AX Tank Farm Groundwater Monitoring Well Network



Note: Borehole E-25-236 has been decommissioned and scheduled for replacement. Groundwater flow direction has varied with time. The distribution of contaminants in groundwater reflects changing flow directions and gradients; the flow direction shown was for mid-2000.

RCRA = *Resource Conservation and Recovery Act of 1976*

Figure 3-12. Recent Nitrate Concentrations in Wells 299-E24-20 and 299-E25-93

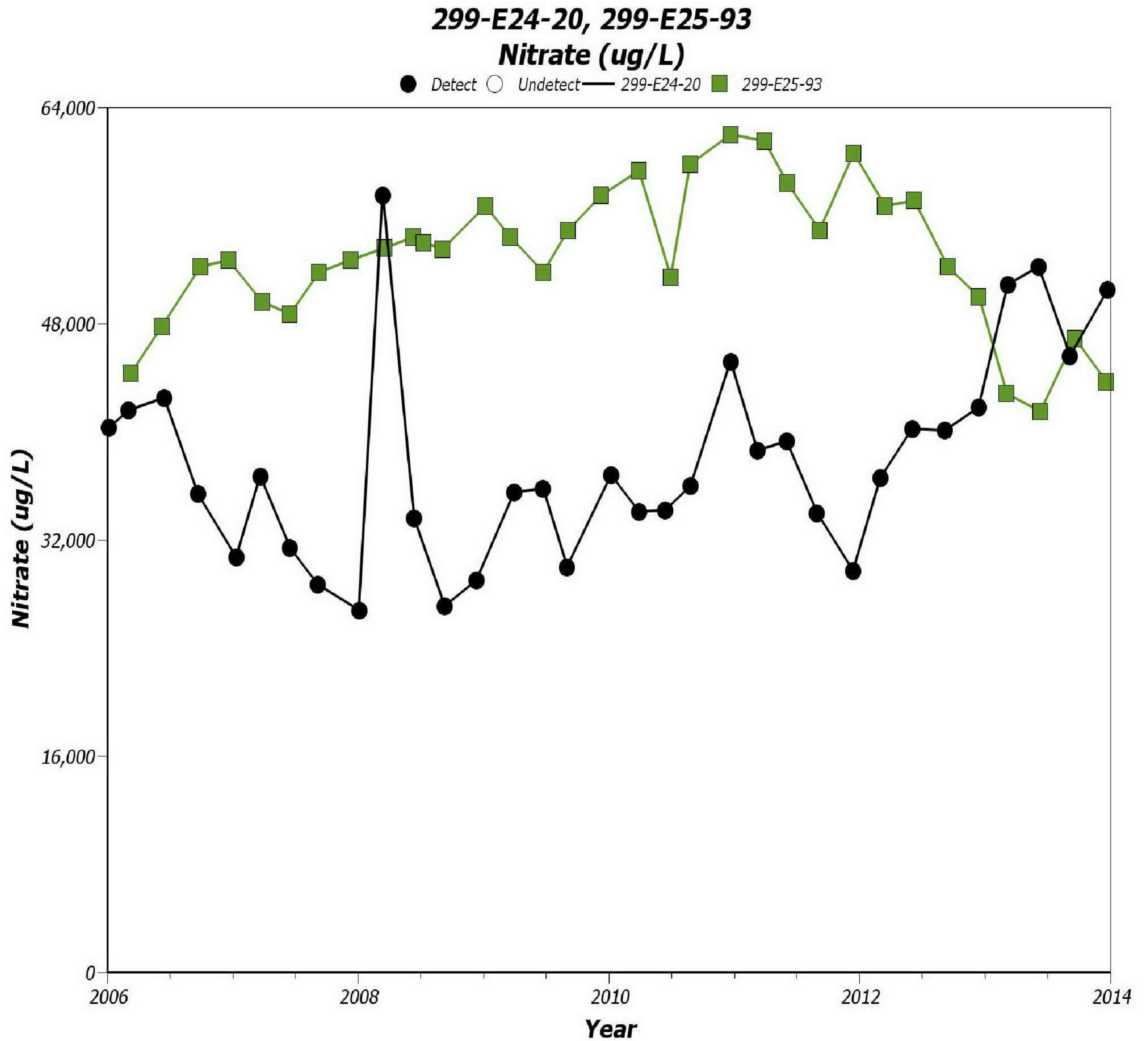


Figure 3-13. Recent Nitrate Concentrations in Wells 299-E24-22, 299-E25-2 and 299-E25-40

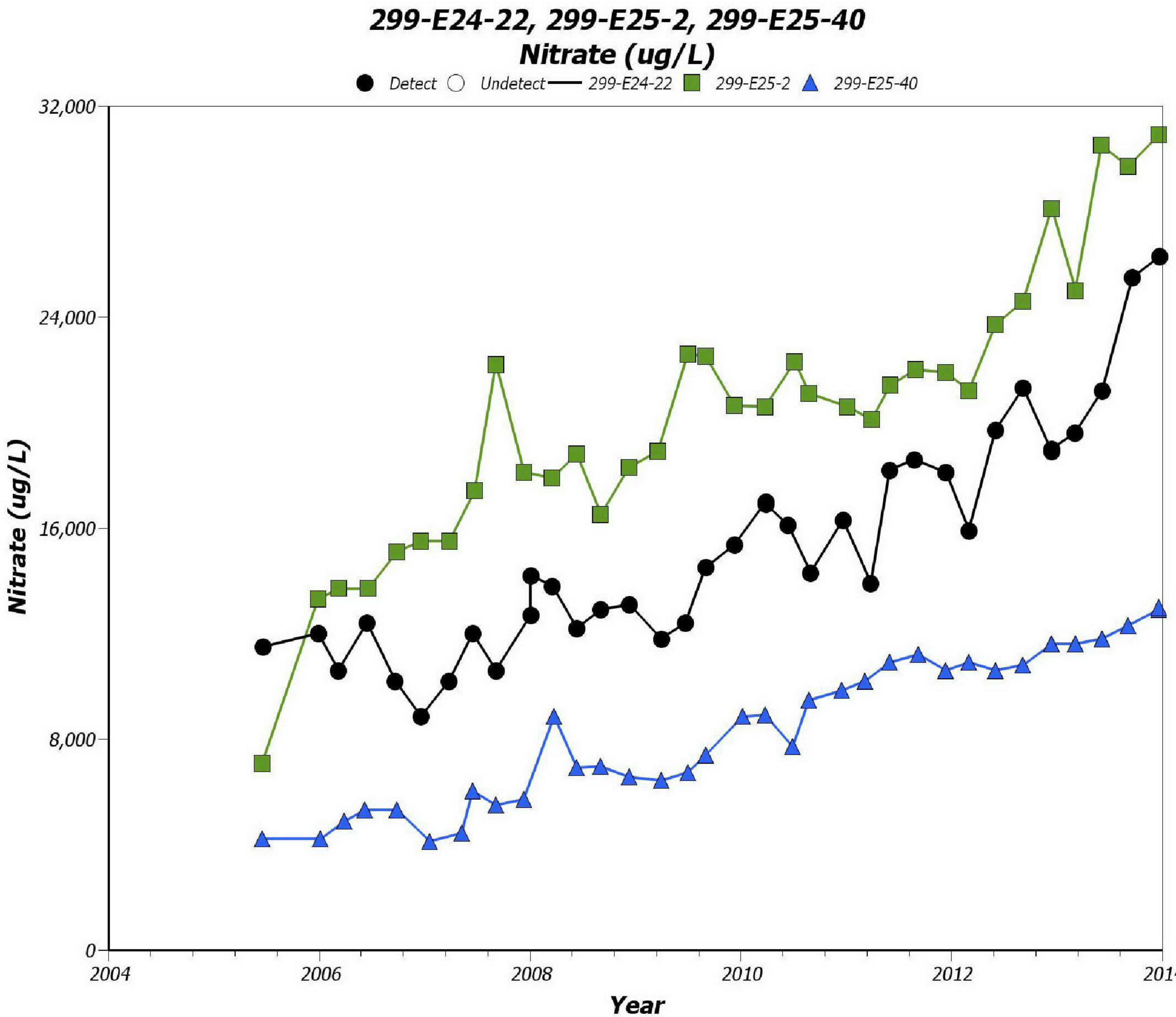


Figure 3-14. Recent Technetium-99 Concentrations in Wells 299-E24-22 and 299-E25-93

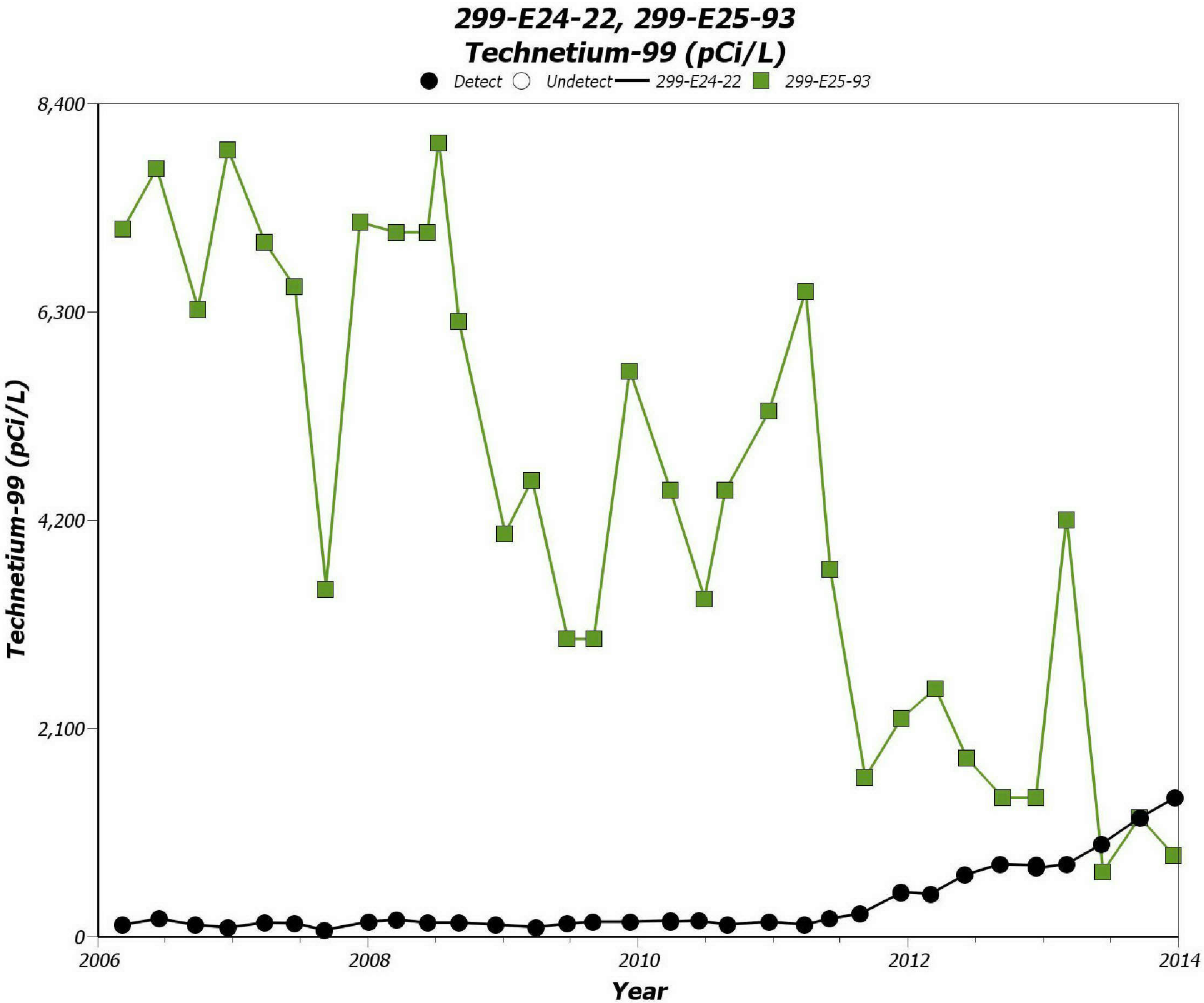
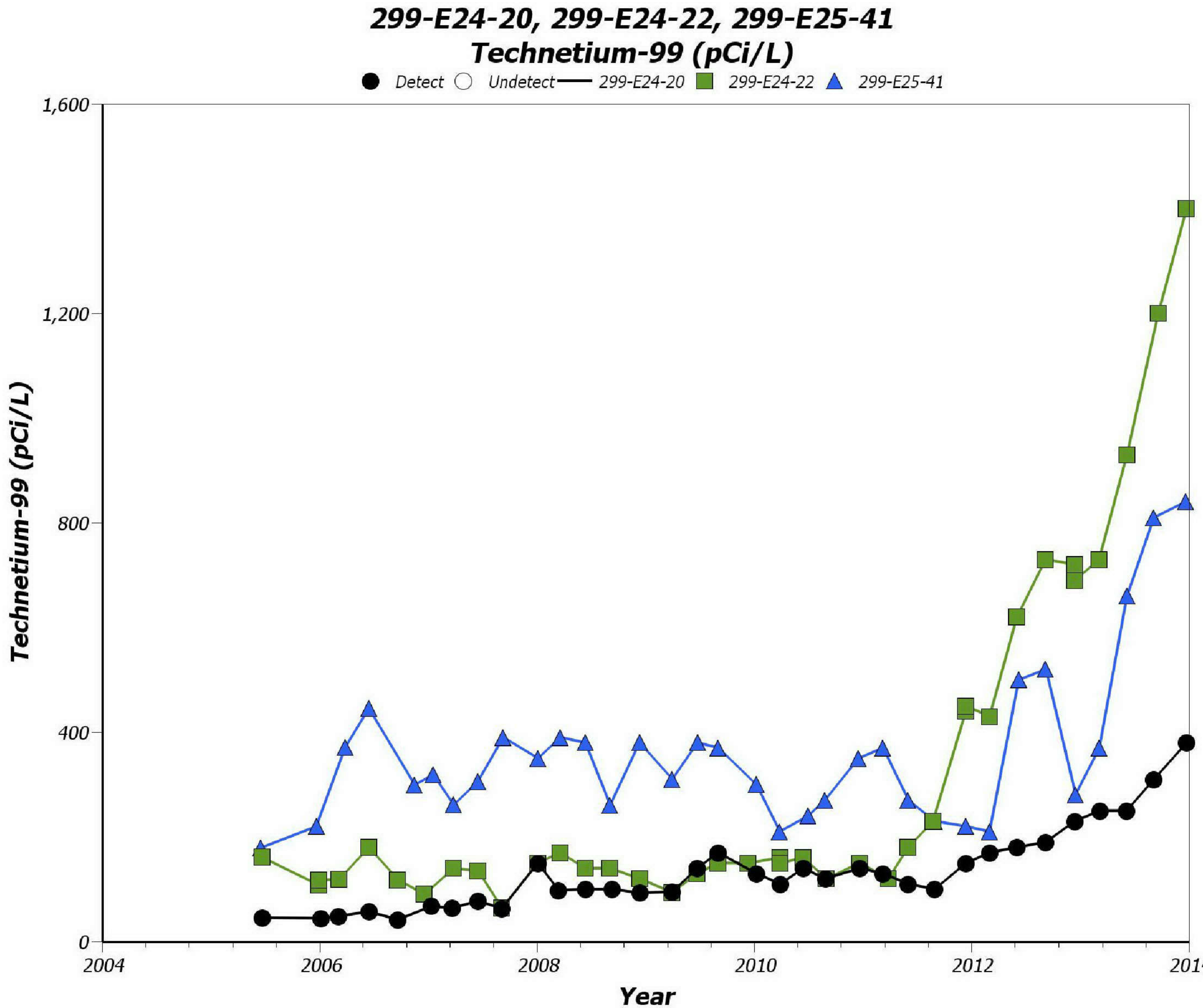


Figure 3-15. Recent Technetium-99 Trends in Wells 299-E24-20, 299-E24-22, and 299-E25-41



It is worth noting that ^{99}Tc also exceeded the DWS in well 299-E25-236 starting in 2012. In November 2012, review of a television survey completed within well 299-E25-236 revealed accelerated corrosion. The corrosion was identified between 80.2 and 81.4 meters (263 and 267 ft) bgs. Black staining from the corroded casing extended downward ~8.5 to 9.8 meters (28 to 32 ft) to groundwater at 89.9 meters (295 ft) bgs. The surface of the groundwater was covered with various particles. The increase in ^{99}Tc activity at this well may be associated with liquid from the perched zone seeping through the corroded casing and migrating down the inside of the casing to the groundwater within the well because ^{99}Tc was found to be associated with two nearby wells with similar casing corrosion (e.g., 299-E24-19 and 299-E25-46, PNNL-15141, *Investigation of Accelerated Casing Corrosion in Two Wells at Waste Management Area A-AX*). Well 299-E25-236 was decommissioned in June 2013. From PNNL-15141:

> "[T]he sidewall core samples from well 299-E24-19 were elevated with respect to water extractable sodium, while the sidewall core samples from well 299-E25-46 contained significantly elevated concentrations of water extractable nitrate. Since both sodium and nitrate are common components in Hanford waste streams, the water extract samples were further analyzed for technetium-99. Surprisingly, the sidewall core samples from both failed wells contained measurable quantities of technetium-99 (ranging from 0.984 to 21.9 pCi/g). These findings, when coupled with groundwater monitoring data, clearly demonstrate that the vadose zone/groundwater chemistry in the vicinity of the two failed wells has been affected/compromised by a Hanford waste stream."

Because of the accelerated casing corrosion found at well 299-E25-236, the recent increase of elevated metals (e.g., chromium, iron, manganese, and nickel) appears to be associated with the 304 L stainless steel casing, which contains these same constituents. With respect to these metals associated with the stainless steel well casing, between May and June of 2011 the unfiltered chromium increased from non-detect to 23 µg/L. In December 2011, filtered chromium levels began to be continuously detected just above detection limits. Filtered manganese detections lagged temporally behind the chromium results, but increased substantially in September 2012. Filtered and unfiltered nickel were present since the well was installed, though the concentrations of nickel detected in groundwater samples increased substantially in September 2012.

A summary of results for other constituents monitored for RCRA, *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, and *Atomic Energy Act of 1954* in the WMA A-AX network during 2013 are shown in Tables 3-5 and 3-6.

Table 3-5. 2013 *Resource Conservation and Recovery Act of 1976* Assessment Parameter Summary

2013 Assessment Parameter Summary	
Parameter	**Range**
Alkalinity	84,000 to 110,000 µg/L
Chromium (filtered)	<5 to 47.9 µg/L
Lead (filtered)	<0.05 to 0.799 µg/L
Nitrate	11,600 to 52,200 µg/L
pH Measurement	7.44 to 8.44
Sodium (filtered)	17,300 to 28,300 µg/L
Specific Conductance	435 to 722 µS/cm
Sulfate	81,600 to 213,000 µg/L
Technetium-99	18 to 4,200 pCi/L
Temperature	17.0 to 21.3 °C
Total Organic Carbon	<100 to 1,010 µg/L
Turbidity	0.06 to 7.61 NTU

NTU = nephelometric turbidity unit

Table 3-6. 2013 *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*/*Atomic Energy Act of 1954* Groundwater Monitoring Summary

2013 Comprehensive Environmental Response, Compensation, and Liability Act of 1980/ Atomic Energy Act of 1954 Groundwater Monitoring Summary	
Parameter	**Range**
Arsenic (filtered)	3.94 to 6.63 μg/L
Arsenic (unfiltered)	5.09 to 9.06 μg/L
Chromium (filtered)	<5 to 14.2 μg/L
Chromium (unfiltered)	<5 to 81.6 μg/L
Gross Alpha	<0.12 to 3.6 pCi/L
Gross Beta	16 to 680 pCi/L
Iodine-129	2.36 to 7.02 pCi/L
Manganese (filtered)	<4 to 20.7 μg/L
Manganese (unfiltered)	<4 to 27.8 μg/L
Nitrate	10,600 to 34,100 μg/L
Specific Conductance	429 to 627 μS/cm
Strontium-90	< -0.93 to < 1.3 pCi/L
Technetium-99	12 to 1,000 pCi/L
Temperature	12.3* to 18.7 °C
Tritium	1,400 to 7,000 pCi/L
Turbidity	0.15 to 7.61 NTU
Vanadium (filtered)	11.2 to 23 μg/L
Vanadium (unfiltered)	16.2 to 24 μg/L

*Value suspect. Next lowest measured temperature was 17.2 °C.

NTU = nephelometric turbidity unit

4.0 TANK LEAK INVENTORY ASSESSMENT RESULTS

The following sections describe the A and AX Farm leak assessments and results summarized in Table 4-1. Additional data and information reviewed for tanks classified as “assumed leakers” are presented in Appendix B. Appendix C shows data and information reviewed for tanks classified as “sound.” Appendix D of RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report* describes the rationale and logic used for the assessment.

For each release event, the sections include a description of release, release type (point or non-point source), estimated depth of release, estimated time of release, and estimated magnitude of release (volume and inventory). Uncertainties associated with release parameters are also summarized.

Given the limited information available, a conservative approach was used to estimate leak/release volumes and inventories. Sample data was used when available near the time of release to estimate waste compositions. However, a limited number of constituents were analyzed and composition estimates were largely based on waste types characteristic of the data obtained, total and spectral gamma geophysical logging measurements, and SIM historical process waste estimates.

The Hanford Defined Waste and SIM model estimates are described in RPP-19822, *Hanford Defined Waste Model – Revision 5.0* and RPP-26744. These models used Hanford Plant initial radionuclide inventory estimates from the Oak Ridge Isotope Generation and Depletion Code (RPP-13489, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*), tank waste transfer records, and release timing information to estimate waste composition in the SSTs and releases to the vadose zone.

4.1 TANK 241-A-103

4.1.1 Leak Status of Tank 241-A-103

Tank A-103 was previously designated as an “assumed leaker” with a leak volume of 5,500 gal based on liquid level decreases between October 8, 1981 and March 5, 1987 (HNF-EP-0182). The tank has since been re-designated as “sound” based on data and assessments reported in this section and results of a tank integrity assessment (RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*) conducted in 2009. See Appendix B1.0 for summary information for this tank.

Table 4-1. Summary of Estimated Waste Release Inventories in 241-A and 241-AX Tank Farms[1] (2 sheets)

Tank/UPR	Waste Release Volume, gal	^{60}Co, Ci	^{137}Cs, Ci	^{99}Tc, Ci	Basis
241-A-103	0	NA	NA	NA	Liquid level decreases were likely due to retained gas release and not a loss of waste; retained gas releases have been observed in cycles – build, then release. No increase in radioactivity was detected in drywells or laterals.
241-A-104	~2,000	0.09	0.6	0.6	Inventory based on ^{137}Cs radioactivity in tank laterals. P1 supernate was released. Values of ^{60}Co (4.7E-05 Ci/gal) and ^{99}Tc (2.8E-4 Ci/gal) based on predicted composition for P1 supernate.
241-A-105	~2,000 to 40,000	0.2	56,000	1.9	Inventory based on equivalent ^{137}Cs radioactivity in tank laterals. Volume depends on the relative amounts of P1 and BIX waste released. Range assumes all P1or all BIX supernate waste was released. Measured ^{137}Cs concentration at time of release was 30.7 Ci/gal. Values of ^{60}Co (9.1E-05 Ci/gal) and ^{99}Tc (9.4E-4 Ci/gal) based on predicted composition for P1 supernate.
241-AX-102	0	NA	NA	NA	Based on drywell activity, releases were small and appear to be due to Dresser coupling releases associated with the tank off-gas piping and releases from the ventilation system.
241-AX-104	0	NA	NA	NA	Based on drywell activity, releases were small and appear to be due to Dresser coupling releases associated with the tank off-gas piping and releases from the ventilation system.
Other 241-A/241-AX Farm tanks	0	NA	NA	NA	No change recommended for tanks currently designated as "sound" and no evidence of subsurface releases associated with these tanks.
Near-Surface UPRs in 241-A and 241-AX Tank Farms					Note: Near-surface release estimates based on spectral gamma logging system ^{137}Cs measurements and assumed waste composition and waste type. Waste release volume would be proportionally higher for a more dilute waste stream. Values of ^{60}Co (9.1E-05 Ci/gal) and ^{99}Tc (9.4E-4 Ci/gal) based on predicted composition for A1-Saltcake (saltcake from the first 242-A Evaporator campaign using 241-A-102 feed tank [1977-1980]) supernate.
A Pit	~640	0.06	160	0.6	
241-A Tank Farm general	~400	0.04	10	0.4	
241-AX-101 surface	~110	0.01	130	0.1	
241-AX Tank Farm general	~1,300	0.12	20	1.2	

Table 4-1. Summary of Estimated Waste Release Inventories in 241-A and 241-AX Tank Farms[1] (2 sheets)

Tank/UPR	Waste Release Volume, gal	^{60}Co, Ci	^{137}Cs, Ci	^{99}Tc, Ci	Basis
Intentional Releases to Cribs, Trenches and Retention Basins near 241-A and 241-AX Tank Farms	~780,000,000	0.01	2,800	0.07	RPP-26744, *Hanford Soil Inventory Model, Rev.1*, Appendix C. Volume estimates by facility are presented in Section 6.1. As shown, large volumes of waste were released to the cribs, trenches and retention basins near 241-A and 241-AX Tank Farms. Most of the waste was cooling waste water or decontamination water.

[1]Cesium-137, ^{60}Co, and ^{99}Tc values are approximations decayed to January 1, 2001. To estimate inventory for other constituents, multiply release volume by the composition of waste in RPP-19822, *Hanford Defined Waste Model – Revision 5.0.*

BIX = Bismuth ion exchange waste from 221-B Plant

P1 = Plutonium Uranium Extraction Plant high level waste

UPR = unplanned release

4.1.2 Leak Assessment Considerations

In May 1987 an integrity assessment of the surface level behavior for years 1981 through 1987 was conducted, following the procedures and rules for other tank integrity assessments documented in RHO-CD-1193, *Review of Classification of Hanford Single-Shell Tanks 110-B, 111-C, 103-T, 107-TX, 104-TY, and 106-U* (Internal letter 65000-WWS-87-033, "Tank 103-A Integrity Evaluation"). The integrity assessment panel reviewed information supporting the notion that the observed surface level decrease was attributable to slurry growth (i.e., retained gas accumulation and release). The surface level would slowly rise over a period of 9 to 12 months, then drop rapidly over a one- to two-day period (Internal letter 65950-87-291, "Tank 241-A-103"). Core samples obtained from tank A-103 in April 1986 showed no interstitial liquid and wastes were laced with air pockets or void spaces large enough to be clearly visible in photographs (Internal letter TFS&O-87-00074, 1987, "Surface Level Behavior of Tank 241-A-103"). Drywell and lateral radiation readings were unchanged during the six-year period.

Three out of the five members of the tank integrity assessment panel stated at the 95% confidence level that tank A-103 was "sound;" that the surface level fluctuations (both increases and decreases) were attributable to waste properties, and additional study of this phenomenon should be conducted. The other two panel members stated there was inconclusive evidence to relate the liquid level fluctuations to some waste phenomena. The assessment panel concluded tank A-103 should be classified as an "assumed leaker," although there was no increase in activity detected in the laterals or drywells associated with this tank. The volume of waste released from tank A-103 was estimated to be 0 gal to 5,500 gal, with the variability in the volume due to uncertainty whether the tank actually leaked, and the upper bound on the surface level decrease of 2 in. from the last established 186.0-in. baseline to 184.0 in., the most commonly reported Computer-Automated Surveillance System reading.

In 2008, tank A-103 was again reviewed. The team observed that the phenomenon of retained gas release has been observed in other tanks (e.g., 241-SY-101, 241-SY-103, 241-AW-101, 241-AN-103, 241-AN-104, and 241-AN-105) and is referred to as a buoyant displacement gas release event (BDGRE). During the 1990s, significant technical work was performed to understand the BDGRE behavior. The current tank farm safety basis relies upon a process developed from the culmination of this work to categorize waste tanks for BDGRE hazard. The process is described in RPP-10006, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*. The BDGRE process and mechanisms were not understood in 1987 when the integrity investigation for tank A-103 was conducted, but explain the liquid level fluctuations observed in tank A-103.

Spectral gamma data for several drywells (10-03-01, 10-03-05, 10-03-07, 10-02-03, and 10-03-11) around tank A-103 measure small amounts of ^{137}Cs (about 0.1 pCi/g) at 80 ft bgs and below, which is thought to be associated with drag-down of contamination when the well depths were extended (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*, pp. 2-11). Gross gamma logging of the laterals beneath tank A-103 was conducted in March 2005 and also shows only small amounts of equivalent ^{137}Cs (less than 10 pCi/g) beneath the tank (RPP-RPT-27605, *Gamma Surveys of the Single-Shell Tank Laterals for A and SX Tank*

Farms, pp. B-4 thru B-9). The gamma loggings do not show any evidence of waste loss from tank A-103. The interstitial liquid in tank A-103 was sampled in April 1986 and results for ^{137}Cs were an average of 3.97E+05 µCi/ml (SD-RE-TI-198, *Data Transmittal Package for 241-A-103 Waste Tank Characterization*). If tank A-103 had leaked 5,500 gal, then ~8,260 Ci of ^{137}Cs (decayed to April 1986) would have leaked to the soil. The gamma loggings do not shown any evidence of waste loss from tank A-103 and certainly not this level of ^{137}Cs in the laterals or drywells.

Another notable liquid level decline in tank A-103 was reported on November 16, 1987. The liquid level declined from a reference of 143.4 in. to 140.6 in. during a three-day period. However, the FIC liquid level monitor readings fluctuated up and down between 143 in. to 140.6 in. during this time frame (DSI "103-A FIC Reading" [Vermeulen 1987]). Inspection of photographs taken inside tank A-103 on December 28, 1988 showed that the FIC plummet was contacting dry solids in a deep depression of multiple elevations, leading to erratic readings (DSI "Unusual Occurrence Report WHC-UO-88-043-TF-07, TK 241-A-103" [Baumhardt 1989]). Therefore, no waste loss from tank A-103 is associated with this event.

The 2008 assessment team members concluded that there is no evidence tank A-103 lost containment or that there was a release near tank A-103 and recommended a tank integrity assessment per TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process."

An integrity assessment (TFC-ENG-CHEM-D-42) for tank A-103 was performed in May 2009. The TFC-ENG-CHEM-D-42 assessment team concluded that the most likely causes of the surface level changes observed during the 1977 to 1988 period were the episodic accumulation and release of trapped gas in the waste combined with waste evaporation, along with measurement errors created by the irregular waste surface, and consequently recommended the integrity designation for tank A-103 be changed to "sound" (RPP-ASMT-42278). In accordance with this recommendation, after being presented to the Executive Safety Review Board (ESRB) and discussed with DOE's Office of River Protection and Ecology, the leak designation for tank A-103 was changed to "sound" in the October 2011 revision of HNF-EP-0182.

On November 13, 2013, releases near tank A-103 were again reviewed to consider additional information obtained since the 2008 inventory assessment, to update this report as described in Section 2.0 and to include results of the tank integrity assessment (see Appendix A, November 13, 2013 Meeting Summary). No new information was presented other than the results of the integrity assessment and suspect intrusions to tank A-103 (presented in Appendix B1.0) and the 2013 team concurred with previous assessment conclusions.

4.1.3 Conclusions

In accordance with RPP-ASMT-42278, tank A-103 has been re-designated as a "sound" tank. The data reviewed indicates that there were no subsurface releases associated with tank A-103; the high ^{137}Cs content in drywell 10-03-07 from tank bottom to 110 ft (the base of the drywell) was from a nearby release.

4.2 TANK 241-A-104

4.2.1 Leak Status of Tank 241-A-104

Tank A-104 was designated as a "confirmed leaker" in April 1975 based on increased radioactivity detected in laterals14-04-01 and 14-04-02. See Appendix B2.0 for summary information for this tank.

4.2.2 Leak Assessment Considerations

Tank surface level measurements, transfer histories and drywell gamma and lateral data included in Appendix B2.0 were reviewed. Lateral data obtained from 1975 to 1986 show elevated gamma activity below the tank that indicates the presence of a tank liner leak (see Appendix B2.5.3). The assessment team concurred with previous assessments that the tank leaked.

The level of radioactivity measured at the laterals indicates that the leak was small. HNF-EP-0182 estimates between 500 to 2,500 gal of waste was loss from SST A-104 in 1978. The basis for this estimate is cited as PNL-4688, *Assessment of Single-Shell Tank Residual Liquid Issues at Hanford Site, Washington*. Section 3.1.3.1 of PNL-4688 discusses past leaks from SSTs as of May 1982 and provides a table summarizing estimated leak volume by each tank. PNL-4688 references RHO-RE-SR-14-May 1982, *Waste Status Summary May 1982*, as the source identifying leaking SSTs and states the estimated waste leaked from SST A-104 is 2,500 gal. RHO-RE-SR-14-May 1982 identifies SSTs that were categorized as having leaked waste, but does NOT list the volume of waste leaked from any of these SSTs. PNL-4688 provides no other basis for the estimated waste loss from SST A-104.

The first time that estimates for waste losses from SSTs appear in a monthly waste status summary report is in September 1983 (RHO-RE-SR-14 SEPTEMBER 1983, *Waste Status Summary September 1983*, pp. 28). The reported estimated waste loss from SST A-104 is less than 1,500 gal. The estimated waste loss from SST A-104 reported in RHO-RE-SR-14 SEPTEMBER 1983 is consistent with the estimated waste loss of 700 to 1,500 gal reported in July 1975 by the Hanford Site contractor in correspondence with the U.S. Energy Research and Development Administration [Letter Burton 1975, "Status of Tank 241-A-104 Contract E(45-1)-2130"]. Furthermore, the tank farm contractor's monthly report for June 1975 also reports the estimated waste loss from SST A-104 as 700 to 1,500 gal, containing 840 to 1,800 Ci of ^{137}Cs (ARH-LD-206 B, *Atlantic Richfield Hanford Company Monthly Report June 1975*, pp. 10). This equates to 1.2 Ci/gal ^{137}Cs as of June 1975 or 0.56 Ci/gal as of May 2008.

In September 1975 Atlantic Richfield Hanford Company (tank farm contractor) conducted a study at tank 104-A to reevaluate the leak size and note the behavior of the leak plume with respect to the subsurface geology. A series of isotopic and directional gamma readings were taken in three horizontal monitoring laterals three meters below tank A-104 at the time of the leak and again about three months after the leak was confirmed. "From the initial readings, conclusions based on the initial data are: (1) The leak plumes were in the shape of hemiprolate spheroids; the predominant isotope was ^{106}Ru with trace elements ^{137}Cs and ^{60}Co; and the ^{106}Ru concentration profile and shape of the leak plumes established the size of the leak to be approximately 2,000 gallons" (ARH-LD-209 B, *Atlantic Richfield Hanford Company Monthly Report September 1975*, pp. 34).

Although the level of radioactivity in the laterals indicates a small leak, tank transfer records and unaccounted-for liquid level changes indicate that the volume of waste released may be significantly greater. The tank transfer ventilation system was identified as a large contributor to the unaccounted-for liquid losses.

The tank farm contractor's monthly report for June 1975 indicates pumpable liquid was removed from SST A-104 and an exhauster connected to remove remaining liquid via evaporation (ARH-LD-206 B, pp. 10). Atlantic Richfield Hanford Company reported in July 1975 that an estimated 7,000 gal of liquid was removed from SST A-104 as a result of operation of the connected exhauster (Burton 1975 – Letter). Photographs of the tank interior taken on May 29, 1975 were reported to show ~9 in. of sludge, "… no evidence of any surface liquid and the exposed sludge appears to be severely cracked which indicates a dry condition" (ARH-LD-206 B, pp. 10). Additional photographs of the interior of SST A-104 were obtained on June 25, 1975. These photographs "… indicate the sludge is definitely drying (no visible pools of liquid and a surface of cracked solids) due to operation of a portable exhauster" (ARH-LD-207 B, *Atlantic Richfield Hanford Company Monthly Report July 1975*, pp. 10).

The team also discussed a study of liner leak locations and causes (RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations - 241-A Farm*). It was determined that the leak site or sites are located at or near the tank footing as the tank A-104 liquid level was reported at 31 in. at the end of February 1975, shortly before the tank was first suspected of leaking. Several possible causes for liner leaks were examined, but the most likely cause is the tank A-104 thermal conditions. The design did not allow for expansion of the bottom liner as the tank heated, which created stresses. Initial heat-up rate of tank A-104 is not available, but available data infer heat-up rates in excess of the allowable 2 °F/day for periods of time; if the rate of rise was too high, grout moisture could have resulted in the vapor pressure under the liner increasing enough to cause a bulge in the tank bottom liner. The highest rate of rise during waste storage occurred in February 1963 at ~4.9 °F/day. Temperature rate of rise could have set up stresses that may have weakened the tank bottom liner where other factors such as unmeasured bulging fluctuations and corrosion may have further compromised the liner. Based on available temperature data (RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*), tank A-104 appears to have experienced the third highest temperature of all tanks (427 °F in February 1963). This temperature far exceeded the tank design temperature of 300 °F.

On January 14, 2014, releases near tank A-104 were again reviewed to consider additional information obtained since the 2008 inventory assessment, to update this report as described in Section 2.0 and to include results of the tank integrity assessment (see Appendix A, January 14, 2014 Meeting Summary). No new information was presented, other than discussing a liner leak location and cause report and evaluations recently released (RPP-RPT-54912). The 2014 team concurred with previous assessment conclusions.

4.2.3 Conclusions

Based on the information discussed, the assessment team concluded that the current designation for tank A-104 as an "assumed leaker" appears to be correct. The estimated waste loss from SST A-104 was determined to be ~2,000 gal based on radioactivity in the laterals. Based on the activity in the laterals under the tank and the absence of gamma activity from drywells surrounding the tank, it appears that the tank liner leaked at or near the tank footing, likely due to tank liner failure. The actual size of the leak is uncertain, and additional characterization is recommended to better assess the volume and extent of the tank liner leak.

4.2.3.1 Release Type. The waste type leaked from tank A-104 is PUREX sludge supernate (PSS), containing ~0.56 Ci/gal ^{137}Cs as of May 2008. This waste type is consistent with the waste type used in RPP-26744 and the field investigation analysis in RPP-35484.

4.2.3.2 Depth of Release. Leak locations in Figure 4-1 are based on peak readings and are a representation of possible initial and subsequent boundaries of radioactivity. Based on gamma activity measured in the laterals, it is likely the leak site or sites are located at or near the tank footing and below the 31-in. waste level as the tank A-104 liquid level was reported at 31 in. at the end of February 1975, shortly before the tank was first suspected of leaking.

4.2.3.3 Magnitude of Release. The level of radioactivity measured at the laterals indicates that the leak was small. Leak volume estimates range from 500 to 2500 gal. The best estimate for the leak volume was determined to be ~2,000 gal (ARH-LD-207 B, pp. 10) of PSS waste containing ~0.56 Ci/gal of ^{137}Cs as of May 2008. The ^{137}Cs inventory for this release would be ~1,100 Ci.

4.3 TANK 241-A-105

4.3.1 Leak Status of Tank 241-A-105

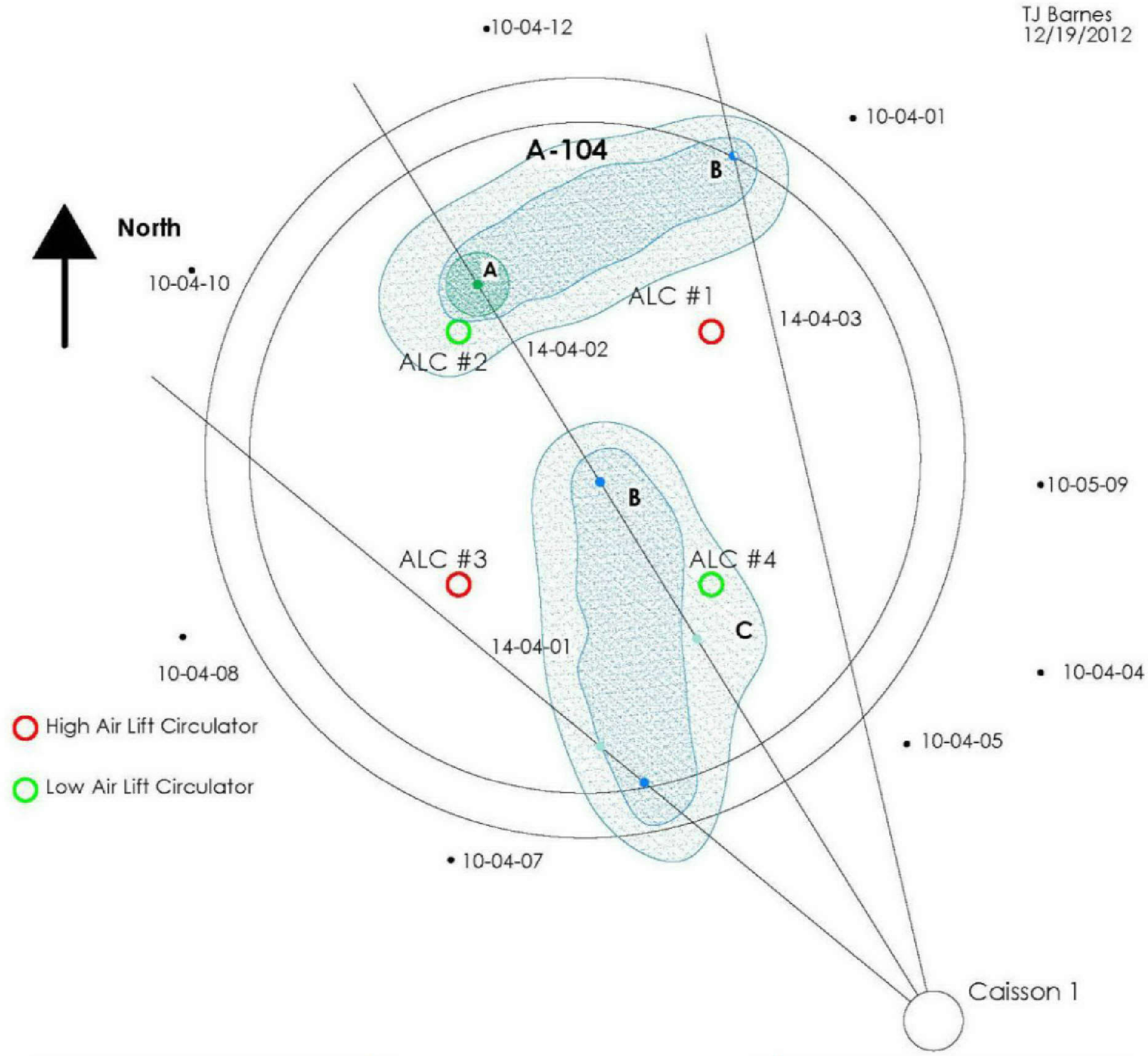
Tank A-105 was designated as a "confirmed leaker" in April 1975, based on increased radioactivity detected in laterals 14-04-01 and 14-04-02 and information resulting from the 1965 sudden steam release incident. See Appendix B3.0 for summary information for this tank.

4.3.2 Leak Assessment Considerations

Tank process information and gamma logging data for tank A-105 was presented and discussed in 2008 and again in 2013/2014 assessments. In addition to information in the current A and AX Farm leak assessment report (RPP-ENV-37956), information from the A and AX Farm leak locations and causes report (RPP-RPT-54912) was also discussed during 2014 assessments.

RPP-35484 and DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas* provide an extensive review of field investigations conducted to characterize the contamination beneath tank A-105. A summary of the findings from RPP-35484 is provided in this section and in Appendix B3.0.

Figure 4-1. Tank 241-A-104 Possible Leak Locations and Indicators



A	B	C
March 1975	**April 1975**	**May 1975**
Radioactivity first detected in lateral 14-04-02 in March 1975 in the northern portion of tank A-104 shortly after the start of sluicing the tank in September 1974. The peak radioactivity was reported at 100 cpm in lateral 14-04-02 at approximately 94-ft from the caisson. No radioactivity was detected in the other laterals or drywells during this time.	A week after initial radioactivity was detected in lateral 14-04-02, counts continued to increase in the northern portion of the tank. Thus, sluicing was halted on April 7, 1975. On April 8, 1975, radioactivity was first detected in lateral 14-04-01 and an additional peak was recorded in lateral 14-04-02, both in the southern portion of the tank. On April 21, 1975, radioactivity was first reported in lateral 14-04-03 in the northern portion of the tank. Tank A-104 was declared a confirmed leaker and supernatant was pumped out of the tank from April 9 through April 19, 1975.	In May 1975, additional peaks were detected in lateral 14-04-02 along the southern edge of the tank. Radioactivity in site B continued to slowly increase through 1975. Radioactivity in lateral 14-04-03 slowly increased in May 1975 and then slowly declined. The tank A-104 liquid level was reported at 6.5-in at the end of April 1975 and radioactivity in the laterals appeared to stabilize by the end of 1975. No radioactivity was detected in the surrounding drywells.

Reference: RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations - 241-A Farm*.

In April 2005 logs for the three laterals beneath tank A-105 showed increased gamma activity along laterals 14-05-02L and 14-02-03L. These laterals interrogate the central portion (14-05-02L) and northeastern quadrant (14-05-03L) of the tank. The highest gamma concentrations were found in lateral 14-05-03, where equivalent cesium activity was 3.4×10^7pCi/g near the distal end of that lateral, but other activities detected were significantly lower. The gamma logs indicate that the majority of the waste from tank A-105 leaked from regions near the perimeter of the tank, where drywell logs would have the optimal opportunity to detect the contaminants. However, none of the drywells show high ^{137}Cs or other gamma activity. Elevated ^{137}Cs does not extend beyond ~10 ft horizontally from the regions of peak intensity before declining to near background levels. The nearest drywells to these locations are 10-06-09 and 10-05-12, which are beyond that distance. Neither the lateral set of logs nor the drywell set of logs indicate a major release of mobile gamma-emitting radionuclides. However, drywells 10-05-02, 10-05-11 (abandoned), and 10-06-12 indicate corrosion in the steel casing at ~64 ft. This may indicate tank waste has reached these drywells and beyond.

The extent of the waste lost below the laterals was discussed. Because the measured gamma activity in the laterals was less than the ^{137}Cs saturation capacity for soils and the sodium concentration of the waste leaked was lower than for Reduction-Oxidation (S Plant) waste (in the 241-SX Farm tanks), it was assumed that waste did not migrate deeper than the laterals – an assumption that needs to be tested. For such reasons it was also assumed, based on the location of gamma activity peaks in the laterals, the observation of tears in the liner around ¾ of the tank perimeter, and the distribution of gamma activity along the laterals, that gamma activity was confined to within ~8 ft outward from the tank perimeter and ~8 ft inward under the tank perimeter, recognizing that waste/water discharges may have gone near vertically downward. This approach provides a leak volume estimate comparable to the previous estimates in WHC-MR-0264, *Tank 241-A-105 Leak Assessment*.

Previous estimates in WHC-MR-0264 and HNF-EP-0182 show that 5,000 to 15,000 gal of tank waste leaked before August 1968 and 5,000 to 15,000 gal of waste leaked while the tank was being sluiced from August 1968 to November 1970. In addition, 610,000 gal of cooling water was added to the tank and, based on evaporation estimates, 0 to 232,000 gal of cooling water may have been released from the tank.

A model to estimate the tank A-105 leak inventory and volume was developed based on measured gamma radioactivity in surrounding drywells and laterals under the tank, properties of cesium sorption capacity in the soil, the extent of leaks in the tank liner, and the waste type leaked. Using this approach an estimated 56,000 Ci of ^{137}Cs was released to the soil and 2,000 to 40,000 gal of waste for PUREX HLW supernate (P1) and 221-B Plant (B Plant) ion exchange (BIX) waste types respectively (see Section 4.3.3.3).

On December 3, 2013, releases near tank A-105 were again reviewed to consider additional information obtained since the 2008 inventory assessment, to update this report as described in Section 2.0 (see Appendix A, December 3, 2013 Meeting Summary). No new information was presented, other than discussing a leak location and cause report and evaluations recently released (RPP-RPT-54912). The 2013 team concurred with previous assessment conclusions and added the following observation.

In addition to the waste, large volumes of cooling water may have been released. An estimated 610,000 gal of cooling water was added to tank A-105 during November 1970 through December 1978 and 200,000 to 232,000 gal of cooling water were unaccounted for in the estimate of evaporation. Because of the mixture rule in RCRA, when a solvent/coolant is added to dangerous waste, the entire mix becomes hazardous/dangerous waste. The waste in tank A-105 had been sluiced in 1968 with supernate, leached with sulfuric acid and sluiced in 1969 and 1970 (see Appendix B3.0). This sluicing and acid leaching partially dissolved and suspended sludge that was pumped from the tank, leaving a very hard and insoluble sludge in the tank. Given the insoluble state of the sludge remaining in tank A-105, it is doubtful that water addition to this tank actually dissolved much of the contaminants present. However, the addition of water diluted the activity/concentration of contaminants in tank A-105 and provided a driving force for more widespread distribution of waste leaked from the tank.

Additional data is needed to confirm assumptions that waste did not migrate below the laterals or further toward the middle of the tank. Suggested characterizations included:

- Investigate to determine the source of low electrical resistivity levels above a series of pipelines southeast of tank A-104 and southwest of tank A-105 and the influence of pipelines on resistivity measurements,

- Determine if vadose zone layering is present in A Farm such as was observed in 241-C Tank Farm that may influence waste migration patterns,

- Analyze direct push soil samples for sulfur as a tracer for migration of sulfuric acid that was added to tank A-105,

- Perform a slanted direct push with sample collection for dangerous waste and/or radionuclides 5 to 10 ft below the laterals to corroborate the assumption that waste did not leak past the laterals, and

- Investigate corrosion of drywells and groundwater wells to determine if tank waste is the cause.

Three carbon steel-cased drywells adjacent to tank A-105 indicated corrosion between 54 and 70 ft in depth in 1978, suggesting the possibility of tank waste diluted by cooling water intersecting the boreholes. Three groundwater wells (stainless steel) south of A Farm also indicated corrosion at ~260 ft in depth and had to be decommissioned within 10 years of their construction. Further investigations were recommended to assess the cause of corrosion, to identify dry wells that may have a similar problem, and to establish relationships, if any, between the corroded drywells and groundwater wells. These drywells and groundwater monitoring wells are of similar construction to all others on the Hanford Site, and yet this is the only location where such corrosion has been observed.

Approximately 60,000 gal of water were released between the morning of February 22 and February 23, 1978 between tanks 241-A-102 (A-102) and A-105 (see Section 5). There were increased gamma radiation readings at 60 ft around the caisson that serves the laterals under tanks A-103, A-105, and A-106, indicating possible contamination transport during this time frame. The potential impact of this large water release should be evaluated to determine how it may have affected transport of generally immobile contaminants such as ^{137}Cs. This evaluation would have important implications to understanding the fate of tank waste and the 230,000 gal or more of cooling water introduced and leaked from tank A-105 to the vadose zone.

4.3.3 Conclusions

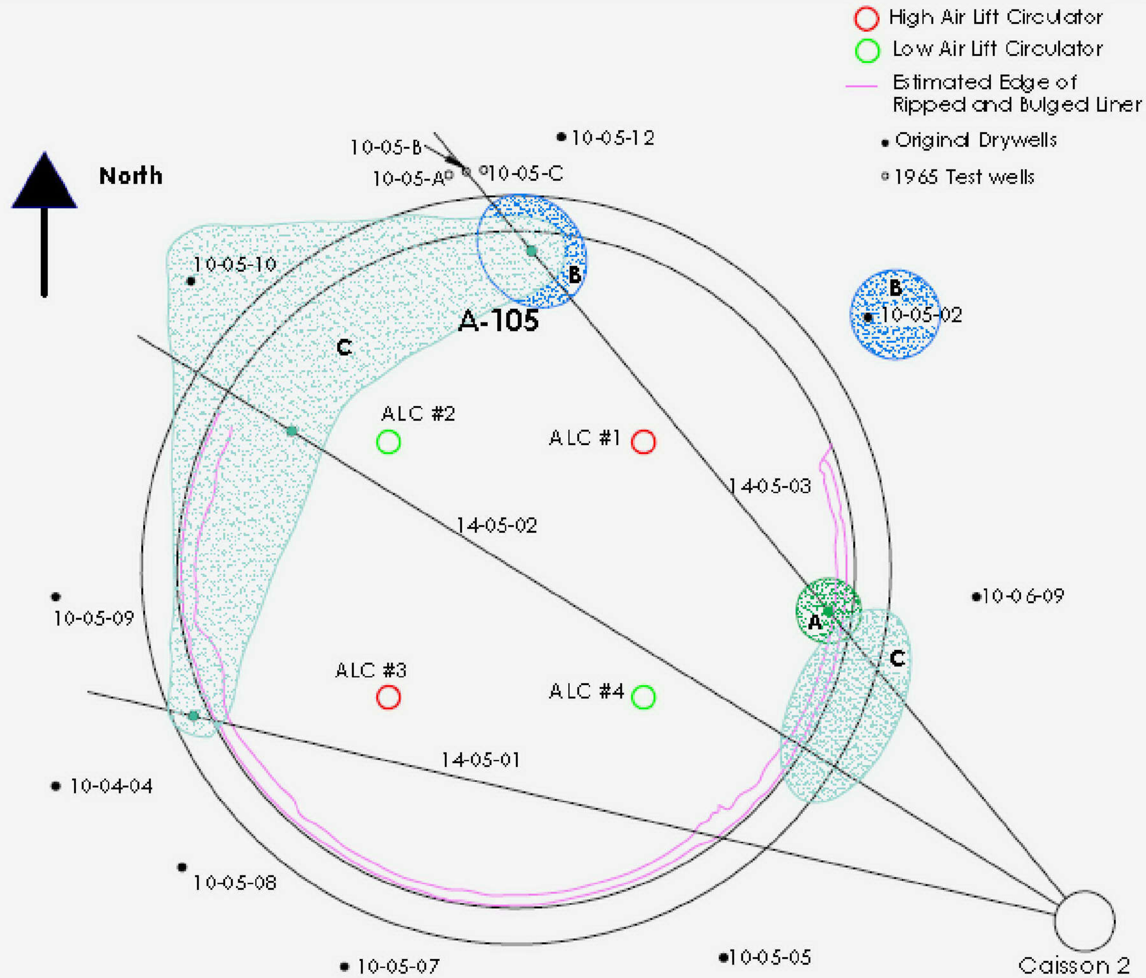
Lateral data obtained from 1963 to 1986 shows elevated gamma activity and high temperatures below tank A-105 that clearly indicate the presence of a tank liner leak. In-tank surface level changes and video observation of a bulge and ripped liner confirm that the tank leaked. The assessment team agreed that lacking additional information, there is no basis or reason to change the inventory estimates that were presented in Revision 1 of this report. Section 4.3.2 identifies characterization needs discussed during the 2014 assessment meetings for tank A-105.

The inventory estimate for the leak was based on the extent of the ripped liner, the dates when increased gamma activity was detected in the tank laterals, and the extent of contamination in the laterals. The estimated leak volume was 2,000 to 40,000 gal depending on the waste type based on an estimated 56,000 Ci of ^{137}Cs in the soil. In addition to the P1 and/or BIX supernate waste leaked, cooling water likely leaked from tank A-105. An estimated 610,000 gal of cooling water was added to tank A-105 during November 1970 through December 1978 and 200,000 to 232,000 gal of cooling water were unaccounted for by evaporation estimates and may have leaked to the soil. At the time of this incident, tank A-105 contained ~900,000 gal of waste that was over 300 °F, resulting in a disrupted liquid surface.

4.3.3.1 Release Type. Based on the dates that increased gamma was detected in the laterals, the waste type leaked from tank A-105 was determined to be a combination of PUREX supernatant waste with a ^{137}Cs concentration of 30.7 Ci/gal (as of May 1965, [ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and Its Implications on Waste Containment and Control*]) and B Plant ion exchange waste with a ^{137}Cs concentration of 1.38 Ci/gal (as of June 1968 [Interoffice memorandum 7G420-06-004, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration During Sluicing in August 1968"]). This waste type is consistent with the waste type used in RPP-26744 and the field investigation analysis in RPP-35484.

4.3.3.2 Depth of Release. Leak locations in Figure 4-2 are based on peak readings and are a representation of possible initial and subsequent boundaries of radioactivity. Based on gamma activity measured in the laterals, and the ripped liner on the tank perimeter at the base of the tank, the tank likely leaked from around the tank perimeter at the tank base.

Figure 4-2. Tank 241-A-105 Possible Leak Locations and Indicators



A	B	C
Nov-63	Feb-65	Aug-68
Radioactivity first detected in lateral 14-05-03 in November 1963 in the southeast portion of tank A-105. Readings remained relatively stable through March 1965. A sidewall leak was postulated during this time; however, it was not confirmed. No radioactivity was detected in the other laterals or drywells, and tank A-105 remained in service.	A steam eruption occurred in tank A-105 on January 28, 1965 causing the bottom liner to tear. One month later, radioactivity was reported in lateral 14-05-03 in the north portion of the tank. Three test wells were drilled near this lateral; however, no radioactivity or moisture was detected in these test wells. Radioactivity was detected January 1965 in drywell 10-05-02 at 74-ft BGS. The source of radioactivity may have been migration of mobile Ru-106 from a tank A-105 leak, possibly related to the November 1963 event.	In March 1968, tank A-105 was declared a confirmed leaker. Tank A-105 sluicing campaigns were conducted in 1968 and 1970. Laterals 14-05-01 and 14-05-02 began to increase in radioactivity during the first sluicing campaign August 1968 to November 1968. Sluicing became ineffective and was shut down. A second, more aggressive, sluicing campaign began August 1970 and was halted November 1970 after significant increases were detected in all the laterals underneath tank A-105. Radioactivity in drywell 10-05-10 increased between 1965 and 1972 which appears to be associated with radioactivity detected in lateral 14-05-02.

TJ Barnes
12/3/2012

Reference: RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations - 241-A Farm.*

4.3.3.3 Magnitude of Release. Historically, a volume estimate range of 5,000 to 15,000 gal was proposed for this leak (BNWL-CC-376, *Techniques for Calculating Tank Temperatures and Soil Temperatures Near Leaks – Application to PUREX Waste Tank 105A*) depending on the location of the contaminated soil volume with respect to the hot spot on lateral 14-05-03. However, the physical model used as the basis for this estimate was devised to facilitate the modeling analysis and did not represent important conditions affecting contaminant behavior. Therefore, it is not surprising that the estimated leak volume range needed to create the observed temperature profiles using these assumptions is implausible. Some of the implausible assumptions were steady state thermal conditions, heat generation caused solely by ^{137}Cs decay, a maximum temperature of 260 °F in the elevated temperature zone and complete saturation of a hemispheroidal volume of vadose zone sediment underneath the tank before evaporation occurs. Heat dissipation was highly transient in 1965, ^{137}Cs was not the dominant heat producer affecting the elevated temperature zone early on, and the maximum temperature exceeded 300 °F. The concept of saturated flow in the vadose zone is contradicted by numerous field observations. For example, field injection experiments designed and implemented to simulate a small leak tracked moisture content in the vadose zone near an injection point. These experiments have shown that excess fluid quickly distributes in the subsurface to restore ambient sediment moisture contents and that this distribution occurs primarily under unsaturated conditions.

Given the modeling analysis configuration, BNWL-CC-376 estimated that a minimum leak volume of 6,000 gal was needed to generate the highest elevated temperature in lateral 14-05-03. This corresponds to a ^{137}Cs loss of ~184,000 Ci, which is a gross overestimate of actual vadose zone contamination. To put this value in perspective, ^{137}Cs losses from the 115,000 gal tank 241-T-106 leak are ~11,000 Ci and ^{137}Cs was measured in numerous drywells around that tank. Clearly, a significantly smaller volume of waste was discharged in the 1965 event.

In an effort to better quantify the inventory of waste leaked from tank A-105, a new conceptual model was devised to describe the leak. Tank A-105 was assumed to have leaked over an area ¾ of the tank circumference, based on the topographical mapping of the tank bottom (Appendix B3.0). The waste is assumed to have leaked from the tank to the laterals, a distance of 10 ft and spread the same width as indicated by the gross gamma analyses for the three laterals (see Figure B3-19). The concentration of ^{137}Cs in the soil contacted by the leaked waste is assumed to be at the maximum cesium sorption capacity of 4.0E+07 pCi/g. The estimated waste loss was then calculated for two cases: 1) assuming only P1 was leaked and 2) assuming only BIX waste was leaked. In actuality, information supports the conclusion that both types of waste were leaked from tank A-105 but, the quantity of each type lost cannot be estimated from available data. By assuming the radioactivity detected in the laterals is attributable to only one waste type the range of waste volume leaked from tank A-105 was estimated as follows.

Assumptions/Inputs:

- Soil density = 1.7 g/cc
- Distance to lateral below base of tank = 10 ft
- Cs Sorption capacity = 4.0E7 pCi/g (RPP-ENV-33418)

- Assume waste does not extend below laterals based on Cs-Sorption chemistry
- Assume waste was not affected by 230,000 gal of water introduced to the tank from 1968 to 1978 and no additional waste has leaked since 1978
- Assume lateral gamma measurements are ^{137}Cs
- Based on activity in the laterals and where the steel tank liner is ripped, up to ¾ of the tank circumference (75-ft diameter tank) could have leaked
- As a conservative estimate, assume the waste spread as much at the base of the tank as at the laterals in a cylindrical distribution (field verification by some angled pushes beneath the tank would provide additional insight)
- Calculate estimated leaked waste volume for two cases:
    - PUREX supernatant waste concentration, ^{137}Cs = 30.7 Ci/gal (as of May 1965 from ARH-78)
    - B Plant ion exchange waste concentration, ^{137}Cs = 1.38 Ci/gal (as of June 1968 from 7G420-06-004 – Interoffice memorandum).
- Width of contamination at the laterals and base of the tank = 16.8 ft (8.4 ft outward from tank perimeter and 8.4 ft under tank). This is based on an average of 5 leak diameter widths measured at the laterals (30, 22, 16, 8 and 7 ft) at a base concentration of 100 pCi/g (see Figure B3-19).

Calculation:

Volume of contaminated soil = 0.75 × tank circumference × depth to laterals
= $0.75 \times 3.14 \times [(75/2 + 8.2)^2 - (75/2 - 8.2)^2] \times 10$
= 29,000 ft^3

Total Ci in soil = 29,0000 ft^3 × 1.7 g/cm^3 × 4 E7 pCi/g × 1 Ci/10^{12} pCi × 28,320 cm^3/ft^3
= 56,000 Ci

Volume lost:

For PUREX supernate = 56,000 / 30.7 Ci/gal = 1,824 or ~2,000 gal

For B Plant liquid waste = 56,000 / 1.38 Ci/gal = 40,580 or ~40,000 gal.

4.4 TANK 241-AX-102

4.4.1 Leak Status of Tank 241-AX-102

Tank AX-102 was classified as an "assumed leaker" in September 1988 based on an estimated 3,400-gal liquid level decrease reported to have occurred from June 18, 1984 through May 27, 1988. However, no radioactivity corresponding to tank waste leakage was detected in the leak detection pit or the drywells associated with this tank, indicating that the vertical spread of contamination appears to be from a pipeline. See Appendix B4.0 for summary information for this tank.

4.4.2 Leak Assessment Considerations

The historically estimated waste loss from tank AX-102 is 3,400 gal and is based solely on the 1.25-in. liquid level decline reported in WHC-UO-88-029-TF-04, *Unusual Occurrence Report Tank 241-AX-102 has Exceeded the 1.00 inch Decrease Criteria and Evaluations Cannot (with 95% Confidence), Show the Decrease to be Due Solely to Evaporation*. No increase in radiation was detected in the tank AX-102 leak detection pit or drywells associated with this tank. However, this estimate for the volume of waste loss from tank AX-102 is inconsistent with the relatively low level of radiation detected in the leak detection pit and drywells associated with this tank and discussed in RPP-ASMT-42628, *Tank 241-AX-102 Integrity Assessment Report*.

A sample of the liquid in SST AX-102 was obtained in August 1988 and is reported in Appendix B of HNF-SD-WM-ER-472, *Tank Characterization Report for Single-Shell Tank 241-AX-102*. Select analytes reported in the August 1988 tank AX-102 liquid sample are summarized in Table 4-1. This waste composition should be representative of the waste leaked from the tank.

If 3,400 gal of the complexant concentrate waste had been released from SST AX-102 to the soil from June 18, 1984 through May 27, 1988, the inventory of ^{137}Cs and ^{90}Sr leak would equate to 4,500 and 2,190 Ci, respectively. The gamma radiation detected in the associated drywells and leak detection pit is expected to be far higher than actually observed if this quantity of these two radionuclides were leaked to the soil. RPP-ASMT-42628 stated that evaporation was the determined cause of a decrease in tank waste surface level, and gamma activity in drywells near the tank was due to releases from the ventilation system Dresser couplings. Therefore, it is unlikely that SST AX-102 leaked 3,400 gal of complexant concentrate waste to the soil.

RPP-35484 states that the primary indication of tank waste loss began in May 1975, when an increase in gross gamma levels from 38 to 152 c/s occurred at ~55 ft bgs in drywell 11-02-11. By September 1975, the gamma level increased to 1,021 c/s and stayed at that level through December 1976. Additional drywells 11-02-12 and 11-02-22 were constructed shortly after May 1975, but only drywell 11-02-12 showed anomalous radiation levels. Significant contamination was encountered in the first measurement essentially throughout the drywell, as shown in Figure 4-3 (GJO-97-14-TAR/GJO-HAN-12, *Vadose Zone Characterization Project at the Hanford Tank Farms: AX Tank Farm Report*). Current spectral gamma analyses for drywells 11-02-12 show ^{137}Cs as the dominant gamma emitter at ~12 ft bgs and only ^{60}Co at

~0.1 pCi/g from 30 to 45 ft bgs. Other short-lived gamma emitters present in 1975 would have decayed below detection limits by the mid-1990s when these measurements were taken. Other drywells near SST AX-102 do not show any significant contamination. Migration of ^{137}Cs contamination down the inside or outside of the drywell casing is suspected to have affected the distribution of some of the contamination detected in the drywells.

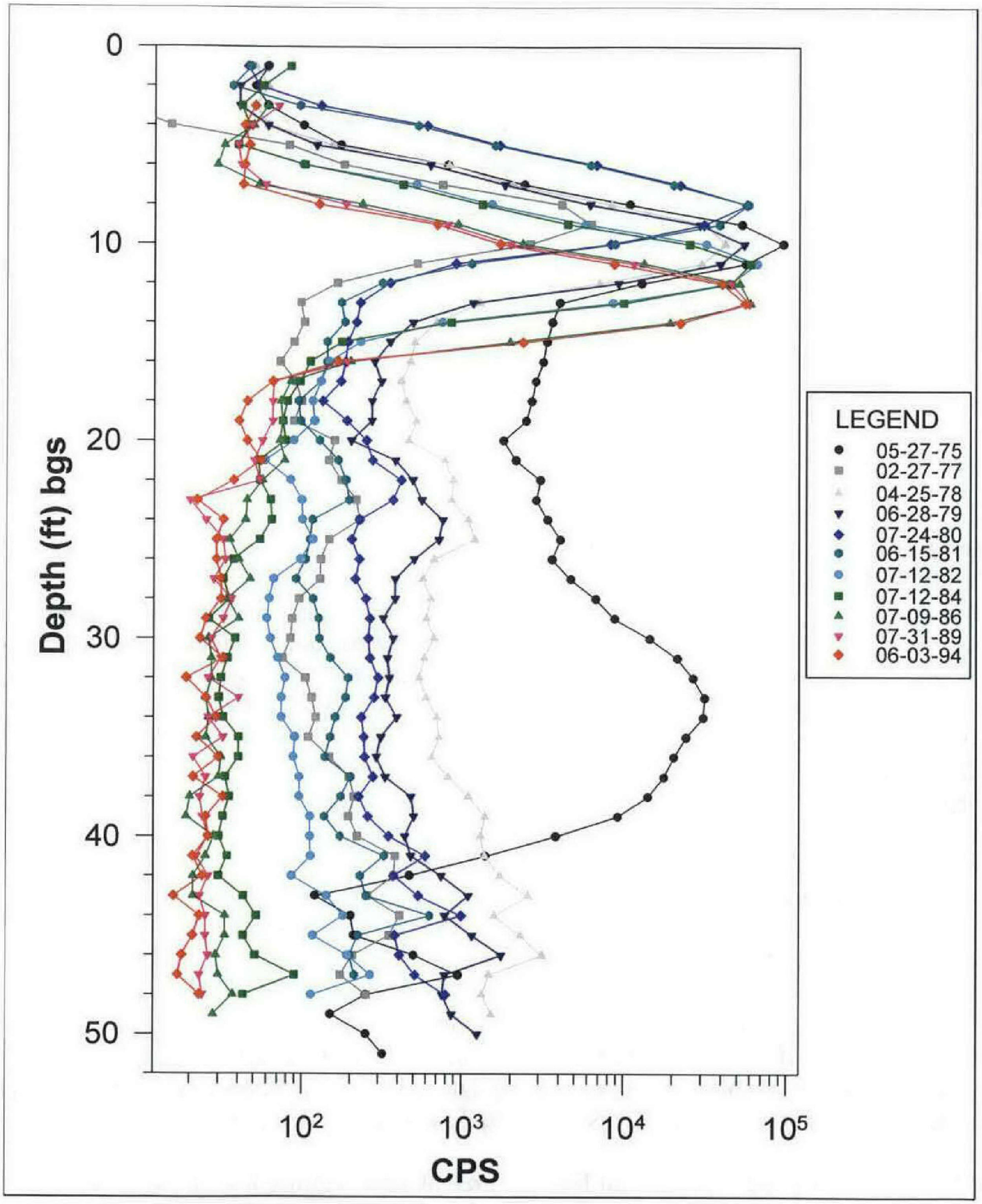
Table 4-1. Tank 241-AX-102 Liquid Composition (August 1988)

Analyte	Value	Units
Al	0.006	Molarity
Cr	0.004	Molarity
Na	7.32	Molarity
K	0.002	Molarity
pH	11.3	
NO_3	3.7	Molarity
NO_2	1.4	Molarity
PO_4	< 0.056	Molarity
CO_3	0.98	Molarity
NH_4	0.028	Molarity
Total Organic Carbon	36.8	g/L
Sr-90	1.7E+05	µCi/L
Cs-137	3.5E+05	µCi/L
Pu	97	µCi/L
Am	1,000	µCi/L

The most likely source of waste release from tank AX-102 was identified as a Dresser coupling failure between a 20-in. buried vapor line and the tank vessel vent system header. In late 1975, asphalt sealant was injected into the soil in an attempt to repair the Dresser couple. The drywell gamma data suggest that relatively little waste entered the soil column after this action was taken (RPP-35484).

On February 11, 2014, tank AX-102 was again reviewed to consider additional information obtained since the 2008 inventory assessment, to update this report as described in Section 2.0 (see Appendix A, February 11, 2014 Meeting Summary). Results and findings of a tank integrity assessment conducted during July 2009 per TFC-ENG-CHEM-D-42. The consensus of the integrity assessment team was that the 1.25-in. surface level decrease observed between the 1984 to 1988 time period was the result of evaporation and that tank AX-102 did not leak. The team determined that the tank breathing rate calculated in 1988 using general atmospheric data was low compared to measured data collected in 1997 (the He tracer gas testing in 1997 measured a breathing rate of 17 cubic feet per minute [cfm] versus the 1988 calculated rate of ~1.8 cfm) and the measured rate of 17 cfm could easily explain the liquid level decrease between 1984 and 1988.

Figure 4-3. Historical Gross Gamma Log Data from Drywell 11-02-12



The 2013 inventory assessment team concurred with previous inventory and tank integrity assessment conclusions.

4.4.3 Conclusions and Recommendations

The assessment team determined the estimated waste loss of 3,400 gal from tank AX-102 is inconsistent with the relatively low level of radiation detected in the leak detection pit and drywells associated with this tank. The likely source of radioactivity detected historically in drywells 11-02-11 and 11-02-12 is the leaking Dresser coupling associated with the tank off-gas piping rather than breach of the tank liner (RPP-ASMT-42628).

In the 2008 inventory assessment it was recommended that HNF-EP-0182 be revised to indicate there is no basis for assuming a leak loss volume or inventory for a tank AX-102; therefore, no leak inventory was assigned. In addition, it was recommended that the current designation for tank AX-102 as an "assumed leaker" be reevaluated.

An integrity assessment was conducted in July 2009. The recommendation of the 2009 tank integrity assessment team was that the integrity status of tank AX-102 be changed from "assumed leaker" to "sound." The results were presented to the ESRB on December 3, 2009. The ESRB agreed with the recommendation of the team and requested that the leak detection pits in AX farm be swabbed to confirm the findings of the team and present sample results to the ESRB prior to releasing the AX-102 tank integrity assessment report (ESRB 2009-30, *Executive Safety Review Board Meeting Minutes*). Leak detection pit swabs are schedule to be obtained in fiscal year (FY) 2014, however, to date, the swabs have not been obtained and the tank integrity assessment report has not been released. It should be noted that swabs will only indicate removable contamination, and any fixed contamination from old leaks may not be detected. Additionally, the radiation detection well that is part of the leak detection apparatus has not been recently measured.

4.5 TANK 241-AX-104

4.5.1 Leak Status of Tank 241-AX-104

Tank AX-104 was designated a questionable integrity tank and was removed from active service in August 1978 as a result of the radioactivity detected in drywell 11-04-08 (Occurrence Report 77-202, *Radiation Peak in Dry Well 11-04-08 Exceeding Increase Criterion*). However, the source of the radioactivity detected in drywell 11-04-08 could not be determined. The strongest gamma radiation signal was detected due east, toward tank AX-104, which led personnel in 1988 to suspect the integrity of the tank. The tank was designated an "assumed leaker" in 1988 (HNF-EP-0182). See Appendix B5.0 for summary information for this tank.

4.5.2 Leak Assessment Considerations

No increase in radiation was detected in the tank AX-104 leak detection pit or drywells associated with this tank that was attributed to a tank leak. However, drywell 11-04-08 was observed in November 1977 to have an increase in radiation above background reaching a peak of 247 cps at 64 ft bgs. The increase in radiation began in May 1976, but did not exceed background levels until August 1976. The radioactivity in this drywell had decreased to 204 cps on March 8, 1978 but then began to increase again, reaching 287 cps on April 19, 1978 during sluicing (Occurrence Report 77-202). Tank AX-104 was receiving PSS solution and sludge from final cleanout of SST AX-103 during the second quarter of FY 1976 through December 1976, and was actively being sluiced from March 31, 1977 through November 5, 1977 and March 2, 1978 through April 20, 1978.

A new drywell, 11-04-19, was installed in March 1978 to further investigate the potential for tank AX-104 to have leaked waste. Drywell 11-04-19 is situated between drywells 11-04-08 and 11-04-07 and is closer to tank AX-104. Initially, the radioactivity detected in drywell 11-04-19 was less than the detection limit of 50 cps (SD-WM-TI-356, pp. 11-04-10). RPP-8821, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-AX Tank Farm – 200 East*, pp. 40 shows that the radioactivity detected in drywell 11-04-19 reached a maximum of ~200 cps 1978 and then slowly decreased. The radioactivity detected in drywell 11-04-08 was subsequently correlated to ^{106}Ru decay rate (RPP-8821, pp. 36-40).

The cause for the increased radiation detected in drywell 11-04-08 could not be determined. The strongest source of the radiation detected in drywell 11-04-08 was determined to be due east, toward tank AX-104. The radioactivity detected in drywell 11-04-08 was subsequently correlated to ^{106}Ru decay rate (RPP-8821, pp. 18-21). The tank was classified as "questionable integrity" and removed from active service in August 1978 as a result of the radioactivity detected in drywell 11-04-08 (Occurrence Report 77-202).

Drywells nearby SST AX-104 do not currently show any significant contamination associated with a tank leak, as shown in Figure 4-4 (GJO-97-14-TAR/GJO-HAN-12). Although historical gamma anomalies existed, the activity detected in drywells 11-04-08 and 11-04-19 in 1996 shows no signs of contamination from a tank waste leak. Migration of ^{137}Cs contamination down the inside or outside of the drywell casing is suspected to have affected the distribution of some of the contamination detected in the drywells. Much of the bias of the drywell log data that is due to drywell migration effects was removed from the surveys and is designated as "removed" in Figure 4-4.

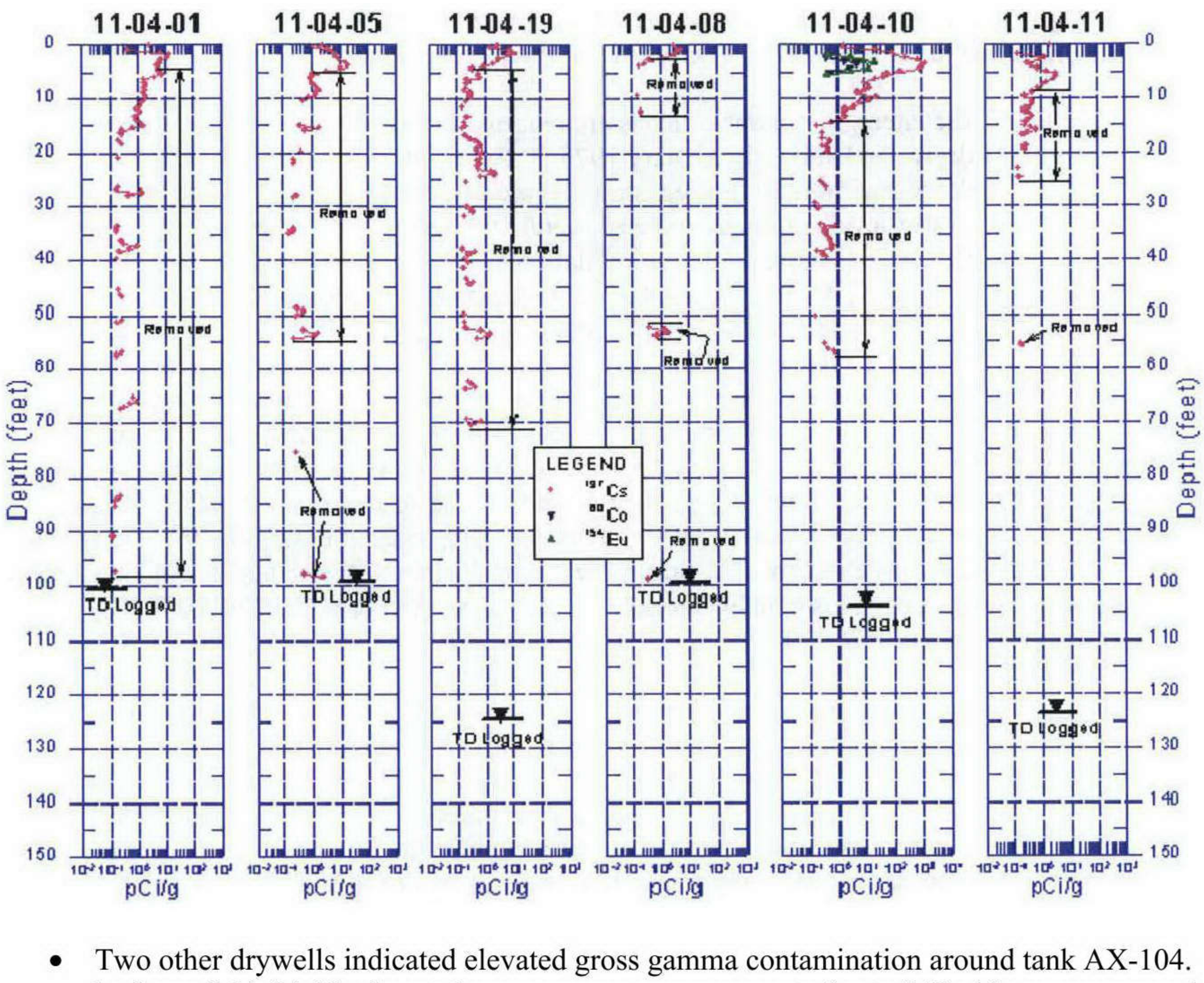
In an attempt to quantify the potential waste loss, Rockwell Hanford Operations personnel averaged the waste loss for 18 other SSTs that had not shown a catastrophic leak (i.e., excluded tanks 241-T-106 and 241-A-105). The average waste loss for these 18 SSTs is 8,000 gal. The estimated waste loss from tank AX-104 was assigned 8,000 gal in HNF-EP-0182 based solely on the average waste loss from 18 other SSTs for which liquid level decline was reported (Letter 8901832B R1, "Single-Shell Tank Leak Volumes").

RPP-35484 states the following:

- Elevated gross gamma levels are reported in the first measurements taken at drywell 11-04-11 in January 1975 (1,490 c/s at 25 ft bgs, 255 c/s at 39 ft bgs, and 950 c/s at 64 ft bgs), suggesting the presence of pre-existing contamination. The higher level counts diminished rapidly thereafter to near detection limit levels by late 1978 (Figure 4-5). A similar profile was also observed at nearby drywell 11-04-01 (Figure 4-6). In this drywell, maximum levels were found in one depth interval between

15 and 40 ft bgs, and maximum values of nearly 8,000 c/s suggest that this drywell was closer to the source of leakage. Given the relatively rapid decrease in gross gamma levels shown in Figure 4-5 and Figure 4-6, shorter-lived radionuclides (e.g., ^{106}Ru) are likely the primary radiation producers. Recent spectral gamma analyses show only measurable ^{137}Cs concentration near the surface, which may be related to these losses or some other near-surface release. As with tank AX-102, analysts concluded that the source of this waste release was part of the buried 20-in. vapor line and vessel vent header system. This conclusion is based on information presented in ARHCO Occurrence Report 75-47, *Increasing Dry Well Radiation Adjacent to Tank 104-AX.*

Figure 4-4. Spectral Gamma Log Data from AX-104 Drywells



- Two other drywells indicated elevated gross gamma contamination around tank AX-104. In drywell 11-04-08, elevated gross gamma measurements (up to 350 c/s) were measured in 1977 and 1978 between 60 and 65 ft bgs. A reduction by half within a year's time suggests that ^{106}Ru was the primary contributor. Whether this observation indicates a continuation of waste migration from the same source affecting drywells 11-04-01 and 11-04-11 is not clear, though the timing and radiation levels are consistent with that hypothesis. On the other hand, no indications of elevated gross gamma activity were observed at drywell 11-04-10, which is located between drywell 11-04-08 and the other drywells. A migration path that bypassed drywell 11-04-10 appears problematic, particularly because the contamination below the Dresser couplings had been stabilized by an asphalt sealant. Alternatively, the activity was coincident with sluicing in the tank and activity observed in the radiation detection well that is part of the leak detection pit apparatus that reached its maximum level in 1978. Drywell 11-04-10 is also notable for an apparently independent near-surface waste loss. Unlike the other drywells around tank AX-104, mid-1990s spectral gamma data analyses show ^{137}Cs peaks at ~5 ft bgs, accompanied by ^{60}Co and ^{154}Eu peaks in the same location.

- Tank AX-104 was identified as having "questionable integrity" in 1977 and assumed a leak of 8,000 gal because of vapor system losses in 1988. No reports are available that explain the "questionable integrity" designation, nor is the information used to determine the leak volume estimate of 8,000 gal given in past assessments.

On February 11, 2014, tank AX-104 was again reviewed to consider additional information obtained since the 2008 inventory assessment, to update this report as described in Section 2.0 (see Appendix A, February 11, 2014 Meeting Summary).

4.5.3 Conclusions and Recommendations

The leak inventory assessment team concluded that it is doubtful that PSS waste actually leaked from tank AX-104, since the leak detection pit and drywells associated with this tank do not show the level of radiation that is normally associated with a tank waste loss. The likely source of radioactivity detected historically in drywells 11-04-01 and 11-04-11 is the Dresser coupling associated with the tank offgas piping. The source of the historical ^{106}Ru radioactivity detected in drywells 11-04-08 and 11-04-19 cannot be definitively determined, but could be from migration of contamination associated with the Dresser coupling leaks in this tank farm or nearby condensate lines which may have leaked. Ruthenium is known to readily migrate through Hanford soils. However, it is important to note that the increased activity in drywell 11-04-08 was coincident with sluicing.

The 2008 team recommended that HNF-EP-0182 be revised to indicate that there is no basis to assign a leak loss volume or inventory for tank AX-104. In the 2008 assessment, participants could not conclude whether tank AX-104 lost integrity. However, because the tank has been sluiced and remaining residuals are "hot," participants believed that tank AX-104 was not a likely candidate for sluicing regardless of whether it has lost integrity and an integrity analysis was not recommended. Upon reassessing the leak inventory for tank AX-104 and based upon the tank AX-102 integrity assessment and observed similarities with tank AX-104, an integrity assessment for tank AX-104 is recommended after swabbing the AX Farm leak detection pits and reviewing sample results. However, it is noted that swabs of the pits may not be definitive. For example, if any older contamination has dried leaving a hard surface, the contamination may be largely fixed and the removable portion may not be representative of the true concentration of the waste. Consequently, swab measurements reported in dpm or mrem/h are not directly relatable to concentration in Ci/g, and determination of the origin of contamination (i.e., tank waste) using this comparison alone may not be valid.

Figure 4-5. Historical Gross Gamma Log Data from Drywell 11-04-11

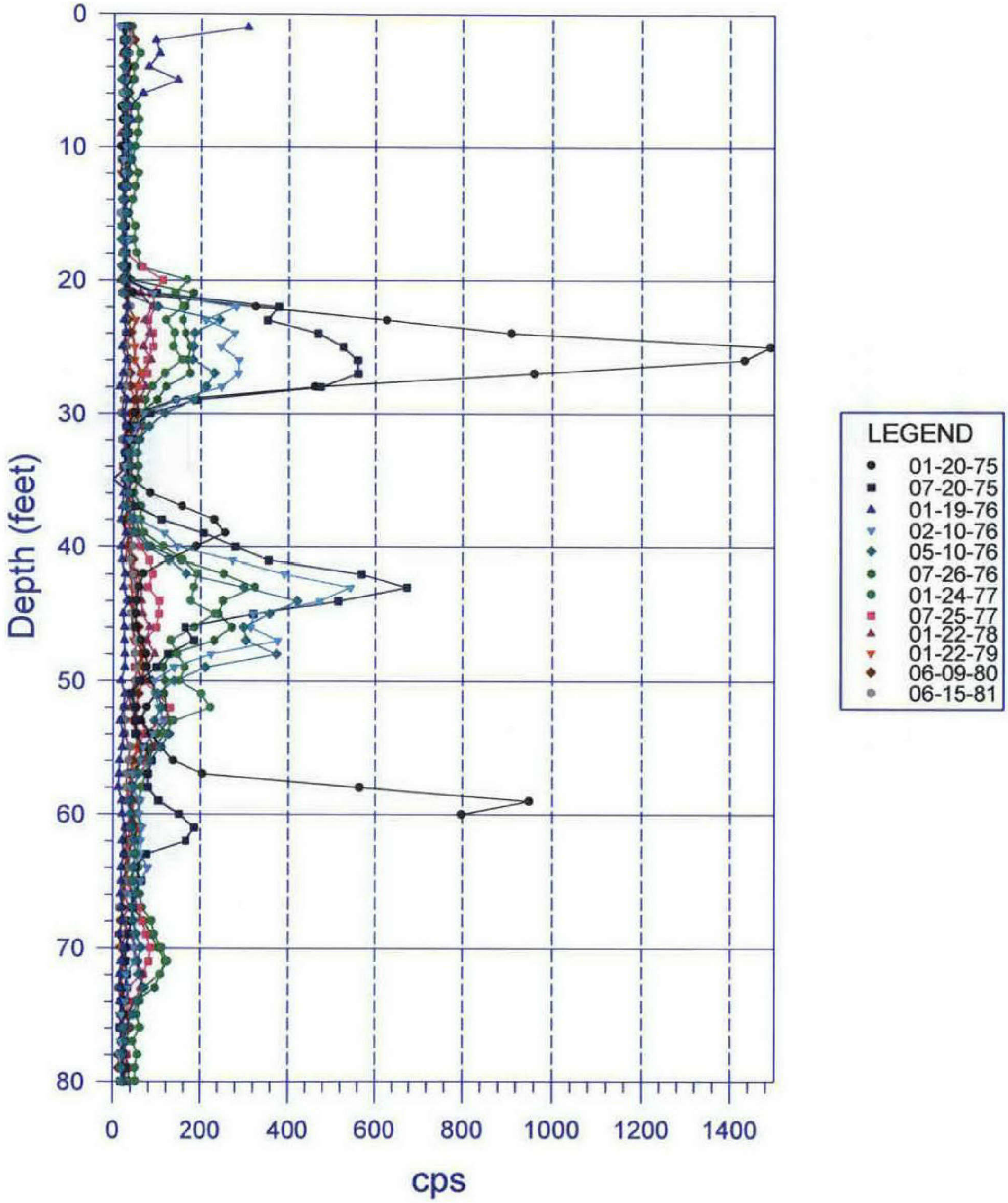
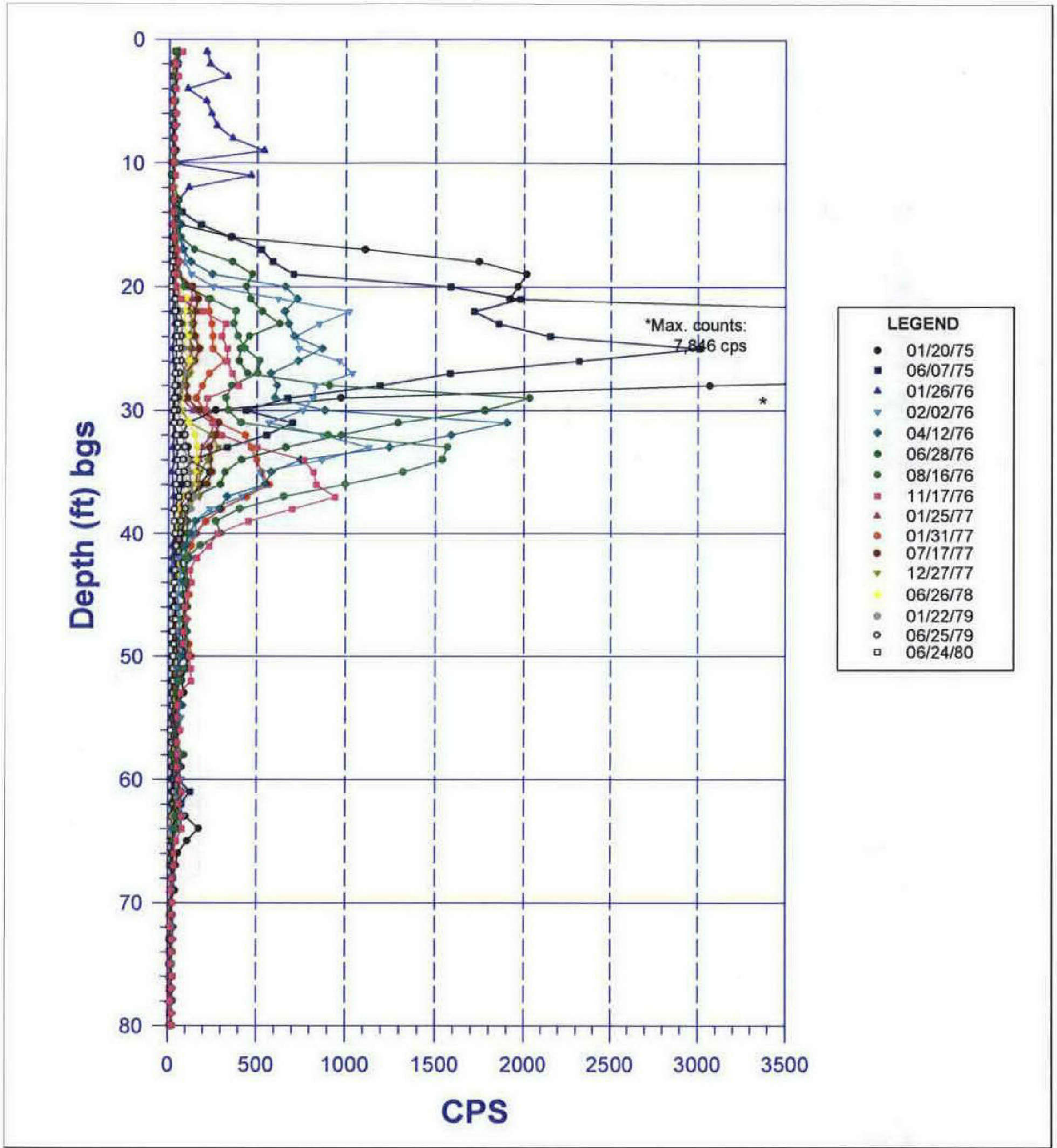


Figure 4-6. Historical Gross Gamma Log Data from Drywell 11-04-01



4.6 OTHER 241-A AND 241-AX FARM SINGLE-SHELL TANKS

In addition to tanks assumed to have leaked in the past, tanks currently classified as "sound" tanks (HNF-EP-0182) were reviewed. Summary information for these tanks is included in Appendix C. Many of the tanks were overfilled and some tanks show activity in nearby drywells that have been attributed to operations spills, line releases or leaks from another tank. There was no evidence of a liner failure for any of these tanks and based on the level of gamma activity observed in drywells, in general the releases either appear to be small compared to releases from tanks A-104 and A-105 or are included as UPRs. No separate inventory was estimated for A or AX Farm tanks currently designated as "sound" except for UPRs for tanks A-101 and AX-103. High ^{137}Cs concentration, ^{60}Co and ^{154}Eu were detected near these tanks in the SGLS logs.

Occurrence Report 81-03, *Radiation Peak in Dry Well 10-01-04 Exceeding the Increase Criterion* shows that the gamma activity detected at drywells 10-01-03, 10-01-04, 10-01-28, 10-01-39 and 10-01-16, near tank A-101 can be attributed to releases from the 241-A-01B pit and subsequent migration from an unknown water source. The drywell activity was first detected in July 1980. Based on the SGLS data and assumed composition of the waste an inventory was estimated. The peak concentration of the ^{137}Cs plume was 1×10^6 pCi/g (GJO-98-64-TARA/GJO-HAN-23, *Hanford Tank Farms Vadose Zone: Addendum to the A Tank Farm Report*). If the plume extends 10 ft in depth with a 10 ft radius, and assuming a soil density of 1.8 g/cm^3 (50,976 g/ft^3), an estimated 160 Ci of ^{137}Cs (decayed to 1999) would have been released to the soil. Sample results (Tank Waste Information Network System [TWINS] 2014, historical analytical data, \\twins.pnnl.gov) show ^{137}Cs concentrations of ~1.1 Ci/gal in 1976 and ~2.3 Ci/gal in 1980. At these waste compositions the volume of waste released would have been less than 150 gal. Given the extent of ^{154}Eu and ^{60}Co measured in the soil, the waste released was likely more dilute and the volume significantly greater.

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5.0 POTENTIAL PIPELINE FAILURES AND OTHER UNPLANNED RELEASES

Information on potential spare inlet or cascade line releases, pipeline failures and other UPRs in WMA A-AX was collected from the following sources:

- DOE/RL-88-30, *Hanford Site Waste Management Units Report*
- RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*
- RHO-CD-673, *Handbook 200 Areas Waste Sites*
- Waste status summary reports for the SSTs from January 1945 through December 1980 (various reports)
- Review of radiation incident reports and A and AX Farm occurrence reports.

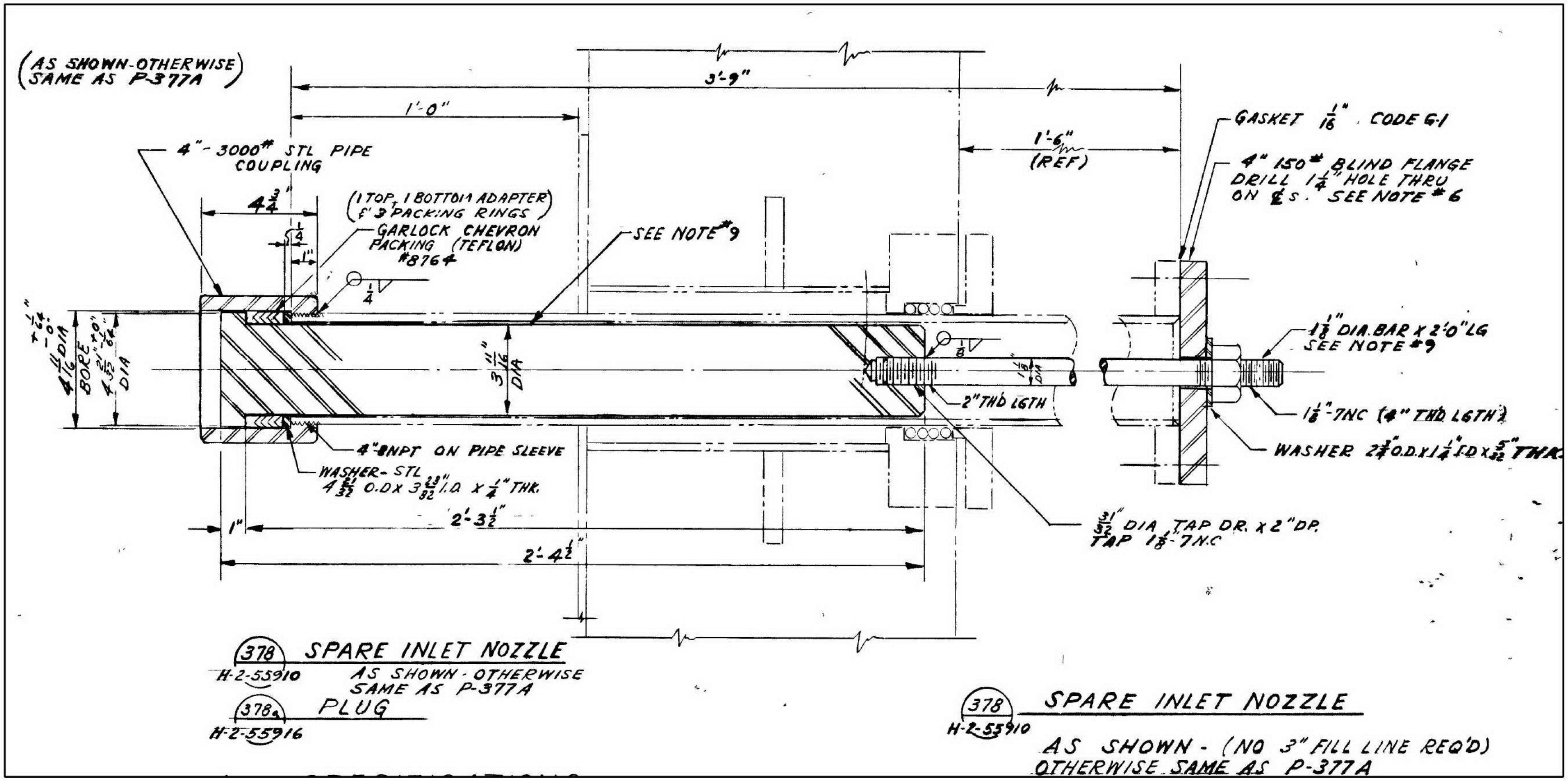
5.1 SPARE INLET NOZZLES

The SSTs in A and AX Farms are each equipped with horizontal inlet, outlet and spare nozzles, as shown in Figures 3-2 and 3-5. Process waste transfer pipelines were inserted through the inlet nozzle and protruded into the SST. A loose seal was installed around the process waste transfer pipeline at the nozzle. Tank waste may have been discharged from the SST inlet nozzles if the waste elevation in the tank exceeded the elevation of the inlet nozzles and if the inlet line connection was not water tight. Figure 5-1 shows a spare inlet nozzle for an A Farm tank. The SST inlet nozzles in A and AX Farms are located at the top of the steel liner, 32 ft 6 in. from the tank bottom. The hydraulic head and tightness of seal around spare inlets and other ports varied from tank to tank, making it difficult to evaluate.

Some of the inlet nozzles on the SSTs are spares and do not have installed process waste lines. The design for the SSTs identified that a 4.5-in. diameter cover was to be placed over the 4-in. diameter spare inlet nozzles (Figure 5-1). It is known that some of the spare inlet nozzles are poorly sealed, “some have blanks which are welded tight, some have tapered wooden plugs driven in the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with a waterproofing membrane and then sealed in cement” (see HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*, page 5).

Waste may have been lost to the ground in the A and AX Farms if SSTs were filled above the height of the spare inlet nozzles (32 ft 6 in. above the tank bottom, at which level the tank contains ~1,070,000 gal and is designated as “full”).

Figure 5-1. 241-A Farm Tank Spare Inlet Nozzles



Reference: H-2-55916, *Waste Storage Tanks Nozzle Assemblies & Details*, Rev. 2. See also H-2-55973, *Waste Line Encasement Fill Line Layout*, Sheet 2, Rev. 2.

The waste volumes in all SSTs were reported in monthly waste status summaries from January 1956 through December 1960 (except no data for August 1951 through March 1952), semi-annually from January 1961 through June 1965, quarterly from September 1965 through September 1976, and monthly thereafter. WHC-MR-0132, *A History of the 200 Area Tank Farms* shows quarterly waste levels for each of the tanks; it reports that SSTs were removed from service in January 1981 and no waste additions were allowed after this date. Potential losses from spare inlets were assumed for tank fill levels ≥ 1,000,000 gal for tanks A-102, AX-103 and AX-104. Potential overflows are summarized in Table 5-1.

Table 5-1. Potential Waste Losses Through Spare Inlets on Waste Management Area A-AX Single-Shell Tanks*

Tank	Date	Waste Type and Volume in Tank
241-A-101	1969	Plutonium Uranium Extraction Plant (PUREX) high-level waste (HLW) waste, Max Vol. 992,000 gal; below nozzles
241-A-102	1962	PUREX HLW waste, 1,014,000 gal
241-A-103	1976	Double-shell slurry feed waste, Max. Vol. 976,000 gal; below nozzles
241-A-104	1968	PUREX HLW waste, Max Vol. 983,000 gal; below nozzles
241-A-105	1967	PUREX HLW waste, Max Vol. 887,000 gal; below nozzles
241-A-106	1974	221-B Plant bismuth phosphate waste, Max Vol. 987,000 gal; below nozzles
241-AX-101	1971	221-B Plant bismuth phosphate waste, Max Vol. 990,000 gal; below nozzles
241-AX-102	1968	PUREX HLW waste, Max Vol. 964,000 gal; below nozzles
241-AX-103	1969	PUREX HLW waste, Max Vol. 1,000,000 gal
241-AX-104	1971	PUREX HLW waste, 1,001,000 gal

* Height/Volume levels for nozzles was ~288 in. above the tank bottom, equivalent to 1,070,000 gal (SVF-1770, *Tank Waste Volume Calculator.xlsx*). Potential waste loss assumed for 1,000,000 gal or more.

References: WHC-MR-0132, *A History of the 200 Area Tank Farms*, and WHC-SD-WM-TI-591, *Maximum Surface Level and Temperature Histories for Hanford Waste Tanks*.

5.2 UNPLANNED RELEASES

Information on UPRs in WMA A-AX was collected from the following sources:

- DOE/RL-88-30, *Hanford Site Waste Management Units Report*
- RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*
- RPP-7494, *Historical Vadose Zone Contamination from A, AX, and C Tank Farm Operations*

- RPP-25113, *Residual Waste Inventories in the Plugged and Abandoned Pipelines at the Hanford Site*
- RPP-RPT-29191, *Supplemental Information Hanford Tank Waste Leaks*
- Waste status summary and monthly report for the Hanford site from January 1945 through December 1980 (various reports)
- RHO-CD-673, *Handbook 200 Areas Waste Sites*
- Historical Occurrence Reports.

Table 5-2 identifies documented known or suspected UPRs in A and AX Farms. The date the release was detected, the waste type and the volume of waste released to the soil (if known) are listed in Table 5-2. Some, but not all of these releases are designated UPRs in the Waste Information Data System (WIDS) database. Releases not currently included in WIDS will be submitted to the WIDS coordinator. Figures 5-2 to 5-5 show pipelines in the A and AX Farms and identify the location of some of the releases described in Table 5-2.

Except as noted, information available was insufficient to estimate a release volume or inventory for pipeline failures and surface releases. In some cases, failed pipelines were contained within a concrete diversion box, vault, or pipeline encasement. The surfaces of these concrete structures were coated with a chemically resistant paint. However, the integrity of the coatings and concrete structures are unknown and it is not known whether waste was released from these concrete structures. Additional near-surface data needs will be determined through data quality objective workshops in support of WMA A-AX performance assessments and corrective management studies.

5.3 OTHER POTENTIAL LOSSES

Unplanned releases in Table 5-2 are those for which documented information was available. Other UPRs likely occurred that were not documented or for which information is not available.

A 1984 BWIP water balance study (Internal letter 65633-128, "Status of the BWIP Water Balance Study") showed that between 1977 and 1984, between 15% and 41% (24% average) of the 8E9 L of water discharged to East Area general raw water lines was unaccounted for, suggesting either error in process measurements or significant losses in the water lines. While raw water losses do not increase the inventory of waste lost to the soil, they provide a substantial driving force to move mobile contaminants toward groundwater. Although raw water lines and waste process lines are constructed to different specifications, these raw water loss estimates give an indication of other potential losses from waste process lines.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
10/1957	241-A Tank Farm Off-gas Ventilation System Tank 433	High level radiation work was accomplished during the month at the 241-A Tank Farm (A Farm). The work involved the inspection of a portion of the 412 off-gas line, the replacement of the 433 de-entrainment tank, and the subsequent replacement of piping associated with the 433 tank. Dose rates during decontamination and shielding varied from 500 to 2,000 mrad/hr. The replacement was complicated by contamination leaking from the failed lines as stated above. The maximum radiation from these leaks was 12 R/hr.	HW-53449, pp. C-3, HW-53967, pp. C-3	The Tank 433 is located in the 241-A-413 Fan House building near single-shell tank A-103.
1/1959	216-A-8 Sampler Pit outside A Farm	Fission product contamination seeped into the ground around the edges of the concrete pad, contaminating it on the soil surface. Contamination is from moisture dripping from the vent pipe bonnet.	UPR-200-E-18, HW-60807, pp. 18	Placards denote underground contamination source. Waste type was process condensate from 241-A Tank Farms.
4/1962	Pipeline leak 216-A-10 crib	The process condensate line to the 216-A-10 crib ruptured on 4-6-62 and has been unable to take the entire condensate flow. Consequently part of the condensate stream has been diverted to the abandoned A-5 crib while a new stainless steel transfer and distributor line is installed.	HW-73525, pp. B-2	Work on the A-10 crib was completed in July 3, 1962 and the A-5 crib was taken out of service as referenced in HW-74505, pp. B-2.
11/1964	417-A Jumper Pit	Several hundred gallons of condensed vapors from the 241-A waste storage tanks were pumped out of a stub on the west side of the 417-A jumper pit due to installation of a jumper to the wrong nozzle by construction forces. The condensate flow resulted in a ground area being contaminated to 50 mrads at surface. The construction forces backfilled the area to cover this contamination.	RL-SEP-112, pp. B-3	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
1/28/1965	241-AX-151 diverter station line	A severe "bump" occurred in tank 241-A-105 (A-105). Four Plutonium Uranium Extraction Plant (PUREX) Operation personnel were in the immediate vicinity of tank A-105 at the time. They noticed vibration of the ground and steam emission from the A Farm tanks. A lead sheet was blown off an 8-in. nozzle on tank 241-A-103 (A-103). The steaming from tank A-105 lasted about ½ hour before subsiding to a point where the ventilation system could handle it. At the same time, Jones Construction forces were preparing to make the final weld in a line to tie tank A-105 into the 151-AX diverter station. The line was observed to shake and liquid spilled to the ground in the excavation. Radiation readings of 400 R/hr at one foot were observed.	WHC-MR-0250 pp. A-10	
2/1965	152-A Diversion Box	On February 18, 1965 a leak was also discovered in the underground line adjacent to the 152-A Diversion Box. Failed line is 8041 per drawing H-2-2338, *Diversion Box 241-CR-152 Nozzle Information*, sheet 45. Line V8107 replaced the failed line 8041 per drawing H-2-33087, *Ln 8107 (241-CR-152 to 102-C) V843, V844 (241-CR-151 to 102-C) V050, V051 (241-A-152 to 104-C)*.	RL-SEP-332 pp. B-2	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
6/1966	AX-801A	Approximately 20 gal of tank 241-AX-103 (AX-103) contents were spread on the 241-AX-801-A Control Building floor during replacement of a section of piping. Decontamination was performed over a 3-week period by flushing the interior of the building with caustic-tartrate, caustic-permanganate, tartaric acid, and water. The flush solutions were discharged to two cribs (216-A-39) constructed adjacent to the north perimeter of the 241-AX Tank Farm (AX Farm). The radiation readings were reduced from >500 R/hr to localized spots of 10 – 20 R/hr. A team was changing out a valve on the tank AX-103 air-lift circulator line. The radioactive line pressurized and resulted in a release to the floor of the instrument (241-AX-801-A) building. The trench extended eastward ~90 ft. A hole was cut through the back side of the 801 Building and a fire hose was used to wash the contamination out the door and into the trench. The first trench was covered with dirt and a second trench was dug, parallel to the first, to receive a second rinsing of the 241-AX-801-A building floor. This trench was also backfilled.	ISO-75-RD, pp. 99 RHO-CD-673	Waste Information Data System (WIDS) describes 216-A-39 as a crib and two trenches dug from the north door of the 241-AX-801-A Building. The trenches extended to the brow of the north hill, then over the hill to the flat ground below. The trenches continued eastward 27 meters (90 ft). The trenches were backfilled with 3 ft of earth cover. No record was located that details the volume of the flush solutions used.
8/1966	Pipeline release in encasement Diverter station 241-AX-151	A leak developed in the G8-R8 transfer line from the PUREX Building to 151 AX Diverter Station. The break in the line was found in a 45 degree bend and is believed to be caused by thermal bending of the pipe. Investigation of several other bends revealed that no other breaks in any of the lines in the encasement have occurred, but two of the bends in the F-18 line have flattened inside radii. These flattened bends will be removed and new pipes will be installed.	ISO-75 RD, pp. 129	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
8/1966	Pipeline release Encasement	Pages 5-6: Following the discovery in July of a leaking waste line in the concrete encasement between the PUREX canyon building and A Farm, the encasement was broken into and the pipes were inspected at nine separate bends. Although no additional leaks were found, four wrinkles were observed in the piping at two locations. These distorted sections of pipe were replaced. Engineering analysis indicates that temperatures in excess of 180 °F may have been encountered which would cause expansion interference with adjoining hardware. Page B-1: Minor Construction completed repairs to the damaged organic wash waste line and the F-18 waste line in the encasement between the 202-A Building and the 241-AX diverter stations.	ISO-476-DEL	
1968	AX-101/ AX-102 Condensate Line	In 1968, the 1.5-in. steam condensate line was abandoned in place and replaced by a new 4-in. direct buried pipeline. This new 4-in. pipeline routed steam condensate from two coils in tank 241-AX-101 (AX-101) and one coil in tank 241-AX-102 (AX-102) to tank 241-A-417, as shown on drawing H-2-34266.	H-2-58896 and H-2-34266	The pipeline may have been replaced to enable a larger volume of steam condensate to be discharged to tank 241-A-417.
1/29/1968	Plugged line AX-102 to C-102	Attempted to unplug the 102-AX to 102-C line with hot water and using pressure from Fire Department truck. Liquid noticed coming from underground near 103-AX pump pit. Flushing discontinued.	ARH-258, pp. 40	Radiation levels on ground at the leak were 400 mrad/hr and greater than 5 R/hr on the line.
1/30/1968		Opened 101-AX pump-out pit and pumped two Fire Department tank trucks of water thru line to 241-CTankFarm. Line open from this point. Still plugged from 102-AX to 101-AX.	ARH-258, pp. 42	Area roped off within the farm. Hot dirt hauled off to burial. Plastic placed over remaining hot dirt and line in the excavation.
1/31/1968		Line from 102-AX to 102-C now appears to be unplugged. No pressure build-up noted. Line was flushed with 750 gal of hot water.	ARH-258, pp. 44	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
12/22/1969	Ground near tank 241-AX-104 (AX-104)	An employee mistakenly pulled a contaminated electrode cable out of tank AX-104 and set it on the ground; he then removed his contaminated gloves and set them on the ground. Due to the high dose rate on the electrode, the employee received a whole body and extremity dose.	UPR-200-E-119	
6/22/1970	Plugged line Tank 241-A-101 (A-101)	Tank A-101: Installed flush head in pump pit to try unplugging line to 151C. Still plugged.	ARH-1526-2, pp. 140	
11/6/1972	241-AX-151 diverter station	Contamination spread at the 241-AX-151 diverter station as a result of a steam jet being left on at 244-AR. Surveys revealed direct and smearable contamination of 200 to 300 mrad/hr with a few spots in excess of 5 R/hr. The green tape covering the cover blocks cracks was contaminated to 20 R/hr.	UPR-200-E-42	In 1972, the area was cleaned and the cover blocks cracks were sealed. A WIDS sign is located at the release site
11/7/1972	A-102 Riser	Dose rate of 3 R/hr was detected on some electrode wire in a bucket which led into the 102-A Sludge Riser. 3 R/hr smearable gamma was found at the top of the riser. The sludge tape had been pulled further out of the tank than it should have been.	ETF Historical Occurrence Report	Area was decontaminated.
2/12/1974	241-AX-103 Pump Pit and soil	During bleeding of air from a line, air flowed up (instead of down) causing contaminated liquid to spray onto two employees and the ground adjacent to the 241-AX-103 Pump Pit. The 241-AX-103 pump pit was contaminated with levels up to 5 R/hr. The ground around the pump pit had maximum contamination levels of 2 R/hr.	UPR-200-E-115	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
2/27/1974	102-A pump pit	On a calm day, while moving a fabrofilmed sludge pump from the 102-A Pump Pit to the 103-A Pump Pit, a whirlwind hit the area raising the plastic from the ground and whipping it up and down causing two skin contaminations and ground contamination. Maximum skin contamination was 90,000 dpm. An area of about 20 × 40 ft between the two pump pits was generally contaminated from 5 to 20 mrad/hr with spotty levels up to 250 mrad/hr.	ETF Historical Occurrence Report	The personnel contaminated were adding rocks to the plastic, trying to hold it down.
6/5/1974	North gate A Farm	12 "spots" of contamination of 50,000 dpm to 150 mrad/hr were found on the blacktopped surfaces north and northeast of the north gate of A Farm. Further surveys showed a few spots to 250 mrads/hr between the gate and the 106-A Sluice Pit. General levels of contamination to 50 mrad/hr were detected around the pit and the blocks and edge of the pit smeared 20,000 dpm.	ETF Historical Occurrence Report	
9/16/1974	Tank 241-A-104	A 53-ft long tube bundle heat exchanger was removed from a 12-in. riser on tank 241-A-104 and placed in a 12-in. riser on tank A-101. Dose rates were >5 R/hr at 12 ft. Dripping of contamination onto the riser, plastic and ground occurred at both risers. Total drippage was estimated at 100 to 500 ml.	ARHCO Occurrence Report 74-130	
10/9/1974	A-101 instrument building	One and a half gallons of waste was spilled onto the ground, contaminating an area ~2 ft by 4 ft. The spill resulted when an attempt was made to isolate a failed steam coil in tank A-101 with the air-lines going to the 101-A Instrument Shack.	ARHCO Occurrence Report 74-134	A worker received 9,000 counts per minute (c/m) contamination. The worker was decontaminated and contaminated earth was covered with gravel, then placed into barrels and buried the next day.
10/14/1974	702-A Building	One of the Number 1 filters in the 702-A Building was breached, causing a contamination spread in an area of 100 × 400 ft north-northwest of the stack and another area of 100 × 100 ft southwest of the stack. Contamination levels were 20-30,000 dpm with white pasty material adjacent to the building at 80-300,000 dpm, and a weep-hole in the stack reading 35 mrad/hr.	ETF Historical Occurrence Report	

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
10/14/1974	Contaminated surfaces in the 241-A Tank Farm	Contamination in the form of small white specks was detected in A Farm on October 14, 1974. The specks covered an area ~30 meters (100 ft) by 76 meters (250 ft), extending in a northwesterly direction from the 702-A Vessel Ventilation Building. Contamination levels ranged from 30,000 c/m near the building to 1,000 c/m at the edge of the spread. It was assumed the material came from a breech in the number 1 filter on the 702-A stack.	UPR-200-E-47, ARHCO Occurrence Report 74-135	In 1974, the no.1 filter in the 702-A building was replaced, the contaminated soil was removed, and the area released for normal service.
11/5/1974	241-A-106 pump pit and soil	Failed jumpers and obsolete equipment were being removed from the 241-A-106 pump pit. While a flex jumper was being removed from the pit, the lower end caught on an object, which raised and then dropped back to the pit floor, splashing contaminated solution out of the pit to the soil. An area ~10 ft by 10 ft was contaminated up to 18 R/hr. The side of the instrument house was also contaminated up to 3 R/hr and part of one cover block read off scale on a CP dose rate meter.	200-UPR-E-48, ARHCO Occurrence Report 74-144	The contaminated soil was placed into six, 55-gal drums and buried. The contaminated soil was replaced with an equal volume of clean dirt. Clean up of the instrument house and cover block was completed.
11/14/1974	702-A building stack	Low-level contamination was released to the blacktop parking area adjacent to the A Farm complex control house and ventilation building. The contamination covered a 30-ft diameter area and surveys indicated 25,000 c/m direct and 5,000 c/m smearable. The source of the contamination is believed to be the 702-A building stack.	OR-75-130	The 702-A building houses the ventilation system for tanks in 241-A, 241-AX, 241-AY and 241-AZ Farms. No radiation increase was observed on the stack sampler or change in in differential pressure across any of the five high-efficiency particulate air filters in parallel.
11/22/1974		The 241-A-106 cover blocks were contaminated and wrapped in plastic to prevent contamination spread. During the installation of a new pump at the 241-A-106 pump pit the cover blocks were unwrapped. Wind caused contamination to spread from the exposed cover blocks, affecting A Farm, several personnel, five vehicles and the A Farm parking area. Contamination levels ranged from 700 to 2,000 c/m.	200-UPR-E-48, ARHCO Occurrence Report 74-144	The parking areas and vehicles were cleaned and returned to normal operations and new cover bocks were installed.
1/1975	Transfer line V-113	Transfer line V-113 from tank AX-103 to tank 241-C-105 failed to meet pressure test requirements.	ARH-LD-201 B pp. 13	Possible pipeline release.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
1/1975	Release of condensate from 241-AX offgas header Dresser couplings	Release of condensate from 241-AX offgas header Dresser couplings. Dresser couplings were installed on the 241-A and 241-AX vapor header system. The investigation determined that the exhaust vapor header system to the AX Farm tanks was the source of several sizeable radiation releases to the soil. Test probing suggested that the Dresser couplings in the vapor header system had suffered degradation with a resulting loss of service integrity.	MEM-011676	Dresser couplings were installed on the 241-A and 241-AX vapor header system. Deterioration and release from the Dresser couplings could have occurred throughout the operational life of these tank farms (i.e., 1956 – 1980).
1/1975	241-AX	Scheduled ion-exchange processing of PUREX sludge supernate for cesium recovery was not conducted during January. Failure of the existing transfer route from tank AX-103 to tank 241-C-105 to meet pressure test requirements prevented resumption of cesium ion-exchange feed deliveries to 221-B Plant.	ARH-LD-201 B pp. 13	See also Internal letter Lorenzen 1975, "Transfer Routes for Feed to the Evaporators," pp. 26, which identifies the failed pipeline as line V-113 between the 103-AX pump pit and the 151-C diversion box.
3/24/1975	702-A Filter Builing	Contamination found while changing air sample filter in 702-A Filter Building. Floor smears were up to 1,000,000 dpm and white material to 600,000 dpm.	ETF Historical Occurrence Report	Contamination was cleaned up and a check of ventilation system made for potential causes.
6/1975	Waste discharge to ground Vapor Header release Tanks AX-101, AX-102 and AX-104	Both Boeing and Battelle Northwest systems demonstrated a salt contamination area north of tank AX-102. Using the tank farm total gamma profiling (NaI) and direction Ge(Li) profiling, the leak was determined to be from the 20-in. vapor header connecting tank AX-101 and tank AX-102. The Dresser couplings which connect several sections of the header have been found to be leaking, and auger drilling in the immediate vicinity of the couplings was used to confirm the leak source and support the belief that the tank itself is sound. A similar condition was found over tank AX-104 which is also the apparent cause of recent radiation increases at the 42-ft depth in a tank dry well. Other peaks in the same well at 23- and 60-ft depths have decreased during this period.	ARH-LD-206 B, pp. 10	See also ARH-CD-587, *Containment of the Deteriorated Vapor Exhaust Header in 241-AX Tank Farm.* See also ARHCO Occurrence Report 75-47, *Increasing Dry Well Radiation Adjacent to Tank 104-AX* and ARHCO Occurrence Report 75-60, *Increasing Radiation in a Dry Well Adjacent to Tank 102-AX.*

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
9/2/1975	102-A-02B	Fabrofilmed and wrapped sluicer being removed from 102-A-02B for shipment contaminated the ground in spots reading to 200 mrad/hr between the shipping capsule location to the trailer. Also contaminated rigging truck, crane and rigger's neck.	ETF Historical Occurrence Report	Immediate action taken to ensure no extensive spread. Cleanup initiated immediately.
10/1975	Pipeline release – Overground line	Leak in Overground Transfer Line. A leak occurred in an overground transfer line and contaminated an area of soil ~18 in. square, to a depth of one inch. The leak volume was estimated at one cup and the soil had a maximum radiation of 2 R/hr at contact. The leak was located at a point where the above-ground pump is joined to the line with a vertical nozzle and connector head. The transfer had been running about nine hours when the connection developed a very slow leak. The connector head at the pump is scheduled to be tightened and wrapped with plastic. The procedure for preparing overground lines will be modified to specify wrapping remote connector heads when they are used above ground as in this application.	ARH-LD-210 B, pp. 10	See also Occurrence Report 75-115, *Leak in Overground Transfer Line*. Waste was being pumped from tank 241-C-108 to tank 241-C-103.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
10/1975	Waste discharge to ground Vapor Header Releases Tank AX-102	The “hot” test to seal a subsurface vent header and stabilize the surrounding radioactive sediments was completed in AX Farm near tank AX-102. Isotopic directional readings were taken in the five 4-meter deep wells that were drilled for monitoring purposes and for injecting the asphalt emulsion around a suspected leaking Dresser coupling. Readings were also taken in the 11 and 12 o’clock 102-AX dry wells. Readings in the injection wells were taken twice before the injection at a three-week interval. Important results were (1) the activity was primarily cesium, (2) the count rate was as high as 14×10^6 c/m, (3) where direction could be ascertained (difficult because of the high activity) the highest activity was coming from the direction of the Dresser coupling, (4) the activity peaked at the 2.5- to 3.5-meter depth, and (5) diffusion upward toward the surface was evident, readings at the 0.6-meter level being as high as 5×10^6 c/m. Readings in the deeper wells indicated cesium at the top and changing over to ruthenium at the lower depths (below about 9 meters). Six hundred and fifty gallons of a 2:1 mixture of 65% asphaltic emulsion were added to the four injection wells surround the Dresser coupling. An estimated volume of about three cubic meters was injected into sediments around the coupling. Radionuclide concentrations monitored before and after the injection did not indicate any significant change, and the volume added did not move the other radionuclides downward. This test was not planned for this fiscal year. The results indicate that this technique is beneficial in sealing leaking pipes and stabilizing radioactivity in sediments.	ARH-LD-210 B, pp. 34	Additional information on sealing the vapor header leader is available in ARH-LD-212 B, pp. 32.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
10/31/1975	Between tanks AX-101 and AX-102	Ground contamination between tanks AX-101 and AX-102 in an area of 10 × 12 ft around the #1 Well and three other wells up to 20 mrad/hr. An attempt was made to remove the contamination around the casing, and the soil along the casing was contaminated to 90 mrad/hr at 9 in. deep. A smear taken inside the casing was 1,000 dpm.	ETF Historical Reports	Contaminated area cleaned up and source of contamination roped off.
11/14/1975	A Farm Control House Lot	Parking lot adjacent to A Farm Control House, change house and ventilation building contaminated to 250,000 dpm direct and 50,000 dpm smearable. Contamination extended eastward, down the A Farm incline to within a few feet of Canton Avenue. Radiation Check points on the #1 and #2 filter boxes revealed a drop in levels. The #2 filters were changed, and liquid ran out while bagging out the filters. Interior of plenum was contaminated to 20 mrad/hr. Internals of fan housing were contaminated to 500 mrad/hr.	ETF Historical Occurrence Report	Area roped off and deconned.
12/08/1975	East of 101-AX-01C	Crane found contaminated to 1.5 R/hr at 2 in. after work on the sluicer head and controls on the 101-AX-01C Sluice Pit. Surveys found an area 50 ft wide east of the 101-AX-01C sluice pit from 200,000 dpm to 300 mrad/hr. Surveys of ground where crane had been parked found levels to 150 mrad/hr below hooks and cables.	ETF Historical Occurrence Report	Crane deconned and ground contamination placed in drums.
2/1976	Plugged pipeline	Plugged Cross-Country Transfer Line. During a radioactive solution transfer of terminal liquor from 200 West Area to 200 East Area the transfer line became plugged. Shortly before the plug was confirmed, the pump had been cut off due to an interlock system that cut all power to the 241-S facility. The line has since been unplugged and is being prepared for service.	ARH-LD-214 B, pp. 12	See also RPP-25113.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
8/24/1976	Tank A-103	The P-100 pump was fabrifilmed as it was removed from tank A-103. The fabrifilm was allowed to drain and dry before transfer to the burial capsule. On lowering into the capsule, the pump hung up, slipped and dropped about 12 in., showering 18 personnel and the ground with loose contamination not completely secured with the fabrifilm.	ETF Historical Occurrence Report	Personnel were deconned, the burial completed and ground area deconned.
9/30/1976	A-103 Pump Pit	Failed pump from 103-A Pump Pit was coated with fabrifilm on removal and hung over pit to dry. When a second crane was hooked up to the pump to lower it onto the truck, the fabrifilm coating over the baseplate of the motor slid off and dropped to the ground, missing the plastic laid on ground. An area of 10 × 50 ft south of the trailer contaminated up to 250 mrad/hr.	ETF Historical Occurrence Report	Contamination picked up and put in barrels. The area was washed down, restoring it to pre-job status.
12/3/1976	102-AX-02A Pit	During a hairpin jumper removal from the 102-AX-02A Pit, a dark-colored process solution ran from an open nozzle to the pit floor. Due to the high dose rates, it was agreed that an operator flush the pit floor with water. The temperature of the pit and process solution was higher than the air and flush water and the water unexpectedly flash vaporized and a vapor formed carrying contamination up out of the pit in a fan shaped plume for about 75 ft in a southerly direction from the 02A pit with levels from 30-50,000 dpm.	ETF Historical Occurrence Report 76-165	Job stopped, pit covered, contamination surveys of work site, equipment and adjacent areas. Decon efforts initiated.
8/25/1977	Riser #9 AX-104	Operator removing a sludge weight from Riser #9 on tank AX-104 for disposal contaminated skin to 200,000 dpm, clothing to 20,000 dpm, and several spots on the ground to 500 mrad/hr. Also contaminated sluicer shack and change room floor to 500,000 and 300,000 dpm, respectively.	ETF Historical Occurrence Report	Contamination at riser picked up, and contaminated surfaces cleaned up.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments
2/23/1978	Release of water in A Farm	Raw water was found to be flowing from a hole 30 ft southeast of the 501 valve pit building, ~1 R/hr was present at the edge of the hole. A cave-in was discovered on February 24 between tanks A-102 and A-105. Water meter readings indicate that ~60,000 gal of water was released. The apparent cause was rupture of the M5a line ~30 ft southeast of the 501 building.	Occurrence Report 78-24	The cave-in between tanks A-102 and A-105 is attributed to the channeling of water from the site of rupture along the pipe encasement to the area of cave-in. The area was surveyed and no evidence of any release of radioactivity was found.
3/25/1980	F-100 pipeline release	On March 25, 1980, a routine pressure test of the F-100 condensate return line (buried) from 501-AX valve pit to the 417 condensate catch tank (i.e., TK-A-417) failed. Investigation on April 3, 1980 revealed a leak at a flange connection adjacent to the 417 tank.	Occurrence Report 80-41	The line was excavated and one to two barrels of contaminated soil (10,000 c/m) were removed to the burial ground. The leak was determined to be at a gasket on a flange on this pipeline. A new gasket was installed and plans were made to replace the flanged joint with a welded joint to avoid future leaks.
7/1980	241-A-01B	A radiation peak at the 40-ft level in drywell 10-01-04 was first detected during July 1980. On January 12, 1981 the radiation peak at the 40-ft level increased. "The cause of the activity is the result of radionuclides being leached down from past soil contamination around the 241-A-01B pit area. The activity is being transported by an unknown water source." Auger samples showing a 3% moisture increase in three months at 40 ft indicate a large water source.	Occurrence Report 81-03	Neither the time of the release from 241-A-01B nor the volume are known.
12/17/1984	105-A Sluice Pit	Survey followed observation of vapors rising from the blocks of the 105-A Sluice Pit. Blocks were reading to 200 mrad/hr direct with smears of 800,000 dpm, Breather Filter flange and trunk to 20 mrad/hr and smears of 200,000 dpm. Smearable contamination from 20,000-80,000 dpm found on 01-A Pump Pit, 241-A Distribution Pit, sluice pit 05-B and risers R-5 and R-11.	ETF Historical Occurrence Report	Cause apparently warm air rising from pit. Area roped and 105-A sluice pit sealed with plastic to prevent a future spread. Long range planning for exhaust systems for specific A Farm tanks.

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

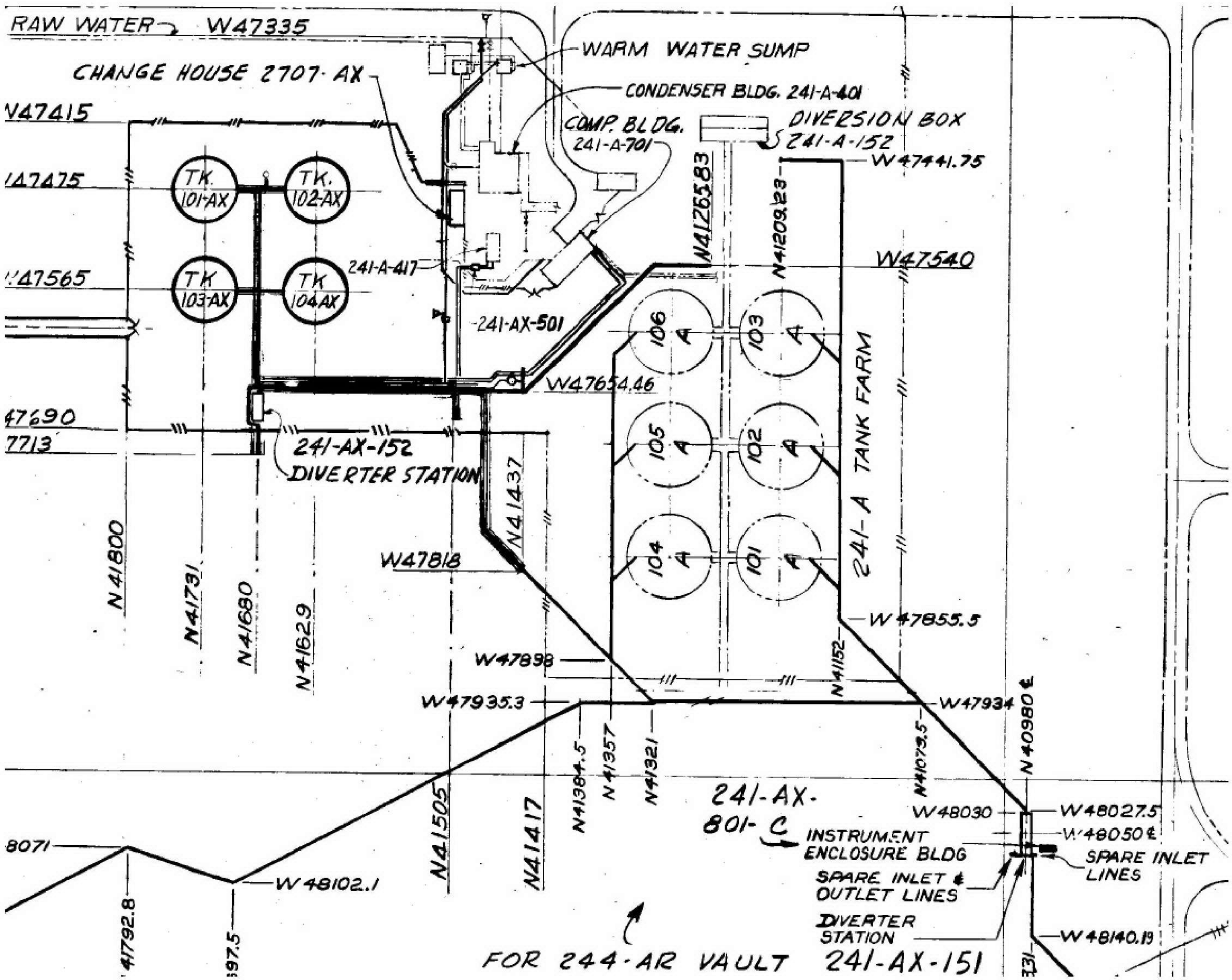
Date	Facility	Description of Event	Reference	Comments
9/12/1985	702-A vent Station	During a flush of the de-entrainer pads at the 702-A Vent Station, there was an apparent carry over of flush solution to the stack. Contamination levels ranged from 50 mrad/hr at an exhauster drain line to general ground contamination within farm zoned areas to 40,000 dpm, and spotty contamination to 10,000 dpm at the 200-E exclusion fence. An additional contamination spread within the farm occurred when the second 702-A exhaust fan was started: levels were 2,000-40,000 dpm. An Operator received hair contamination of 5,000 dpm.	ETF Historical Occurrence Report	Operations began stabilization and decon. Personnel were deconned. Surveys made to determine extent of contamination.
12/13/1993	East of A Farm. Northeast of the 242-A Evaporator Building	Suspected leakage from a 15-in. vitrified clay pipe was identified during excavation for installation of a new pipeline for project W049H (the 15-in. vitrified clay pipe originates from the 216-A-8 Sample Pit and traverses to the 216-A-34 crib, as shown on drawing H-2-44501 sheet 69, zones C-6 thru E-3). The new pipe (within an encasement) was laid inside the north/south excavation, underneath the existing 15-in. vitrified clay pipe. The new, encased pipe was covered with about 1 foot of surrounding soil. Plastic was laid inside the excavation to contain contaminated soil. Approximately 6 ft of the 15-in. vitrified clay pipeline was exposed during excavation for the replacement line. Soil samples indicated the contamination was primarily uranium oxide.	UPR-200-E-145	The contaminated soil was returned to the excavation and covered with plastic. The hole was filled to grade with clean dirt. In December 2003, contaminated tumbleweeds were found on the surface of this underground pipeline. The weeds were removed and the surface was stabilized. An area measuring approximately 3 meters by 6 meters (10 ft by 20 ft) is posted with Underground Radioactive Material signs.
2007	Berm East of the 241-A Tank Farm Complex	A berm extends southeast from 241-AN Tank Farm, crosses Canton Avenue and continues beyond the 200 East perimeter fence to the Vitrification Plant, under construction. More than 30 contaminated tumbleweed fragments were discovered on the east side of the berm in February 2007. Posted Contamination Areas continued to be located on the gravel berm in 2009. A site visit in July found the area on the berm posted with Soil Contamination Area signs. No growing vegetation was visible. The site is identified in WIDS as 200-E-287 (see Figure 6-2).	CH2M-PER-2007-0287 WIDS site 200-E-287	Start date for berm and contamination is unknown. Several occurrence reports have been issued for contaminated tumbleweeds in this and other areas in Waste Management Area A-AX. These are included in the occurrences data base at http://toc.rl.gov/rapidweb/ENG-RESOURCES/index.cfm?pagenum=152

Table 5-2. Unplanned Releases and Potential Releases in and near 241-A and 241-AX Tank Farms (15 sheets)

Date	Facility	Description of Event	Reference	Comments

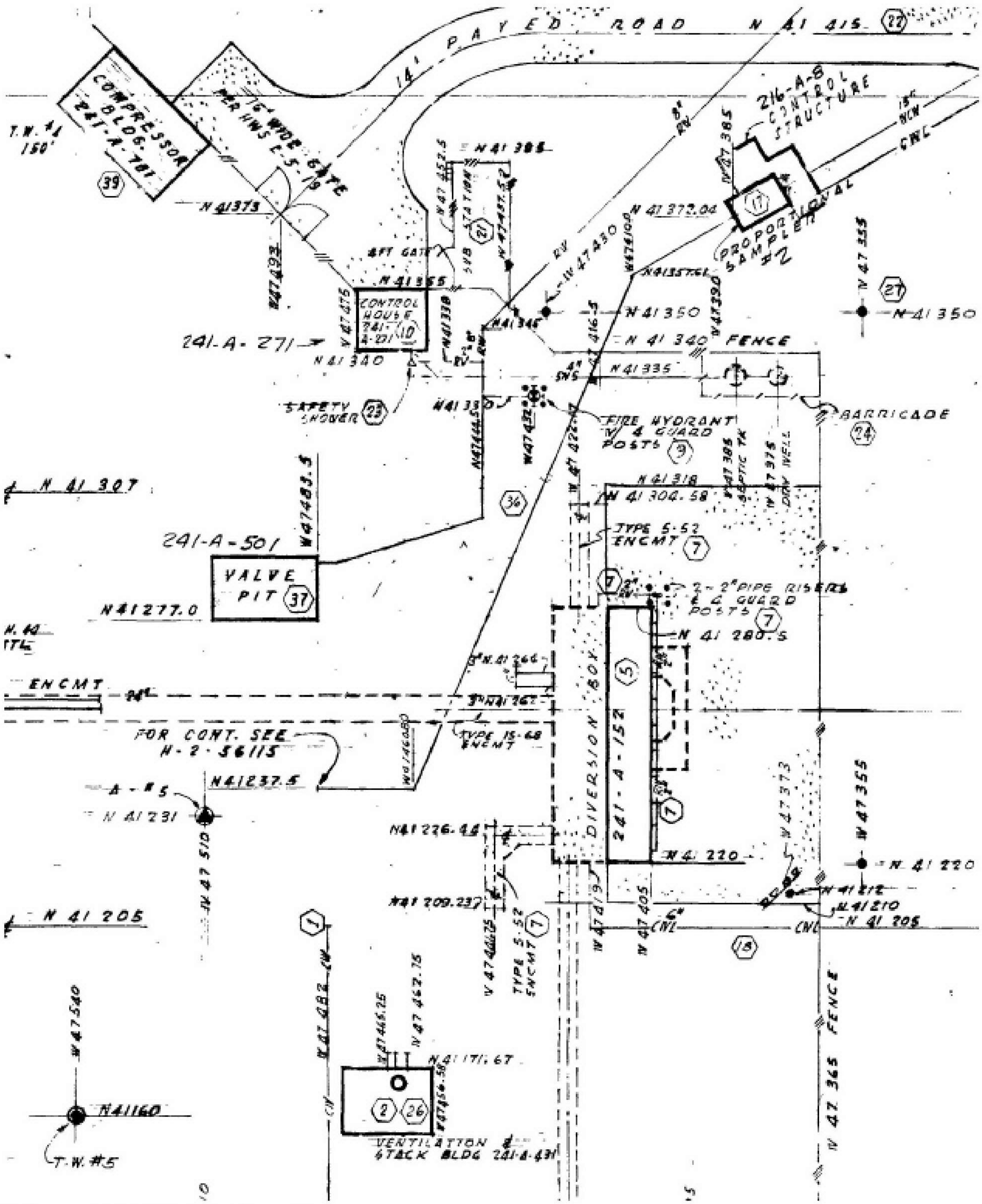
References:
ARH-258 DEL, *Chemical Processing Division Daily Production Reports January, 1968 through March, 1968.*
ARH-1526 2, *Chemical Processing Division Daily Production Reports April 1970 Through June 1970.*
ARH-CD-587, *Containment of the Deteriorated Vapor Exhaust Header in 241-AX Tank Farm.*
ARHCO Occurrence Report 74-130, *Contamination Spread.*
ARHCO Occurrence Report 74-134, *Spill of Radioactive Liquid Onto the Ground.*
ARHCO Occurrence Report 74-135, *Spread of Contamination.*
ARHCO Occurrence Report 74-144, *Contamination Spread.*
ARHCO Occurrence Report 75-47, *Increasing Dry Well Radiation Adjacent to Tank 104-AX.*
ARHCO Occurrence Report 75-60, *Increasing Radiation in a Dry Well Adjacent to Tank 102-AX.*
ARH-LD-201 B, *Atlantic Richfield Hanford Company Monthly Report January 1975.*
ARH-LD-206 B, *Atlantic Richfield Hanford Company Monthly Report June 1975.*
ARH-LD-210 B, *Atlantic Richfield Hanford Company Monthly Report October 1975.*
ARH-LD-212 B, *Atlantic Richfield Hanford Company Monthly Report December 1975.*
ARH-LD-214 B, *Atlantic Richfield Hanford Company Monthly Report February 1976.*
CH2M-PER-2007-0287, *Approximately 30 plus contaminated tumbleweed pieces were discovered on the east side of the transfer line burm east of A farm.*
H-2-2338, *Diversion Box 241-CR-152 Nozzle Information*, Sheet 45, Rev. 5.
H-2-33087, *Ln 8107 (241-CR-152 to 102-C) V843, V844 (241-CR-151 to 102-C) V050, V051 (241-A-152 to 104-C)*, Rev. 7.
H-2-34266, *4" Steam Condensate Line - 241-AX-101 to 241-A-417 - Plan & Det's*, Rev. 4.
H-2-44501, *Area Map 200 East A Plant Facilities*, Sheet 69, Rev. 12.
H-2-58896, *Plan & Profile Steam Condensate Line TK-101 to TK-A-417*, Rev. 4.
HW-53449-DEL, *Chemical Processing Department Monthly Report for October, 1957.*
HW-53967-DEL, *Chemical Processing Department Monthly Report for November, 1957.*
HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas–1959.*
HW-73525, *Chemical Processing Department Monthly Report April, 1962.*
HW-74505, *Chemical Processing Department Monthly Report July, 1962.*
ISO-75 RD, *Fission Products Process Engineering Monthly Reports January – December, 1966.*
ISO-476-DEL, *Chemical Processing Division Monthly Report for August, 1966.*
Memorandum MEM-011676, "Addendum, Atlantic Richfield Hanford Company Occurrence Report 75-90, "Increase Dry Well Radiation Adjacent to Tank 102-AX" Contract E(45-1)-2130."
Occurrence Report 75-115, *Leak in Overground Transfer Line.*
Occurrence Report 75-130, *Contamination Spread.*
Occurrence Report 76-165, *Contamination Spread to Ground Vehicles.*
Occurrence Report 78-24, *Release of Raw Water in 241-A Tank Farm.*
Occurrence Report 80-41, *Unexpected Leakage of F-100 Condensate Return.*
Occurrence Report 81-03, *Radiation Peak in Dry Well 10-01-04 Exceeding the Increase Criterion.*
RHO-CD-673, *Handbook 200 Areas Waste Sites.*
RL-SEP-112, *Chemical Processing Department Monthly Report for November, 1964.*
RL-SEP-332 DEL, *Chemical Processing Department Monthly Report for February, 1965.*
RPP-25113, *Residual Waste Inventories in the Plugged and Abandoned Pipelines at the Hanford Site.*
WHC-MR-0250, *Waste Tank 241-A-105 Supporting Documentation, Miscellaneous Reports, Letters, Memoranda, and Data.*

Figure 5-2. General Layout for Waste Management Area A-AX



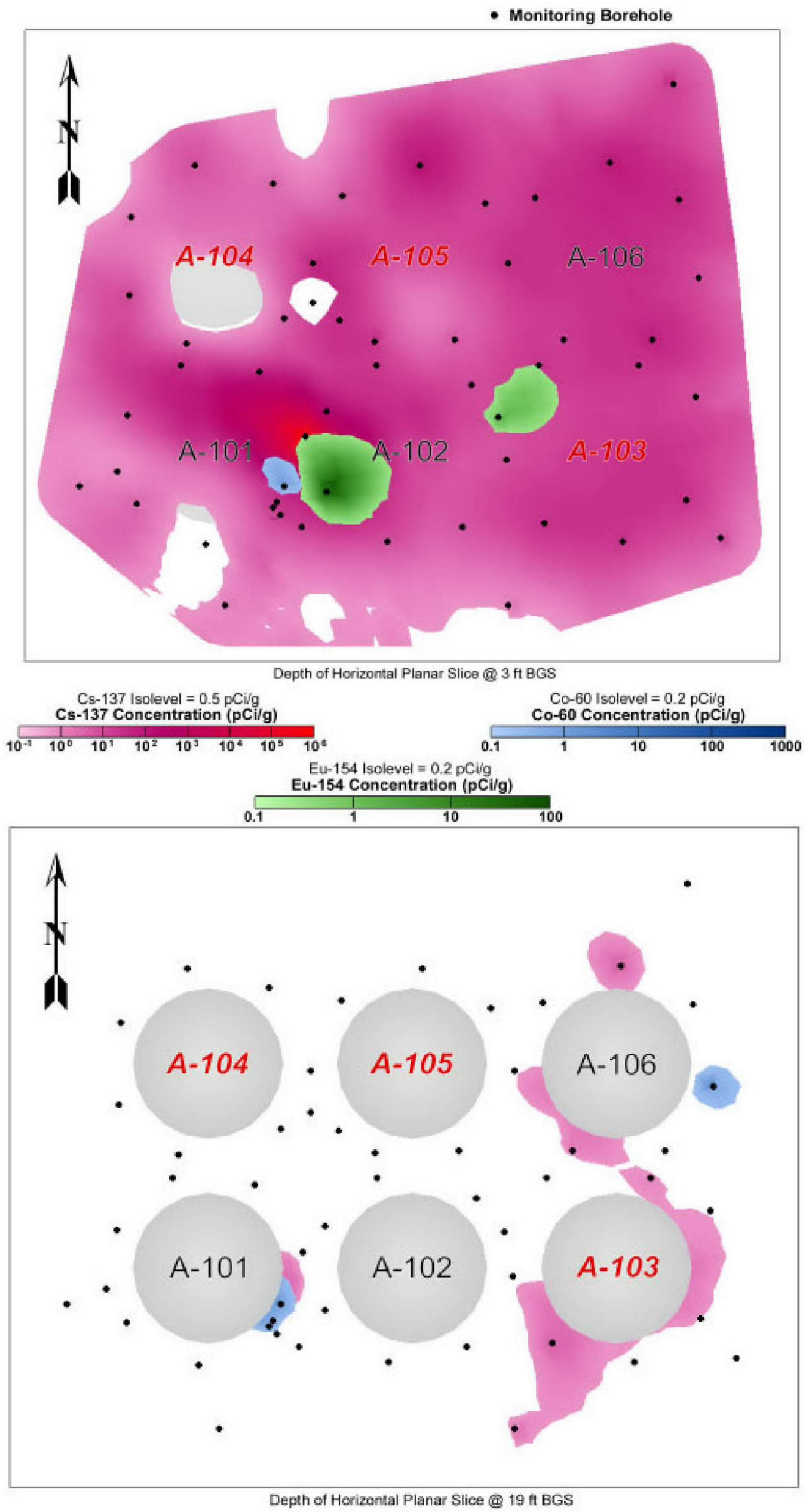
Reference: H-2-44501, *Area Map 200 East A Plant Facilities*. Note: North is to the left.

Figure 5-3. Facilities South of 241-A Tank Farm



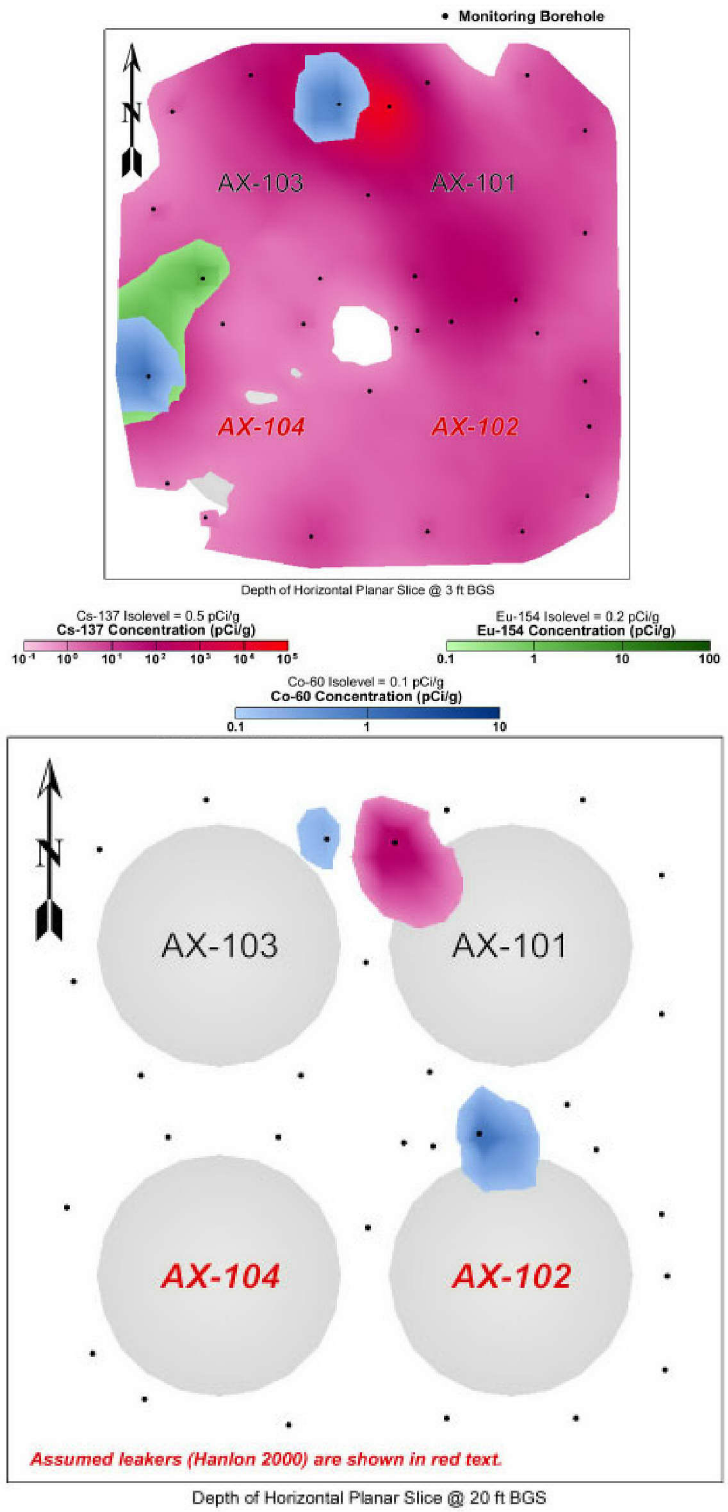
Reference: H-2-55901, *241-A General Layout*.

Figure 5-4. 241-A Tank Farm Spectral Gamma Logging Visuals



Notes: Previously assumed leaking tanks shown in red text. As noted in Section 4.1, tank 241-A-103 has been reevaluated and designated a "sound" tank.
High activity 137Cs and 154Eu plumes near tanks 241-A-101 and 241-A-105 attributed to XXXX
Source: GJO-98-64-TARA/GJO-HAN-23, *Hanford Tank Farms Vadose Zone: Addendum to the A Tank Farm Report*.

Figure 5-5. 241-AX Tank Farm Spectral Gamma Logging Visuals



Notes: Previously assumed leaking tanks shown in red text. As noted in Section 4.1, tank 241-A-103 has been reevaluated and designated a "sound" tank.

^{154}Eu and ^{60}Co plume near tank 241-AX-104 attributed to XXXX

Source: GJO-97-14-TARA/GJO-HAN-12, *Vadose Zone Characterization Project at the Hanford Tank Farms: Addendum to the AX Tank Farm Report*.

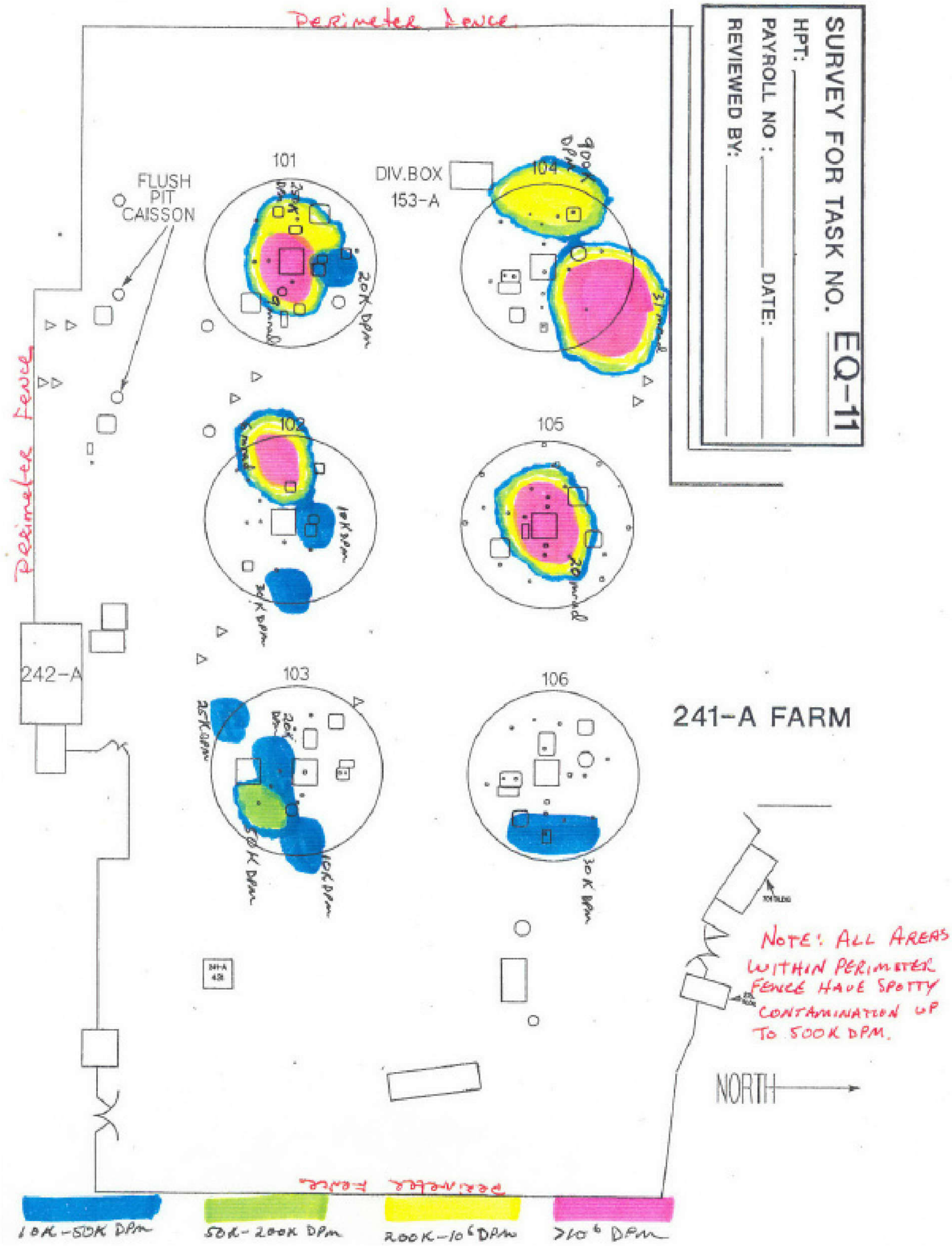
Figures 5-4 and 5-5 show cross section visualizations of potential gamma activity in the A and AX Farms based on SGLS drywell logging data. The figures show low levels (< 10 pCi/g) of ^{137}Cs activity at 3 ft bgs across both farms and identify hot spots on the east side of tank A-101 and north side of tank AX-101. Some of the surface radioactivity may be shine from other areas, but many spills and releases occurred during operations which could account for the extensive near-surface gamma radioactivity. Only a few isolated areas of gamma radioactivity were detected below 20 ft bgs. Figures 5-6 and 5-7 show surface radioactivity survey results for A and AX Farm.

In general, the highest gamma activity levels were observed near tanks or where an inventory has been determined. This suggests that other, undocumented releases may have been smaller; contaminants have been flushed; or the waste lost contained lower levels of non-mobile gamma activity (i.e., ^{137}Cs). Additional investigations are needed to better quantify UPRs and to provide inventory estimates for corrective measures studies. Investigations to be conducted will be determined through a data quality objectives process.

Based on the SGLS measurements and visualizations shown in Figures 5-4 and 5—5, the inventory of ^{137}Cs in the A and AX Farms was estimated to be ~320 Ci (see Table 4-1). The SGLS visualizations show a plume of ~100 pCi/g across the entire surface of A Farm and plumes of 1,000 pCi/g and 100 pCi/g across ¼ and ¾ respectively of the surface area of AX Farm to depths of ~10 ft bgs. The visualizations and log results also show surface level hot spots near tanks A-101 and AX-101. Figure 5-8 shows rough inventory and volume calculations for these areas. The volume of waste released depends on the composition of waste at the time of the release. Assuming the waste released had about the same composition as the composition of waste in the tanks (based on TWINS historical sample data) the estimated volume of waste released to the soil would have been ~2,500 gal. If the near-surface waste releases were more dilute than the supernatant waste in the tanks, the volume released would be proportionally greater. Water additions or raw water leaks would have resulted in more extensive distribution of the waste.

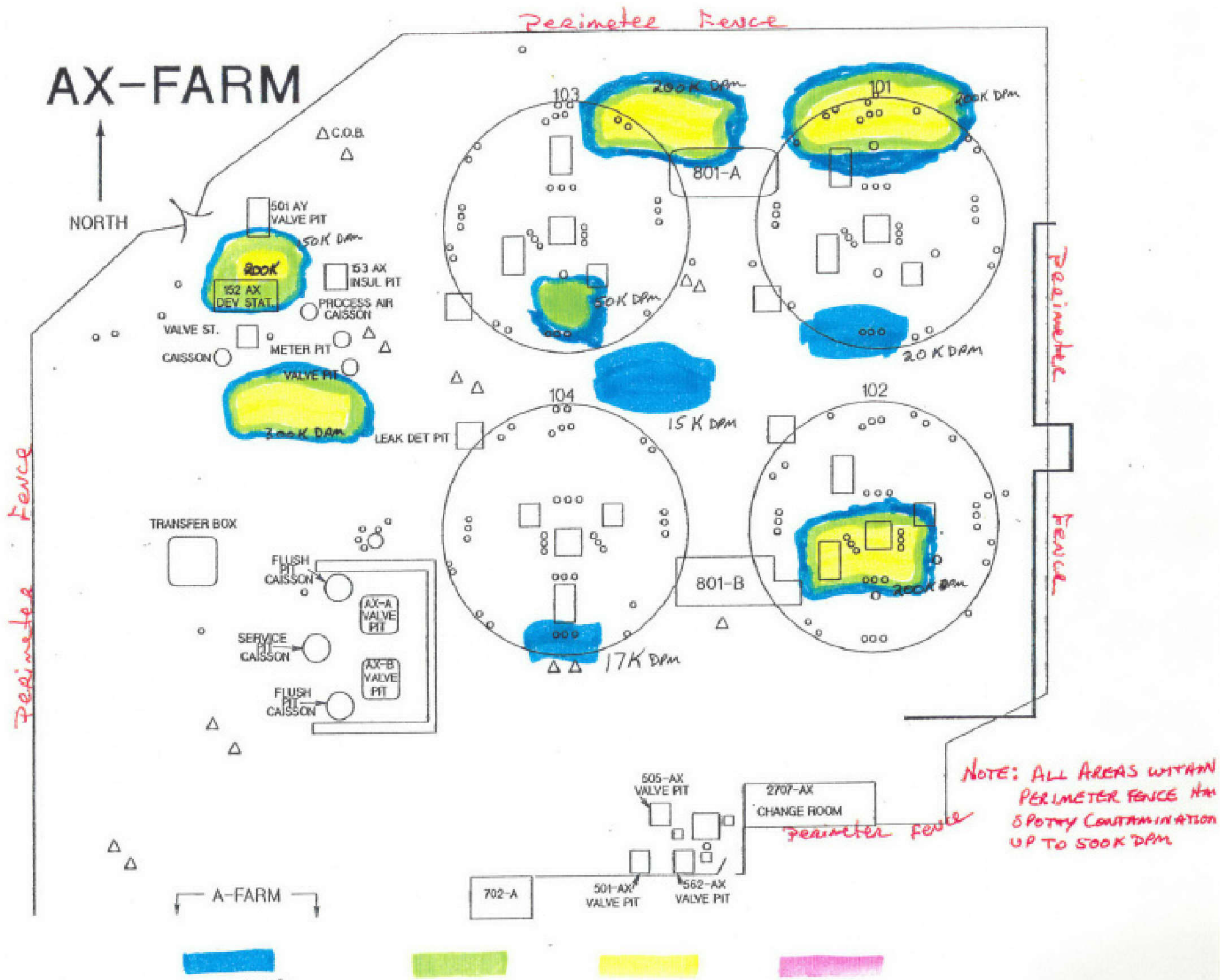
To estimate inventory for other constituents, multiply release volume by the composition of saltcake from the 242-A Evaporator campaigns (A-Saltcake) in RPP-19822.

Figure 5-6. 241-A Tank Farm Radioactivity Surface Survey Map



Note: The 241-A Tank Farm surface survey status map is a sketch showing results of weekly radioactivity survey reports and is posted at the 241-A Tank Farm entrance for worker protection (exact date of the map is unknown, after 1990).

Figure 5-7. 241-AX Tank Farm Radioactivity Surface Survey Map



Note: The 241-AX Tank Farm surface survey status map is a sketch showing results of weekly radioactivity survey reports and is posted at the 241-AX Tank Farm entrance for worker protection (exact date of the map is unknown, after 1990). The rad reading colors indicate the same levels as those in Figure 5-6.

Table 5-8. 241-A and 241-AX Tank Farms Near-Surface Waste Inventory and Volume Estimates

UPR Volume estimates based on SGLS data									
Note: all values are rough estimates									
A-Farm									
241-A-01B Pit Release			(see Section C1.0)						
A-101 (01B) Pit release (~ 1984, based on max drywell vol, rpp-									
High 137Cs in drywell 10-01-04, 10-01-16 and 10-01-28									
Assume 1984 release (peak rad year, RPP-8820)									
Plume based on SGLS: ~ 10 ft deep and 10 ft radius									
1980 sample (TWINS historical sample data) shows 0.4 Ci/gal to 3 Ci/gal for Cs-137								(0.4 Ci gal = 0.25 Ci/gal decayed to 2000)	
SGLS peak =		1E6 pCi/g	Cs-137						
Vol of Cs-137 contaminated soil from pit release:					3140	ft3 =	10*3.14*100		
Inventory of Cs-137 =					160	Ci =	3140*1.8*28317*1000000/1000000000000		
Volume released for 0.4 Ci/gal Cs-137					640	gal =	160/0.25		
	waste type in A-101 in 1984: A-salt cake								
A-Farm Surface (General)									
Surface Cs-137 ~100 pCi/g									
Depth ~10 ft									
A Farm Fenced Area ~			16,000 m2 (from QMap)						
Volume of Cs-137 contaminated soil from surface UPRs =						1.72E+06	ft3 =	16000*10*3.281^2	
Total Ci Cs-137 released =			8.8	Ci =	100*1720000*1.8*28317/1000000000000				
			~10 Ci						
~ Range of historical (during operations) Cs-137 SU waste compositions for A farm in TWINS 1974 to 1988									
0.04 to 2 Ci/gal		(0.04 = 0.025 decayed to 2000)							
Gal released depends on composition of liquids released. Based on the lowest measured composition (0.025 Ci/gal)									
		< 400 gal waste would have been released.					= 10/0.025		
AX-Farm									
Release by 11-01-11/11-02-02									
Assume 1984 release (peak rad year RPP-8821)									
Plume based on SGLS: ~ 20 ft deep and 20 ft radius									
1980 samples (TWINS historical sample data) shows ~1.9 Ci/gal for Cs-137								(1.9 Ci/gal = 1.2 Ci/gal decayed to 2000)	
SGLS peak rad =		1E5 pCi/g							
Vol of Cs-137 cont. soil from pit release:				25120	ft3 =	20*3.14*400			
Inventory of Cs-137 =				128	Ci =	25120*1.8*28317*100000/1000000000000			
				~130 Ci					
Volume released depends on composition of waste stream.									
Volume released for 1.2 Ci/gal Cs-137				107	gal =	128/1.2			
waste type in AX-101 in 1984: A-salt cake				~110 gal	(this volume seems low, waste stream likely more dilute)				
AX-Farm Surface (General)									
Surface Cs-137 ~100 pCi/g									
Depth ~10 ft									
A Farm Fenced Area ~			10,700 m2 (from QMap)						
Est Volume of Cs-137 contaminated soil from surface UPRs =						1.15E+06	ft3 =	10700*10*3.281^2	
Ci of Cs-137 released =			14.65	Ci	1/4 of surface area ~ 1,000 pCi/g				= 1000*1150000*0.25*1.8*28317/1000000000000
			4.40	Ci	3/4 of surface area ~100 pCi/g				= 100*1150000*0.75*1.8*28317/1000000000000
		Total	19.05	Ci	~20 Ci				
~ Range of historical (during operations) Cs-137 SU waste compositions for AX Farm in TWINS 1976 to 1980									
0.015 to 12 Ci/gal		(0.015 = 0.0095 decayed to 2000)							
Gal released depends on composition of liquids released. Based on the lowest measured composition (0.015 Ci/gal)									
		<1,300 gal waste would have been released.					= 20/0.015		

SGLS = spectral gamma logging system
TWINS = Tank Waste Information Network System
UPR = unplanned release

Reference: RPP-8821, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-AX Tank Farm – 200 East*.

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6.0 FACILITIES IN AND NEAR WASTE MANAGEMENT AREA A-AX

Waste Management Area A-AX is part of the PUREX Source Management Area. Figures 6-1 and 6-2 show facilities in and near WMA A-AX. Unplanned releases identified in these figures are discussed in Section 5.0. Facilities and operations in WMA A-AX are summarized in this section. More detailed descriptions and discussion of WMA A-X facilities and operations are provided in the following:

- DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report*,
- RPP-7494, *Historical Vadose Zone Contamination from A, AX and C Tank Farm Operations*,
- RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX* and
- Waste Information Data System (WIDS).

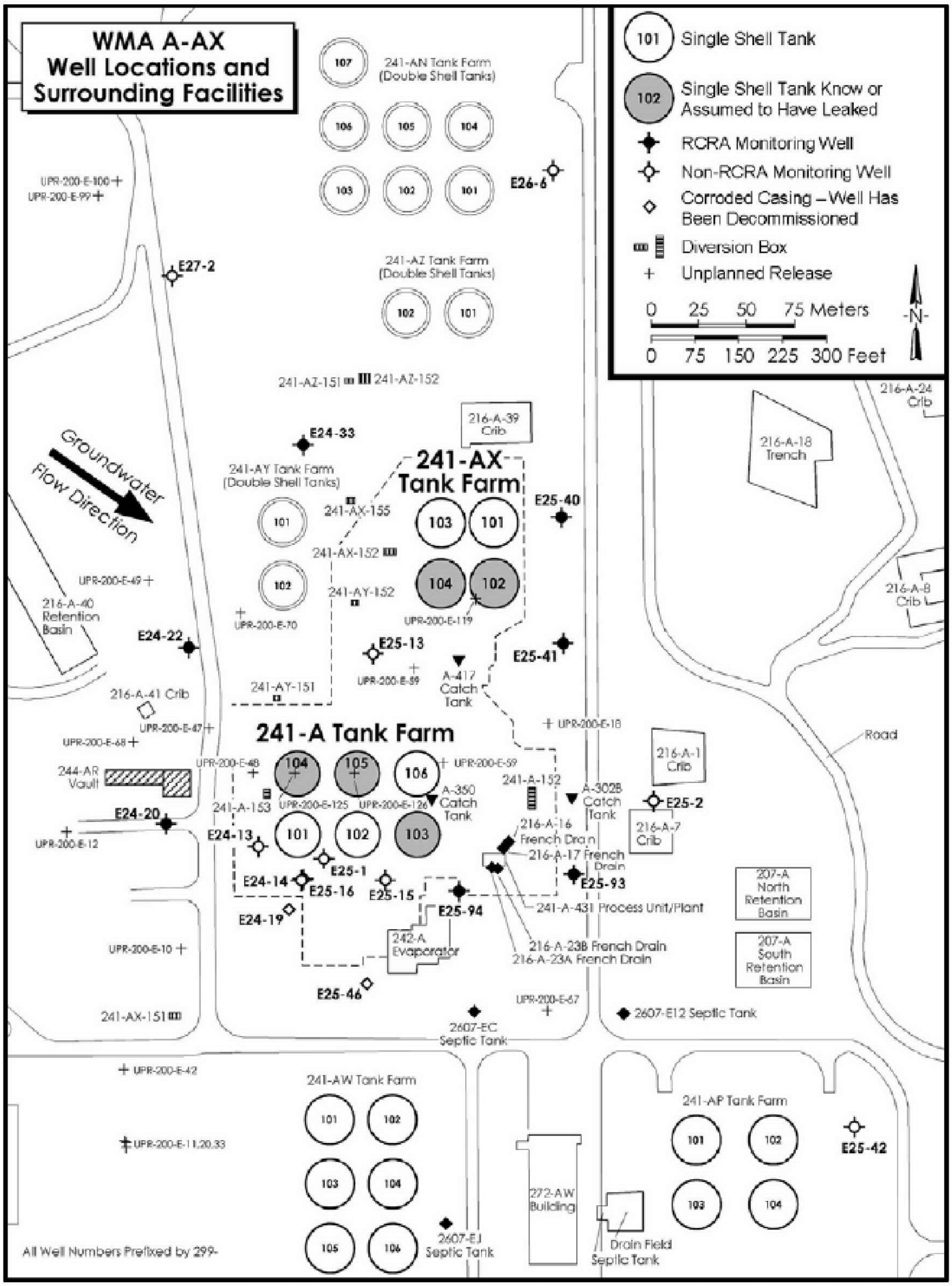
Operations at PUREX went through two phases: the first phase began in 1956 and continued until 1972 and the second phase occurred from 1983 to 1985. During these phases waste discharges to the environment, to cribs and other facilities located around WMA A-AX, were large and frequent. A set of facilities was constructed around WMA A-AX (mostly on the east side), and another set was constructed ~0.5 mile south to support PUREX operations. Additionally, significantly larger quantities of dilute waste (primarily cooling water and steam condensate from various facilities) were disposed of at B Pond, located ~1 mile to the east of WMAs C and A-AX, and at Gable Mountain Pond several miles to the northwest. Together, these discharges have affected water table levels, groundwater flow direction, and groundwater chemistry underlying these WMAs (RPP-35484). For general information, Table 6-1 summarizes the waste management units and waste volumes received (as applicable) in and near WMA A-AX.

6.1 CRIBS, TRENCHES AND RETENTION BASINS

6.1.1 216-A-1, 216-A-7, 216-A-18, 216-A-19 and 216-A-20 Cribs

Initially, cold start-up wastes from PUREX were discharged into four cribs located just north and east of A Farm (216-A-1, 216-A-7, 216-A-18, 216-A-19, and 216-A-20). Approximately 1.6E+06 L of waste, containing ~2,600 kg of uranium, were disposed in these cribs between November 1955 and January 1956. Shortly thereafter, full-scale PUREX operations began, and several liquid discharge facilities began to receive a variety of wastes. In this same time frame, small amounts of overflow waste from diversion box 241-A-152 were discharged into crib 216-A-7 (8E+04 L in 1955 and 1956).

Figure 6-1. Waste Management Area A-AX and Surrounding Facilities



Note: Recent assessments concluded that tank 241-A-103 did not leak and recommend reevaluating the leak designation for tanks 241-AX-102 and 241-AX-104. Dashed lines show perceived WMA A-AX boundary (fence line).

RCRA = *Resource Conservation and Recovery Act of 1976*
UPR = Unplanned Release
WMA = Waste Management Area

Figure 6-2. 241-A and 241-AX Tank Farm Facilities (Waste Information Data System Map)

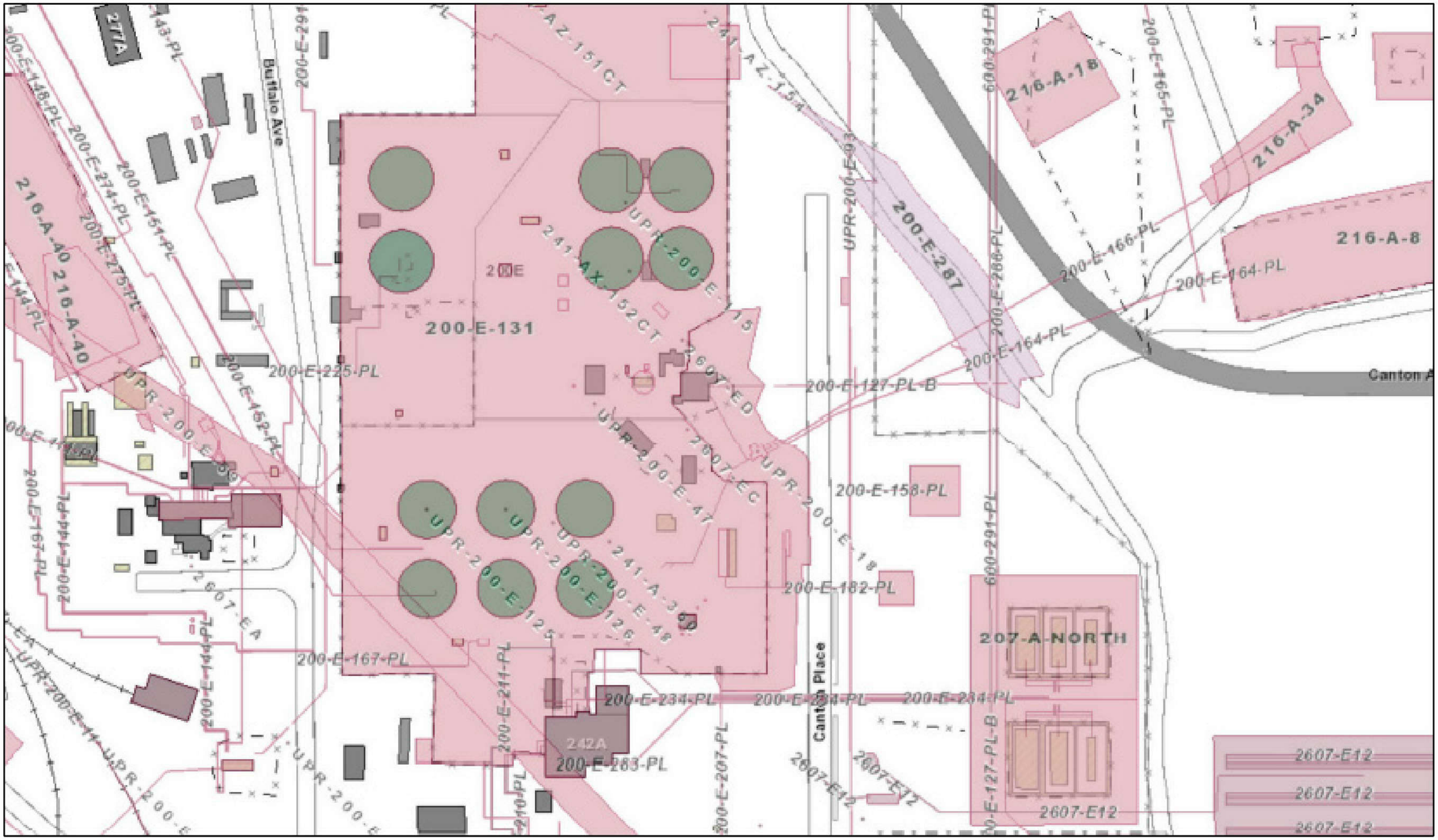


Table 6-1. Summary of Waste Management Area A-AX Waste Management Units (2 sheets)

WIDS Unit	Source Description/Type	Waste Volume Received (L)	Waste Received
244-AR	Vault	Not Specified	Waste sluiced from the 241-A and 241-AX Tank Farms
204-AR	Waste Unloading Station	NA	Rail car and decontamination and regeneration operations waste at Hanford
241-A-431	Ventilation building	NA	241-A Tank Farm waste and 296-A-11 Stack drainage
242-A Evaporator	Evaporator	NA	Mixed waste from the Double-Shell Tank System
241-A-350	Catch Tank	Not Specified	Drainage from pits, clean out boxes, ventilation equipment, and retention basin
241-A-417	Catch Tank	Not Specified, (currently contains 3,240 gal)	Condensate from the 241-A-401 Condenser House, 241-A-702, and from 241-AZ-154
241-A-302B	Catch Tank	Not Specified	Waste solutions from processing and decontamination
241-AX-152CT	Catch Tank	Not Specified	Waste solutions from processing and decontamination
241-AX-151	Diversion Box	Not Specified	Waste from the 202-A Plant
241-AX-152DS	Diversion Box	Not Specified	Waste from processing and decontamination operations
241-A-152	Diversion Box	Not Specified	Waste from processing and decontamination operations
241-A-153	Diversion Box	Not Specified	Waste from processing and decontamination operations
216-A-16	French Drain	122,000	Floor drainage and the 296-A-11 Stack drainage from the 241-A-431 Building
216-A-17	French Drain	60,000	Floor drainage and 296-A-11 Stack drainage from the 241-A-431 Building
241-A-702-WS-1	French Drain	Not Specified	Steam condensate from the 241-A-702 Ventilation Building
216-A-23A	French Drain	6,000	Deentrainer tank condensate and the back flush waste from the 241-A-431 Building
216-A-23B	French Drain		
2607-ED	Septic Tank	Not Specified	Sanitary wastewater and sewage from 2707-AX
2607-EC	Septic Tank	Not Specified	Sanitary wastewater and sewage from 241-AR-271

Table 6-1. Summary of Waste Management Area A-AX Waste Management Units (2 sheets)

WIDS Unit	Source Description/Type	Waste Volume Received (L)	Waste Received
241-AX-IX	Storage Tank, Inactive Miscellaneous Underground Storage Tank	Not Specified	702-A tank vapor condensate
241-A-A	Valve Pit	Not Specified	Waste to and from 242-A Evaporator; 241-AN, 241-AW, 241-AY, and 241-AZ Tank Farms, PUREX and the 244-A DCRT
241-A-B	Valve Pit	Not Specified	Waste to and from 242-A Evaporator; 241-AN, 241-AW, 241-AY, and 241-AZ Tank Farms, PUREX and the 244-A DCRT
241-AX-A	Valve Pit	Not Specified	Tank 241-AY-102 and 241-AX Farm tank waste
241-AX-B	Valve Pit	Not Specified	Tank 241-AY-102 and 241-AX Farm tank waste
241-AX-501	Valve Pit	Not Specified	241-AX Tank Farm waste
216-A-1	Crib	98,400	Depleted uranium waste from 202-A during 1955
216-A-7	Crib		
216-A-18	Trench	488,000	
216-A-19	Trench	1,100,000	
216-A-20	Trench	961,000	241-A-431 contact condenser cooling water and depleted uranium waste from 202-A during 1955
216-A-8	Crib	1,150,000,000	Condensed vapors and cooling water from 241-A and 241-AX Tank Farms
216-A-24	Crib	820,000,000	
216-A-9	Crib	981,000,000	Acid fractionator condensate and cooling water from PUREX and contamination waste from N reactor
216-A-40	Retention Basin	946,000	Steam condensate and cooling water from the AR vault
216-A-39	Trench	20	241-AX-801-B spill
216-A-34	Ditch	Not Specified	Cooling water from the contact condenser in the 241-A-431 building
207-A South	Retention Basin	Not Specified	242-A Evaporator process condensate
207-A North	Retention Basin	Not Specified	Steam condensate from the 242-A Evaporator

DCRT = double-contained receiver tank
NA = not applicable
PUREX = Plutonium Uranium Extraction (Plant)
WIDS = Waste Information Data System

The 216-A-1 and 216-A-7 cribs are located within the same radiologically posted area. They are marked and posted with Underground Radioactive Material signs and are located inside the 200 East Area perimeter fence extension, east of A Farm, along Canton Avenue. These cribs received the depleted uranium waste from the cold startup run in the 202-A Building during November and December 1955 via an overground pipeline.

In addition to uranium, some ^{137}Ce, ^{60}Co and ^{90}Sr is present. When the specific retention capacities of the cribs were reached, the cribs were deactivated by removing the overground piping and backfilling. In 1992, the contaminated soil was scraped and consolidated on top of the 216-A-1 and 216-A-7 cribs. The area was backfilled with 46 to 61 cm (18 to 24 in.) of uncontaminated backfill. The posting was changed to Underground Radioactive Material.

The 216-A-18 trench is located outside of the 200 East Area perimeter fence, east of AX Farm, along Canton Avenue. The trench received waste via an aboveground pipeline. The site was an excavation with a side slope of 1:2. No crib structure was built. The 216-A-18 trench received the depleted uranium waste from the cold start-up run at 202-A Building. The site was deactivated by removing the overground piping and backfilling the excavation when the specific retention capacity was reached. The trench was removed from service in December 1955 and surface stabilized in September 1990. The site is marked and posted with Underground Radioactive Material signs. In February 2001, a narrow area posted with Soil Contamination Area signs extended between the 216-A-19 southern site boundary and northern boundary of 216-A-34.

The 216-A-19 trench is located east of the 200 East Area perimeter fence, north of the 216-A-8 crib. The site received PUREX start-up waste during November and December 1955. The site was deactivated by removing the overground piping and backfilling the excavation when the specific retention capacity was reached. The site was surface stabilized in September 1990. The Soil Contamination Area extending between 216-A-19 and 216-A-34 was stabilized and downposted to Underground Radioactive Material in October 2001.

The 216-A-20 trench is located east of the 200 East Area perimeter fence, north of the 216-A-8 crib. The 216-A-20 trench was originally a test hole excavated with a drag line and used for PUREX start-up waste. The site received the 241-A-431 Building contact condenser cooling water via the 216-A-34 Ditch and the depleted uranium waste from the cold start-up run at the 202-A Building. The site was deactivated in 1955 when the specific retention capacity was reached by removing the overground piping and backfilling the excavation. The site was surface stabilized in 1990. In April 2007, more surface contamination was backfilled with clean dirt. HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas–1959* notes that the 216-A-20 trench overflowed, covering an area measuring ~30 meters (100 ft) north and 60 meters (200 ft) east of the crib site. The site is marked and posted with Underground Radioactive Material signs.

6.1.2 216-A-8 and A-24 Cribs

After PUREX startup, the largest volume of waste discharges into nearby cribs was generated by tank condenser operations. Both condensate and condenser cooling water were intentionally discharged, and the majority of the discharges occurred in facilities east of WMA A-AX. The first facility to receive this waste was the 216-A-8 crib, which was built in 1955 and is located east of A Farm. This crib received 9.3E+08 L of tank condensate and condenser cooling water through May 1958, when the crib had reached its radionuclide capacity. At that point, crib 216-A-24, also located just north of crib 216-A-8, began receiving this waste. The waste is low in salt, neutral to basic and has a record of organic content.

In 1960, an order of magnitude reduction in annual receipt volume was achieved (from ~3E+08 L/yr to < 3E+07 L/yr), when a more efficient condenser system was installed that permitted diversion of the condenser cooling water to Gable Mountain Pond. By 1967, ~8.2E+08 L of fluid had been discharged into this crib. In 1966, condensate discharge reverted back to crib 216-A-8, which received another 2E+08 L through 1976. Subsequently, at crib 216-A-8, additional condensate was received in 1978 (600 L) and from 1983 through 1985, ~1.5E+06 L because of PUREX restart.

The 216-A-8 crib overflow was accomplished through a 16-in.-diameter pipe exiting to the north at the east end of the crib. The pipe emptied into a narrow ditch that flowed northward. A small overflow pond was excavated at the northeast end of the ditch to receive the excess waste water from the crib. The crib was surface stabilized in September 1990.

The 216-A-24 crib was built with four sections, each 107 meters (350 ft) long, separated by soil berms. The sections were installed at increasingly lower elevations, to allow the effluent to cascade from one section to the next. The 216-A-24 crib was believed to have been deactivated in 1966 by valving out the pipeline at the 216-A-508 diversion box (adjacent to the 216-A-8 crib), but in 1979 when excess moisture and radioactive contamination were encountered the valve was discovered to be open and allowing fluid to migrate to crib 216-A-24. The volume of waste released from 1967 through 1979 is unknown. A corrective action backfill was done in 1981 following the contamination spread. The entire crib was surface stabilized in 1988.

The 216-A-8 and 216-A-24 cribs were isolated in 1995 by filling the distribution box with concrete and removing the control structure filter and crib vent filters. The cribs and overflow area are surrounded by chain and concrete AC-540 markers and posted with Underground Radioactive Material signs.

6.1.3 216-A-9 Crib

The 216-A-9 crib located 500 ft west of the A Farm, received acid fractionator condensate and cooling water from PUREX between 1956 and 1958 (9.8E+08 L). The crib surpassed its capacity in 1958 and was taken out of service. The crib was approved to receive contamination waste from N reactor in 1966 (2E+06 L) and was again inactive until August 1969, when PUREX acid fractionator waste was transported to the crib in tanker trucks.

The site contains a 10-in. Schedule 30 steel perforated pipe, placed horizontally, 9 ft below grade. The site has 65,000 ft^3 of gravel fill and has been backfilled. The side slope is 2:1. The site was deactivated by blanking the effluent pipeline (200-E-238-PL) to the unit after replacing 100 ft of the pipeline that had failed. The truck unloading station at this site was interim stabilized in 1991. In 1993, filters were removed from the crib risers, surveyed, and disposed of as nonradioactive waste. The crib surface was covered with 18 to 24 in. of uncontaminated backfill. In July 2000, the vent risers were sealed as a preventative measure for potential passive radioactive emissions. The crib is a surface stabilized area, marked with light post and chain. It is posted as an Underground Radioactive Material area.

6.1.4 216-A-40 Retention Basin

The 216-A-40 retention basin is located about 500 ft west of AX Farm and consists of a trench 400 ft long by 20 ft wide. The basin received 9.5E +05 L of steam condensate and cooling water from the AR vault in 1968. The site was originally an open, rubber-lined trench that was divided into three sections. A 12-in.-diameter Schedule 40 distribution pipe ran horizontally through the south end of the unit, 12 ft below grade. Collapsible rubber bladders were utilized to contain the contaminated cooling water and steam condensate. Contaminated cooling water and steam condensate from the 244-AR Vault were diverted to the 216-A-40 Retention Basin when the effluent was above standard release limits for the water to be sent to the 216-B-3 or 216-A-25 Ponds. The retention basin bladders failed in 1979 and the unit was removed from service.

Although it was not being used, it remained an open basin until 1994. Contaminated soil and the bladders were consolidated into the east end of the trench. Contaminated soil from the adjacent Soil Contamination Area (UPR-200-E-143 and remnants of UPR-200-E-100) was also scraped into the east end of the basin. The basin was backfilled with clean material. This eastern end was posted as an Underground Radioactive Material Area. The remaining portion was released from radiological control.

6.1.5 216-A-39 Crib

The 216-A-39 crib is located near the southeast corner of the 241-AZ Tank Farm (AZ Farm), inside the tank farm fence. The site consists of a crib and two trenches dug from the north door of the 241-AX-801-A Building. The trenches extended to the brow of the north hill, then over the hill to the flat ground below. The trenches continued eastward 90 ft. Later, a pipeline was added that connected the 241-AX-801-B building to the 216-A-39 crib.

The 216-A-39 crib received liquid from a spill of radioactive material which was washed out a hole in the back of the 241-AX-801-A building in June 1966 (see Table 5-1). The spill was washed down using a fire hose. The maximum dose rate from this release was 5 rad per hour at a distance of 3 meters (10 ft). Later, a pipeline was connected and the crib received floor drainage via a pipeline from the 241-AX-801-B Building. Based on RHO-CD-673, WIDS shows the total volume of waste released was 20 L. The volume of water used is unknown.

6.1.6 216-A-34 Crib

The 216-A-34 crib is located east of the 200 East Area perimeter fence and north of the 216-A-8 crib. The site received cooling water from the contact condenser in the 241-A-431 Building. A 15-in.-diameter clay pipe fed the 216-A-34 crib and was connected to the headwall. Ditch effluent was routed to the 216-A-19 and 216-A-20 trenches. The site consists of two ditches, one ditch measuring 280 ft long and 30 ft wide and a second ditch measuring 130 ft long and 30 ft wide. The headwall structure had 1:2 side slopes. The headwall structure tapered off into an open ditch which terminated at the 216-A-20 crib.

Disposal at this site was terminated due to the potential for release of contamination to the environment. The pipeline to the ditch was valved out and the effluent was rerouted to the 216-A-8 crib. The ditch was backfilled. This site was surface stabilized in September 1990.

6.1.7 207-A South Basin

The 207-A South retention basin is located east of the 242-A Evaporator Building and consists of three unlined concrete cells that are coated with a white polyurethane sealant. The cells were fed from the pump pit, located between the 207-A South and 207-A North basins. A 4-in. fill line entered each cell inside the basin structure. A 3-in. drain line exits the bottom of each cell. The 200-E-236-PL basin distribution pipelines were consolidated into the 207-A South basin waste site.

When operating, the three cells of the 207-A South basin were filled alternately, sampled, and discharged to the 216-A-37-1 crib after meeting release specifications. The 242-A Evaporator could retrieve the liquid waste for reprocessing or storage in the tank farm, via line 300, if discharge specifications were not met. After the 207-A North and South basins ceased to operate, the effluent was diverted to the 200 Area Treated Effluent Disposal Facility (TEDF). The 207-A South basin received waste between March 1977 and April 12, 1989.

Operation of the 207-A South basin was discontinued in April 1989. The basins were pumped out and radiologically surveyed. The basins initially remained posted as a Contamination Area due to low levels of fixed contamination in the sump areas. The radiological postings were removed in May 2003.

6.1.8 207-A North Basin

The 207-A North basin is located east of 242-A Evaporator building and consists of three Hypalon lined, concrete basins. Each of the three basins is 55 ft long, 10 ft wide at the bottom, and 7 ft deep with a total capacity of 210,000 gal. A 4-in. fill line enters each basin, ~2 ft long (inside basin structure) and a 3-in. drain line exits. The basins were alternately filled, sampled, and emptied when meeting specifications.

The basins received steam condensate from the 242-A Evaporator since 1977. Effluent was originally sent to the 216-A-25 (Gable) Pond and later to the B Pond system. When the B Ponds became inactive, effluent was diverted to TEDF. The basins discharged via pipeline to the 216-B-3C pond. Discharge to the 216-B-3C pond was discontinued in early 1997 and the basin effluent was diverted to the 200 Area TEDF.

The 207-A North basins were physically isolated and ceased to operate in November 1999. The basins are surrounded with posts and chain. There is no radiological posting on the north basins.

6.2 CATCH TANKS

6.2.1 241-A-350

This catch tank is an underground reinforced concrete pump pit, with a cover block. The pump pit drains any releases from the pump through the pump pit floor drain to an 800-gal (3,000-L) stainless steel tank below. The tank is located inside the A Farm fence, southeast of tank A-106. It is designed to receive drainage from the 241-A-A and 241-A-B valve pits, 241-A service pit, 241-A&B flush pits, 241-A clean out boxes, 241-A-431 ventilation equipment, and out of specification 241-A-207 retention basin solution.

6.2.2 241-A-417

This catch tank is an underground cylindrical concrete vault lined with an all welded steel liner. Two overflow lines near the top of the vault prevent overflow of the tank. Above the tank are two rectangular pits, a pump pit and a valve pit. The floor of both pits slope to drains that empty to the tank. The tank is located inside the A Farm fence, east of the 241-A-702 Building. The tank collects condensate from the 241-A-401 Condenser House, 241-A-702, and from 241-AZ-154. Condensate may be pumped back to the AX Farms or overflow to the 216-A-24 crib. On March 25, 1980, a routine pressure test of the underground F-100 condensate return pipeline from the AX-501 Valve Pit to the 241-A-417 condensate catch tank failed. An April 3, 1980 investigation found a leak at the flange connection. An excavation at the pipeline leak was done. Two barrels of contaminated soil, reading 10,000 counts per minute, was taken to a burial ground.

6.2.3 241-A-302B

This catch tank was used for transfer of waste solutions from processing and decontamination operations to the tank farms and is buried outside the tank farm perimeter fence, east of A Farm, adjacent to Canton Avenue. Shotcrete surrounds the area where the 241-A-302B Catch Tank is located. A riser and electrical box are visible. A staircase has been installed to provide access to the tank surface. The underground tank is positioned horizontally. The tank is marked and radiologically posted.

The tank received liquid effluents from the 241-A-151 diversion box, located south of PUREX, and the 241-A-152 diversion box, outside the A Farm fence. The tank was isolated in 1985 and interim stabilized in 1990. The volume of waste reported to be remaining in the tank is not consistent in all documents. The Waste Tank Summary Report (HNF-EP-0182) states there is a total of 18,685 L (4,943 gal) of waste remaining in the tank.

6.2.4 241-AX-152CT

The 241-AX-152 Catch Tank and Diverter Station are located in the western portion of AX Farm. The catch tank is located under the diverter station. It is constructed of 0.76-meter (2.5-ft)-thick concrete walls. The tank walls and floor are lined with stainless steel. The tank was constructed in 1962 and declared a "leaker" in March 2001. The tank was stabilized by removing all liquid and isolated using both administrative and engineering controls.

6.3 DIVERSION BOXES

6.3.1 241-AX-151

This diversion box is an underground reinforced concrete structure located near the corner of 4th Street and Buffalo Avenue, south of the 244-AR Vault facility. There are four diverter tanks (tanks 241-AX-151-D, 241-AX-151-E, 241-AX-151-F and 241-AX-151-G) in individual cells and a catch tank (241-A-151CT) in a pump pit. Each cell has a stainless steel liner on the floor that extends approximately one foot up the wall. The cells and pump pit drain into the catch tank below. The structure is surrounded with posts and chain. It is posted with radiological and Inactive Miscellaneous Underground Storage Tank signs.

The unit routed waste from the 202-A Plant to the 244-AR Vault and to the AY and AZ Farms. This unit was isolated by the B-231 project. The last documented waste transfer for this site was in 1977. Gravel was placed on the east and south side slopes in April 2005, to prevent soil erosion.

6.3.2 241-AX-152DS

The 241-AX-152 diverter station (DS), diversion box is a reinforced concrete structure with the top at ground level. There are two diverter tanks in a common cell with a stainless steel liner on the floor that extends ~1 ft up the cell wall. There is also a pump pit that does not have a stainless steel liner. The cell and pump pit drain to a catch tank below.

This DS is located in the western portion of AX Farm and was used to transfer mixed waste solutions from processing and decontamination operations. The unit was pumped out on August 29, 1992 and declared isolated in March 2002.

6.3.3 241-A-152

This diversion box is a reinforced concrete structure containing four stainless steel transfer pipes and adequate space to allow for jumper replacement activities. The major portion of the diversion box is below grade with concrete cover blocks and lifting hooks. The diversion box is located inside the A Farm fence, east of tank A-106.

This unit routes waste from 241-A-151 diversion box to 241-CR-151 diversion box through a pipe encasement containing four stainless steel lines. Waste transferred through the diversion box includes fuel decladding waste, organic wash waste, sump waste, and laboratory waste. Lead shielding may also be contained inside the diversion box. The last documented waste transfer for this diversion box was May 1980.

6.3.4 241-A-153

This diversion box is a reinforced concrete structure sized to accommodate the pipes and provide space for jumper replacement. The 241-A-153 is one type of diversion box, known as a transfer box. It connects one common pipe to several others, one at a time, uses only one jumper and has the several nozzles arranged in a circle about the common nozzle. The 241-A-153 diversion box is located inside the A Farm fence, southwest of tank A-104.

This unit routes waste from A Farm to the 244-AR Vault and contains PUREX high level waste and PUREX organic wash waste. Lead shielding may also be contained inside the diversion box. The last documented waste transfer for this site was July 1985. The diversion box has been stabilized with plastic foam to prevent surface infiltration into the unit.

6.4 FRENCH DRAINS

6.4.1 216-A-16

This French drain is composed of a bell-end concrete pipe, 1.8 meters (6 ft) long, placed vertically 3.4 meters (11 ft) below grade. The unit is rock-filled with a 1.9-cm (3/4-in.) carbon-steel cover. A 5-cm (2-in.) steel vent riser extends 0.9 meters (3 ft) from the top. There is a carbon steel inlet pipe, ~0.6 meters (2 ft) long coming from the 216-A-17 French Drain. The French drain is located in the southeast corner of A Farm, inside the tank farm fence.

The site received the floor drainage and the 296-A-11 Stack drainage from the 241-A-431 Building. The waste is low in salt, neutral to basic, and contains less than 10 Ci total beta activity. This unit receives the overflow from the 216-A-17 French Drain. The piping was water-sealed when the 296-A-11 Stack exhaust system was deactivated.

6.4.2 216-A-17

This French drain is composed of a bell-end concrete pipe, 1.8 meters (6 ft) long, placed vertically 3.3 meters (11 ft) below grade. The unit is rock-filled with a carbon steel cover. The side slope of the excavation is assumed to have been 1:1. The French drain is in the southeast corner of A Farm, inside the tank farm fence.

The French drain received 60,000 L of contaminated water from floor drainage and 296-A-11 Stack drainage from the 241-A-431 Building. The waste is low in salt, neutral to basic, and contains less than 1 Ci total beta activity. Overflow from the 216-A-17 French Drain is routed to the 216-A-16 French Drain.

6.4.3 241-A-702-WS-1

This French drain received steam condensate from the 241-A-702 Ventilation Building. The unit is located inside the A Farm fence, west of the 241-A-702 Ventilation Building.

Process steam was used in steam heaters during normal and reduced operating conditions to raise the temperature of vent gases from the AY and AZ Farm Tanks to prevent wetting of filters. The drain was used in conjunction with a steam trap for the system. The drain was isolated October 26, 1995.

6.4.4 216-A-23A and 216-A-23B

These French drains are 1.07-meter (3.5-ft)-diameter, 1.8-meter (6-ft)-long bell-end concrete pipes, placed vertically 1.98 meters (6.5 ft) below grade. The concrete pipe are filled with 0.9 meters (3 ft) of rock and have a carbon steel cover. These French drains are located in the southeast corner of A Farm, just south of the 241-A-431 Fan House building.

The drains received the deentrainer tank condensate and the back flush waste from the 241-A-431 Building. The waste is low in salt, neutral to basic and contains less than 50 Ci total beta activity. The total amount discharged by this waste stream, 6,000 L (1,580 gal), applies to both 216-A-23A and 216-A-23B. The 216-A-23A French drain is connected to the 216-A-23B French drain, located 3 meters (10 ft) to the west, by an underground overflow pipe. The sites were deactivated by water-sealing the piping leading to the drains.

6.5 SEPTIC TANKS

6.5.1 2607-EC

Septic tank 2607-EC includes a tank and dry well and is located in the northeast corner of A Farm, near the fence.

This septic tank is associated with 241-AR-271 and was abandoned in 1999 or 2000. During operation, the tanks received sanitary wastewater and sewage at a rate of ~0.45 m^3 per day. Due to the surface contamination zone surrounding the facility and various other obstructions, the exact location of the septic tank could not be determined.

6.5.2 2607-ED

The 2607-ED Septic Tank receives sanitary wastewater and sewage from the 2707-AX Building and drains to the drain field. The drain field has a capacity of 973 L (257 gal) per day. This tank lies south of tank AX-102, inside the tank farm fence.

The 2607-ED Septic Tank receives sanitary wastewater and sewage from the 2707-AX Building at an estimated rate of 0.28 m^3 (10 ft^3) per day. This site is in a radiation zone and was abandoned in 1998.

6.6 241-AX-IX INACTIVE MISCELLANEOUS UNDERGROUND STORAGE TANK

The 241-AX-IX ion exchange system, located in the southern portion of AX Farm, consists of an aboveground filter and ion exchange column. The ion exchange column is enclosed in a shielded structure. The ion exchange column sits on top of an 8-ft concrete structure. The 241-AX-IX ion exchanger is comprised of the exchange column and underground piping. The resin column is located inside a shielded structure that is open at the top. It was installed in 1967 and operated from 1973 to 1976 to remove cesium from the 702-A tank vapor condensate, collected in the 241-A-417 tank. Condensate was pumped from 241-A-417 through the filter and into the top of the ion exchange column. The condensate would gravity flow through the column and normally be discharged to the 218-A-8 crib. During the summer of 2003, field work was performed to isolate the 241-A-417 tank. The drain line from the 241-A-417 tank to the ion exchange column was sealed. The floor drain was covered with foam.

6.7 VALVE PITS

6.7.1 241-A-A and 241-A-B

The 241-A-A and 241-A-B valve pits were built in 1974 and are underground structures with reinforced concrete walls, floor, and cover blocks located inside the A Farm complex, south of tanks A-101 and A-102. The A Farm valve pits were used to route wastes to and from the 242-A Evaporator; 241-AN, 241-AW, 241-AY, and 241-AZ Tank Farms, PUREX and the 244-A Double-Contained Receiver Tank. The 204-AR Facility was connected to 241-A-A valve pit, but waste was re-routed to 241-AW-A valve pit in 2003 when line LIQW-702 was tied into line SN-220. Transfers from 244-A may have included cross-site, 244-CR, and B Plant wastes.

6.7.2 241-AX-A and 241-AX-B

The 241-AX-A and 241-AX-B valve pits were built in 1965 and are underground reinforced concrete structures with 1-ft-thick walls and floor located inside AX Farm, southwest of tank AX-104. The 241-AX-A and 241-AX-B valve pits were used to direct slurry into tanks or supernate out of tanks and to route waste solutions from processing and decontamination operations.

6.7.3 241-AX-501

The 241-AX-501 Valve Pit is a reinforced concrete structure located inside the north end of A Farm that contains a valve that routes AX Farm condensate to the 241-A-417 Pump Pit and tank.

6.8 PROCESS FACILITIES

6.8.1 242-A Evaporator

The 242-A Building is located adjacent to the south side of A Farm, outside the tank farm. It contains the evaporator vessel, supporting process equipment, and the principal process components of the evaporator-crystallizer system. The building comprises two adjoining, structurally independent structures, designated A and B. Structure A houses the processing and service areas while structure B houses operating and personnel support areas.

The 242-A Evaporator is used to treat mixed waste from the DST System by removing water and most volatile organics. Two waste streams leave the 242-A Evaporator following the treatment process. The first waste stream, the concentrated slurry, is pumped back into the DST System (Tank Farms 241-AN, 241-AW, and/or 241-AP). The second waste stream, process condensate, is routed through condensate filters for treatment before release to the Liquid Effluent Retention Facility and receives final treatment at the Effluent Treatment Facility. Waste types include: dilute non-complexed radioactive waste, PUREX dilute miscellaneous waste, PUREX cladding removal waste, and complexed radioactive waste. Hazardous chemicals used include: sodium nitrate used to regenerate ion exchange column, sodium hydroxide used for decontamination applications, and the antifoam agent used in the evaporator vessel.

6.8.2 204-AR

The 204-AR Unloading Facility is northwest of the 241-AX-151 diversion box and south of the 244-AR Vault and is a reinforced concrete structure. The structure includes a shielded railcar unloading room, floor drains, a 1,500-gal capacity catch tank, transfer pumps and four chemical storage tanks. The chemical tanks contain caustic, nitrite and pH buffer solutions.

The 204-AR Facility received railroad tank cars of liquid radioactive waste to be remotely unloaded inside a fully enclosed, heated, and ventilated building. The rail cars were pumped, sampled, and sluiced as needed. When sample results showed the contents of the railroad car or the catch tank did not meet tank farm specifications, chemical adjustments were made inside the rail car or catch tank. Liquids in the catch tank were periodically sent to the tank farm on a batch basis. Liquid in excess of the catch tank capacity overflows into the sump pit, from which it can be pumped to the 241-A-A valve pit. The unit also received wastes generated from decontamination and regeneration operations in the 100 and 200 Areas; from recovery, fuels fabrication, and laboratory operations in the 200 and 300 Areas; and from decontamination operations in the 400 Area. The waste is chemically adjusted in-line during pump-out to double-shell underground storage tanks to meet corrosion specifications.

6.8.3 244-AR

The 244-AR Vault was built in 1966 and is located west of A Farm. Facilities include a canyon building, a service building, two concrete housings, and a change room. The canyon building is a reinforced concrete, two-level, multi-cell structure. The lower process cells contain four tanks and a failed equipment cell, while the upper cells contain the associated piping and equipment. The upper and lower cells are separated by cover blocks with recessed lifting bails.

The unit received waste sluiced from A and AX Farms. Processing took place, then the waste was shipped to B Plant. The facility was the focal point for reprocessing and routing of PUREX-generated waste between the tank farms and B Plant facilities in the late 1960s and between the tank farms and the Waste Encapsulation Storage Facility in the late 1970s. In 1984, a decision was made to upgrade the 244-AR Vault for use as a waste transfer facility. The extensive upgrading effort provided improved features for the safe and efficient transferring of PUREX-generated waste between the tank farms and B Plant. The waste consisted of cladding removal waste en route to B Plant and transuranic waste from B Plant/Waste Encapsulation Storage Facility to the tank farms.

The vault was placed in a standby mode in 1978. The last documented waste transfer for this site was in 1978. The facility was isolated from steam and water in 1996. In June 2003, ~18,000 gal of liquid waste were pumped from the vault to the DST System. In April and May of 2003, all the pumpable liquid in the facility was consolidated into tank 001 and sampled. In June 2003, ~66,880 L (17,600 gal) of waste and flush water were pumped out of tank 001 and transferred to tank 241-AY-102. Facility isolation and intrusion prevention was done in August 2003.

There are an estimated 660 gal of sludge and up to 194 gal of liquid in the tank in tank 001 cell 1 (RPP-12051, *244-AR Vault Interim Stabilization Completion Report*, pp. 3-2). In tank 002 cell 2, there are an estimated 2,080 gal of sludge and up to 194 gal of liquid (RPP-12051, pp. 3-3). The facility is posted with multiple radiological postings including Internally Contaminated Systems, Radiation Area, Underground Radioactive Material Area, Radiological Buffer Area, Radioactive Material Area, Contamination Area, High Contamination Area, and Fixed Contamination Area.

6.8.4 241-A-431

The 241-A-431 ventilation building, located southeast of tank A-103 inside the A Farm fence, is a concrete structure with the lower portion below grade. The unit is divided into two sections. One section houses the ventilation equipment. The other section houses the de-entrainment equipment. The building is 25 ft high, with the lower 16 ft below grade.

This structure is a tank farm ventilation building that provided off gas de-entrainment for A Farm and also received the 296-A-11 Stack drainage. The unit contains radioactively contaminated equipment and concrete. It provided off-gas de-entrainment for A Farm and also received the 296-A-11 Stack drainage.

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APPENDIX A

241-A/AX FARM TANK LEAK ASSESSMENT MEETING SUMMARIES

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MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: November 27, 2007
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Jim Field, CH2M HILL
Les Fort, ECOLOGY
Paul Henwood, S.M. Stoller
Mike Johnson, CH2M HILL
Marcus, Wood, FLUOR

PURPOSE:
Assess Tank 241-A-105 leak events.

Review of Previous Meeting Summary:
The November 6, 2007 meeting summary was revised per comments received from Ecology. The revisions were reviewed and approved.

Review of C-Farm Assessment Report
After the draft Hanford C-Farm Assessments Report (RPP-ENV-33418, Rev. 1) is revised to incorporate unplanned releases, supplemental data and applicable meeting summaries, the report will be sent to Ecology for review. This differs from the original plan to release the draft Rev.1 previously sent to Ecology for review with only the four tank leak assessments (C-101, C-110, C-111 and C-105).

Discussion of A-105 Leak Events
Marc Wood walked through the conceptual model prepared for the A/AX and C Farm Field Investigation report (FIR). The conceptual model and tank leak descriptions in the FIR will be referenced in the assessment report and not duplicated. Based on the conceptual model presented an approach to estimate a leak volume and inventory was discussed. Leak volume and inventory estimates will be developed for discussion in the next meeting. Assumptions for the estimate will include:

1. Assume lateral gamma measurements are Cs-137 contamination
2. Based on activity in the laterals near the edge of the tank and based on where the steel liner is ripped along the edge of the tank, up to ¾ of the tank circumference could have leaked.
3. The leak moves downward from the tank edge to the laterals in a triangular distribution.

4. The width of the contamination at the laterals is the average measured plume size for activity detected along the laterals.
5. The concentration of the entire plume from tank to laterals is assumed to be at Cesium saturation capacity.
6. The composition of the tank leak was either B-Plant waste or PUREX (P1) waste leaked. The relative amounts of each waste type are unknown, but provide a range for the inventory estimate.

NEXT MEETING AGENDA

1. Continue to Assess Tank 241-A-105
2. Start A-103 Assessment

ACTIONS:

1. J. Field: Prepare and distribute November 27, 2007 Draft Meeting Summary.
2. M. Johnson: Prepare Draft C-Farm Assessment report (Rev. 1) for review.
3. M. Johnson/Mark Wood: Prepare A-103 discussion for next meeting summarizing discussion in the C and A/AX FIR.

NEXT MEETING:

Date: December 11, 2007
Time: 3:00-4:30
Location: ECOLOGY Office

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: December 19, 2007
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Les, Fort, ECOLOGY
Linda Lehman, CH2M HILL
Marcus, Wood, FLUOR

PURPOSE:
Assess Tank 241-A-105 and A-103 leak events.

Review of Previous Meeting Summary:
The November 27, 2007 meeting summary was reviewed and approved as written.

Review of C-Farm Assessment Report
Les Fort noted that he had found out that Ecology concurrence on the leak assessment process report (RPP-32681), requested in a letter submitted to Ecology on September 26th , was past due. Les requested that CH2M HILL resend a copy of the leak process report and promised to turn it around promptly upon its receipt. He also noted that he is anxious to see the revisions to the C Farm leak loss summary report.

Discussion of A-105 Leak Information
Further discussion of tank A-105 was tabled for the next meeting when Jim Field can attend.

Discussion of A-103 Leak Information
Marc Wood discussed the A-103 materials and his findings. Marc noted that A-103 was considered to be a sound tank for a very long time. An earlier study investigated laterals and no contamination was found except some minor hits were seen in the bend outside the Tank Farm. The laterals were investigated again in 2005 and confirmed the findings of the previous study.

In the 1970's they observed fluctuations in liquid levels within the tank. This tank had been receiving ion exchange wastes from B Plant. It was also noted that the FIC was rapidly becoming encrusted in salts and its performance suspect. It was considered to be a gassy active tank that developed crusts and gas pockets and therefore the variations in liquid levels could not be definitively related to tank leaks.

Data from the late 1960's reported gross gamma signals at about 75 feet below ground surface in Dry wells 10-03-07 and 10-03-01 which surround A-103. These dry wells are adjacent to the laterals and no significant evidence of contamination was found in the laterals. The gross gamma measured in the dry wells in the 1960's is assumed to be ruthenium because little or no gamma activity was detected in subsequent logging of drywells 10-03-07 and 10-03-01 conducted in 1987.

It was concluded that no vadose zone drywell or lateral measurements were attributed to a vadose zone leak and liquid level measurement variations in tank A-103 can be attributed to other causes, such as trapped vapor releases in the waste and salt build-up on the FIC surface level gage. More detailed discussion of liquid level decreases will be included in the assessment report.

The change in status from a sound tank to an assumed leaker occurred in the 1980's. A panel of experts was convened to determine whether selected tanks were sound or were leakers. Their charge was to have better than a 95% confidence level that a tank was one or the other. The vote for tank A-103 was 3 for Sound and 2 not sure to the 95% confidence level. Because there was some doubt the tank integrity classification was changed to "assumed " leaker. They assigned a leak volume of 5,500 gallons, which was based on the uncertainty in the FIC liquid level measurements.

The assessment team members present concluded that based on the available information, there is no evidence that tank A-103 lost containment and no leak volume or inventory was assigned for this tank.

Tank A-104 will be studied next, after concluding A-105 leak discussions. The next meeting is scheduled for January 8, 2008.

NEXT MEETING AGENDA

1. Continue to Assess Tank 241-A-105
2. Start A-104 Assessment

ACTIONS:

1. J. Field: Prepare and distribute December 8, 2007 Draft Meeting Summary.
2. M. Johnson: Prepare Draft C-Farm Assessment report (Rev. 1) for review.
3. J. Field: Send Ecology the leak assessment process report RPP-32681

<u>NEXT MEETING:</u>

Date:	December 11, 2007
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: January 8, 2008
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Les Fort, ECOLOGY
Jim Field, CH2M HILL
Linda Lehman, CH2M HILL
Beth, Rochette, ECOLOGY
Marcus, Wood, FLUOR

PURPOSE:
Review Tank A-103 Assessment and Discuss Tank 241-A-105 leak volume calculations.

Review of Previous Meeting Summary:
The December 19, 2008 meeting summary was reviewed and changes were identified. Previous discussions and assessments for tank A-103 were clarified. The changes will be made and the December 19 meeting summary redistributed for review.

Review of C-Farm Assessment Report
CH2M HILL provided a disk to ECOLOGY to review the C Farm leak loss assessment report (RPP-ENV-33418, Rev. 1) and requested comments by the end of January. It was noted that this revision does not change the write-up or conclusions reviewed previously for C-101, C-110, C-111 and C-105 assessments. The primary change is the addition of Unplanned Releases (UPRs) and other potential releases assessed.

Discussion of A-105 Leak Information
Calculations for tank A-105 leak volume estimates were presented and discussed. The calculations were based on assumptions documented in the November 27 meeting. Based on these assumptions the volume of soil impacted by the leak was calculated to be 14,500 ft3 with 28,000 Ci of Cs-137 (based on a cesium sorption capacity of 4E7 pCi/g, RPP-ENV-33418, Rev. 0). The leak volume calculation ranged from roughly 1,000 gallons to 20,000 gallons for a PUREX supernatant (Cs-137 concentration = 30.7 Ci/gal) and for a B-Plant waste concentration (1.38 Ci/gal) respectively. Based on lateral gamma measurements the contamination appears to be a combination of the two waste types, but the relative contribution of each is unknown. Any dilution of the waste would further increase the estimated leak volume. However, neither the waste type or dilution change the estimated Cs-137 Ci content.

After reviewing the calculation participants agreed that the volume of soil impacted could have been larger than that assumed for a triangular distribution of waste from the base of the tank to the laterals 10 feet below. As a result, calculations presented were doubled to cover a worst case assuming waste spread at the base of the tank as much as it did at the laterals (ie. a cylindrical distribution from the tank). This results in a Ci content for the leak of 56,000 Ci with volumes ranging from roughly 2,000 gal to 40,000 gallons. Detailed calculations and figures will be presented in the assessment report.

Future Assessments

Tank A-104 will be studied next meeting scheduled for January 22, 2008.

Participants then discussed a potential shift in the Tank Farm leak assessments from focusing on tank farm closure needs to focusing on central plateau vadose and groundwater priorities identified by the groundwater integration project team (IPT). All were supportive of this shift in focus. Prioritized groundwater needs are scheduled to be discussed January 23 in IPT meetings.

NEXT MEETING AGENDA

1. A-104 Assessment

ACTIONS:

1. J. Field: Prepare and distribute January 8, 2008 Draft Meeting Summary.
2. All: review C-Farm Assessment report (Rev. 1).
3. M. Wood: prepare A-104 discussion for next meeting

NEXT MEETING:

Date:	January 23, 2008
Time:	3:00-4:30
Location:	ECOLOGY Office

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: January 29, 2008
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Attendees: Joe Caggiano, ECOLOGY
Les Fort, ECOLOGY
Jim Field, CH2M HILL
Paul Henwood, STOLLER
Beth, Rochette, ECOLOGY
Marcus, Wood, FLUOR

PURPOSE:
Review Tank A-104 leak loss

Review of Previous Meeting Summary:
The December 19, 2007 and January 8, 2008 meeting summaries were reviewed and approved.

Discussion of A-104 Leak Information
The A-104 tank operating history and waste types and lateral and drywell logging results were discussed. This information will be included in the assessment report. Tank A-104 was declared an assumed leaker based on an increase in radioactivity observed in lateral #1 during sluicing in April 1975. Lateral data obtained from 1977 to 1991 show elevated gamma activity below the tank that indicates the presence of a tank leak. The level of radioactivity measured at the lateral (<250 counts per second) indicates that the leak was small. No elevated activity was observed in nearby drywells. The basis for the 500-2500 gallon leak estimate in HNF-EP-0182 will be discussed in the next meeting.

NEXT MEETING AGENDA

3. Complete A-104 Assessment, Start AX-102 and AX-104 Assessments

ACTIONS:

4. J. Field: Prepare and distribute January 29, 2008 Draft Meeting Summary.
5. M. Johnson: Review basis for A-104 leak volume estimate
6. M. Johnson: Prepare AX-102 and AX-104 information to discuss

NEXT MEETING:
Date: February 12, 2008
Time: 3:00-4:30
Location: ECOLOGY Office

DRAFT MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From:	J. G. Field, CH2M HILL Hanford Group, Inc
Phone:	376-3753
Location:	Ecology Office,
Date:	February 19, 2008
Subject:	Tank Farm Leak Evaluation

To: Distribution/Attendees

Distribution:	Joe Caggiano, ECOLOGY	
	Les Fort, ECOLOGY	(Attendee)
	Jim Field, CH2M HILL	
	Paul Henwood, STOLLER	(Attendee)
	Michael E. Johnson	(Attendee)
	Beth, Rochette, ECOLOGY	
	Marcus, Wood, FLUOR	

PURPOSE:
Review Tank A-104 leak volume estimate.
Review background information for historical leaks from Tanks AX-102 and AX-104.

Review of Previous Meeting Summary:
The January 29, 2008 meeting summary was reviewed and approved without changes.

Discussion of A-104 Leak Volume Estimate
HNF-EP-0182, rev. 237, *Waste Status Summary Report for Month Ending December 31, 2007*, estimates between 500 to 2,500 gallons of waste was loss from SST A-104 in 1978. The basis for this estimate is cited as PNL-4688, *Assessment of Single-Shell Tank Residual Liquid Issues*. Section 3.1.3.1 of PNL-4688 discusses past leaks from SSTs as of May 1982 and provides a table summarizing estimated leak volume by each tank. PNL-4688 references RHO-RE-SR-14 - May 1982, *Waste Status Summary May 1982*, as the source identifying leaking SSTs and states the estimated waste leaked from SST A-104 is 2,500 gallons. RHO-RE-SR-14 – May 1982 identifies SSTs that were categorized as having leaked waste, but does NOT list the volume of waste leaked from any of these SSTs. PNL-4688 provides no other basis for the estimated waste loss from SST A-104.

The first time estimates for waste losses from SSTs appear in a monthly waste status summary report is in September 1983 (RHO-RE-SR-14 - September 1983, page 28). The reported estimated waste loss from SST A-104 is less than 1,500 gallons. The estimated waste loss from SST A-104 reported in RHO-RE-SR-14 - September 1983 is consistent with the estimated waste loss of 700 to 1,500 gallons reported in July 1975 by the Hanford site contractor in correspondence with the U.S. Energy Research and Development Administration (Burton, 1975). Furthermore, the tank farm contractor's monthly report for June 1975 also reports the estimated waste loss from SST A-104 as 700 to 1,500 gallons (ARH-LD-206 B, page 10).

None of the identified reference documents provide an actual basis for the estimated waste loss from SST A-104. The team recommended that the reference for the estimated waste loss from SST A-104 be cited as Burton 1975 in future revision of HNF-EP-0182 and the estimated waste loss volume be changed to 700 to 1,500 gallons.

Discussion of Tank AX-102 Leak Loss

A summary of Tank AX-102 design features, operational history, and historical leak loss information that was distributed to team members prior to this meeting was reviewed and discussed.

Attendees discussed the leakage of condensate that was evolved from Tank AX-102 through an underground vapor header as well. Condensate leakage from the underground vapor header was detected in drywell 11-02-11 when first monitored on February 11, 1975. Auger drilling conducted around this vapor header in 1975 lead to the discovery that compression seals (i.e. Dresser couplings) on the vapor header were leaking. A new drywell 11-02-12 installed in May 1975 confirmed the condensate leakage from this vapor header. No historical estimate was located for the volume of condensate leaked from this vapor header. The boiling waste tanks in the 241-AX and 241-A tank farms were connected to this header and material balance information is inadequate to determine vapor header losses.

The attendees also reviewed the historical gamma scans for drywells 11-02-11 and 11-02-12 from RPP-8821. These scans show gross gamma radiation detected in drywells 11-02-11 and 11-02-12 were correlated to ruthenium-106 decay rate for radioactivity detected at 50-60-ft bgs in drywell 11-02-11 and 32-50-ft bgs in drywell 11-02-12. The historical gross gamma radiation detected 32-50-ft bgs in drywell 11-02-12 was also correlated to cobalt-60 decay rate as well.

Attendees also discussed the 1.25-inch liquid level decrease detected in Tank AX-102 from June 18, 1984 through May 27, 1988. This liquid level decrease is the basis for the estimated waste loss of ~3,000-gallons from Tank AX-102.

Discussion of Tank AX-104 Leak Loss

A summary of Tank AX-104 design features, operational history, and historical leak loss information that was distributed to team members prior to this meeting was reviewed and discussed. A graphical timeline for Tank AX-104 events was also presented.

As with Tank AX-102, the Dresser coupling joining the Tank AX-104 exhaust pipe to the underground vapor header was found to be leaking condensate in 1975. No historical estimate was located for the volume of condensate leaked from this vapor header. The boiling waste tanks in the 241-AX and 241-A tank farms were connected to this header and material balance information is inadequate to determine vapor header losses.

Tank AX-104 was classified as questionable integrity and removed from active service in August 1978 as a result of the radioactivity detected in drywell 11-04-08. However, the source of the radioactivity detected in drywell 11-04-08 could not be determined. The strongest gamma radiation signal was detected due east, toward tank AX-104, which led personnel in 1978 to suspect the integrity of the tank. No corresponding liquid level decline or elevated radiation readings were detected in the leak detection pit at the time increased radioactivity was detected in drywell 11-04-08. The estimated waste loss of 8,000-gallons for tank AX-104 is based solely on the average waste loss from 18 other SSTs for which liquid level decline was reported.

The attendees discussed that a conceptual model needs to be developed that would account for the postulated waste loss from tankAX-104. This conceptual model would need to account for radioactivity detected in drywell 11-04-08 without corresponding activity being detected in the leak detection pit associated with tank AX-104.

NEXT MEETING AGENDA

1. Complete AX-102 and AX-104 Assessments

ACTIONS:

1. M. Johnson: Prepare and distribute February 19, 2008 Draft Meeting Summary.
2. M. Johnson: Present historical gamma analyses for drywells surrounding Tank AX-104 at next meeting.
3. M. Johnson: Prepare AX-102 timeline.
4. P. Henwood: Provide reference information for precision and detection capability for probes used to scan drywells.
5. P. Henwood: Review gross gamma plots for drywells 11-02-12, 11-04-01, and 11-04-11 to determine if correction of the data is needed based on different probes used to scan drywells.

NEXT MEETING:

Date: March 4, 2008
Time: 3:00-4:30
Location: ECOLOGY Office room 3B

References:

ARH-LD-206 B, 1975, *Atlantic Richfield Hanford Company Monthly Report June 1975*, Atlantic Richfield Hanford Company, Richland, Washington

Burton, G., 1975, *Status of Tank 241-A-104 Contract E(45-1)-2130*, letter dated July 10, 1975 from G. Burton Vice President Production and Waste Management Atlantic Richfield Hanford Company to O. J. Elbert, Director Production and Waste Management Programs Division, U.S. Energy Research and Development Administration, Richland Washington

HNF-EP-0182, rev. 237, *Waste Status Summary Report for Month Ending December 31, 2007*, CH2M HILL Hanford Group Inc., Richland Washington

PNL-4688, 1983, *Assessment of Single-Shell Tank Residual Liquid Issues*, Murthy, K. S., et al., Pacific Northwest Laboratory, Richland, Washington

RHO-RE-SR-14 - May 1982, *Waste Status Summary May 1982*, Rockwell Hanford Operations, Richland Washington

RHO-RE-SR-14 - September 1983, *Waste Status Summary September 1983*, Rockwell Hanford Operations, Richland Washington

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: March 4, 2008
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Distribution: Joe Caggiano, ECOLOGY
Jim Field, CH2M HILL
Paul Henwood, STOLLER
Michael E. Johnson
Beth, Rochette, ECOLOGY
Marcus, Wood, FLUOR

PURPOSE:
Complete AX-102 and AX-104 assessments.

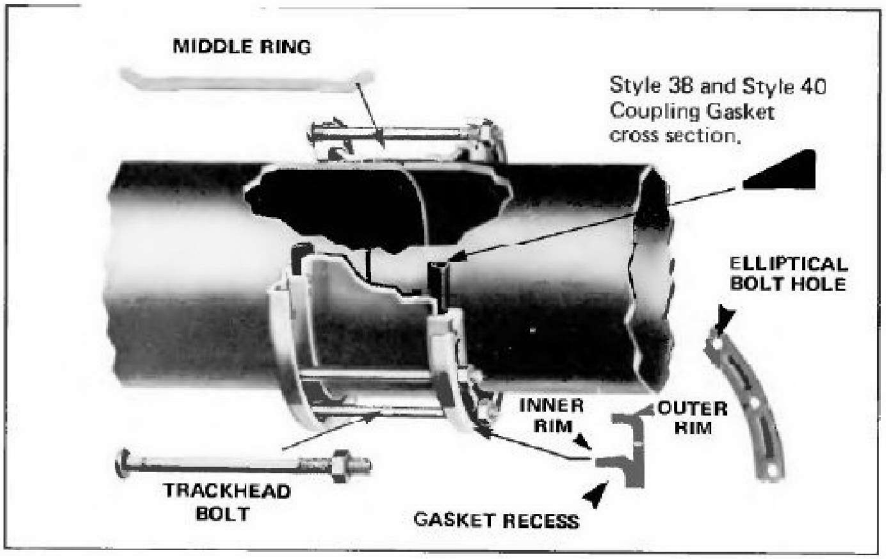
Review of Previous Meeting Summary:
The February 19, 2008 meeting summary was reviewed and approved. Information requested by Ecology will be included in the assessment report.

Assigned actions were completed. Paul Henwood verified that the gross gamma data for drywells 11-02-12, 11-04-01 and 11-04-11 were obtained using probe 4. Therefore it was agreed that correction of the data is not needed. The assessment report will clarify which probe was used to obtain the data.

The assessment team was informed that the C-Farm assessment report (RPP-33141, Rev. 1) was issued and posted to a CH2M HILL external web page.

Discussion of AX-104 Leak Volume Estimate
Mike Johnson presented historical gamma analyses for drywells surrounding tank AX-104.
No Cs-137 was discovered in the drywells around AX-104 or AX-102.
Dresser couplings provide a compression seal on the outer surface of vapor header pipe segments in the 241-AX and 241-A tank farms. The couplings provide for expansion and contraction of the vapor header pipe segments (See Figure 1). The team concluded that waste losses from dresser couplings were a probable cause of measured gamma in drywells and a leak from the tank was unlikely. No liquid level decreases were observed in Tank AX-104. Other contamination in nearby drywells and radioactivity surface data will be discussed in the next meeting.

Figure 1. Typical Dresser Coupling arrangement



Discussion of AX-102 Leak Volume Estimate
Contamination from a dresser coupling was verified as the source of 1975 contamination discovered in a nearby drywell. However, no drywell contamination was discovered after 1975 or near the time of liquid level decreases. Liquid level decreases equating to 3400 gallons do not correlate with potential evaporation losses. Liquid level measurement results have been questioned because of a buildup of corrosion/scum on the instrument probe. However, there is insufficient evidence to verify the instrument was bad. It was further observed that AX-102 is one of the few tanks where multiple gamma emitters were measured. Gamma emitters should have been observed if there was a 3400 gallon leak from the tank.

The panel concluded that there is sufficient evidence to question a tank leak and no basis for assigning a leak loss volume or inventory for this tank.

NEXT MEETING AGENDA

1. Complete AX-104 Assessments and begin UPR assessments.
   In preparation for next meeting M. Johnson distributed a handout summarizing UPRs in the A and AX Farms.

ACTIONS:

1. J. Field: Prepare and distribute March 4, 2008 Draft Meeting Summary.
2. P. Henwood: Review drywell data in A and AX farm
3. M. Johnson: Look up information for surface radioactivity measurements in the farms.

<u>NEXT MEETING:</u>

Date:	April 1, 2008
Time:	3:00-4:30
Location:	ECOLOGY Office room 3B

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: April 1, 2008
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Distribution: Joe Caggiano, ECOLOGY
Jim Field, CH2M HILL
Les Fort, ECOLOGY
Paul Henwood, S. M. STOLLER
Michael Johnson, CH2M HILL
Marcus Wood, FLUOR

PURPOSE:
Complete AX-104 Assessment and assess other releases in the A- and AX-Farm.

Review of Previous Meeting Summary:
The March 4, 2008 meeting summary was reviewed. A typo was observed and a request to define "dresser coupling." Changes to the summary will be incorporated and the final summary distributed.

Continued Discussion of AX-104 Leak Volume Estimate
It was noted that the gamma activity in dry well 11-04-08 started to increase during sluicing of tank AX-104. Several possibilities for the gamma activity were discussed. The gamma signature is not consistent with a tank leak. The only indication of a possible tank leak is the continued increase of gamma activity in 11-04-08 during the previous sluicing campaign. However, AX-104 is a "hot" tank and there was no observed evidence of a high activity waste type in the soil. Participants could not conclude whether tank AX-104 lost integrity. However, because the tank has already been sluiced and remaining residuals are "hot," participants believed that AX-104 is not a likely candidate for sluicing regardless of whether it has lost integrity.

Unplanned Releases
A list summarizing unplanned releases in 241-AX was prepared and discussed.
UPR's included in the Waste Information Data System (WIDS) include the following.
UPRs-E-18 and E-42 are outside the farm and are identified in WIDS as "cleaned up" sites. Clean up criteria and standards are not specified.
Note: UPR E-115 and UPR-E-119 were interchanged on the C-Farm and A Complex Drawing 020196 dated 11-7-02. (need to check to be sure these are correct in WIDS).

UPR-E-145 is far outside the farms (do not include in assessment). The soil inventory model (SIM) assumes a P3 waste type for this release. It was noted that the waste is likely condensate in a vitrified clay pipe.

UPRs-E-47, 48, 115 and 119 are identified in WIDS as particulate or small releases. No inventory could be determined.

Surface Radioactivity surveys from Feb. 2006 (the most current in IDMS) do not show high activity between the tanks; only known activity is over the tanks at riser pit locations. Between the tanks a 100 cpm (near back ground was measured)

Two locations not currently identified as UPRs were identified in 241-AX farm and discussed. These were:

1. At drywell 11-03-02 near AX-103 high activity was observed. A tank integrity assessment concluded AX-103 was not the source. The source of this activity is likely a June 1966 10 to 20 gal of high activity waste discharge from an air lift circulator air supply pipeline routed between AX-103 and the AX-801A instrument building. The AX-801A instrument building was decontaminated intermittently over a three week period using water and chemical (sodium hydroxide, citric acid, oxalic acid, tartaric acid, tri-sodium phosphate, and potassium permanganate) flushing. These flush solutions were initially discharged to open trenches (quantity not specified) dug outside the building. These trenches were backfilled with three feet of earth cover. Subsequently, flushes were routed to two cribs at the north edge of the 241-AX Farm. Following these flushes, lead sheet was installed inside the AX-801A building to further reduce the radiation dose rate (ISO-416 PT1 page 4). No record was located that details the volume of the flush solutions used.
2. A pipeline failure near AX-103 where Cs-137 was observed at 25 ft bgs. This is attributed to a pipeline leak between AX-102 and the 102C pump pit. Liquid was observed coming from the ground near the AX-103 pump pit on 1-29-68 during attempts to unplug the AX-102 to C-102 line with hot water.

Participants recommended these pipeline failures be added to WIDS along with pipeline leaks in C-Farm that are not yet identified as UPRs.

No tank overflows are indicated for boiling waste tanks in A and AX Farm. More detailed descriptions and references for these UPRs and information presented during the meeting will be included in the A-AX Assessment report.

Additional Discussions:
C-Farm inventory discussions in Tank Farm Vadose Zone Contamination Volume Estimates (RPP-23405) were updated consistent with C-Farm leak assessments (RPP-ENV-33418, Rev. 1). A draft revision was distributed for Ecology review.

NEXT MEETING AGENDA
Begin SX-Farm assessments

ACTIONS:

1. J. Field: Prepare and distribute April 1, 2008 Draft Meeting Summary.
2. M. Johnson: Prepare SX-Farm information for discussion.
3. M. Johnson: Prepare A-AX Farm Assessment Report.

NEXT MEETING:

Date:	April 15, 2008
Time:	3:00-4:30
Location:	ECOLOGY Office room 3B

MEETING SUMMARY

CH2MHILL
Hanford Group, Inc.

From: J. G. Field, CH2M HILL Hanford Group, Inc
Phone: 376-3753
Location: Ecology Office,
Date: April 15, 2008
Subject: Tank Farm Leak Evaluation

To: Distribution/Attendees

Distribution: Joe Caggiano, ECOLOGY
Jim Field, CH2M HILL
Les Fort, ECOLOGY
Paul Henwood, S. M. STOLLER
Michael Johnson, CH2M HILL
Beth Rochette, ECOLOGY
Marcus Wood, FLUOR

PURPOSE:
Begin SX-Farm leak assessments

Review of Previous Meeting Summary:
The April 1, 2008 meeting summary was reviewed and approved with changes.

Additional Discussion of A/AX-Farm UPRs
Emphasis was added that the inventory for UPRs in A/AX –Farm could not be determined. Although some UPRs are listed as "cleaned up" in WIDS. The criteria for considering the sites cleaned up at the time are unknown, as is the detection limit for any instruments used to make this judgment. Typically in the past sites were cleaned enough to eliminate smearable contamination and to allow workers into the location.

Assessment of SX-114
Information regarding tank transfers, operating conditions and contamination observed near SX-114 was presented by Mike Johnson. Multiple unique aspects of SX-Farm were identified. Presentation details will be in the assessment report.

SX-114 was classified as an assumed leaker based on gamma activity (60,000 cpm) in drywell 41-04-06 observed measured in 8/10/72 at 38 ft below ground surface (bgs), about 16 ft above the tank base. On 8/21/72 contamination was observed at 51 ft bgs. No liquid level loss has been observed and no leak inventory assigned in the past. However, there are no known pipeline leaks around SX-114 and a structural failure was a typical cause of leaks for tanks with temperature and waste type histories similar to SX-114.

Based on the gamma level and decay the drywell activity appears to be Ru-106 and/or Co-60. The waste type in the tank at the time was REDOX Ion Exchange waste. In this waste type, Cs-137 was extracted from REDOX high level waste. An action was assigned to look closer at the records to determine the percent of Cs extracted in the process and the ratio of Cs to Ru waste following extraction. This may enable a rough calculation to estimate an upper bound leak inventory. Lacking that, no leak volume estimate could be determined.

Because no Cs was observed and Ru-106 has decayed, future characterization near drywell 41-04-06 would target chemical constituents. This leak appears to be minor compared to other SX-Farm releases and additional characterization may not be warranted.

NEXT MEETING AGENDA

Continue SX-Farm leak assessments (SX-113 and 115)

ACTIONS:

1. J. Field: Prepare and distribute April 15, 2008 Draft Meeting Summary.
2. M. Johnson: Look for information showing the Cs-137 concentration after the Cs extraction process and the Cs/Ru ratio for the waste.

(Finding: The HDW rev. 5 Model does not contain a separate defined waste type for REDOX ion exchange waste and no sample analyses of this waste type were located. Therefore an estimate of the waste loss inventory can not be made at this time using the Ru-106 concentration and assumed leak geometry.)

3. M. Johnson: Prepare additional SX-Farm information for discussion.

NEXT MEETING:

Date:	April 29, 2008
Time:	3:00-4:30
Location:	ECOLOGY Office room 3B

MEETING SUMMARY

washington river protection solutions

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: November 13, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Jared, Mathey, ECOLOGY

PURPOSE:
The purpose of this meeting was to initiate and kick-off updated discussions on the A/AX Farm leak inventory estimates with discussions starting on three tanks currently categorized as being sound (no waste released as the result of a loss in tank liner integrity) tanks A-101, A-102 and A-103.

Background Discussion
The previous A/AX farm leak inventory assessment report (RPP-ENV-37956) will be revised to include a comprehensive assessment of the designated sound tanks and to incorporate lessons learned and new information gleaned from working through the tank leak assessment process. The following proposed schedule for A/AX farm leak inventory assessments was presented to attendees and accepted:

Nov. 13, 2013: Kick-off and discuss tanks A-101, A-102 and A-103
Dec. 3, 2013: Discuss tank A-105
Dec. 17, 2013: Discuss tanks A-104 and A-106
Jan. 14, 2014: Discuss unplanned releases in A Farm
Jan. 28, 2014: Discuss all AX Farm tanks
Feb. 11, 2014: Discuss unplanned releases in AX Farm
Feb. 25, 2014: Discuss groundwater and impacts to groundwater from A and AX Farms

A summary overview of the previous A/AX leak inventory report and assessments was presented.

It was noted that the maximum temperatures for A-Farm tanks far exceeded the operating temperature limit of 300 °F. The maximum recorded temperatures for A-Farm tanks will be included in the revised report.

Several possible explanations for the corrosion of three groundwater monitoring wells near A farm and a drywell near tank A-105 (where it has been observed that the outer casing is corroded) were discussed. Inhibited sulfuric acid added to tank A-105 was identified as a possible cause of the corrosion. Road salt stored in the vicinity of A Farm and lateral movement from surface waste spills were also identified as possible causes. These possible causes will be further evaluated in discussions of unplanned releases and groundwater impacts. It was suggested that due to these corrosive conditions, future characterization in A farm should include sampling and analysis for metals and ions.

Tank A-101 Discussion
Tank process information and gamma logging data for tank A-101 was presented and discussed. Additional detail was requested regarding the "four-tank cascade series" in A Farm. It was pointed out that the tanks were tied together, but not in a true cascade. This will be further explained in the revised report.

Logging data shows extensive ^{137}Cs activity from ground surface to ~20 ft bgs in A farm. The gamma activity in drywells 10-01-04 and 10-01-16 was previously attributed to past soil contamination around the 241-A-01B pit area (OR-81-03). This was confirmed by 15 ft holes that were drilled and soil samples taken near the sluice pit. However, spectral gamma logging results, not available at the time of the occurrence report; indicate that ^{60}Co and ^{154}Eu plumes may have increased in size and activity level through 1997. This added information suggests that there may be a second source of contamination contributing to the gamma activity in drywell 10-01-04. UPRs near drywell 10-01-04, the OR-81-03 report, and any relevant additional information will be presented and evaluated in the next meeting. An action was taken to provide a copy of OR-81-03 to Mike Barnes of Ecology; this was done following the meeting.

Tank A-102 Discussion
Tank process information and gamma logging data for tank A-102 was presented and discussed. Participants agreed that A-102 appears to be sound as currently classified. Liquid levels were below the cascade overflow level and there was no unexplained liquid level decrease identified for this tank. It was noted that liquid level measurements were not very accurate for self-boiling tanks and as a result waste liquid levels were not a primary means of leak detection. The only gamma activity observed was in drywell 10-2-08 at 85 ft (Co-60) and was attributed to releases from the 241-A-01B pit and or A-101 contamination from a possible leak near the base of the tank. It was noted that this possibility should be considered for retrieval actions and the interval be monitored during retrieval.

It was noted that low levels of ^{137}Cs activity appear to increase slightly at about the 80 ft level in four additional drywells. Originally some of the drywells were shorter and it was suggested that the slight increase in ^{137}Cs activity may be due to surface contamination carried to the bottom of the well by water introduced into the drywell before the drywell was lengthened. An action was taken to determine the depths of the drywells before they were lengthened to assess this possibility. It was suggested that future characterization efforts in A Farm should consider investigations at about this depth.

Tank A-103 Discussion
Tank process information, gamma logging data, and recent tank integrity assessments for tank A-103 were presented and discussed. Tank A-103 was previously categorized as an assumed leaking tank based on waste surface level decreases. ^{137}Cs activity was measured in some of the tank drywells near tank A-103 beginning at approximately 50 ft and in the worst case (drywell 10-03-07) extending to the bottom of the drywell, although very low in activity (e.g. 1 to 10 pCi/g. In 10-03-07, contamination was observed from 50 ft to the bottom of the drywell at 70 ft in 1975. The drywell was deepened to 130 ft in May 1978. Between 1977 and 1979, the character of the gamma profile changed to the extent that some contamination may have been redistributed downward in the drywell. It was also possible the contaminated interval contained minor amounts of ^{137}Cs along with short lived radionuclides that quickly decayed away. Gamma peaks at 55, 75, and 95 ft exhibited in 1979 coincide with the highest ^{137}Cs activity if approximately 5 ft was added to the depths. Because the profile indicates character at these depths and the hiatus of surface contamination between 30 and 50 ft, it appears there was insufficient material to be dragged down to the bottom of the drywell between 50 and 125 ft, while there was not definitive evidence of a tank leak, additional characterization could determine if the contamination was drywell related or in the sediment.

Radiation monitoring in the 3 laterals below tank A-103 from 1977 to 1991 and again in 2005 detected no evidence of tank leakage. It was noted that gamma activity in many of the laterals in caisson #2 that serves tanks A-103, A-105, and A-106 in A-farm appears to increase at ~55 to 67 ft bgs at the bend in the laterals from mostly vertical to horizontal. A marked increase was observed from February 21, 1978 to February 24, 1978. Gamma activity also was indicated at approximately 23 ft in depth. Attendees made no conclusions regarding this contamination although a characterization borehole adjacent to the caisson could determine if the activity was inside or outside the caisson and isolate potential sources.

The 2009 tank leak integrity assessment (TFC-ENG-CHEM-D-42 assessment) conducted in response to recommendations identified in the 2008 A/AX farm leak inventory report (RPP-ENV-37956) concluded that the most likely cause of the surface waste level changes in tank A-103 were the episodic accumulation and release of trapped gas in the waste, combined with waste evaporation and measurement errors created by the irregular waste surface (RPP-ASMT-42278). The 2009 assessment panel recommended that the categorization for tank A-103 be changed to "sound." A copy of the 2009 assessment report was requested by Mike Barnes of Ecology and was provided after the meeting. It was noted that, a footnote was added to HNF-EP-0182 to document leak assessment recommendations; a formal change to the leak categorization presented in HNF-EP-0182 for Tank A-103 is pending.

ACTIONS:
1. J. Field: Prepare and distribute November 13, 2013 Meeting Summary
2. L. Fort: Prepare summary for tank A-105 for the next meeting.

3. L. Fort: Provide electronic copy of OR-81-03 and RPP-ASMT-42278) to Mike Barnes, Ecology.
4. P. Henwood: Determine the depth of A-Farm drywells before they were elongated.
5. All: Review tank A-101 information for additional discussion and prepare to review tank A-105 information.

NEXT MEETING:
December 3, 2013, 9 A.M. in Conference Room 3A, Ecology Building.

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: December 3, 2013
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:
- Jim Alzheimer, ECOLOGY
- Mike Barnes, ECOLOGY
- Jim Field, WRPS
- Les Fort, WRPS
- Paul Henwood, S. M. Stoller
- Jeremy Johnson, ORP

PURPOSE:
The purposes of these Tank Farm Leak Inventory Assessment meetings are to reassess the A and AX Farm leak inventories and to assess tanks currently categorized as "sound tanks" in HNF-EP-0182. These meetings also review the assessment process and review previous A and AX tank farm meeting summaries and conclusions. This meeting discussed tank A-105 leak inventory estimates and information.

Review of Previous Meeting Summary
The November 13, 2013 meeting summary was reviewed and discussed. Highlighted comments provided by Paul Henwood, S. M. Stoller, were discussed. The additional information in the provided comments gave clarity, additional information, and interpretations for tank A-103 drywell logging data. Attendees accepted the meeting summary with the additional information.

Tank A-105 Discussion
Tank process information and gamma logging data for tank A-105 was presented and discussed. In addition to information in the current A and AX Farm leak assessment report (RPP-ENV-37956), information from the A/AX farm leak locations and causes report (RPP-RPT-54912) was discussed.

Previous estimates in WHC-MR-0264 and HNF-EP-0182 show that 5 to 15 kgal of tank waste leaked before August 1968 and 5 to 15 kgal of waste leaked while the tank was being sluiced from August 1968 to November 1970. In addition 610 kgal of cooling water was added to the tank and based on evaporation estimates 0 to 232 kgal of cooling water may have been released from the tank. It was stated that future reports need to clearly distinguish between the tank waste and the added cooling water losses; and need to clearly state if estimates presented are current or previous estimates.

RPP-ENV-37956 provides a model to estimate the A-105 tank leak volume based on measured gamma radioactivity and measured distribution of the gamma activity in the lateral drywells under the tank, properties of cesium sorption capacity in the soil, the extent of leaks in the tank liner, and the waste type leaked. Using this approach an estimated 56,000 Ci of ^{137}Cs was released to the soil and 2,000 to 40,000 gallons of waste for PUREX HLW supernate (P1) and B Plant ion exchange (BIX) waste types respectively. In addition to the waste, large volumes of cooling water may have been released. It was noted that although the cooling water does not add to the total inventory of constituents released, it increases the total mixed waste volume and is a driver for mobile constituents.

The extent of the waste lost below the laterals was discussed. Because the measured gamma activity in the laterals was less than the ^{137}Cs saturation capacity for soils and the sodium concentration of the waste leaked was lower than for REDOX waste (in the SX tanks), it was assumed that waste did not migrate deeper than the laterals —an assumption that needs to be tested. It was also assumed based on the location of gamma activity peaks in the laterals, the observation of tears in the liner around ¾ of the tank perimeter, and the distribution of gamma activity along the laterals, that gamma activity was confined to within ~8 ft outward from the tank perimeter and ~8 ft inward under the tank perimeter. This approach provides a volume estimate comparable to the previous estimates in WHC-MR-0264 and a basis for waste released volume estimates.

Attendees agreed that lacking additional information, there is no basis or reason to change inventory estimates in RPP-ENV-37956 and the current estimates are reasonable. However, additional data is needed to confirm assumptions that waste did not migrate below the laterals or further toward the middle of the tank. Other suggested characterizations included:

- Investigate to determine the low electrical resistivity levels above a series of pipelines SE of tank A-104 and SW of tank A-105 and the influence of pipelines on resistivity measurements,
- Determine if vadose zone layering is present in A Farm such as was observed in C Farm that may influence waste migration patterns, and
- Analyze direct push soil samples for sulfur as a tracer for migration of sulfuric acid that was added to tank A-105.
- Three stainless steel cased drywells adjacent to tank A-105 indicated corrosion between 54 and 70 ft in depth in 1978. Three groundwater wells south of A Farm also indicated corrosion at approximately 260 ft in depth and had to be decommissioned within 10 years of their construction. Further investigations were recommended to assess the cause of corrosion, to identify dry wells that may have a similar problem, and to establish relationships, if any, between the corroded drywells and groundwater wells. These drywells and groundwater monitoring wells are of similar construction to all others on the Hanford Site, and yet this is the only location where such corrosion has been observed. Groundwater and groundwater wells will be further reviewed in a future meeting.
- Approximately 60,000 gallons of water were released between the morning of February 22 and February 23, 1978 between tanks A-102 and A-105. Increased gamma radiation readings at 60 ft around the caisson that serves the laterals under tanks A-103, -105, and -106 indicate contamination transport during this time frame. The potential impact of this large water release should be evaluated to determine how it may have affected transport of generally immobile contaminants such as Cs-137. Other

releases from raw water lines and indiscriminate water addition to the ground may also contribute to contaminant transport. Acute line failures are usually recorded; chronic, continuous slow leaks that go unnoticed can have the same effect.

Finally, it was suggested that temperature data for the tanks be included in the revised A and AX Farm leak assessment report.

ACTIONS:

1. J. Field: Prepare and distribute December 3, 2013 Meeting Summary
2. L. Fort: Prepare summaries for tanks A-104 and A-106 for the next meeting.
3. All: Review tank A-104 and A-106 information.

NEXT MEETING:

December 17, 2013, 9 A.M., Ecology Building.

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MEETING SUMMARY

From: A.M. Hopkins
Phone: 373-3295
Location: Ecology Office,
Date: January 14, 2014
Subject: A/AX Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Jeremy Johnson, ORP
Joe Caggiano, ECOLOGY
Andrea Hopkins, WRPS
Kristin Scott, WRPS
Jared Mathey, ECOLOGY
Beth Rochette, ECOLOGY

PURPOSE:
The purposes of these Tank Farm Leak Inventory Assessment meetings are to reassess the A and AX Farm leak inventories and to assess tanks currently categorized as "sound tanks" designated in HNF-EP-0182. These meetings will also review the assessment process and review previous A and AX tank farm meeting summaries and conclusions. This meeting discussed specific aspects of tanks A-104 and A-106, and the Unplanned Releases (UPRs) documented in A Tank Farm.

Review of Previous Meeting Summary
The December 3, 2013 meeting summary was reviewed and discussed. Comments were received and will be incorporated. Attendees accepted the meeting summary as modified.

General Overview of Discussion
Tank process information and gamma logging data for tanks A-104 and A-106 were presented and discussed. UPRs were also discussed. In addition to information in the current A and AX Farm leak assessment report (RPP-ENV-37956), information from the A/AX farm leak locations and causes report (RPP-RPT-54912) were also discussed. It was noted that a new Hanlon report is out and it identifies changes in tank and waste status that have occurred during the report period.

Tank A-104:
Tank A-104 has been designated as a leaking tank that has lost liner integrity. The history of tank A-104 was discussed including transfers and waste temperature. Tank A-104 was constructed in 1955 and in the late 1950s the tank stored boiling waste. Sluicing of tank A-104 to the 244-AR Vault took place in 1974 and ended in 1975 due to radiation being detected in a

lateral beneath the tank. The current BBI for tank A-104 indicates the overall waste volume in the tank is 28 kgal.

According to HNF-EP-0182, Rev.305, tank A-104 has a tank integrity classification of an assumed leaker with an estimated waste release volume of 500 to 2,500 gallons, attributed to an observed liquid level decrease. HNF-EP-0182 also indicated that the estimated waste release was approximately 2, 000 gallons of PUREX Sludge Supernate (PSS), containing approximately 0.56 Ci/gal of ^{137}Cs (with a decay date of May 2008). However tank transfer records and liquid level changes indicate that the volume of waste released may be significantly greater.

Tank Specific occurrence reports were discussed.

A leak location and cause report, pending release, was discussed as well as the plume depth of the released (leaked) material. It was again noted (as in the previous report) that the tank farm ventilation system was a large contributor to unaccounted for measured liquid losses.

The team concluded that tank A-104 has lost liner integrity. Additional characterization is recommended to better assess the volume and extent of the release.

Tank A-106:
According to HNF-EP-0182, Rev. 305, tank A-106 has an integrity classification of sound. The current BBI waste volume is 79 kgal, comprised of 50 kgal of strontium recovery waste (SFF) and washed PUREX HLW sludge (AR) having a total waste inventory of approximately 450,000 Ci of ^{90}Sr. Because of the large quantity of strontium the tank has a current temperature of 120 degrees F. The tank still appears sound and there has been no indication of releases. It was also noted that ^{60}Co was found in the 10-06-04 dry well from 15 to 23 ft bgs. GJ-HAN-111 states that the ^{60}Co is probably the result of a leak from a nearby pipeline or transfer line.

Unplanned Releases at A Tank Farm
The previous report (RPP-ENV-37956) provided information on UPRs in A Farm including date of release, volume released and waste type. Not all of these releases are designated UPRs in the Waste Information Data System (WIDS) database.

It was noted that several pipelines in the WMA A are known to have failed.

Les Fort was asked to send report HW-53167 to Ecology. Les Fort and Paul Henwood were asked to look for failed water line spills including a reported 60k gallon spill. Les was also requested to show where the 152-A line is located.

It was discussed that a report on the UPRs in AX farm will be provided at the February 25 meeting. It was requested that the drywell near surface depth maps be shown in the report as well as radioactivity survey data.

ACTIONS:

1. A. Hopkins: Prepare and distribute January 14, 2014 Meeting Summary
2. L. Fort: send report HW-53167 to Ecology.
3. L Fort and P Henwood: look for failed water line spills including a reported 60k gallon spill.
4. L. Fort: show where the 152-A line is located.
5. J. Field: talk to Jacob Reynolds regarding the Hanlon Report.

NEXT MEETING:

February 11, 2014, 9 A.M., Ecology Building, Conference Room 3B.

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MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: February 11, 2014
Subject: A/AX Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

- Jim Alzheimer, ECOLOGY
- Mike Barnes, ECOLOGY
- Jim Field, WRPS
- Les Fort, WRPS
- Paul Henwood, S. M. Stoller
- Jeremy Johnson, ORP
- Joe Caggiano, ECOLOGY
- Kristin Scott, WRPS
- Jared Mathey, ECOLOGY

PURPOSE:
The purposes of these Tank Farm Leak Inventory Assessment meetings are to reassess the A and AX Farm leak inventories and to assess tanks currently categorized as "sound tanks" designated in HNF-EP-0182. These meetings will also review the assessment process and review previous A and AX tank farm meeting summaries and conclusions. This meeting discussed previous meeting action items with the focus on information gathered on tanks AX-101, AX-102, AX-103 and AX-104.

Review of Previous Meeting Summary
The January 14, 2014 meeting summary was reviewed and discussed. Comments were received and will be incorporated. Attendees accepted the meeting summary as modified.

Actions from the January 14, 2014 meeting were completed as follows:

- L. Fort: send report HW-53967 to Ecology.
  - October 1957 Monthly Report HW-53449 provided to Ecology. Contents of the report were discussed during the meeting. The report describes high radiation work conducted at A Farm during pipeline leak investigations. Dose rates up to 12 rads/hr were measured from pipeline leaks and corrosion coupons removed from the 101-A tank showed dose rates to 450 rads/hr.

- L Fort and P Henwood: look for failed water line spills including a reported 60k gallon spill.
  - Occurrence Report 78-24
    Meter readings indicate a 60,000 gallon water release.

Cause was a rupture of the M5a line approximately 30 feet southeast of the 501 Building.
A cave-in occurred between 102-A and 105-A.

- L. Fort: show where the 152-A line is located.
  - Review of Drawing # H-2-44501. A copy of the drawing was provided to Ecology at the meeting.
- J. Field: talk to Jacob Reynolds regarding the Hanlon Report.
  - Jim talked to Matt Rogers about the Hanlon report and Matt said he will correct errors Mike Barnes identified in the tank figure and will incorporate other comments provided.

Tanks AX-101 and AX-103:
Tanks AX-101 and AX-103 are designated as sound tanks (HNF-EP-0182). The process history for the tanks and drywell logging data were discussed and this information will be incorporated in the revised A/AX Farm leak inventory report. In addition to drywells the AX farms have leak detection pits that were used to monitor the tanks during operations. The drywells have not been logged since 1997 and it was noted that re-logging is planned to be completed in the next year in support of closure planning for AX-Farm. Radiation detection wells, separate from the leak detection pits, extend adjacent to the bottoms of the pits and were designed to detect gamma profile changes resulting from waste entering the leak detection pits from beneath the tanks (Figure 1). Leak detection pits and radiation detection wells have not been monitored since the late 1980's. P. Henwood suggested that it would be beneficial to log the radiation detection wells in addition to swabbing the pits. It is planned to swab the leak detection pits for all 4 tanks in AX farm in support of the AX-102 tank integrity (TFC-ENG-CHEM-D-42 (D-42)) evaluation. A number of occurrence reports were issued for liquid level changes in tanks AX-101 and AX-103. The changes were attributed to flammable gas content and evaporation. Occurrence reports were also issued for surface spills near the tanks.

The data obtained using the SGLS and the geologic and historical information available from other sources support the designation of the tank as sound and indicate that surface and near-surface spills or leaks have occurred.

The team concluded that tanks AX-101 and AX-103 should remain classified as sound and supported plans to re-log drywells, radiation detection wells, and swab the leak detection pits in the AX farm.

Tanks AX-102 and AX-104:
Tank AX-102 and AX-104 leak inventories were assessed previously and results are reported in RPP-ENV-37956, Rev. 1. The assessments concluded that contaminants in drywells 11-02-11, 11-02-12, 11-04-01 and 11-04-11 likely resulted from the AX farm ventilation system and leaks from dresser couplings. It was concluded that liquid level decreases in the tanks were explained by evaporation losses. The assessment also concluded that the volume of waste released near tanks AX-102 and AX-104 was significantly lower than the 3,400 gal and 8,000 gal respectively, reported in HNF-EP-0182. It was recommended that the current designation for tank AX-102 as an assumed leaker should be re-evaluated per the D-42 process. Participants could not conclude

unanimously whether tank AX-104 lost integrity. However, because the tank has already been sluiced and remaining residuals are dry, participants at the time believed that tank AX-104 was not a likely candidate for sluicing regardless of whether it has lost integrity (See RPP-ENV-37956, Appendix A, April 1, 2008 Meeting Summary) and a D-42 evaluation was not recommended for tank AX-104 at that time.

A D-42 evaluation for tank AX-102 was completed in January 2009 and a draft report prepared and presented to the executive safety review board (ESRB). The D-42 evaluation team concurred with the RPP-ENV-37956 assessment and recommended that the integrity designation of tank AX-102 be changed from "assumed leaker" to "sound." The leak assessment team also observed that AX-104 appeared to be sound and recommended a D-42 investigation for tank AX-104 as well. The ESRB requested that the 4 leak detection pits in AX farm be swabbed prior to changing the integrity designation for tank AX-102. A work package was prepared, but per discussion with management, swabbing of the pits and completing the AX-102 assessment is on hold pending AX farm retrieval design and planning to begin.

Consistent with the ESRB request to swab leak detection pits, the leak assessment team recommends logging the radiation detection wells associated with the pits. The data from each well should be compared and contrasted to determine the potential effectiveness of monitoring the wells during retrieval activities for increased gamma radiation. This approach would be consistent with ALARA principles by possibly precluding further entry into the leak detection pits and providing a cost effective "primary" leak detection method during retrieval.

Results and discussion of the D-42 evaluation for tank AX-102 will be incorporated in the revised A/AX Farm leak inventory assessment report. The leak assessment team concurred with the recommendation to swab the pits and further recommended completing a D-42 evaluation for tank AX-104 in parallel with completion of the existing AX-102 evaluation.

ACTIONS:

1. J. Field: Prepare and distribute February 11, 2014 Meeting Summary
2. All: Review meeting summary for discussion in the next meeting.
3. L Fort: Prepare presentation for AX farm UPRs and Groundwater for the next meeting.

NEXT MEETING:

February 25, 2014, 9 A.M., Ecology Building, Conference Room 3A.

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MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: February 25, 2014
Subject: A/AX Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Andrea Hopkins, WRPS
Jared Mathey, ECOLOGY
Beth Rochette, ECOLOGY

PURPOSE:
The purposes of these Tank Farm Leak Inventory Assessment meetings are to reassess the A and AX Farm leak inventories and to assess tanks currently categorized as "sound tanks" designated in HNF-EP-0182. These meetings will also review the assessment process and review previous A and AX tank farm meeting summaries and conclusions. This meeting discussed previous meeting action items with the focus on information gathered on unplanned releases (UPRs) in and near AX Farm and results for groundwater monitoring wells surrounding the A and AX Farms. This meeting concludes the discussions on the A/AX farms re-evaluation.

Review of Previous Meeting Summary
The February 11, 2014 meeting summary was reviewed and discussed. Comments received from S. M. Stoller and a schematic of an AX farm leak detection pit will be incorporated into the February 11, 2014 meeting summary. Attendees accepted the meeting summary as modified. AX farm leak detection pit data from the surveillance analysis computer system was presented and discussed. The presented information will be reviewed and incorporated in the A/AX farm leak inventory assessment report (A/AX report), Rev. 2.

The Rev. 2 A/AX report is being prepared and a draft is expected to be available for review by the end of March. In addition to distributing the draft to the assessment team participants, Ecology requested that the draft also be reviewed by the WMA A/AX Data Quality Objectives (DQO) team.

AX Farm Unplanned Releases:
Lists of the AX Farm facilities and the designated UPR's in the Waste Information Data System (WIDS) were presented and discussed. Descriptions of the facilities will be included in the A/AX report. WIDS shows a consolidated list for many of the past UPRs for soil releases. Each release event in the consolidated UPRs will be included as a separate item in a Table of UPRs in

the leak assessment report. UPR-200-E-131 consolidates a number of sites and states "these areas will also be considered tank farm soil." Ecology requested clarification from ORP whether all of the sites listed in WIDS are part of A/AX Farm WMA, as suggested or which of the sites, particularly those outside the tank farm fence will be part of the WMA A/AX DQO scope and ORP responsibility. An action was taken to follow-up on this request.

Other releases identified in quarterly and monthly reports; and included in the A/AX report, Rev. 1, were discussed. In addition a list and description of past Radiological Occurrences in AX Farm was presented by Ecology and discussed. These radiological occurrence reports are from a compiled list of occurrences for East and West Area tank farms. As applicable, the information from the occurrence reports and/or additional information for designated UPRs will be included in Rev. 2 of the A/AX report. It was again noted that the occurrence reports discussed are those for which documentation was available. As in reviews of the other farms, there is an apparent gap in the reported occurrences in AX farm during the 1960's.

In the presentation material, a figure of the drywells in AX farm shows drywell 11-04-07 further from the tanks than the other drywells. An action was taken to see if the figure is correct or if there is an explanation for why the drywell is located so far to the SW corner of the farm.

Groundwater Monitoring Results Near the A/AX Farms

A quarterly status report for A-AX farms was presented and discussed. The report shows ^{99}Tc concentrations rapidly increasing in well 299-E25-236 since about 2011. The last data point decreased slightly. It was observed that this well is near where two other monitoring wells were corroded and abandoned. The corrosion occurred at depths of ~260 ft bgs. It was also noted that Well 299-E25-236 may be one of the wells scheduled to be decommissioned. An action was taken to verify this.

There are several instances of corroded well or drywell casings around A farm and "something peculiar going on in A/AX Farms." Sulfuric acid sluicing of tank A-105 and a possible salt storage facility in the farm for road construction were speculated as two possible sources. It was suggested that if the cathodic protection system was operational, this would exacerbate corrosion from salty soils. WRPS will see if any old aerial photos show salt storage areas in the farms and look into cathodic protection operations in the farm. Findings will be included in the A/AX report.

In addition to drawing on information from the annual and quarterly groundwater monitoring reports, it was recommended that someone form CHPRC be contracted to look into the potential for perched water, sources of groundwater contaminants, past trends and future projections and to prepare the groundwater section in the A/AX report.

Additional C Farm Assessment

The next meeting will assess new information for tank C-108 and evaluate stakeholder concerns regarding potential waste releases during retrieval. Ecology suggested that better presentation (larger plots, possibly fewer points on each plot) of drywell moisture monitoring data obtained during retrieval would help to better evaluate changes in moisture. Ecology also expressed concerns with the current focus on changes greater than 3-sigma and the restricted logging interval. These concerns may be discussed during future Tank Waste Retrieval Work Plan meetings.

It was suggested that C-200 investigation results should also be considered and included in future revisions to the C Farm report updates.

ACTIONS:

1. J. Field: Prepare and distribute February 25, 2014 Meeting Summary
2. All: Review meeting summary and send comments.
3. L. Fort: Prepare presentation for C-108 for the next meeting.
4. J. Field: Draft A/AX Farm Report, Rev. 2.
5. J. Field/L. Fort: Follow-up on Ecology's request for ORP to clarify whether all of the sites listed in WIDS are part of A/AX Farm WMA will be part of the WMA A/AX DQO scope and ORP responsibility, particularly those outside the tank farm fence.
6. J. Field/L. Fort: Check A/AX farm aerial photos for salt storage facilities.
7. J. Field/L. Fort: Look into A/AX farm cathodic protection operations.
8. J. Field/L. Fort: See S. Eberlein to set up contract for CHPRC groundwater support.
9. P. Henwood: Check on drywell 11-04-07 location
10. P. Henwood: Verify that Well 299-E25-236 is scheduled to be decommissioned.

NEXT MEETING:

To be Determined - Tentatively the first or second week of April.

MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: May 29, 2014
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Jim Alzheimer, ECOLOGY
Mike Barnes, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Andrea Hopkins, WRPS
Jeremy Johnson, ORP
Jared Mathey, ECOLOGY
Beth Rochette, ECOLOGY

PURPOSE:
The two purposes of this meeting were:

1. Complete actions from the February 25, 2014 meeting and finalize the A and AX Farm leak inventory assessments, and
2. Assess new information for tank C-108 and evaluate stakeholder concerns regarding potential waste releases during retrieval.

Review of Previous Meeting Summary
The February 25, 2014 meeting summary was reviewed and discussed. A minor comment from Ecology will be incorporated into the final summary. No other comments were received and attendees accepted the meeting summary as modified. It was noted that The A and AX farm leak assessment report has been drafted and is going through technical editing. The report is expected to be ready for review and will be distributed to team members before the next meeting.

Actions from Last Meeting:
Actions identified in the February 25 meeting summary were completed as follows:

1. Follow-up on Ecology's request for ORP to clarify whether all of the sites listed in WIDS are part of A/AX Farm WMA will be part of the WMA A/AX DQO scope and ORP responsibility, particularly those outside the tank farm fence. *It was found that all of the sites listed in WIDS as part of the A/AX Tank Farms are consistent with and will be part of the WMA A/AX Data Quality Objectives (DQO) scope.*

2. Check A/AX Farm aerial photos for salt storage facilities. *Review of aerial photographs showed nothing indicating a salt storage facility around the A/AX Tank Farms. While searching through photographs a photo showing construction of the condensate ventilation system in A Farm was discovered (Attachment 1). The photo was presented and discussed*

with meeting participants. This photo helps to explain the presence of near surface releases in A Farm.

3. Look into A/AX Farm cathodic protection operations. *A/AX farm do not have cathodic protection. Cathodic protection testing was done in the 1950's using PUREX waste characteristics. Decisions at that time was to cathodic protect transfer lines only. In the 2009 tank meetings (WRPS-42005) it was pointed out several studies indicating that cathodic protection could actually lead to cracking of the liners and the panel recommended that cathodic protection not be deployed in the SSTs. Herb Berman said the Savannah River Site performed a study several years ago and came to the same conclusion that cathodic protection may cause more harm than good.*

4. Set up contract for CHPRC groundwater support. *Ground water information for the A/AX leak assessment report was available from CHPRC and was provided without a contract for support.*

5. Check on drywell 11-04-07 location. *The location as shown in the GJO reports is correct (See Attachment 2).*

6. Verify that Well 299-E25-236 is decommissioned. *The well was decommissioned on June 26, 2013 (See Attachment 3).*

Tank C-108

Another action was to prepare a presentation on waste releases from tank C-108 during retrieval. Of particular concern are continued changes in the measured ^{60}Co in drywell 30-08-02. The attached white paper (Attachment 4) was prepared and presented. Leak monitoring and mitigation for tank C-108 are addressed in RPP-RPT-55896, *Retrieval data report for Single-Shell Tank 241-C-108* and RPP-RPT-55709, *241-C-108 Tank Waste Retrieval Project Final Report of Drywell Monitoring Data*. The leak detection and monitoring methods used during retrieval of waste from Tank C-108 were drywell logging using total gamma RAS measurements and manual moisture monitoring using a neutron probe, high-resolution resistivity (HRR), groundwater well monitoring waste level measurements, visual inspection, and interpreting material balance calculations. No indication of leaks was observed by HRR. As stated in RPP-RPT-55709, "available log data for drywells associated with C-108 do not exhibit significant changes in gamma activity, except around drywell 30-08-02 (299-E27-94 / A6719) where RAS and SGLS measurements show evidence of gamma-emitting contaminant migration between about 45 and 80 ft." "The remaining drywells around C-108 (30-08-03, 30-05-10, 30-07-02, 30-07-01, 30-11-05, and 30-08-12) show no evidence of any significant changes in either moisture content or gamma activity."

In 2013, following retrieval of tank C-108, spectral gamma logging was performed for five drywells 30-08-02, 30-09-07, 30-09-08, 30-06-10 and 20-06-12 to further assess ^{60}Co changes near tanks C-108, C-109 and C-106. Attachment 4 shows spectral gamma results for each of the wells and changes observed since 1997. RPP-RPT-55709 concludes,

> "The contaminant history in 30-08-02 indicates a series of episodes over almost forty years. Most have occurred prior to December 2006 when retrieval operations began. There is no evidence that contaminant behavior in 30-08-02 has been exacerbated by retrieval operations, but available gamma log data are relatively sparse, and it is possible that effects related to retrieval operations have not yet reached the drywell.
>
> It is recommended that future SGLS logging be conducted in 30-08-02 to assess residual Co-60 levels and to monitor Cs-137 concentrations that may be increasing at 47 to 54 ft depth. SGLS data suggests there has been an increase in Cs-137 at 47 to 54 ft between 2004 and 2010 and possibly between 2010 and 2013. RAS data suggest the bulk of the Cs-137 increase occurred prior to December 2006. Although the changes in Cs-137 activity levels between 2010 and 2013 are not statistically significant, additional photo peaks in the 2013 data suggest the extent of the Cs-137 may be slowly expanding."

Tank C-108 will be further discussed in the next meeting.

Re-Assessment of Other Tanks

The next meeting will assess new information for the C-200 series tanks. Additional C farm discussions and new information will be included in a revision to the C farm leak assessment report and will be used as input to the WMA C RCRA Facility Investigation (RFI) study.

Discussion of which tanks have new information or should be reassessed will continue in the next meeting.

ACTIONS:

1. J. Field: Prepare and distribute May 29, 2014 Meeting Summary
2. All: Review meeting summary and send comments.
3. L. Fort: Prepare presentation for the next meeting for the direct push results near the C-200 series tanks.

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MEETING SUMMARY

From: J. G. Field
Phone: 376-3753
Location: Ecology Office,
Date: July 16, 2014
Subject: Tank Farm Leak Inventory Assessments

To: Distribution/Attendees

Attendees:

Mike Barnes, ECOLOGY
Joe Caggiano, ECOLOGY
Jim Field, WRPS
Les Fort, WRPS
Paul Henwood, S. M. Stoller
Andrea Hopkins, WRPS
Jared Mathey, ECOLOGY
Beth Rochette, ECOLOGY

PURPOSE:

The purpose of the meeting was to:

1. Discuss status and comments on the A/AX Report, rev. 2, and
2. Review near surface and unplanned release C-Farm leak loss inventory estimates.

Review of Previous Meeting Summary

The June 25, 2014 meeting summary was reviewed and comments will be incorporated. Attendees accepted the June 25 meeting summary, as modified.

Status and Comments on the A/AX Report

Discussed were comments from Paul Henwood, S.M. Stoller, and related comments/questions from Joe Caggiano, Ecology, regarding inventory estimates for waste leaks from tank A-105 and AX farm leak detection pits (LDPs) (attachment 1; the inserts, in red, are from Joe). Additional comments from Ecology are being prepared and will be provided before or at the next meeting.

Tank A-105 Leak Inventory Estimate

A key assumption used in the inventory estimates presented in the report was that the majority of Cs-137 contained in the waste that leaked from tank A-105 did not migrate below the tank laterals, 10 ft below the tank. The conjecture stated was that this assumption appeared to be uncertain and improbable due to the large volume of cooling water (~600,000 gallons) added to the tank and the observed hole in the middle of the bulged tank liner that also ripped along the edge of the tank.

As stated in the draft report, this assumption is based on studies and field results that showed the soil sorption capacity for Cs-137 to be about 10^7 to 10^8 pCi/g and that Cs-137 tends to remain immobile in Hanford soils until the Cs-137 sorption capacity is reached unless high sodium content is present in the soils (3-5 M). The composition of total gamma measured in tank laterals was well below this soil Cs-137 sorption capacity and the sodium concentration in the soils in A Farm was assessed to be low. Furthermore, SGLS and gamma measurements fro drywells surrounding tank A-105 indicate that Cs-137 has not migrated in the soil.. Because of this evidence it was assumed that Cs-137 plumes did not extend below the laterals. It was agreed that uncertainties in the leak volume and inventory estimates presented in the reviewed draft report, and concerns/questions regarding Cs-137 sorption capacity assumptions, will be emphasized and more clearly addressed in the final report. The report will also provide the recommendation to obtain additional data, using an angled direct push or other means to validate if Cs-137 migrated below the laterals. Previous evaluations have indicated that an angled direct push would likely be well below the bottom of the tank laterals (~100 ft) and would not provide the needed data. It was suggested that a horizontal push hole may be possible.

Ecology representatives recommended that a better understanding of the extent of past leaks and soil conditions beneath tank A-105 be obtained before starting retrieval operations. They felt that a better understanding is needed to determine the monitoring needs during retrieval and to establish a baseline to evaluate monitoring results.

Leak Detection Pits
Additional information was requested to be incorporated into the report regarding the purpose, value, and limitations of leak detection pits (LDPs) in AX farm; as well as the past LDP monitoring methods. Information on the recent LDP sample results and associated sampling method was also requested. This information is contained in RPP-ASMT-42628, *Tank 241-AX-102 Integrity Assessment report*, released today, and will be summarized and referenced in the A/AX report. As part of the discussion it was stated that due to evaporation through the exhaust header and potential sources of radioactivity other than a tank leak, detection of contaminates in the LDPs may be misleading for tank monitoring during retrieval operations. It was also contended that the swab sample results obtained from the LDPs in May 2014 showing very low gamma activity in the pits may be misleading because fixed waste at the bottom of the pit may not be detected by the sampling method used. All of the LDPs except AX-102 contained liquids and wet swab samples were obtained, the samples were scanned, then dried and scanned again. The swab was weighted down so it could be lowered and contacted with the bottom of the pit. Radioactivity in the liquid or at the bottom of the pit should have been detected by the swab sample. No gamma or alpha radioactivity was detected in dry swab samples from the AX-102 LDP. The LDPs for tanks AX-101 and AX-103 showed 200 and 400 cpm respectively and the AX-104 LDP showed ~1,000 cpm.

Future Re-Assessments
One of the intended purposes for the July 16 meeting was to review near surface and unplanned release C-Farm leak loss inventory estimates and uncertainties; this discussion will be deferred to the next meeting. Another meeting could address data gaps and uncertainties in our knowledge of soil inventory and SST releases.

ACTIONS:
1. J. Field: Prepare and distribute July 16, 2014 Meeting Summary
2. All: Review meeting summary and send comments.
3. L. Fort/J. Field: Incorporate comments to A/AX farm report and release.

4. J. Field/L. Fort: Revise C-Farm leak assessment report, Rev. 2, to incorporate new data for tank C-108 and C-200 series tank investigations.

APPENDIX B

241-A AND 241-AX TANK FARMS INFORMATION SUMMARIES: FOR TANKS CLASSIFIED AS ASSUMED LEAKERS (HNF-EP-0182, *Waste Tank Summary Report for Month Ending March 31, 2014*)

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Abbreviations and Acronyms

bgs	below ground surface
CASS	Computer Automated Surveillance System
cfm	cubic feet per minute
cpm	counts per minute
CY	calendar year
DSSF	double-shell slurry feed (
FIC	Food Instrument Corporation (gauge)
FY	fiscal year
HLW	high-level waste
ILL	interstitial liquid level
LOW	liquid observation well
OWW	organic wash waste
PUREX	Plutonium Uranium Extraction (Plant)
SGLS	spectral gamma logging system
SST	single-shell tank
TMACS	Tank Monitor and Control System

Units

c/s	counts per second

Waste Type Abbreviations

A1-Saltcake	saltcake from the first 242-A Evaporator campaign using 241-A-102 feed tank (1977-1980)
AR	washed PUREX (sludge)
CCPLX	concentrated complexed waste
CPLX	complexed waste
CSR	B Plant cesium ion exchange Supernate
IX	ion exchange
NCPLX	non-complexed waste
P1	PUREX HLW supernate
P2	PUREX HLW sludge
PSS	PUREX sludge supernate
PSS-B	PUREX sludge supernate and acidified waste after strontium removal

B1.0 TANK 241-A-103

This section provides information on the historical waste loss event associated with tank 241-A-103 (A-103). Waste operations for tank A-103 are summarized in Figure B1-1. Figure 3-2 of the main text shows a plan view of a typical tank in 241-A Tank Farm (A Farm) with the location of the pump pit, sluice pit, spare inlet nozzles (N1 – N5) and tank risers.

B1.1 TANK 241-A-103 WASTE HISTORY

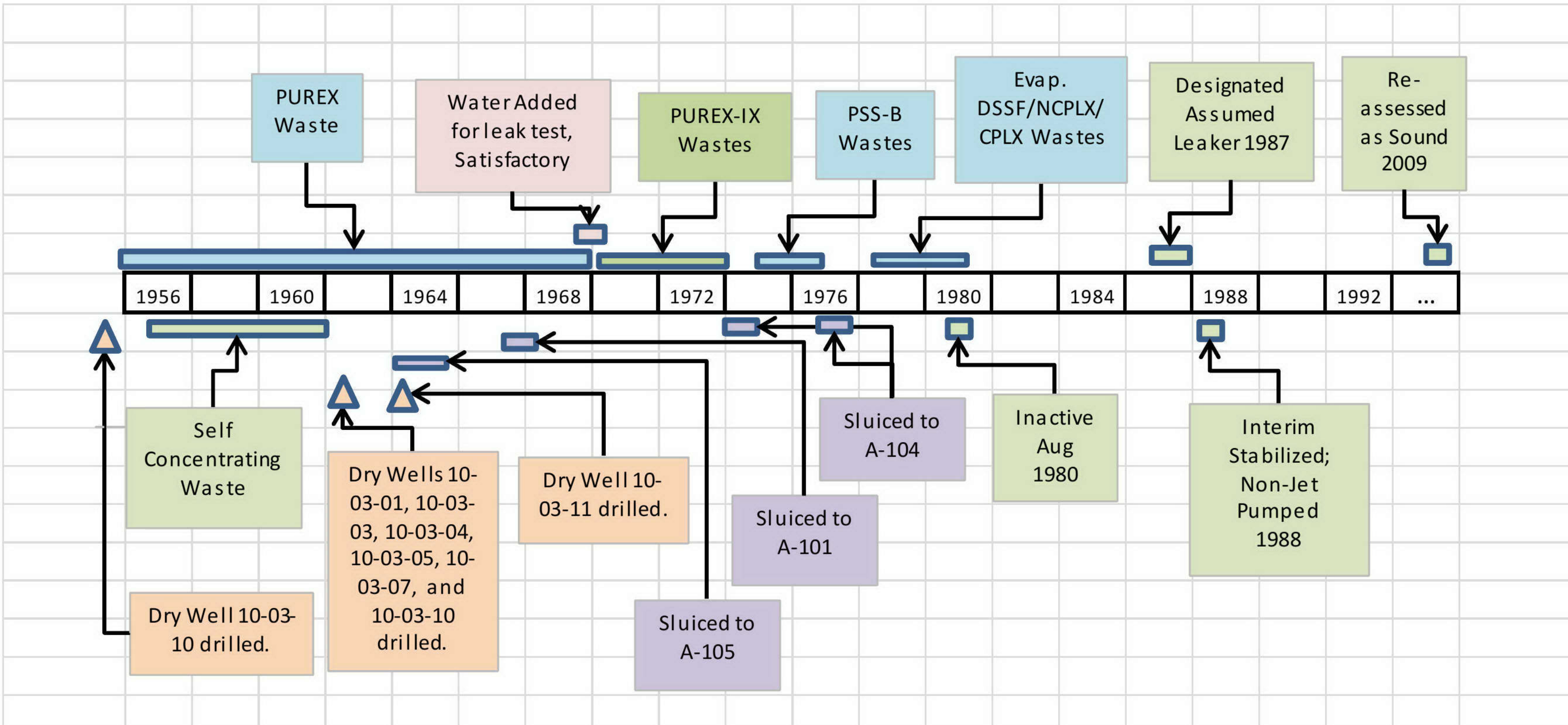
Tank A-103 was constructed in 1955, but remained empty until May 1956. In May 1956, tank A-103 received 72,000 gal of organic wash waste (OWW) from the 202-A Plutonium Uranium Extraction (PUREX) Plant (HW-43490, *Separations Section Waste – Status Summary for May, 1956*, pp. 8). Then in June 1956, tank A-103 received 99,000 gal of high-level waste (HLW) supernate (P1 waste type) from the PUREX Plant (HW-43895, *Separations Section Waste Status Summary for June 1956*, pp. 8). The waste temperature reached boiling (102 °C) on June 25, 1956 (HW-44506, *Design Bases and Performance Characteristics of the PUREX 241-A Waste Tank Farm Condensate Disposal Facility*, pp. 9).

Mild pressure surges were reported to have occurred in the tank head space and off-gas system of tank A-103 as early as July 1956 (HW-44580, *Monthly Report Hanford Atomic Products Operation for July 1956*, pp. Fc-13), when boiling first started. Three consecutive bumps occurred in tank A-103 in September 1956, which blew the by-pass seal pot water seal (60 in.) and forced steam directly out the tank farm stack. The air-lift circulators were stated in the tank to prevent reoccurrence of this event (HW-45707, *Monthly Report Chemical Processing Department for September 1956*, pp. J-7).

Tank A-103 continued to receive PUREX HLW, periodic additions of water and OWW through July 1960 (HW-66557, *Chemical Processing Department Waste Status Summary July 1, 1960 – July 31, 1960*, pp. 8) to maintain the volume of self-concentrating waste at ~500,000 gal in this tank. No waste additions were reported for 1961.

Approximately 330,000 gal of PUREX HLW supernate were transferred from tank A-103 to tank 241-A-105 (A-105) in May 1962 and additional 180,000 gal were transferred in July 1962 (ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and Its Implications on Waste Containment and Control*, pp. 8). These transfers were made in order to demonstrate sludge sluicing capability in tank A-103. Water was then added to tank A-103 to soften the sludge, and the sludge was sluiced to tank 241-A-102 (A-102) from March 1964 (HW-81620, *Chemical Processing Department Monthly Report for March, 1964*, pp. G-2) through November 17, 1964 (RL-SEP-112, *Chemical Processing Department Monthly Report for November, 1964*, pp. B-2).

Figure B1-1. Tank 241-A-103 Waste Operations Summary



CPLX = complexed waste
DSSF = double-shell slurry feed
NCPLX = non-complexed waste
PSS-B = Plutonium Uranium Extraction (PUREX) sludge supernate and acidified waste after strontium removal
PUREX-IX = PUREX-ion exchange

Tank A-103 then received waste from the 244-CR vault and tank 241-C-103, and PUREX OWW in 1965 and 1966. The supernate in tank A-103 was transferred to tank 241-A-101 (A-101) in March and April 1966 (ISO-75 RD, *Fission Products Process Engineering Monthly Report January – December, 1966*, pp. 53 and 70) to flush the tank. A new sluicer was installed in tank A-103 in May 1966 (ISO-75 RD, pp. 85) and sluicing was again conducted intermittently between October 20, 1966 (ISO-75 RD, pp. 174) and February 16, 1967 (ISO-651, *Fission Products Process Engineering Monthly Reports January – December, 1967*, pp. 30) to prepare tank A-103 to receive sludge slurry from tank A-105 sluicing. Following completion of sluicing, the sludge and supernate volumes in tank A-103 were reported as 0 and 55,000 respectively as of March 31, 1967 (ISO-806, *Chemical Processing Division Waste Status Summary January 1, 1967 Through March 31, 1967*, pp. 8). The sludge volume was later revised to reflect further waste volume measurement and density differences following sluicing in December 31, 1967 to 22,000 gal (ARH-326, *Chemical Processing Division Waste Status Summary October 1, 1967 Through December 31, 1967*, pp. 9).

From February 1968 through November 1968, tank A-103 was used to receive the PUREX HLW supernate from tank A-105, subsequent flushes of tank A-105 with cesium denuded ion exchange waste, and sludge sluiced from tank A-105 (Interoffice memorandum 7G420-06-004, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration During Sluicing in August 1968"). Supernates collected in tank A-103 were periodically transferred to other single-shell tanks (SSTs) (e.g., 241-AX-102 [AX-102], A-101, and A-102). Tank A-103 received sludge from a second sluicing campaign conducted in tank A-105 on July 31 and August 1, 1969 (ARH-1023 3-DEL, *Chemical Processing Division Daily Production Reports July, 1969 through September, 1969*, pp. 33-34) and August 25 through November 18, 1970 (Interoffice memorandum 7G420-06-005, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration During Second Sluicing Campaign Conducted July 1969 Through November 1970"), as described further in section 4.4.1.

The sludge slurry collected in tank A-103 from the second tank A-105 sluicing campaign was allowed to settle. Approximately 302,000 gal of supernate were eventually transferred to tank 241-C-105 (C-105) in the second quarter of calendar year (CY) 1972, leaving 244,000 gal of supernate and 102,000 gal of sludge in tank A-103 (ARH-2456 B, *Chemical Processing Division Waste Status Summary April 1, 1972 Through June 30, 1972*, pp. 9). Supernates collected in tank C-105 were transferred to 221-B Plant (B Plant) for cesium ion exchange processing.

Tank A-103 was next used in the second quarter of CY 1973 to receive ~19,000 gal of sludge slurry from sluicing tank A-102 (ARH-2794 B, *Chemical Processing Division Waste Status Summary April 1, 1973 through June 30, 1973*, pp. 9). Tank A-103 then received 71,000 gal of waste from B Plant in the fourth quarter of CY 1973 (ARH-2794 D, *Manufacturing and Waste Management Division Waste Status Summary October 1, 1973 through December 31, 1973*, pp. 9). Approximately 244,000 gal of supernate were transferred from tank A-103 to tank 241-A-104 (A-104) in the first quarter of CY 1974, leaving 125,000 gal of supernate and 102,000 gal of sludge in tank A-103 (ARH-CD-133A, *Operations Division Waste Status Summary January 1, 1974 through March 31, 1974*, pp. 9). This later transfer was conducted to prepare for sluicing in tank A-103. The sludge in tank A-103 was sluiced to 244-AR Vault beginning in the first quarter of CY 1974 (ARH-CD-133A, pp. 9) and completed in September 1974 (SD-WM-TI-302, *Hanford Waste Tank Sluicing History*, pp. 166).

Tank A-103 was used to collect PUREX sludge supernate (PSS) from various SSTs and B Plant waste in the fourth quarter CY 1974 (ARH-CD-133D, *Production and Waste Management Division Waste Status Summary October 1, 1974 through December 31, 1974*, pp. 9) through the first quarter CY 1976 (ARH-CD-702 A, *Production and Waste Management Division Waste Status Summary January 1, 1976 through March 31, 1976*, pp. 9). The PSS waste was generated from washing sludges either in 244-AR Vault or in an SST, then decanting the supernates, which were identified as PSS waste. Approximately 920,000 gal of supernate in tank A-103 were transferred to tank C-104 and 13,000 gal were transferred to tank 241-A-106 (A-106) in the second quarter of CY 1976, leaving 20,000 gal of supernate and 16,000 gal of sludge in tank A-103 (ARH-CD-702 B, *Production and Waste Management Division Waste Status Summary April 1, 1976 through June 30, 1976*, pp. 9).

The removal of supernate from tank A-103 was in preparation for a final sluicing of the sludge in this tank. From October 13, 1976 (ARH-LD-222, *Atlantic Richfield Hanford Company Monthly Report October 1976*, B pp. 13) through early December 1976 (ARH-LD-224, *Atlantic Richfield Hanford Company Monthly Report December 1976*, B pp. 11) the sludge in tank A-103 was sluiced to tank A-106 (SD-WM-TI-302, pp. 166). This final sluicing in tank A-103 was conducted to prepare the tank to receive saltcake from operation of the 242-A Evaporator. Tank A-103 was reported to contain 2,080 gal of sludge following completion of this last sluicing campaign (SD-WM-TI-302, pp. 166).

The 242-A Evaporator was operated using tank A-103 as a slurry receiver and feed tank from early 1977 through April 1980 (RHO-CD-80-1045 5, *Reconcentration of Second PN Campaign Wastes, 242-A Evaporator-Crystallizer Campaign 80-5 March 12 to April 4, 1980*, pp. 8). Tank A-103 received double-shell slurry feed (DSSF) and concentrated complexed waste during this period. Various reports of liquid level decline occurred in 1977 (Occurrence Report 77-141, *Tank 103-A Liquid Level Exceeding Decrease Criterion*), 1978 (Occurrence Report 78-15, *Tank 103-A Liquid Level Decrease Exceeding Criterion*), and 1979 (Occurrence Report 79-118, *Tank 103-A Liquid Level Decrease*), which were attributed to the properties of the DSSF and concentrated complexed wastes; namely foam, irregular waste surface, slurry growth and collapse (i.e., gas retention and release). No activity was detected in the three laterals and drywells associated with tank A-103 during these events, indicating no leakage of waste. After adding the last batch of DSSF to tank A-103 in March through April 1980 (RHO-CD-80-1045 5), there was a reported liquid level decrease from 193.4 in. (533,807 gal) to 190.1 in. (524,698 gal) in tank A-103 that occurred on September 4, 1980 over 11 hours (Occurrence Report 80-82, *Tank 103-A Liquid Level Decrease*). The cause of this liquid level decrease was attributed to mixing of dissimilar solids within the tank and a net volume decrease. In-tank photographs revealed foam and floating yellow masses and a definite decline in liquid level. Tank temperature data indicated a mixing of the bottom and upper layers of solids within tank A-103. Again, there was no activity detected in the laterals or the drywells, indicating tank A-103 was leaking waste (Occurrence Report 80-82). No further waste additions to tank A-103 occurred after these 242-A Evaporator campaigns.

Tank A-103 was deactivated in August 1980 as part of the program to replace the older SSTs with the newer double-shell tanks. Pumpable supernate was removed to reduce the supernate level. Active monitoring of the waste within tank A-103 continued, but no waste additions were allowed.

Figure B1-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, *A History of the 200 Area Tank Farms*, LA-UR-97-311, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)* and tank waste summary reports.

B1.2 INTEGRITY OF TANK 241-A-103

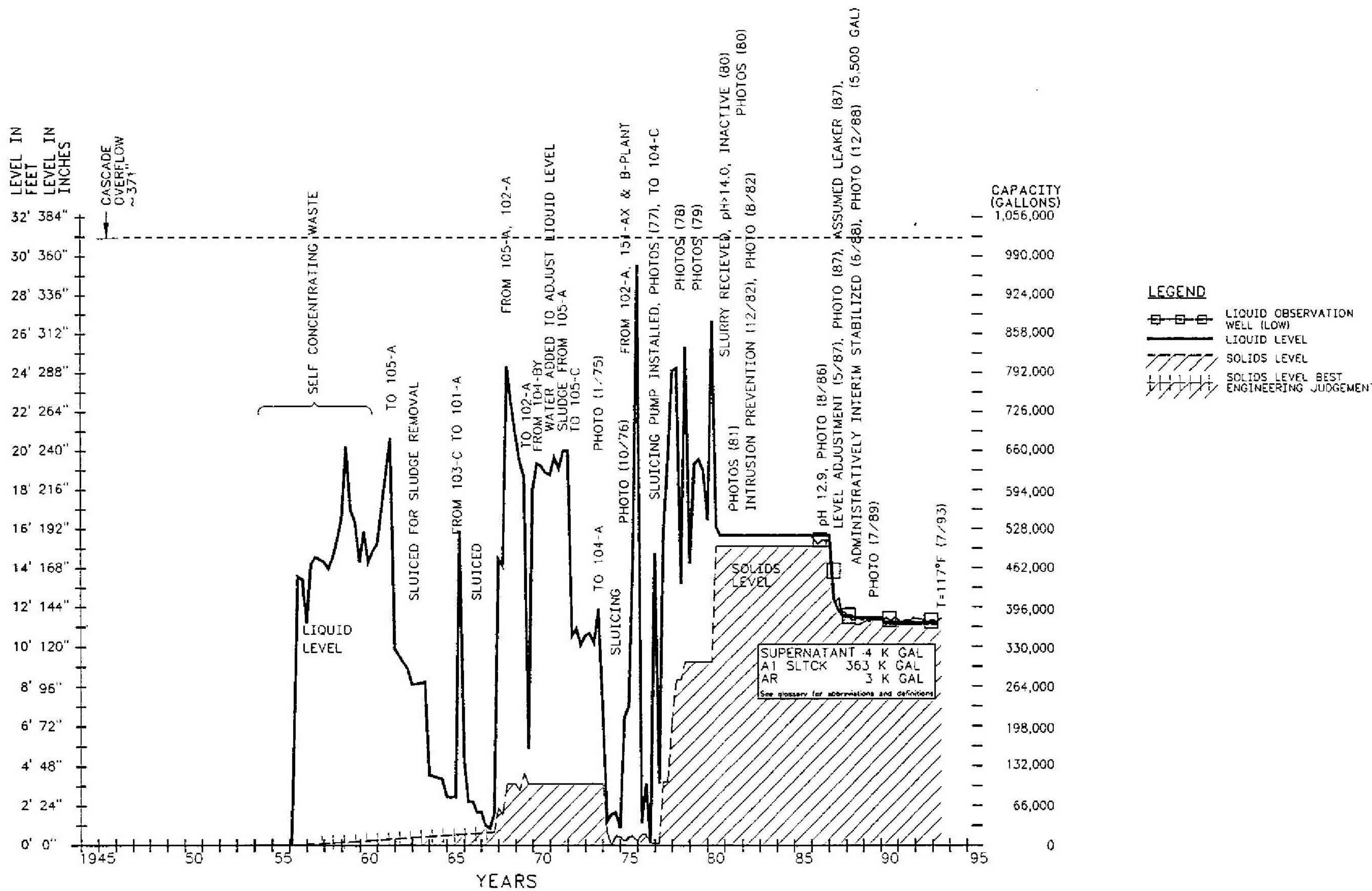
Over a span of approximately 5.5 years (October 8, 1981 to March 5, 1987), the liquid level in tank A-103 was observed to have decreased from 187.5 in. (517,520 gal) to 184 in. (507,860 gal). As of March 5, 1987, tank A-103 contained an estimated 8,800 gal of supernate, 208,000 gal of drainable interstitial liquid, and 499,000 gal of solids. Since in-tank photographs showed the Food Instrument Corporation (FIC) plummet for measuring the waste surface was contacting liquid, this raised questions as to the integrity of this tank (Environmental Protection Deviation Report 87-02, *Tank 103-A Surface Level Measurement (FIC) Exceeding the Two-Inch Decrease Criteria*). Based on the liquid level decrease, the tank was declared an "assumed leaker" in 1987 with a leak volume estimate of 5,500 gal (HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014*).

B1.3 INTERIM STABILIZATION

Pumping of interstitial liquid and supernate from tank A-103 was started on May 16, 1987 and completed on May 24, 1987. A total of 111,000 gal of liquid waste were removed from tank A-103 by jet pumping to stabilize this tank (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*, pp. 15-18).

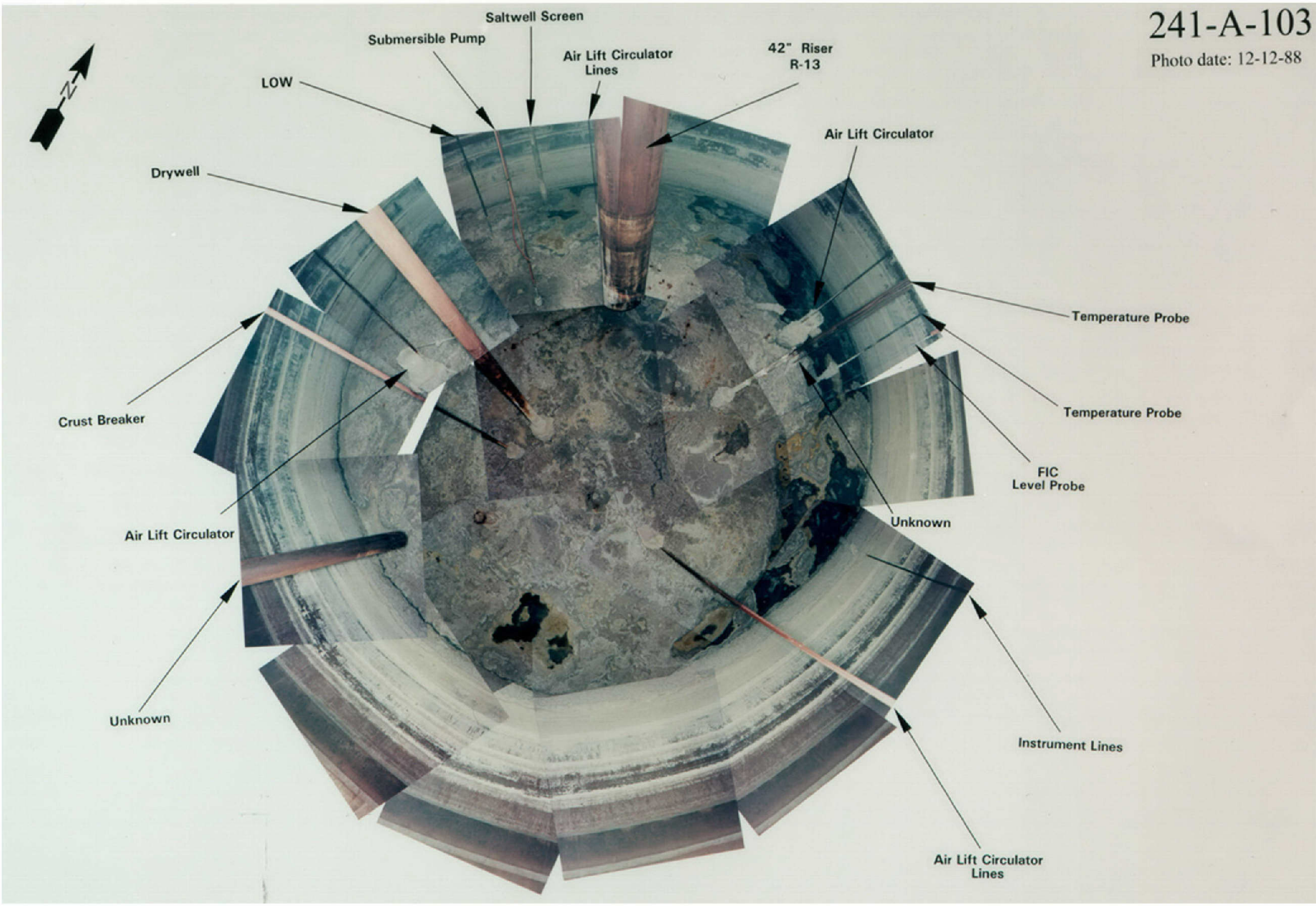
As of April 1, 2005 the tank was estimated to contain 379,000 gal of waste consisting of 372,000 gal of A1-Saltcake from the 242-A Evaporator process, 2,000 gal of washed PUREX sludge (AR sludge) and 4,000 gal of supernate (RPP-RPT-42741, *2009 Auto-TCR for Tank 241-A-103*). Figure B1-3 shows a mosaic photograph of the tank surface on December 12, 1988.

Figure B1-2. Tank 241-A-103 Quarterly Waste Fill History



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B1-3. Tank 241-A-103 Waste Surface Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

B1.4 TANK 241-A-103 TEMPERATURE HISTORY

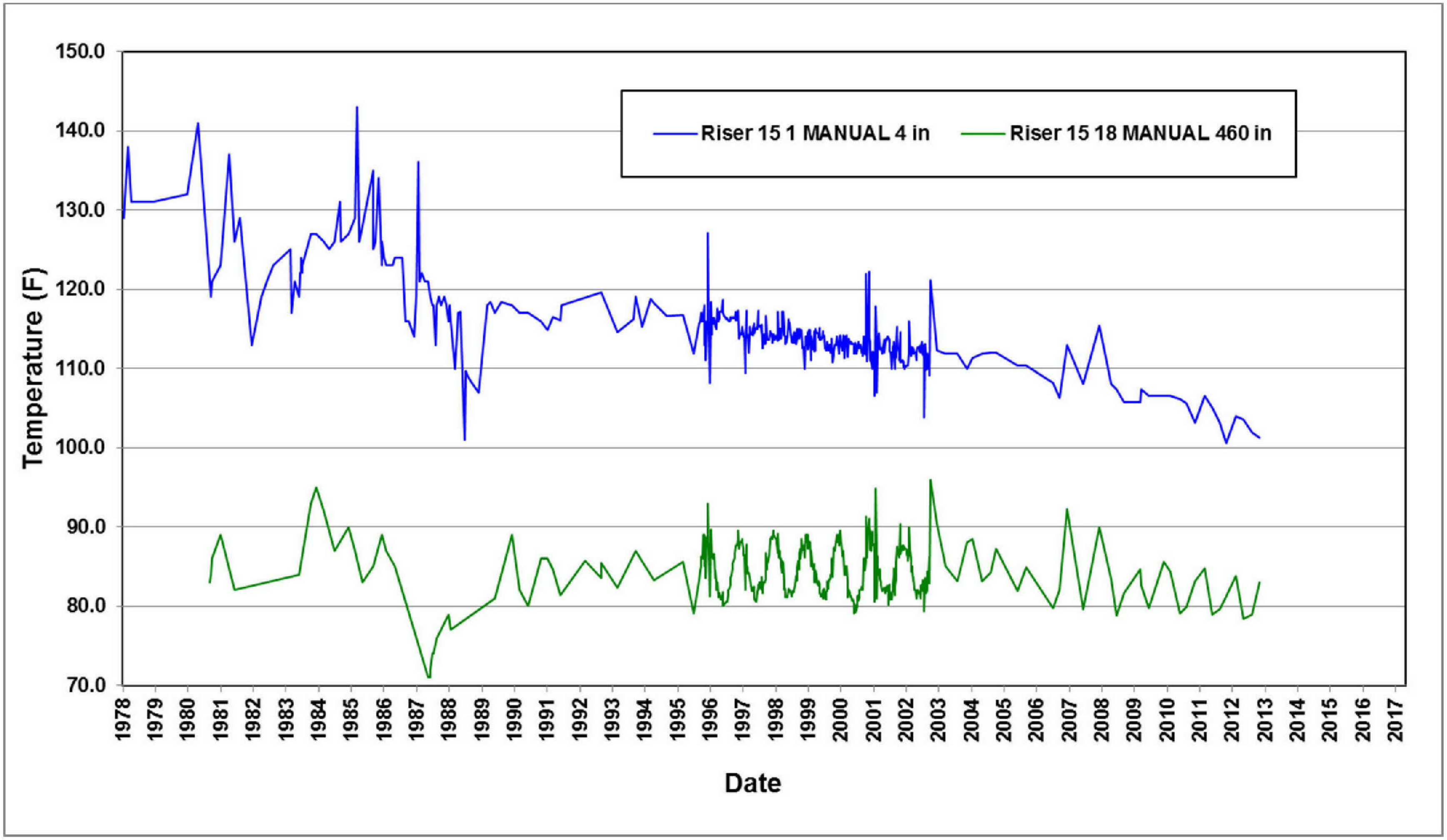
Tank A-103 is a high-heat tank monitored by a single thermocouple tree located in riser 15. Tank temperatures up to 240 °F and pressure excursions occurred during the 1950s and 1960s (RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*). The maximum recorded temperature for the waste in tank A-103 between 1956 and 1979 was 354 °F in January 1976 (WHC-MR-0132).

RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report* notes that tank A-103 experienced two thermal excursions during the initial period when it was receiving PUREX Plant waste. The tank A-103 waste began to self-boil (102 °C) in June, 1956, and the tank continued to receive PUREX HLW and periodic additions of water and OWW through July 1960 to maintain the tank volume.

> "In the first excursion the temperature increased from 143°C on April 5, 1957 to 230°C on April 22, 1947. During this period the Na molarity increased from 8.2 to 9.0. The liquid level increased from 123-in on April 22, 1957 to 149-in on May 3, 1957. The Na molarity decreased to 8.5 and the temperature fell to *[232 °F]* 111°C."
>
> "In the second excursion the temperature increased steadily from 115°C on May 30, 1957 to 140°C on June 15, 1957. There was then a rapid rise to 209°C on June 17, 1957. The liquid level was increased from 146-in to 162-in during the three days after the excursion, and the temperature fell to 130°C. By the tenth day after the excursion, the liquid level was up to 174-in, and the temperature was down to 118°C. During this excursion, the Na molarity reached 9.4, and was down to 8.2 when the temperature fell to 118°C."

Thermal excursions were normally controlled by increasing both the liquid level and the air to the airlift circulators. However, these measures sometimes failed to limit the temperature rise. This was believed to result from accumulation of additional sludge layers that insulated the lowest layer in the tank where the temperature element was located. Removal of most of the high-heat PUREX HLW sludge by the end of 1974 would have dramatically lowered the waste temperature in the tank. Figure B1-4 shows Surveillance Analysis Computer System tank waste temperatures for tank A-103 from 1978 to 2013. During this period the maximum waste temperature at 4 in. from the bottom of the tank was ~140 °F and the temperature was ~80 to 90 °F in the dome space (460 in. from tank bottom). The waste temperature has continually decreased since 1978.

Figure B1-4. Tank 241-A-103 Waste Temperature Measurements (in Degrees Fahrenheit)



B1.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data, and lateral logging data for tank A-103.

B1.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B1-2). Table B1-2 shows liquid level measurements from 1973 to 1986 (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). Liquid level changes due to transfers were observed to 1981. Tank A-103 was designated an "assumed leaker" due to a liquid level decrease from 187.5 in. (517,520 gal) to 184 in. (507,860 gal) between October 8, 1981 and March 5, 1987. Another notable liquid level decrease in tank A-103 was reported on November 16, 1987. The liquid level decreased from a reference of 143.4 in. to 140.6 in. during a three-day period. However, the FIC liquid level monitor readings fluctuated up and down between 143 in. and 140.6 in. during this time frame (DSI "103-A FIC Reading" [Vermeulen 1987]). Inspection of photographs taken inside tank A-103 on December 28, 1988 showed that the FIC plummet was contacting dry solids in a deep depression of multiple elevations, leading to erratic readings (DSI "Unusual Occurrence Report WHC-UO-88-043-TF-07, TK 241-A-103" [Baumhardt 1989]).

The following occurrence reports were issued for tank A-103 liquid level decreases between 1978 and 1988.

- Occurrence Report 77-141, *Tank 103-A Liquid Level Exceeding Decrease Criterion*, (corrected to be associated with tank A-103) in August 1977 the waste level in tank A-103 decreased 0.9 in. in one week (criteria was a decrease of 0.5 in. in a week). The apparent cause of the surface level decrease was the dissolution of foam observed during the prior slurry transfer.

- Occurrence Report 78-15, *Tank 103-A Liquid Level Decrease Exceeding Criterion*: From January 18 to 22, a liquid level decrease exceeding 0.5 in. per week was observed. The decrease was attributed to the FIC plummet moving over an irregular surface.

- Occurrence Report 79-118, *Tank 103-A Liquid Level Decrease*: A liquid level decrease of 4 in. was observed on November 29, 1979. The decrease was determined to be due to slumping tank surface material.

- Occurrence Report 80-82, *Tank 103-A Liquid Level Decrease*: A liquid level decrease of 3.5 in. in 11 hours was observed on September 4, 1980. The cause of the decrease was mixing of dissimilar solids.

- Operating Limit Deviation Report 80-8, *Tank 103-A Level Decrease Following a FIC Plummet Flush*: "The cause of the observed decrease was attributed to post-transfer tank surface conditions (foam) and FIC plummet/tank material interactions following the FIC flush."

- Environmental Protection Deviation Report 87-02, *Tank 103-A Surface Level Measurement (FIC) Exceeding the Two-Inch Decrease Criteria*: During the second quarter of fiscal year (FY) 1987, the liquid loss "appeared to be related to the peculiar nature of the tank solids content rather than tank wall integrity as first suggested." Following an evaluation, the tank was "reclassified as an assumed leaker as a precautionary measure."

- TF-EST-88-0151, "Surface Level Measurement Decrease in Single Shell Tank 241-A-103": On December 21, 1988 the 2.0 in. decrease criteria for tank A-103 was exceeded. The FIC was recalibrated and found to be contacting solids in a depression and readings were determined to be unreliable. The FIC was repositioned into the intrusion mode and the liquid observation well (LOW) became the primary surveillance monitoring device.

Figure B1-5 shows Surveillance Analysis Computer System waste level data for tank A-103 from 1980 to 2014. In general, the tank surface and liquid level have gradually increased since 1988. A LOW was installed in 1985 to monitor the interstitial liquid level (ILL) in the tank and in 1996 the FIC gage was replace by an Enraf®[1] gage. The ILL consistently shows a higher level than the Enraf®, indicating that the Enraf® is measuring the waste surface in a liquid pool and ILL measurements have gradually increased since the LOW was installed. Based on the ILL measurements, further evaluations of potential intrusions were conducted (RPP-PLAN-55112, *September 2012 Single-Shell Tank Waste Level Increase Evaluation Plan*). Video was obtained and although no drips were observed from the tank dome, visual observations confirmed that the liquid pool on the waste surface has grown since 1988 when the tank was interim stabilized (RPP-RPT-50799, *Suspect Water Intrusion in Hanford Single-Shell Tanks*). The ILL data indicate an intrusion rate of 100 to 200 gal/yr.

B1.5.2 Drywell Logging Data

Ten drywells surround tank A-103 (10-03-01, 10-03-02, 10-03-04, 10-00-04, 10-03-05, 10-00-06, 10-03-07, 10-02-03, 10-03-10 and 10-03-11); Figure B1-6 shows the 1996 and 1997 spectral gamma logging system (SGLS) results for these drywells. The SGLS results are presented in GJ-HAN-108, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-103*.

Low activity ^{137}Cs (<100 pCi/g) was detected in the top 20 ft from the ground surface in the immediate vicinity of most of the drywells. Low radiation levels (^{137}Cs levels up <1,000 pCi/g), ^{154}Eu and ^{60}Co were measured in drywells 10-03-10 and 10-03-11. The ^{154}Eu spikes indicate that these measurements may be showing contamination inside near-surface pipelines. The ^{137}Cs in these and other wells could have also resulted from surface spills, pipeline leaks, airborne releases and/or carry-down when the drywells were extended.

[1] Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

Table B1-1. Tank 241-A-103 Liquid Level Measurements and Changes (1974 to 1986) (Sheet 1 of 3)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/18/73	129.00			-8.50	Manual tape
08/14/73	120.50		-8.50	-8.50	Steady decrease
08/15/73	129.00			-8.50	Transfer (Tank 417)
10/25/73	118.50		-10.50	-19.00	Steady decrease
10/26/73	122.75			-19.00	Unexplained addition
11/19/73	119.25		-3.50	-22.50	Steady decrease
12/12/73	144.50			-22.50	Transfers
03/01/74	137.00		-7.50	-30.00	Steady decrease
03/29/74	83.00			-30.00	Transfers
04/16/74	81.25		-1.75	-31.75	Steady decrease
08/24/74	19.75			-31.75	Transfers and sluicing
10/22/74	17.25		-2.50	-34.25	Steady decrease
11/09/74	26.75			-34.25	Transfers and sluicing
11/17/74	26.00		-0.75	-35.00	Steady decrease
11/18/74	28.75			-35.00	Transfer
12/20/74	27.50		-1.25	-36.25	Steady decrease
12/22/74	20.75			-36.25	Transfer
01/16/75	19.25		-1.50	-37.75	Steady decrease
02/06/75	16.75			-37.75	Sluicing and transfers
03/07/75	16.25		-0.50	-38.25	Slow decrease
04/19/75	26.00			-38.25	Transfers and
04/19/75	26.25			-38.25	sluicing; new FIC reading
05/23/75	25.20		-1.05	-39.30	Slow decrease
05/25/75	48.95			-39.30	Transfer
06/02/75	48.35		-0.60	-39.90	Steady decrease
06/07/75	78.50			-39.90	Transfers
06/18/75	77.70		-0.80	-40.70	Steady decrease
06/19/75	77.90			-40.70	Pit flush
07/25/75	76.60		-1.30	-42.00	Steady decrease
07/30/75	17.50			-42.00	Transfers and sluicing
08/11/75	17.00		-0.50	-42.50	Steady decrease
08/14/75	17.80			-42.50	Pit flushes
09/23/75	16.85		-0.95	-43.45	Slow decrease
10/04/75	89.65			-43.45	Transfers
10/13/75	89.10		-0.55	-44.00	Steady decrease
12/18/75	175.65			-44.00	Transfers
01/01/76	174.90		-0.75	-44.75	Steady decrease
04/30/76	15.50			-44.75	Transfers
07/05/76	13.10		-2.40	-47.15	Steady decrease
07/09/76	26.50			-47.15	Transfer
08/20/76	25.20		-1.30	-48.45	Steady decrease

Table B1-1. Tank 241-A-103 Liquid Level Measurements and Changes (1974 to 1986) (Sheet 2 of 3)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
09/02/76	26.70			-48.45	Flushes and crane work
09/13/76	26.40		-0.30	-48.75	Steady decrease
09/17/76	37.40			-48.75	Transfer and sluicing
10/12/76	36.20		-1.20	-49.95	Steady decrease
10/27/76	2.70			-49.95	Transfer and sluicing
11/02/76	2.30		-0.40	-50.35	Steady decrease/FIC o/s
11/30/76	1.00			-50.35	Sluicing and new manual tape
01/25/77	.00		-1.00	-51.35	Steady decrease
01/26/77	4.00			-51.35	Water added
02/15/77	3.75		-0.25	-51.60	Slow decrease
02/17/77	31.75			-51.60	Transfer
02/24/77	31.25		-0.50	-52.10	Steady decrease
03/15/77	168.00			-52.10	Transfers
03/27/77	167.75		-0.25	-52.35	Slow decrease
03/28/77	167.70			-52.35	FIC back in service
03/29/77	177.40			-52.35	Transfer
04/06/77	177.10		-0.30	-52.65	Steady decrease
06/30/77	37.45			-52.65	Transfers
07/06/77	36.90		-0.55	-53.20	Steady decrease
08/06/77	194.20			-53.20	Transfers and received slurry
08/15/77	193.90			-53.20	OR 77-141
09/26/77	189.55		-4.65	-57.85	Erratic decrease
11/01/77	189.55			-57.85	Stable
12/04/77	233.80			-57.85	Transfers and received slurry
12/13/78	234.85		+1.05	-56.80	Steady increase
12/20/78	233.90		-0.95	-57.75	Steady decrease
12/28/78	233.20		-0.70	-58.45	Erratic readings
01/30/78	233.20			-58.45	Erratic readings, OR 78-15
02/06/78	235.10		+1.90	-56.55	Steady increase
02/07/78	233.50		-1.60	-58.15	FIC flush
03/14/78	289.00			-58.15	Transfers and slurry
06/21/78	290.95		+1.95	-56.20	Slow erratic increase
07/13/78	291.30		+0.35	-55.85	Slow increase
07/20/78	290.80		-0.50	-56.35	Unexplained decrease
07/21/78	254.80			-56.35	Transfer
07/31/78	254.70		-0.10	-56.45	Slow decrease

Table B1-1. Tank 241-A-103 Liquid Level Measurements and Changes (1974 to 1986) (Sheet 3 of 3)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
09/04/78		158.70		-56.45	Transfers and slurry
09/26/78	160.40		+1.70	-54.75	Steady increase
09/27/78	159.00		-1.40	-56.15	FIC flush
10/10/78	160.05		+1.05	-55.10	Steady increase
10/11/78	159.25		-0.80	-55.90	FIC flush
10/25/78	160.65		+1.40	-54.50	Steady increase
10/26/78	159.65		-1.00	-55.50	FIC flush
10/31/78	160.10		+0.45	-55.05	Steady increase
01/18/79		319.60		-55.05	Transfers
02/13/79	319.90		+0.30	-54.75	Slow increase
04/05/79		231.20		-54.75	Transfers
11/29/79	235.45		+4.25	-50.50	Steady increase
12/04/79	228.35			-50.50	Surface crust slumpage, OR 79-118
12/12/79		228.30		-50.50	
01/17/79	228.60		+0.30	-50.20	Slow increase
08/15/80		193.40		-50.20	Active transfers
09/09/80		187.50		-50.20	OR 80-02
05/08/81		185.20		-50.20	FIC readings fluctuate between 185.10 to 190.35 in., Operating Limit Deviation Report (OLDR) 81-02 issued
10/16/81	188.30		+3.10	-47.10	Gradual increase
12/11/81		187.00	-1.30	-48.40	Associated with surface solids
12/06/82	186.10		-0.90	-49.30	FIC erratic fluctuation
12/11/83	188.00		+1.90	-47.40	FIC erratic fluctuation
11/14/84	188.90		+0.90	-46.50	Gradual increase
02/13/85	189.30		+0.40	-46.10	Gradual increase
02/14/85	187.60		-1.70	-47.80	Unexplained decrease
02/26/85	187.50		-0.10	-47.90	Stable
02/28/85	185.90		-1.60	-49.50	Unexplained decrease
09/09/85	186.00		+0.10	-49.40	Stable
11/18/85	186.30		+0.30	-49.10	Gradual increase
07/03/86		186.00	-0.30	-49.40	FIC fluctuation due to crystals built up
12/08/86	185.80		-0.20	-49.60	FIC fluctuates between 185.50 and 186.00 in.

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

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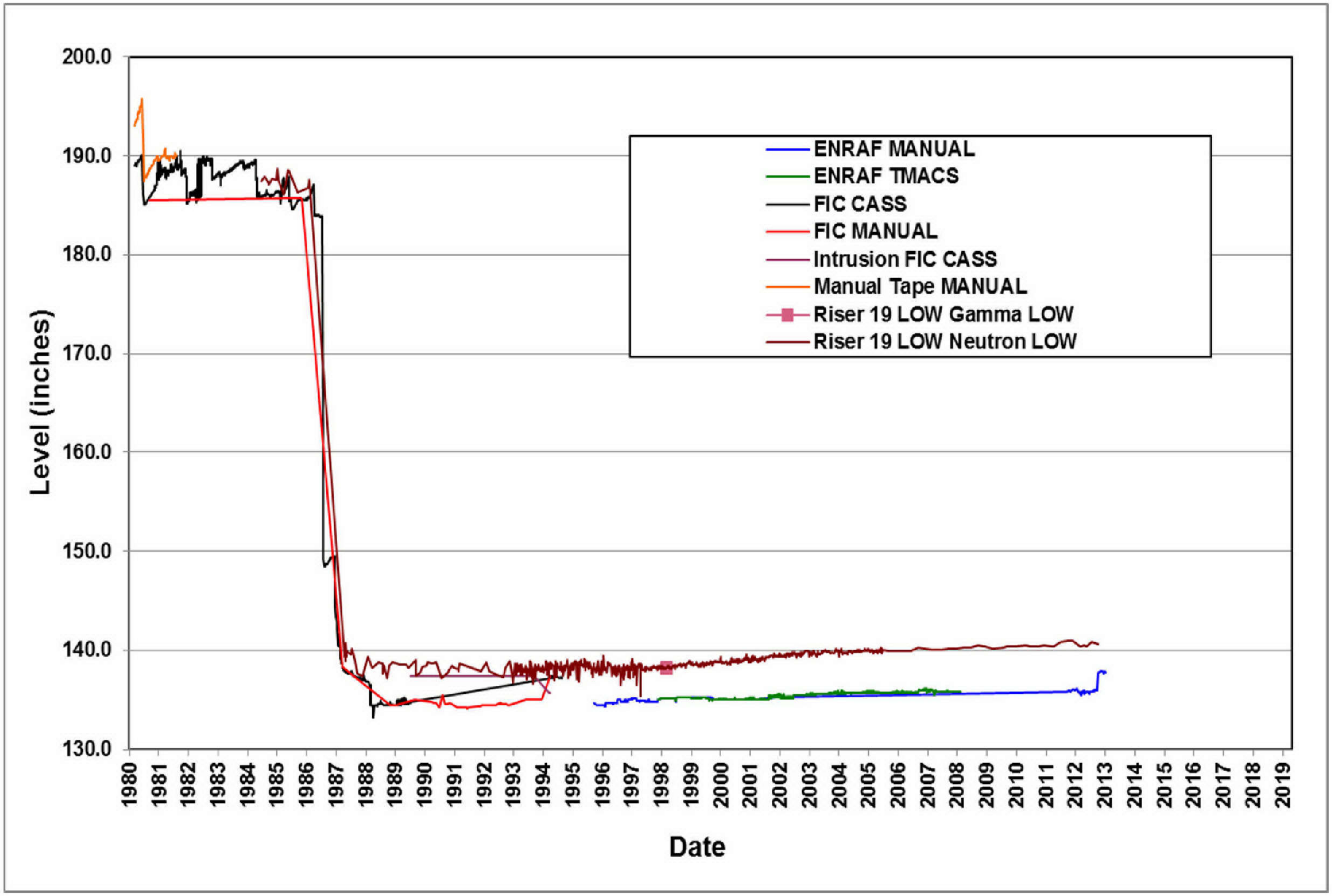
RPP-ENV-37956, Rev. 2

Figure B1-5. Tank 241-A-103 Waste Surface Level Measurements



CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

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Figure B1-6. 1996 and 1997 Spectral Gamma Logging Results for Drywells near Tank 241-A-103 (Sheet 1 of 2)

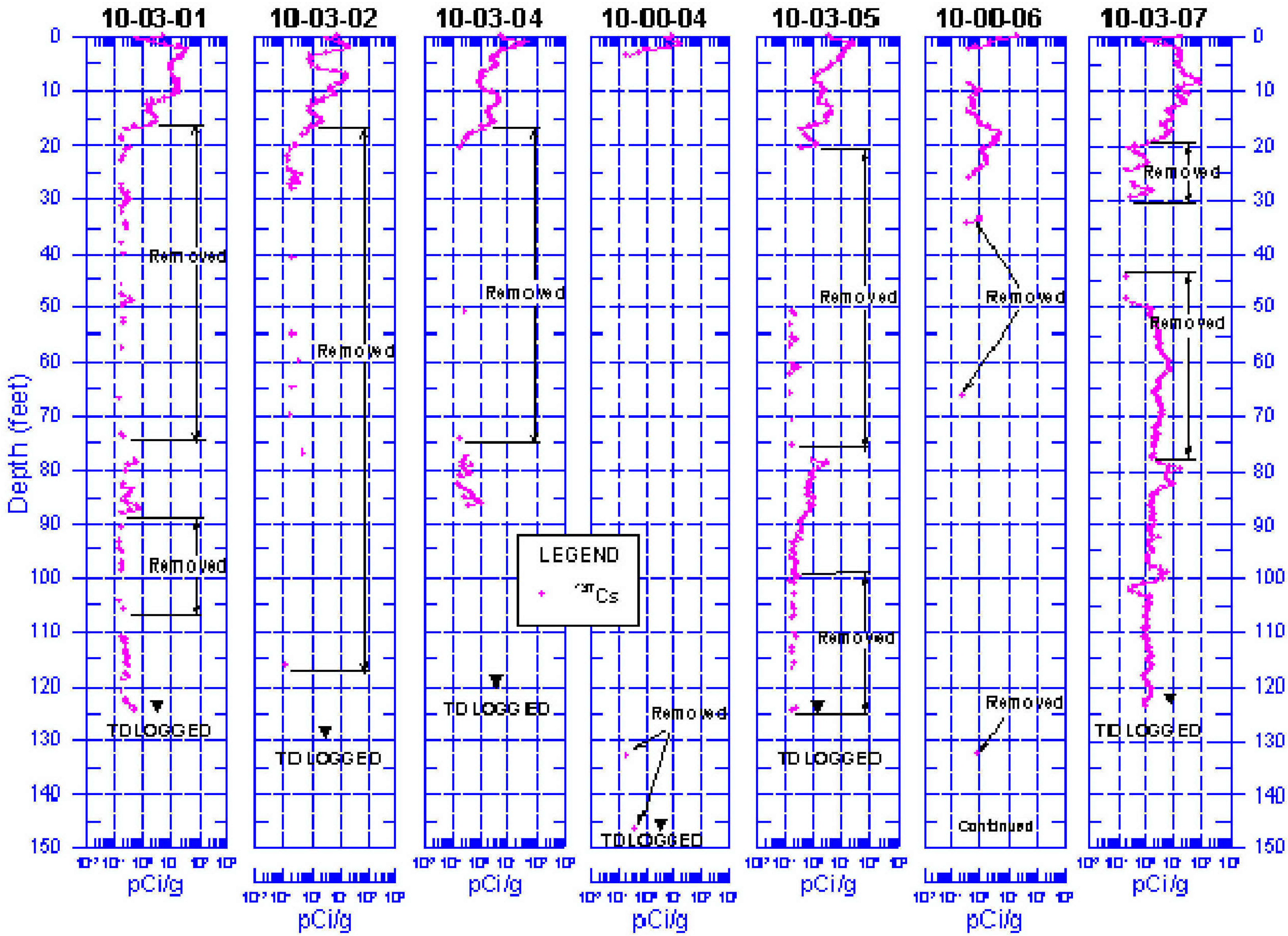
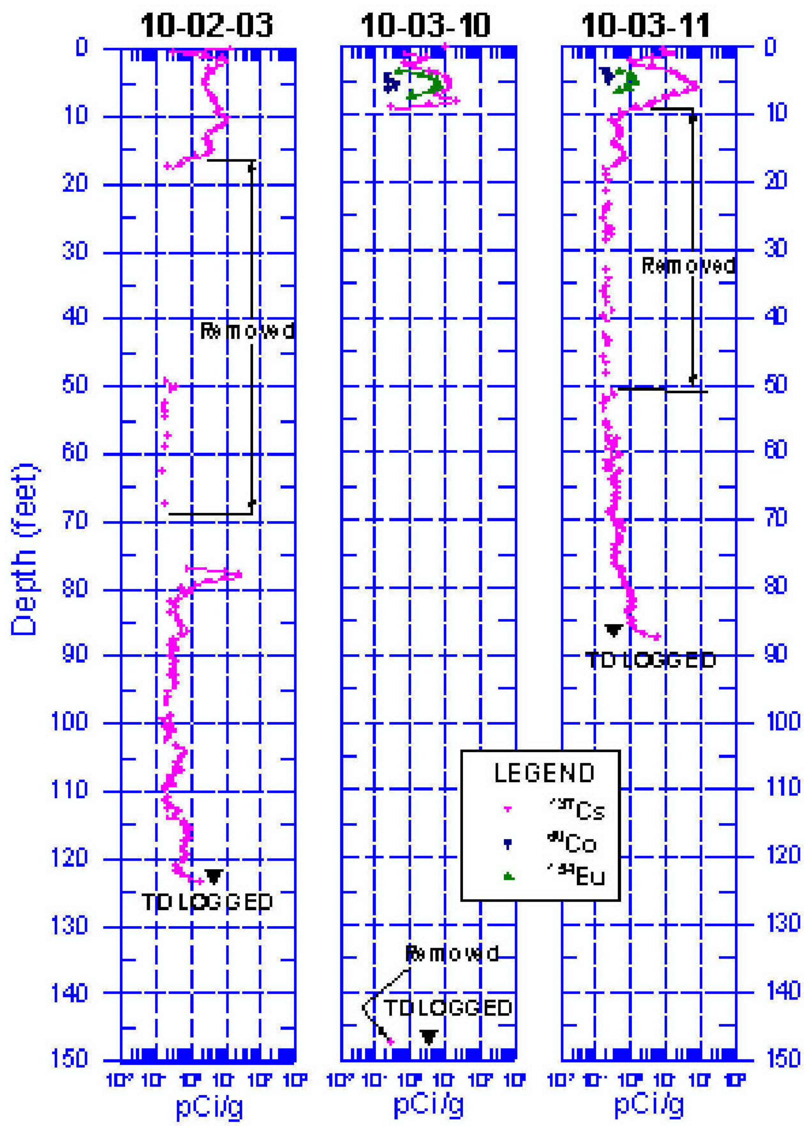


Figure B1-6. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-A-103 (Sheet 2 of 2)



Note: Maximum value of log scales shown is 1,000 pCi/g.
Source: GJO-98-64-TAR/GJO-HAN-23, *Hanford Tank Farms Vadose Zone: A Tank Farm Report*.

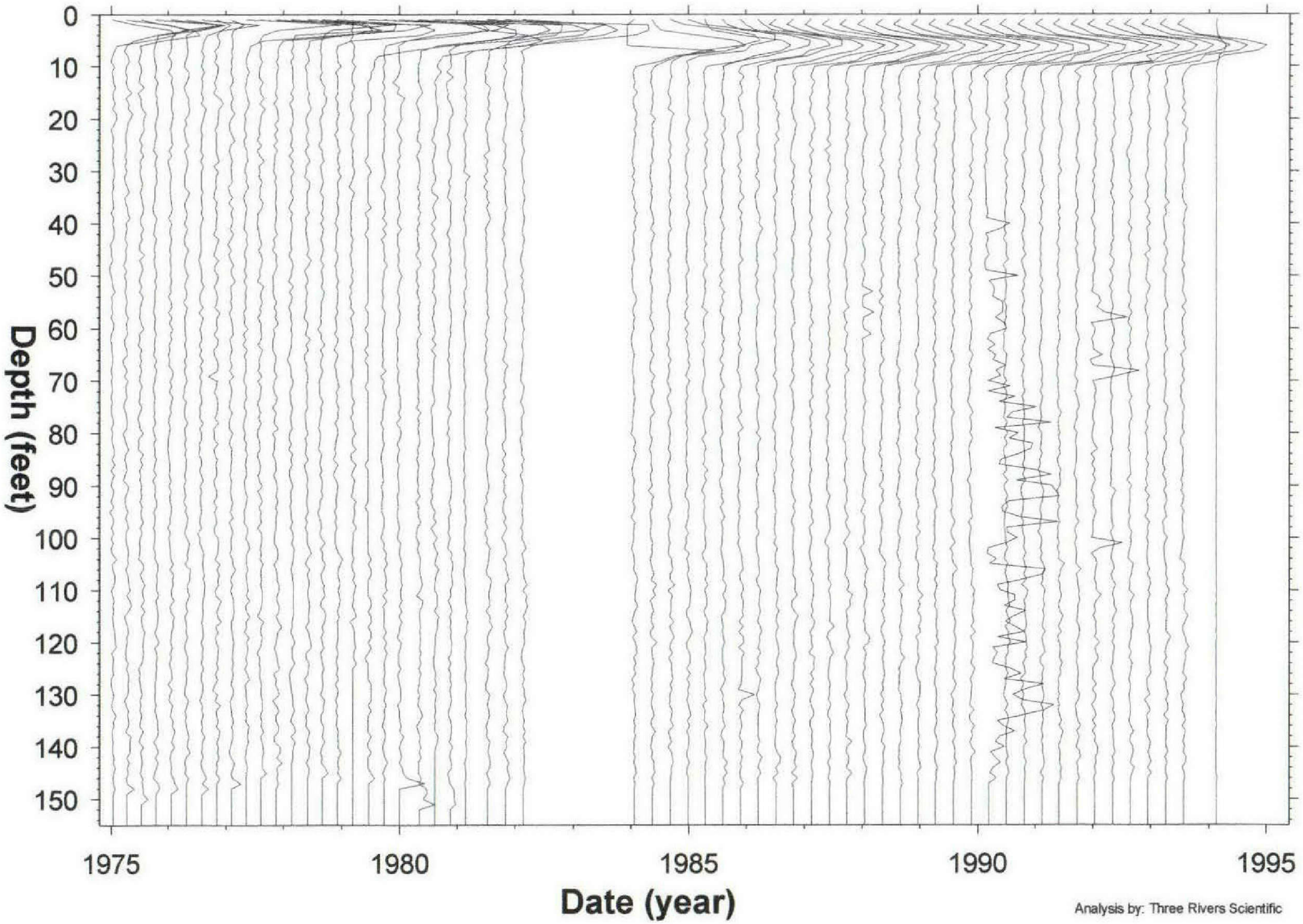
The deep ^{137}Cs measured at the drywells is at lower concentrations compared to the near-surface concentrations. Slight concentration peaks to 10 to 100 pCi/g were detected at 75 to 80 ft below ground surface (bgs) in drywells 10-03-01, 10-03-04, 10-03-05, 10-03-07 and 10-02-03. GJ-HAN-108 concluded that the ^{137}Cs activity at these depths cannot be attributed to a specific source, but may be from "a number of tanks in the vicinity of tank A-103, including tank A-103 itself. Surface spills have also occurred near the tank, and leaks from a shallow subsurface pipeline near the tank are a possibility." Spectral gamma data for several drywells (10-03-01, 10-03-05, 10-03-07, 10-02-03, and 10-03-11) around tank A-103 measure small amounts of ^{137}Cs (about 0.1 pCi/g) at 80 ft bgs and below, which is thought to be associated with drag-down of contamination when the well depths were extended (RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX*, pp. 2-11).

Historical gross gamma-ray data (RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East*) indicate that near-surface gamma activity in drywells 10-03-10 and 10-03-11 and activity at the 75-80 ft level was present before 1975; about the time most of the wells were drilled (see Figures B1-7 and B1-8). Increased gamma activity was measured in drywell 10-03-07 from 50 to 80 ft in 1975; most of the activity decreased by 1980 (Figure B1-9). SD-WM-TI-356 states that "During the period between February 26, 1968 and September 6, 1969, activity at the bottom of dry well No. 10-03-07 increased from 160 to 6,700 c/s. During May 1978 a small peak (100 c/s at 60 ft) developed in dry well No. 10-03-01. Increasing activity was associated with the movement of existing activity, caused by a 60,000-gal raw water leak to the ground on February 23, 1978 (see Occurrence Report No. 78-24)."

B1.5.3 Lateral Logging Data

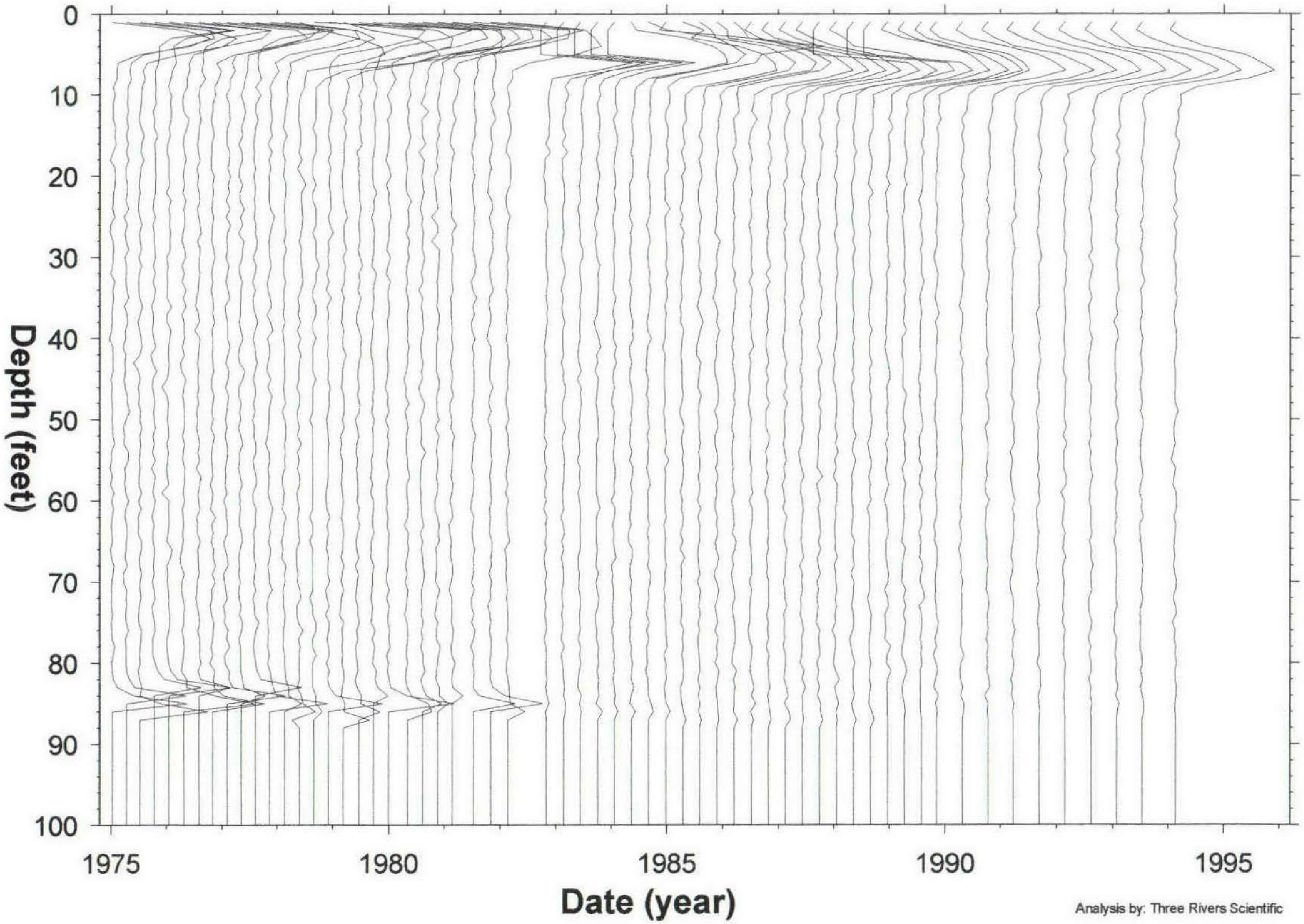
In addition to drywell data, lateral data was obtained from an array of three laterals buried ~10 ft below tank A-103 (Figure 3-6). Gross gamma logging of the laterals beneath tank A-103 was conducted between 1977 and 1991 and again in March 2005. No gamma activity was detected in the laterals through 1991 and less than 10 pCi/g of ^{137}Cs was detected in the laterals beneath the tanks in 2005 (RPP-RPT-27605, *Gamma Surveys of the Single-Shell Tank Laterals for A and SX Tank Farms*, pp. B-4 through B-9) (see Figures B1-10, B1-11 and B1-12). The figures show that soil contamination exists along the vertical section of the laterals before they bend to horizontal and enter the tank shadow beneath the foundation.

Figure B1-7. Tank 241-A-103 Historical Gamma Logging Results for Drywells 10-03-10



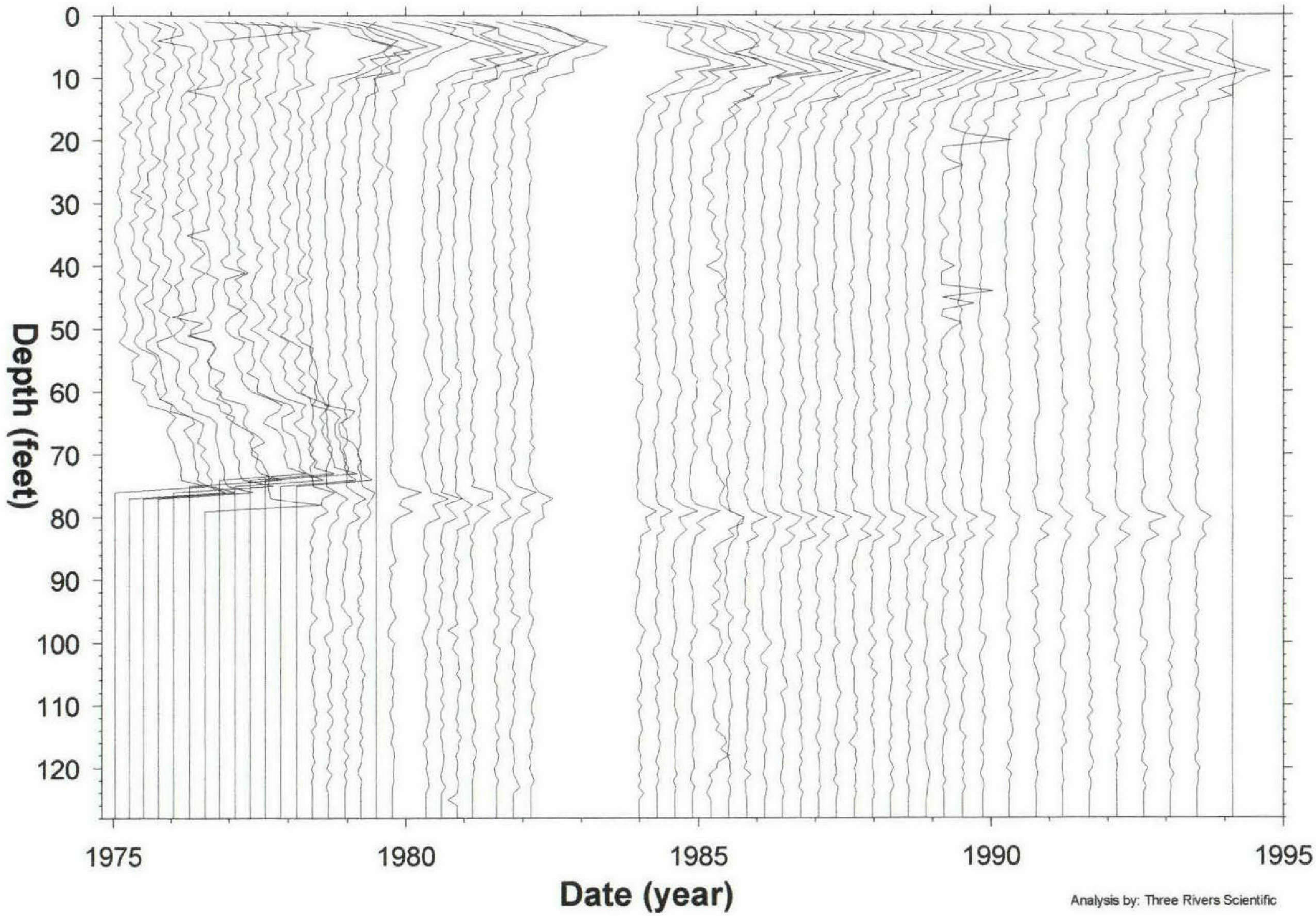
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B1-8. Tank 241-A-103 Historical Gamma Logging Results for Drywells 10-03-11



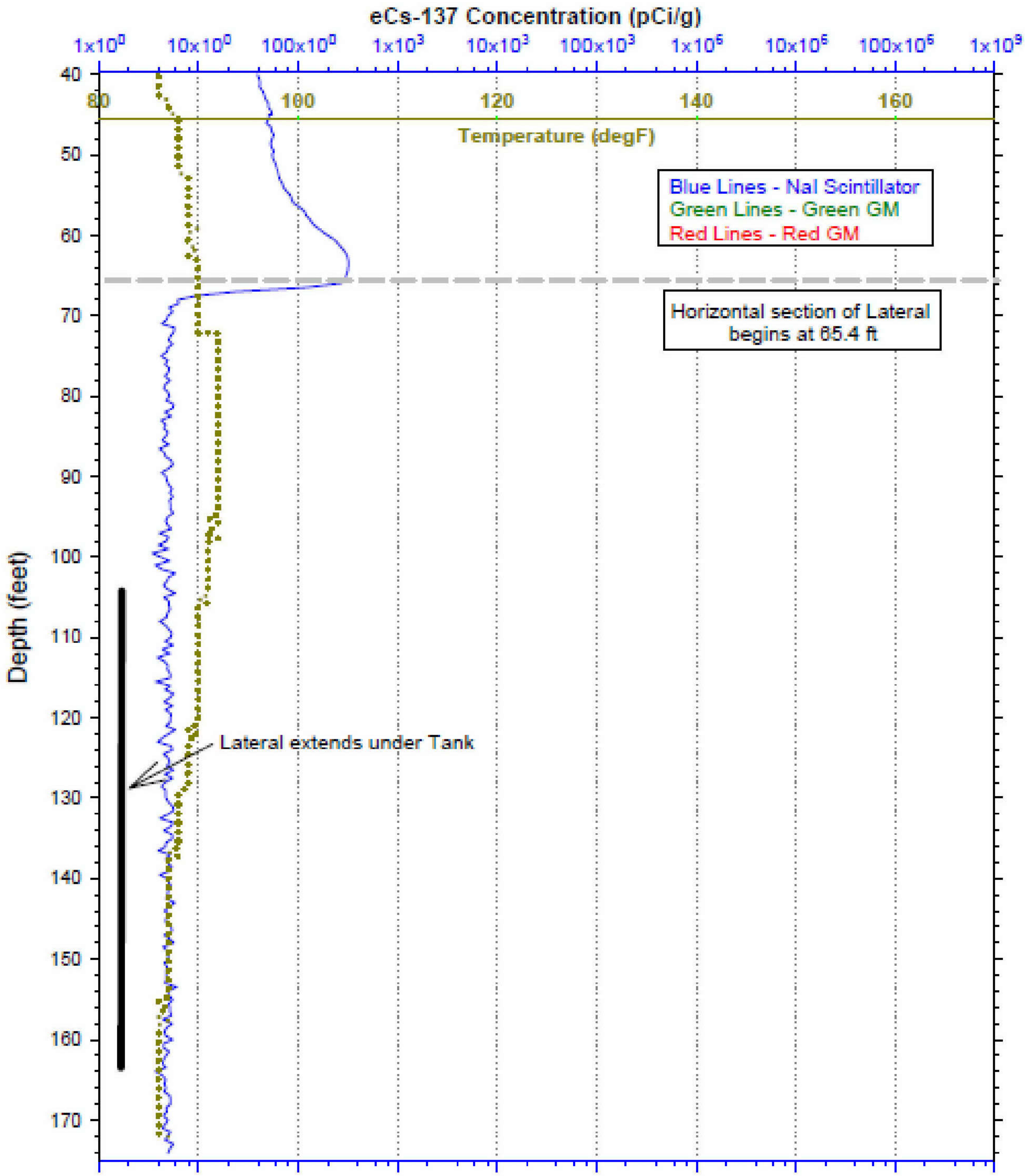
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B1-9. Tank 241-A-103 Historical Gamma Logging Results for Drywells 10-03-07



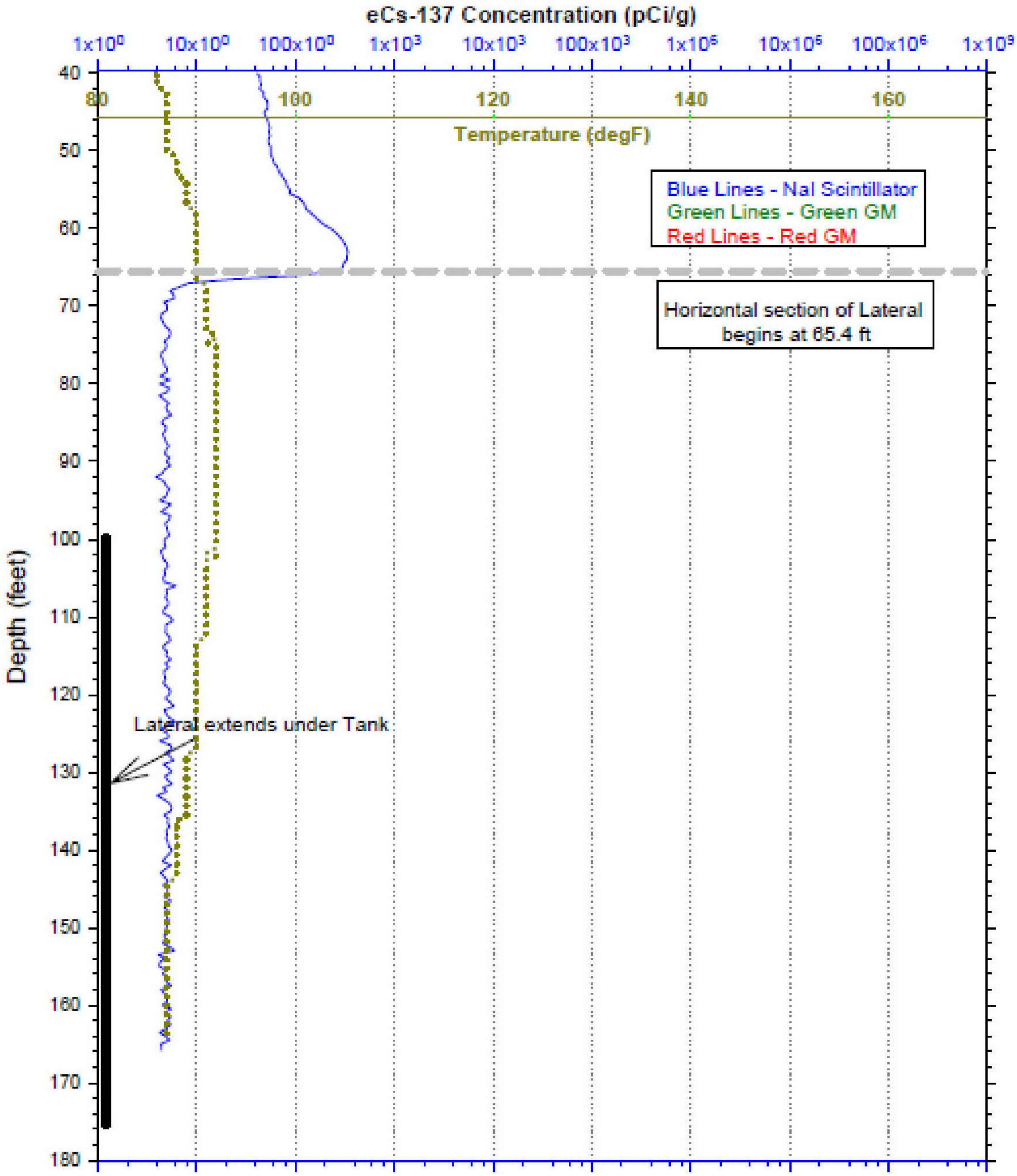
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B1-10. Summary Gamma Survey for Lateral 14-03-01



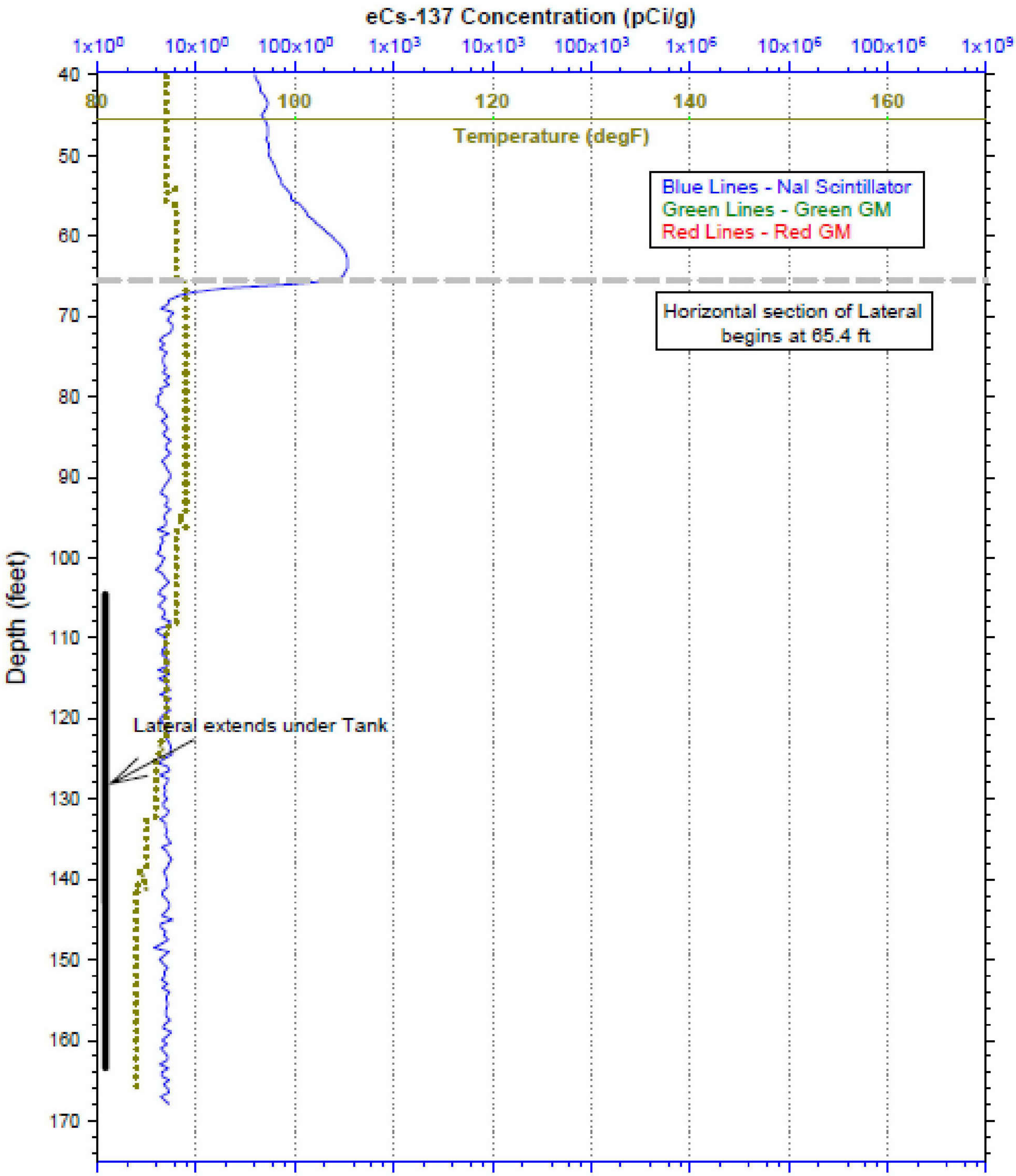
Log date: April 2005. Reference depth: ground level.

Figure B1-11. Summary Gamma Survey for Lateral 14-03-02



Log date: March 2005. Reference depth: ground level.

Figure B1-12. Summary Gamma Survey for Lateral 14-03-03



Log date: March 2005. Reference depth: ground level.

B2.0 TANK 241-A-104

This section provides information on the historical waste loss event associated with tank A-104. Waste operations for tank A-104 are summarized in Figure B2-1. Figure 3-2 of the main text shows a plan view of a typical tank in A Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1-N5) and tank risers.

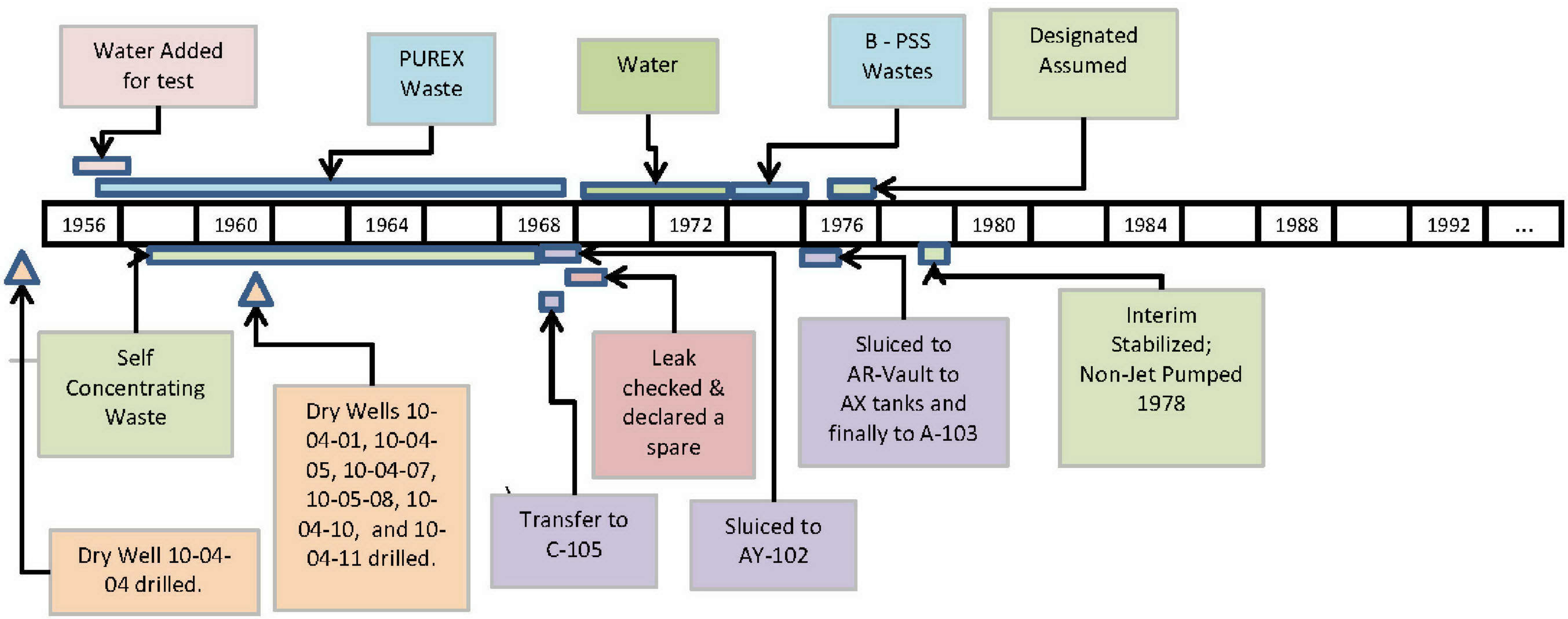
B2.1 TANK 241-A-104 WASTE HISTORY

Tank A-104 was constructed in 1955, but remained empty until 1957. In June 1957, 17,000 gal of "test water" were added to the tank (HW-51348, *Chemical Processing Department Waste Status Summary June 1, 1957 – June 30, 1957 Planning and Scheduling – Production Operation*, pp. 8). The purpose of this test water and the source were not located in available records. The monthly waste status summary reports recorded the volume of test water in SST A-104 varied from 17,000 gal to 36,000 gal from June 1957 through July 1958. No explanation was located in the available records for the reported changes in the test water volume in SST A-104; however, the variations are likely due to calibrating instruments, addition of test water to the tank, or testing transfer systems.

In August 1958, SST A-104 received 20,000 gal of HLW supernate (P1 waste type) from the 202-A PUREX Plant (HW-57550, *Chemical Processing Department Waste Status Summary August 1, 1958 – August 31, 1958*, pp. 8). Self-concentration of waste in SST A-104 was reported to have started in August 1959 (HW-61952, *Chemical Processing Department Waste Status Summary August 1, 1959 – August 31, 1959*, pp. 8), which enabled additional P1 waste to be periodically transferred into SST A-104 from January 1959 through December 1961. Organic wash waste from the PUREX Plant was also reported to have been transferred to SST A-104 during 1960 through March 1968 (Memorandum REP-052163, "History – 241-A Tank Farm" and ARH-534, *Chemical Processing Division Waste Status Summary January 1, 1968 Through March 31, 1968*, pp. 9). The OWW was self-concentrated (i.e., evaporated) in the tank. The peak temperature reported for SST A-104 was 225 °C (437 °F) on February 16, 1963, but was quickly reduced to below 340 °F by adding OWW to the tank to increase liquid level (REP-052163 – Memorandum and RHO-CD-1172, pp. B-4). The waste volume in tank A-104 was generally maintained at less than 980,000 gal during self-concentration of wastes.

In the first and second quarters of 1969, a total of 669,000 gal of the OWW/P1 supernate was transferred from SST A-104 to SST C-105 (ARH-1200 A, *Chemical Processing Division Waste Status Summary January 1, 1969 Through March 31, 1969*, pp. 10 and ARH-1200 B, *Chemical Processing Division Waste Status Summary April 1, 1969 Through June 30, 1969*, pp. 10), leaving ~171,000 gal of solids and 69,000 gal of supernate in SST A-104. Sluicing of the solids from tank A-104 to tank A-106 was conducted from May 12, 1969 (ARH-1200 B, pp. 10) through October 1969 (ARH-1200 D, *Chemical Processing Division Waste Status Summary October 1, 1969 Through December 31, 1969*, pp. 10). An estimated 3,000 gal of solids remained in SST A-104 following sluicing. The tank was refilled with 957,000 gal of water for a leak test to confirm integrity for continued use in accordance with policy and the tank was declared a spare (ARH-1200 D, pp. 10). The supernate temperature in SST A-104 was reported

Figure B2-1. Tank 241-A-104 Waste Operations Summary



PSS-B = Plutonium Uranium Extraction sludge supernate and acidified waste after strontium removal
PUREX = Plutonium Uranium Extraction (Plant)

as ~120 °F following refilling the tank with water (RHO-CD-1172, pp. B-14). No additional temperature data for SST A-104 was found for the period of December 1969 through August 1974.

No waste transfer activity was reported again for SST A-104 until 1972. However, the supernate volume in SST A-104 decreased from 957,000 gal in October 1969 to ~259,000 gal in January 1972 (ARH-2456 A, *Chemical Processing Division Waste Status Summary January 1, 1972 Through March 31, 1972*, pp. 9). A tube bundle heat exchanger (200,000 Btu/hr) was reported to be installed in SST A-104 (drawing H-2-35091, *TK-104-A Heater*) and removed in September 1974 (ARHCO Occurrence Report 74-130, *Contamination Spread*), which may explain the liquid level decrease.

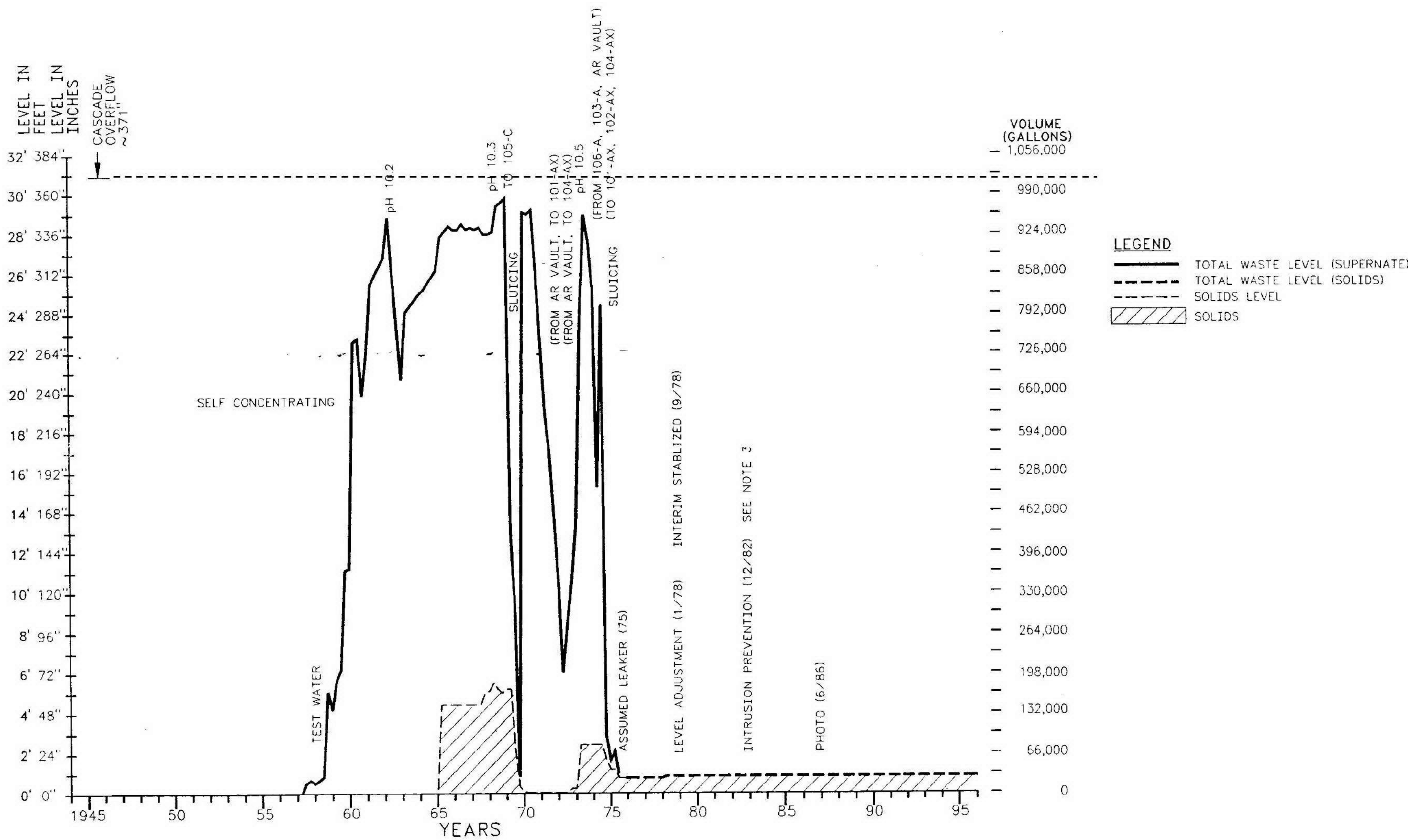
Approximately 132,000 gal of water was transferred from SST A-104 in the first and second quarters of CY 1972 (ARH-2456 A, pp. 9 and ARH-2456 B, pp. 9). Then, SST A-104 was used to receive PUREX Sludge Supernate (PSS waste type) from 244-AR Vault from the third quarter of CY 1972 (ARH-2456 C, *Chemical Processing Division Waste Status Summary July 1, 1972 Through September 30, 1972*, pp. 9) through the second quarter of CY 1974 (ARH-CD-133B, *Operations Division Waste Status Summary April 1, 1974 through June 30, 1974*, pp. 9). Tank A-104 also received B Plant strontium solvent extraction waste (waste type B) in the fourth quarter of CY 1972 (ARH-2456 D, *Chemical Processing Division Waste Status Summary October 1, 1972 Through December 31, 1972*, pp. 9) and first quarter of 1974 (ARH-CD-133A, pp. 9), and water from SST A-103 in first quarter of 1974. Excess supernate was periodically transferred to other SST in 241-AX Tank Farm (AX Farm).

The PSS waste type contained PUREX sludge solids that did not rapidly settle in the relatively small tank 004 in 244-AR Vault and were transferred to the much larger SST A-104 for settling. A total of ~80,000 gal of PUREX sludge solids and 726,000 gal of PSS were present in SST A-104 in the third quarter of CY 1974 (ARH-CD-133B, pp. 9).

Sluicing of the accumulated solids in SST A-104 to the 244-AR Vault was started in September 1974 and was halted April 7, 1975, due to an increase in the radiation detected in lateral no. 2 beneath the tank. Tank A-104 contained 65,000 gal of waste, including an estimated 25,000 gal of sludge when the activity was detected in the laterals. Approximately 46,700 gal of supernate were pumped from tank A-104 from April 9 thru April 19, 1975 to remove the supernate (ARHCO Occurrence Report 75-39, *Leakage From Tank 104-A*).

Figure B2-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, LA-UR-97-311 and tank waste summary reports.

Figure B2-2. Tank 241-A-104 Quarterly Waste Fill History



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*

B2.2 INTEGRITY OF TANK 241-A-104

According to HNF-EP-0182, tank A-104 has a tank integrity classification of an “assumed leaker” with an estimated waste release volume of 500 to 2,500 gal, attributed to an observed liquid level decrease. Tank A-104 was first suspected of leaking in March 1975 when radioactivity was detected in lateral 14-04-02 during sluicing of the tank solids, which was started September 1974. In April 1975, tank A-104 was declared a “confirmed leaker” with a liner failure in at least one location (ARHCO Occurrence Report 75-39).

B2.3 INTERIM STABILIZATION

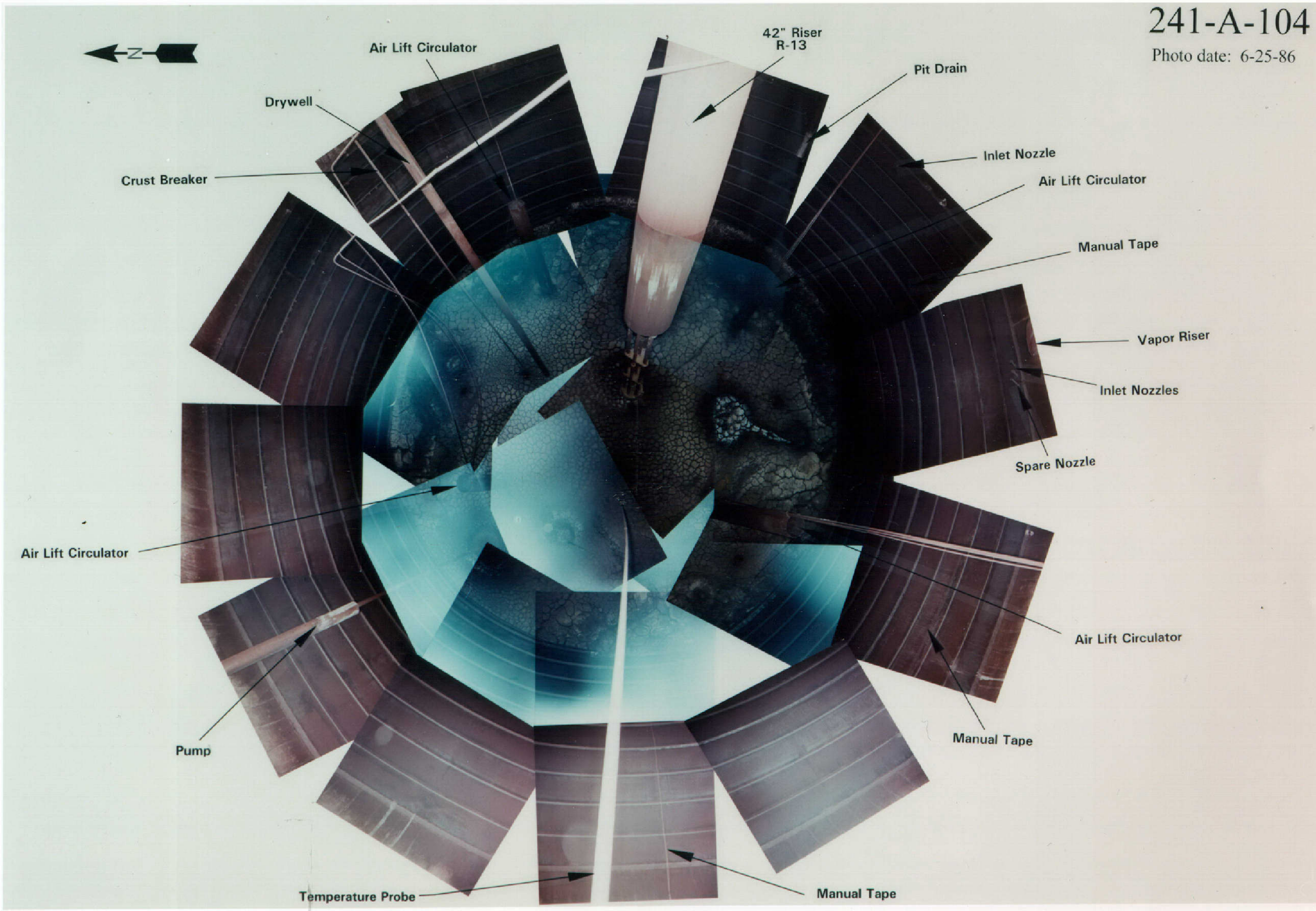
Approximately 47,000 gal of supernate were pumped from tank A-104 from April 9 through April 19, 1975 (ARHCO Occurrence Report 75-39). Tank A-104 was declared interim stabilized in September 1978 (HNF-SD-RE-TI-178). Photographs taken in 1986 show a dry, cracked waste surface with no visible liquid present (Figure B2-3).

As of March 2014, the tank is estimated to contain 28,000 gal of sludge, 24,000 gal of washed PUREX sludge (AR sludge) and 4,000 gal of PUREX HLW (P1). In 1986, an attempt was made to take a core sample from three different risers. Zip core readings from this attempt showed that the bottom of the tank was higher than expected. This indicates that the tank bottom was likely bulged (not confirmed) and the volume of waste in tank A-104 is probably less than 28,000 gal. Current waste level readings show that the waste is relatively dry and any water is likely bound within the waste matrix (RPP-RPT-42742, *2009 Auto-TCR for Tank 241-A-104*).

B2.4 TANK 241-A-104 TEMPERATURE HISTORY

Beginning in August 1958, tank A-104 was filled with 20,000 gal of PUREX HLW and 100,000 gal of water and the waste temperature held at 158 °F for five months to January 1959. Tank A-104 periodically received PUREX HLW from January 1959 through December 1961 and OWW from PUREX from 1960 to 1968. Self-concentration of waste started in August 1959 (RHO-R-39, *Boiling Waste Tank Farm Operational History*). No temperature data for tank A-104 could be recovered from June 1957 to January 1963. A temperature of 257 °F was recorded on January 2, 1963 and the temperature gradually rose to 428 °F by February 6, 1963. On February 16, 1963, a maximum waste temperature of ~437 °F was reached. This temperature exceeded the self-boiling waste operating temperature of 220 °F and 250 °F and the maximum sludge temperature of 300 °F (HW-59919, *Limitations for Existing Storage Tanks for Radioactive Wastes from Separations Plants*). In this 1959 report the waste temperature specification was to ensure continued viability of the tank structure to maintain stability.

Figure B2-3. Tank 241-A-104 Waste Surface Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

The waste temperature gradually declined to ~260 °F by December 1963 and remained relatively stable at this temperature through January 1965. In February 1965, the waste temperature began to increase. The temperature peaked at ~356 °F at the end of April 1965 and remained above 300 °F through July 1965. In August 1965, the temperature gradually declined to ~250 °F and remained relatively stable through May 1967. Beginning in June 1967, the temperature slowly increased and reached slightly over 300 °F by May 1968 and remained around 300 °F until February 1969. The temperature then gradually declined with sluicing of the solids in tank A-104 from May to October 1969. No temperature data was recovered from March 1970 until August 1974. A temperature of 177 °F is recorded in the Surveillance Analysis Computer System on August 25, 1974. No additional data is available until April 1976, when temperatures were ~170 °F. The temperature rose to over 180 °F from 1980 to 1996 and gradually through 2010. Figure B2-4 shows Surveillance Analysis Computer System tank temperatures between 1978 and 2010.

B2.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data, and lateral logging data for tank A-104.

B2.5.1 Tank Surface Level Measurements

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

The liquid level plot in Figure B2-2 indicates the transfers into and out of the tank. The liquid levels are end of quarter levels, so this figure may not reflect all significant transfers into and out of tank A-104 that occurred during the operational history of the tank. Table B2-1 shows historical monthly liquid level readings through 1977. Figure B2-5 shows steady liquid level decreases in 1973 and 1974 were attributed to exhauster operations and transfers. Unexplained liquid level decreases were observed in July 1975 and December 1975. Figure B2-6 shows Surveillance Analysis Computer System liquid levels after 1980.

There were no occurrence reports for tank A-104 liquid level decreases.

Figure B2-4. Tank 241-A-104 Waste Temperature Measurements (in Degrees Fahrenheit)

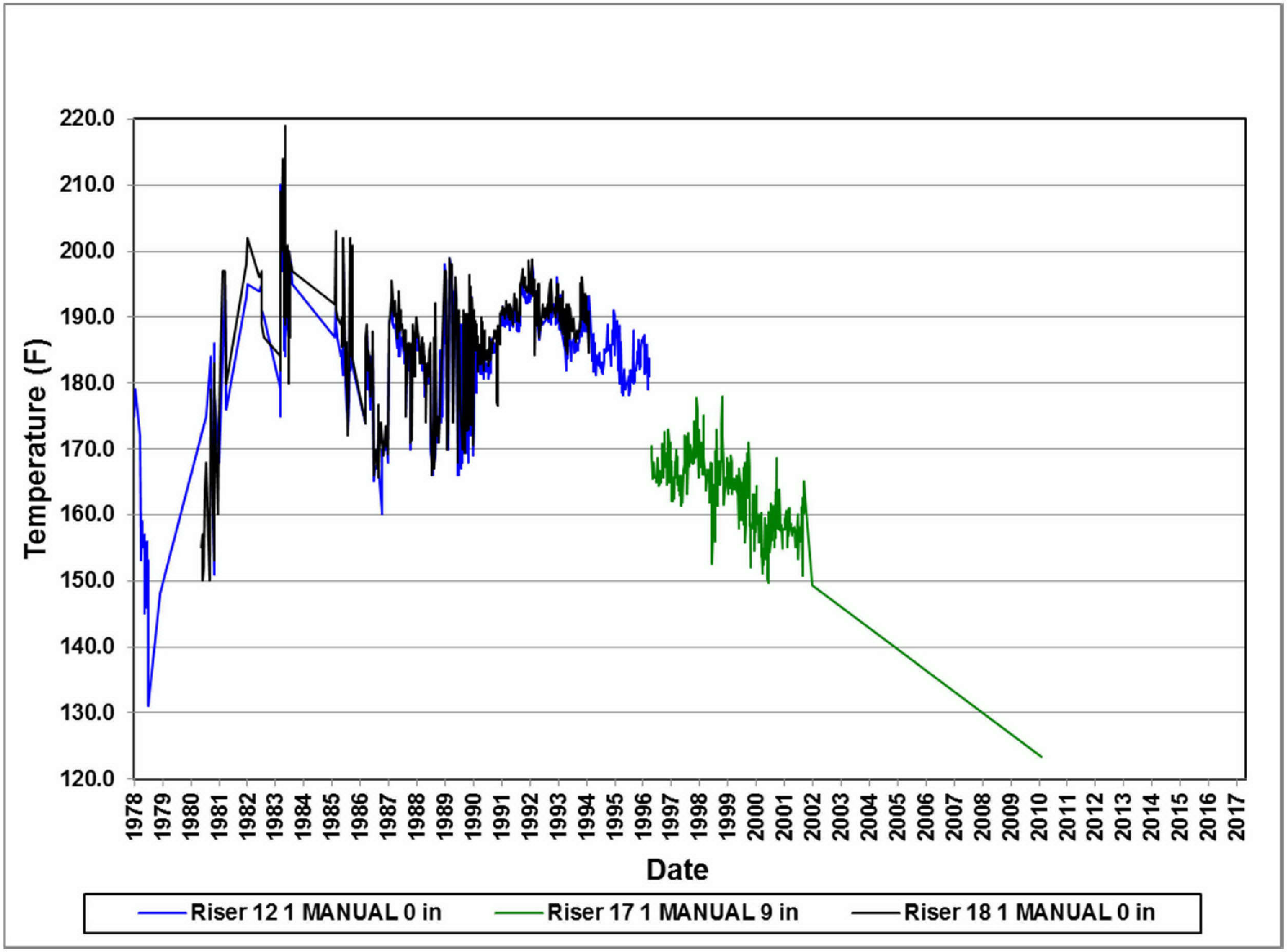


Table B2-1. Tank 241-A-104 Liquid Level Measurements and Changes (1973 to 1986) (sheet 1 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/18/73	348.50				Manual tape
11/09/73	323.75		-24.75	-24.75	Steady decrease
11/10/73	329.00			-24.75	Transfer
11/16/73	328.25		-0.75	-25.50	Slow decrease
12/19/73	306.25			-25.50	Transfers
12/31/73	304.25		-2.00	-27.50	Erratic decrease
01/01/74	306.75			-27.50	Transfer
01/12/74	305.50		-1.25	-28.75	Erratic decrease
01/15/74	319.50			-28.75	Transfer
01/25/74	318.75		-0.75	-29.50	Steady decrease
02/12/74	209.00			-29.50	Transfer
02/21/74	207.00		-2.00	-31.50	Steady decrease
02/22/74	211.25			-31.50	Transfer
03/01/74	210.00		-1.25	-32.75	Steady decrease
03/02/74	297.50			-32.75	Transfer
03/08/74	298.25		+0.75	-32.00	Erratic increase
03/28/74	296.00		-2.25	-34.25	Steady decrease
03/31/74	183.25			-34.25	Transfer
04/17/74	180.00		-3.25	-37.50	Steady decrease
05/15/74	301.25			-37.50	Transfer
06/29/74	293.75		-7.50	-45.00	Steady decrease; exhauster "on" 6/29/74
07/25/74	283.25			-45.00	Steady decrease
08/10/74	65.00			-45.00	Transfers
09/01/74	56.50			-45.00	Steady decrease; exhauster "on"
09/03/74	46.25			-45.00	Transfers
09/10/74	44.25			-45.00	Steady decrease; exhauster "on"
09/23/74	36.00			-45.00	Sluicing and transfers
10/10/74	32.00			-45.00	Steady decrease; exhauster "on"
02/28/75	31.00			-45.00	**FIC installed**
04/14/75	10.55			-45.00	Sluicing and transfer
04/19/75	10.00			-45.00	Transfers
06/30/75	6.40			-45.00	Steady decrease; exhauster "on"

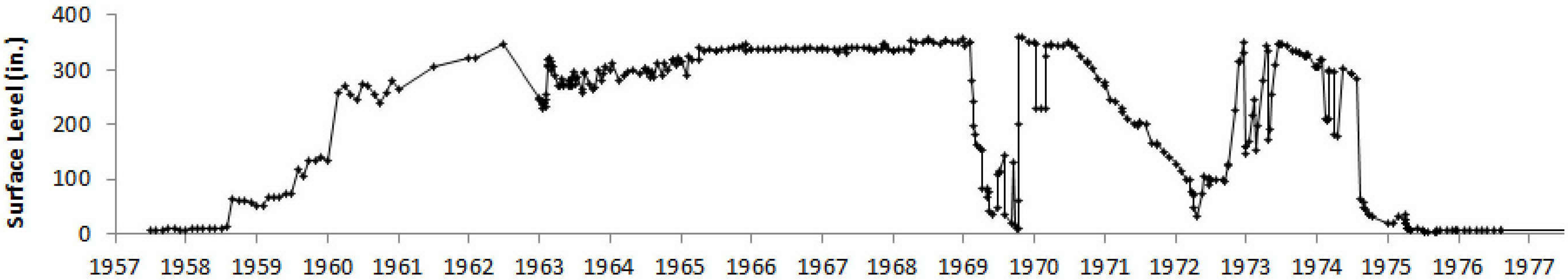
Table B2-1. Tank 241-A-104 Liquid Level Measurements and Changes (1973 to 1986) (sheet 2 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
07/08/75	4.20		-2.20	-47.20	Unexplained drop; but FIC o/s 07/08/75
07/09/95	4.50			-47.20	Manual tape installed
09/08/75	4.50			-47.20	Erratic sludge readings
09/09/75	6.50			-47.20	New zip cord installed
12/21/75	5.50			-47.20	Stable
12/22/75	5.50		-1.00	-48.20	Unexplained drop
08/04/76	5.25		-0.25	-48.45	Esstentially stable; erratic sludge readings
08/05/76	6.50		+1.25	-47.20	Tape recalibrated
07/21/77	6.50			-47.20	Stable
08/12/77	7.00		+0.50	-46.70	Slow increase
09/22/77	7.00			-46.70	Stable
09/23/77	4.00			-46.70	Plummet lost
10/07/77	9.25			-46.70	New tape
11/23/77	10.00		+0.75	-45.95	Erratic increase
01/24/78	10.00			-45.95	Reading varies 9.25 to 10.00 in.
12/31/79	10.00			-45.95	Stable
08/26/80		10.50		-45.95	Sludge movement
12/08/80	9.50		-0.50	-46.45	Stable
12/08/81	9.50			-46.45	Stable--readings fluctuate between 9.50 and 10.50 in.
12/08/82	9.50			-46.45	Stable
12/12/83	10.00		+0.50	-46.95	Stable
10/04/84	10.25		+0.25	-46.70	Stable
01/02/85	11.50		+1.25	-45.45	Erratic increase
04/03/85	11.50			-45.45	Stable
10/04/85	11.00		-0.50	-45.95	Stable
10/01/86	11.00			-45.95	Stable

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

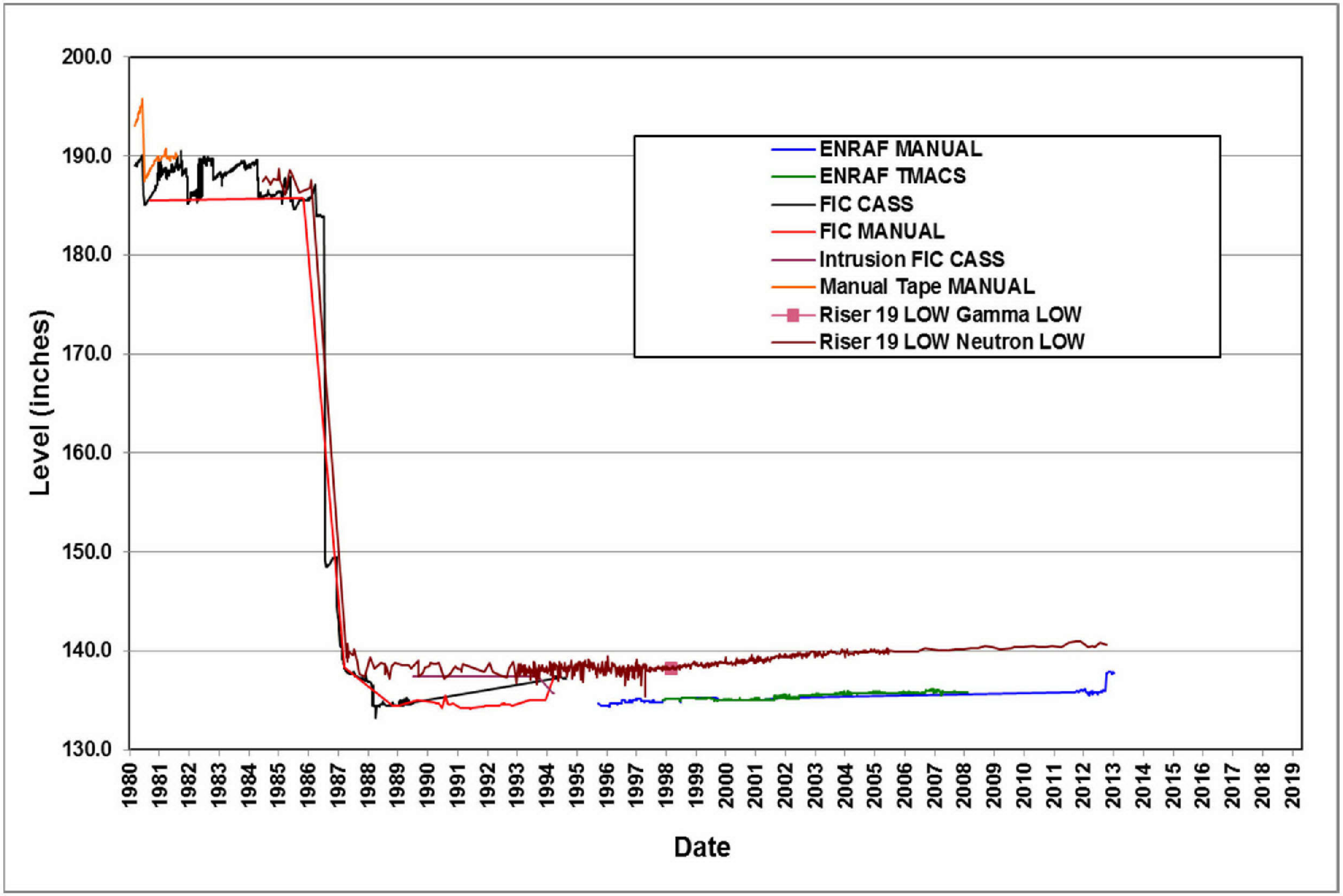
Note: The term “erratic” as used in this table (e.g., “erratic decrease,” “erratic sludge reading”) means “not steady or uniform.”

Figure B2-5. Tank 241-A-104 Monthly Waste Surface Level Measurements (1957 to 1977)



Reference: RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations – 241-A Farm*.

Figure B2-6. Tank 241-A-104 Waste Surface Level Measurements



CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

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B2.5.2 Drywell Logging Data

Eight drywells surround tank A-104 (10-04-01, 10-05-09, 10-04-04, 10-04-05, 10-04-07, 10-04-08, 10-04-10 and 10-04-12); Figure B2-7 shows the 1997 SGLS results for these drywells. The SGLS results are presented and discussed in GJ-HAN-109, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-104*.

Low activity ^{137}Cs (<100 pCi/g) was detected in the top 10 to 20 ft from the ground surface in the immediate vicinity of most of the drywells. Low ^{137}Cs levels (<1,000 pCi/g), ^{154}Eu and ^{60}Co were measured in drywell 10-04-12. The most likely source for this contamination is buried pipelines that run just under the ground surface. The ^{137}Cs in these and other wells could have also resulted from surface spills, pipeline leaks, airborne releases and/or carry-down when the drywells were extended. The ^{137}Cs from 50 to 80 ft bgs may be associated with gamma activity detected in the laterals and may be contamination that was carried down during extension of the drywells. The SGLS data indicate that surface spills have occurred, but there is no evidence, or minimal evidence, that there was a leak from tank A-104.

Historical gross gamma-ray data (RPP-8820) and SD-WM-TI-356 indicate that near-surface gamma activity was present before 1975 (see Figures B2-8 and B2-9). Many operational spills occurred that could account for the near-surface contamination (see Table 5-1). Occurrence report 74-130 documents one such surface spill, when a 53-ft-long tube was remotely removed from a 12-in. riser on tank A-104. In 1976, 18 months after tank A-104 was designated an "assumed leaker;" most of the drywells associated with tank A-104 were deepened from 75 to 125 ft. Near-surface ^{137}Cs activity present around the drywells before 1975 may have been carried downward during the drywell extension activities. Recoverable drywell readings before 1975 are presented in RPP-RPT-54912, Appendix D.1.

Cesium contamination detected in drywell 10-05-09 from 51 to 76 ft bgs may be related to leaks from tank A-104 or tank A-105. This drywell borehole was never deepened and did not show surface contamination until early 1984 (Figure B2-10).

Figure B2-7. Spectral Gamma Logging Results for Drywells near Tank 241-A-104 (Sheet 1 of 2)

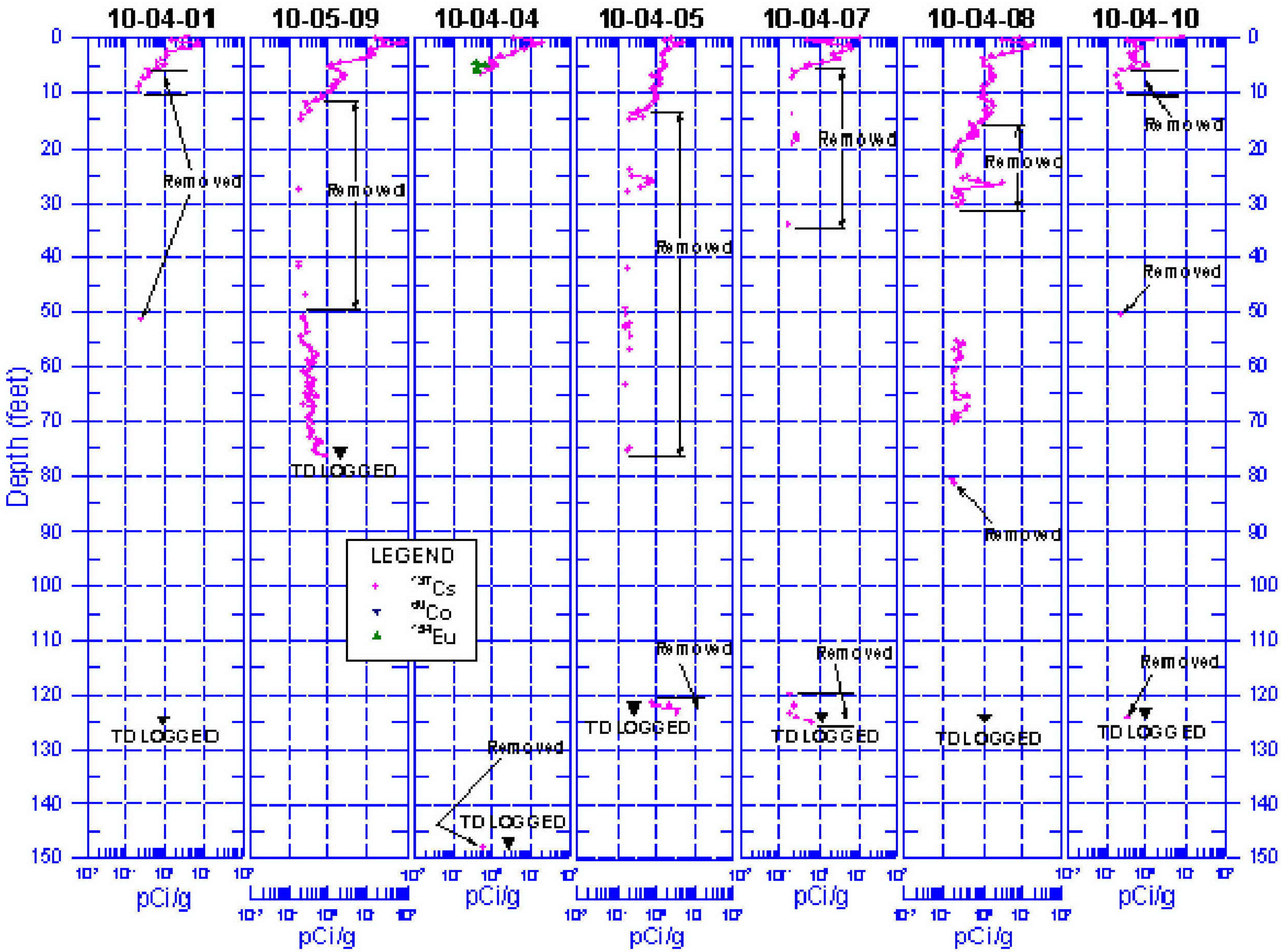
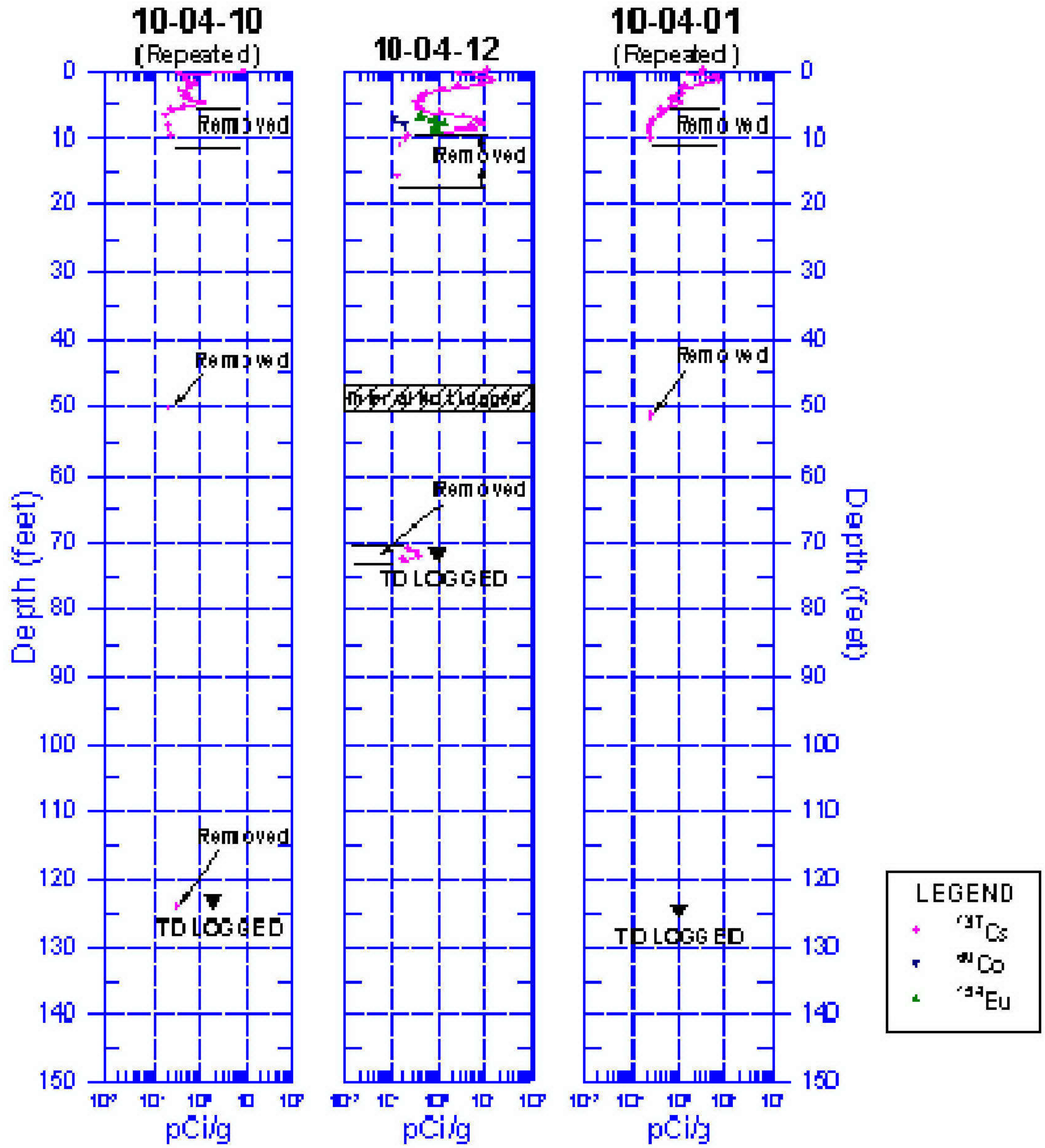
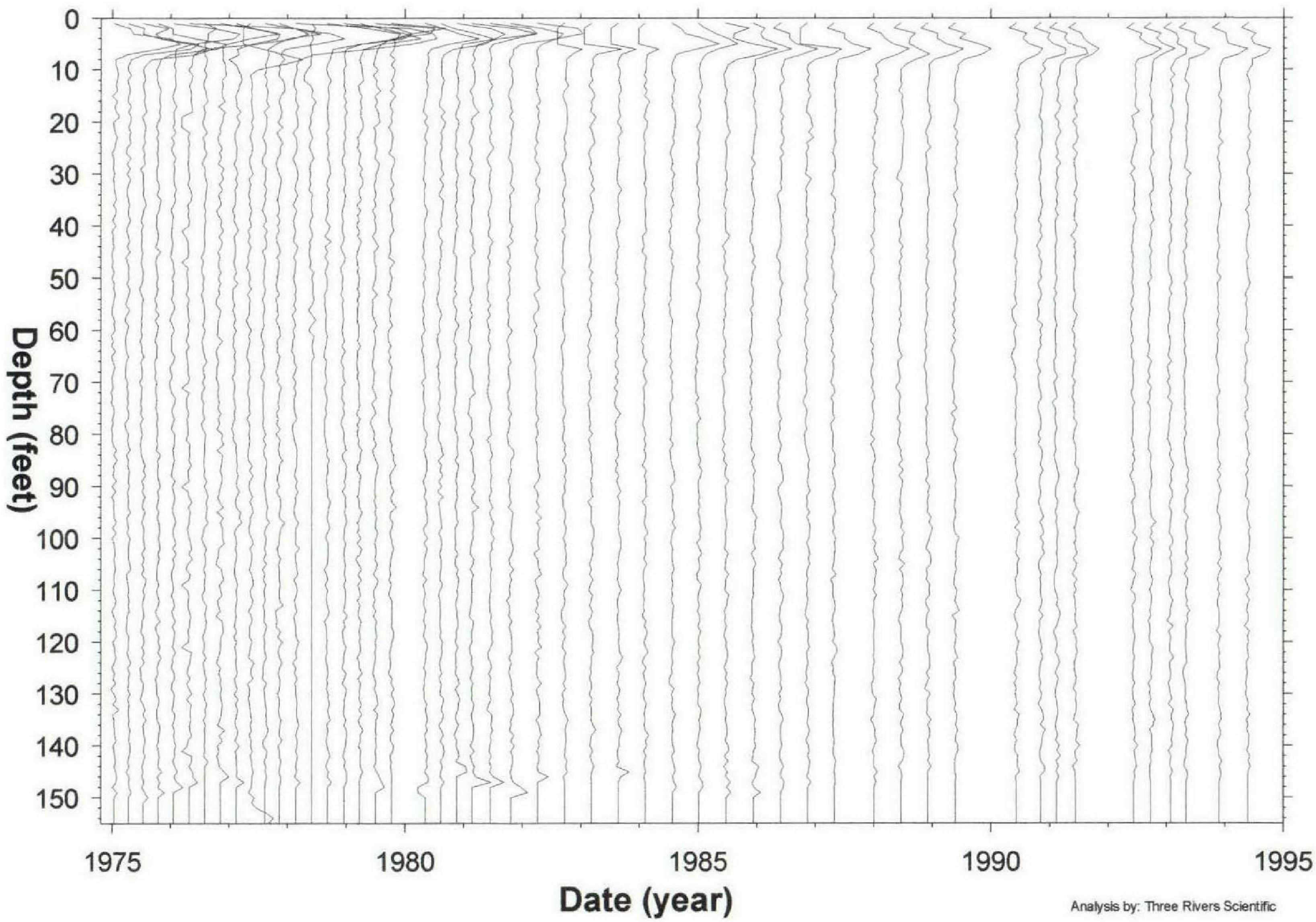


Figure B2-7. Spectral Gamma Logging Results for Drywells near Tank 241-A-104 (Sheet 2 of 2)



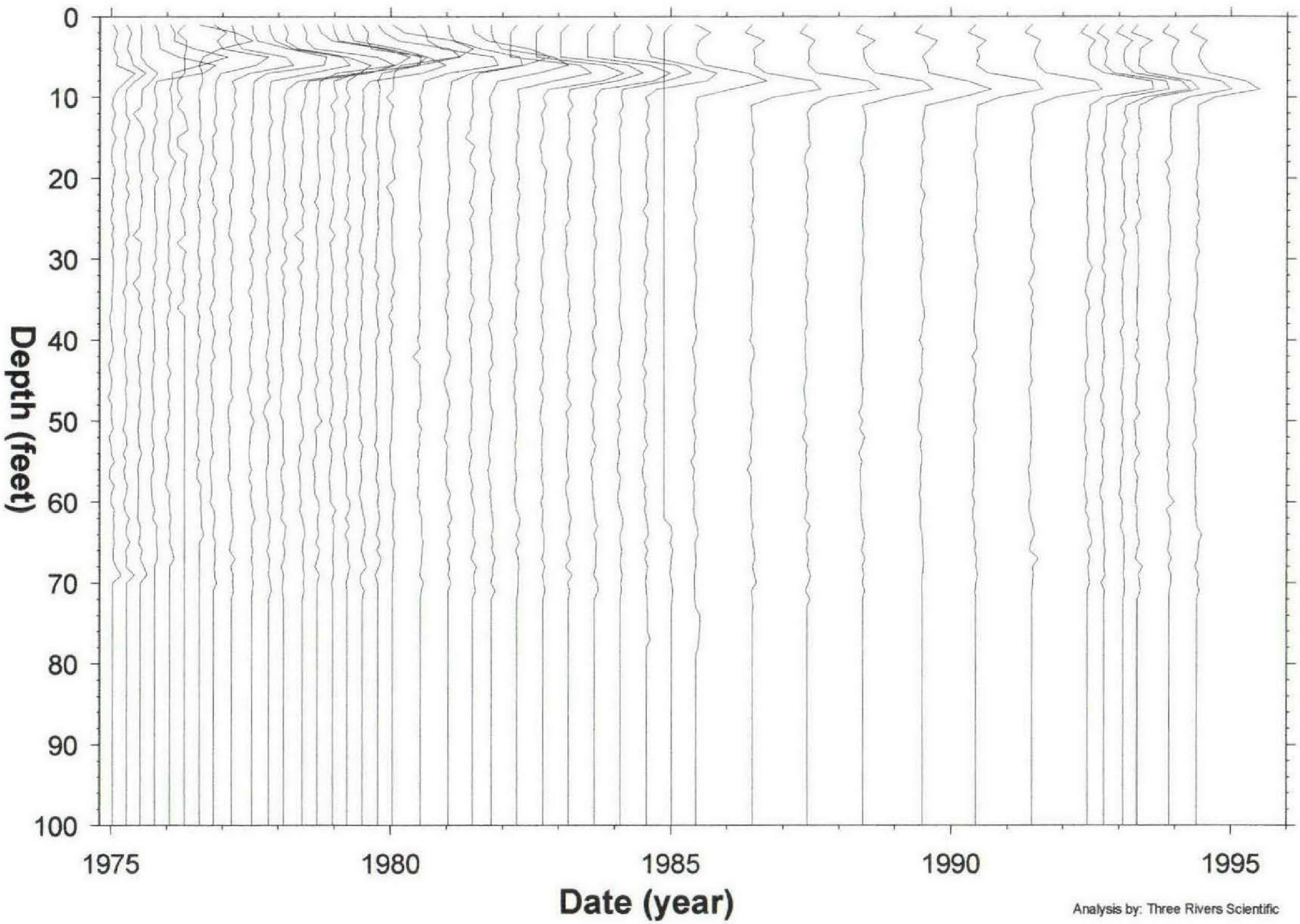
Note: Maximum value of log scales shown is 1,000 pCi/g.
Source: GJO-98-64-TAR/GJ-HAN-23, *Hanford Tank Farms Vadose Zone: A Tank Farm Report*.

Figure B2-8. Tank 241-A-104 Historical Gamma Logging Results for Drywells 10-04-04



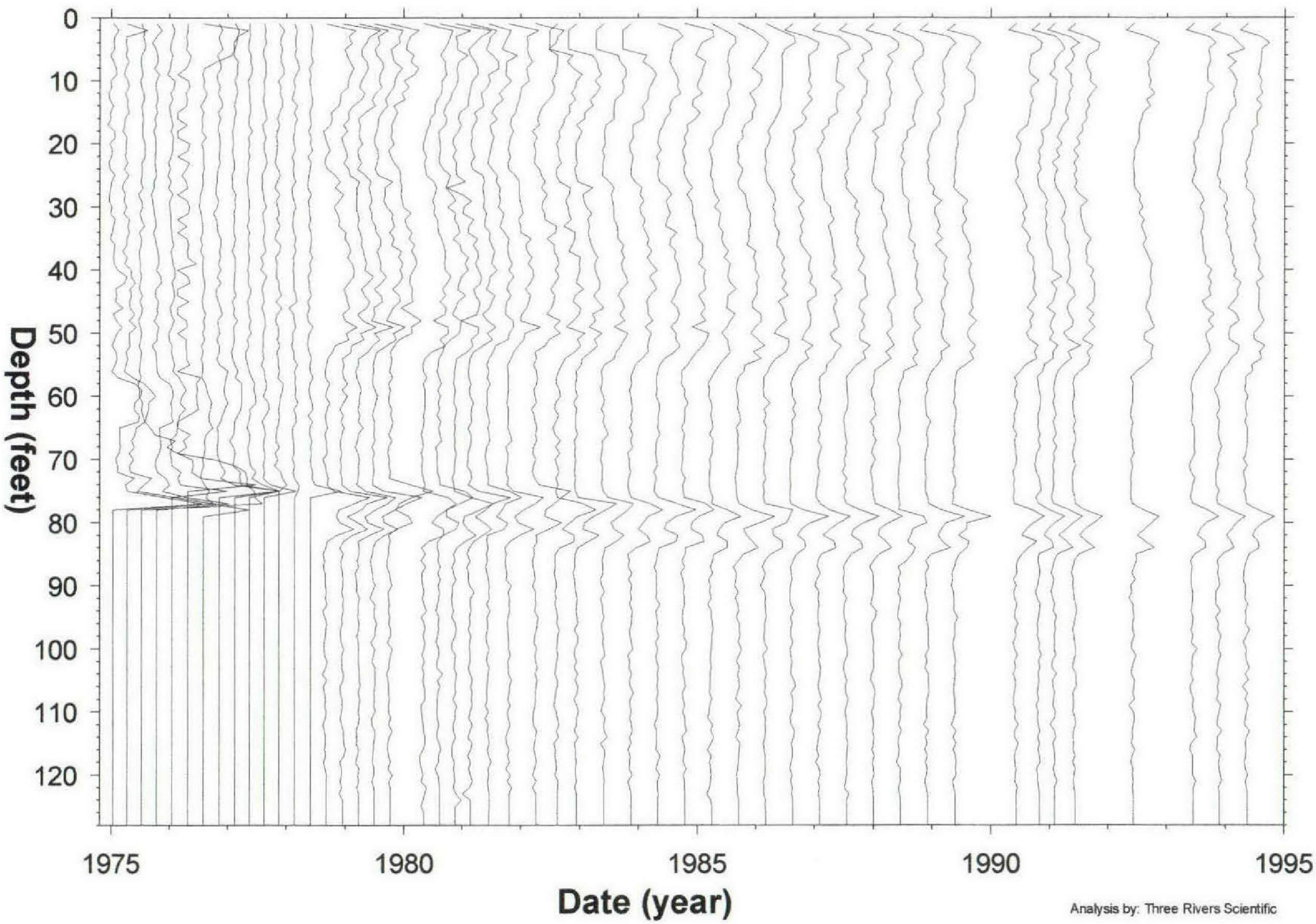
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B2-9. Tank 241-A-104 Historical Gamma Logging Results for Drywells 10-04-12



Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B2-10. Tank 241-A-104 Historical Gamma Logging Results for Drywells 10-05-10



Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

B2.5.3 Lateral Logging Data

In addition to drywell data, lateral data was obtained from an array of three laterals buried ~10 ft below tank A-104 (Figure 3-6). The lateral data provides the primary source of information that tank A-104 leaked.

The first indication of a tank A-104 leak occurred in March 1975, shortly after the start of sluicing in September 1974, when radioactivity was detected in lateral 14-04-02 (see Table B2-2). On March 18, 1975, the first indication of a tank A-104 leak was reported at 100 counts per minute (cpm) in lateral 14-04-02 at ~94 ft from the caisson. A week later, counts increased to 305 cpm at that location in lateral 14-04-02. Sluicing was halted April 7, 1975 due to the increase in radioactivity in lateral 14-04-02. The following day on April 8, 1975, additional radiation peaks were recorded, one in lateral 14-04-02 and one in lateral 14-04-01, both along the southeast edge of the tank (see Figure B2-11). On April 8, 1975 ARHCO Occurrence Report 75-39 reported increasing gamma activity in the center of one of the laterals ~18 ft in from the northwest edge of the tank, and a second radiation peak in an adjacent lateral located ~13 ft in from the southeast edge of the tank.

Radiation readings were monitored daily in April 1975 for all three laterals (Table B2-2). Radiation readings continued to increase in laterals 14-04-01 and 14-04-02 throughout April 1975. The first indication of radioactivity in lateral 14-04-03 occurred on April 21, 1975 at a reading of 95 cpm along the northeast edge of the tank and increased to 480 cpm by May 2, 1975. Tank A-104 was declared a "confirmed leaker" in April 1975 and supernate was pumped out of tank A-104 from April 9 through April 19, 1975.

Beginning on May 1, 1975 a new peak was recorded in lateral 14-04-02 at 47 ft from the caisson at 1,200 cpm. A new peak was also recorded in lateral 14-04-01 on May 19, 1975 at 45 ft from the caisson. Gross gamma scans of the drywells around tank A-104 did not indicate radioactivity below the tank above background during this time (ARH-LD-120, *Nuclear Waste Tank and Pipeline External Leak Detection Systems*). In July 1976, Occurrence Report 76-100, *Radiation Increase Exceeding Action Criteria in Two (2) Laterals Under Tank 104-A* reported that "Two of the three laterals monitoring 104-A have developed a new minor peak, expanding the base of older peaks, generated by the tank leak which occurred in April, 1975."

Radiation readings remained relatively stable through 1976. See Table B2-2 for lateral data from July 1974 through June 1986.

April 2005 lateral gamma surveys under tank A-104 did not identify any gamma activity above background levels (see Figures B2-12 and Figure B2-13). Lateral 14-04-03 was not surveyed during this time.

Table B2-2. Tank 241-A-104 Lateral Logging Results (1974 to 1986) (5 sheets)

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]
7/25/1974	< 25	N/A	7/25/1974	< 25	N/A	7/25/1974	< 25	N/A
9/25/1974	< 60	N/A	9/25/1974	< 60	N/A	9/28/1974	< 55	N/A
10/4/1974	< 90	N/A	10/4/1974	< 90	N/A	10/4/1974	< 55	N/A
11/5/1974	< 50	N/A	11/5/1974	< 90	N/A	11/4/1974	< 50	N/A
12/10/1974	< 30	N/A	12/10/1974	< 30	N/A	12/10/1974	< 30	N/A
12/31/1974	< 30	N/A	12/31/1974	< 30	N/A	12/31/1974	< 50	N/A
1/7/1975	< 50	N/A	1/7/1975	< 50	N/A	1/7/1975	< 75	N/A
1/16/1975	< 50	N/A	1/16/1975	< 50	N/A	1/16/1975	< 60	N/A
1/20/1975	< 60	N/A	1/20/1975	< 50	N/A	1/20/1975	< 55	N/A
1/30/1975	< 30	N/A	1/30/1975	< 35	N/A	1/30/1975	< 50	N/A
2/5/1975	< 30	N/A	2/5/1975	< 35	N/A	2/5/1975	< 50	N/A
N/A			2/11/1975	< 30	N/A	2/11/1975	< 50	N/A
N/A			2/12/1975	< 50	N/A	2/12/1975	< 55	N/A
2/18/1975	< 55	N/A	2/18/1975	< 60	N/A	2/18/1975	< 50	N/A
N/A			2/25/1975	< 50	N/A	2/25/1975	< 50	N/A
3/4/1975	< 55	N/A	3/4/1975	< 50	N/A	3/4/1975	< 50	N/A
N/A			3/11/1975	< 60	N/A	3/11/1975	< 50	N/A
N/A			3/18/1975	100	93.6	3/18/1975	< 60	N/A
3/25/1975	< 65	N/A	3/25/1975	305	93.6	3/25/1975	< 60	N/A
4/8/1975	105	38.6	4/8/1975	220	67.6	4/8/1975	< 50	N/A
				700	95.6			
4/8/1975	105	38.6	4/8/1975	200	67.6	4/8/1975	< 50	N/A
				1,170	95.6			
4/8/1975	155	38.6	4/8/1975	495	67.6	4/8/1975	< 60	N/A
				1,305	95.6			
N/A			4/8/1975	420	67.6	N/A		
				1,860	95.6			
N/A			4/8/1975	390	67.6	N/A		
				1,665	95.6			

Table B2-2. Tank 241-A-104 Lateral Logging Results (1974 to 1986) (5 sheets)

14-04-01			14-04-02			14-04-03		
Date	**Peak (cpm)**	**Distance (ft)[3]**	**Date**	**Peak (cpm)**	**Distance (ft)[3]**	**Date**	**Peak (cpm)**	**Distance (ft)[3]**
N/A			4/8/1975	375	67.6	N/A		
				1,725	95.6			
4/9/1975	210	38.6	4/9/1975	600	67.6	4/9/1975	< 50	N/A
				1,965	95.6			
N/A			4/9/1975	855	67.6	4/9/1975	< 50	N/A
				1,980	95.6			
N/A			4/9/1975	615	67.6	N/A		
				2,055	95.6			
4/10/1975	205	38.6	4/10/1975	800	67.6	4/10/1975	< 50	N/A
				2,850	95.6			
4/11/1975	185	38.6	4/11/1975	750	67.6	N/A		
				3,100	95.6			
4/12/1975	205	38.6	4/12/1975	850	67.6	N/A		
				3,200	95.6			
4/13/1975	245	38.6	4/13/1975	1,050	67.6	N/A		
				2850	95.6			
4/14/1975	345	38.6	4/14/1975	1,000	67.6	N/A		
				3,200	95.6			
4/15/1975	420	38.6	4/15/1975	950	67.6	N/A		
				3,350	95.6			
N/A			4/16/1975	1,150	67.6	N/A		
				3,800	95.6			
4/17/1975	465	38.6	4/17/1975	900	67.6	N/A		
				3,750	95.6			
N/A			4/18/1975	1,100	67.6	N/A		
				4,150	95.6			
4/19/1975	445	38.6	4/19/1975	750	67.6	N/A		
				3,750	95.6			

Table B2-2. Tank 241-A-104 Lateral Logging Results (1974 to 1986) (5 sheets)

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]
4/20/1975	475	38.6	4/20/1975	1,100	67.6	4/20/1975	< 50	N/A
				4,850	95.6			
4/21/1975	680	38.6	N/A			4/21/1975	95	96
4/22/1975	1,785	38.6	4/22/1975	700	67.6	4/22/1975	205	96
				4,350	95.6			
N/A			4/23/1975	1,100	67.6	N/A		
				3,900	95.6			
N/A			4/24/1975	900	67.6	4/24/1975	390	96
				5,250	95.6			
N/A			4/25/1975	1,150	67.6	N/A		
				4,450	95.6			
4/26/1975	1,665	38.6	4/26/1975	900	67.6	4/26/1975	400	96
				4,000	95.6			
4/27/1975	3,400	38.6	4/27/1975	1,750	67.6	N/A		
				4,750	95.6			
4/28/1975	3,650	38.6	4/28/1975	1,050	67.6	4/28/1975	320	96
				5,000	95.6			
4/29/1975	2,450	38.6	N/A			N/A		
5/1/1975	2,745	38.6	5/1/1975	1,200	47	N/A		
				4,900	93			
5/2/1975	4,350	38.6	N/A			5/2/1975	480	96
5/5/1975	4,520	38.6	N/A			N/A		
5/7/1975	4,450	38.6	5/7/1975	1,150	67.6	5/7/1975	325	96
				4,550	95.6			
5/19/1975	650	45	N/A			5/16/1975	365	96
	5,800	35						
N/A			N/A			6/6/1975	280	96
6/9/1975	1,350	45	6/9/1975	1,000	47	6/9/1975	275	96
	6,450	35		5,300	93			

Table B2-2. Tank 241-A-104 Lateral Logging Results (1974 to 1986) (5 sheets)

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]
N/A			N/A			6/16/1975	235	98
N/A			N/A			6/23/1975	385	98
N/A			N/A			6/30/1975	365	98
N/A			10/6/1975	997	48	10/6/1975	258	93
				7,550	97			
1/7/1976	325	53	1/6/1976	720	48	1/6/1976	330	93
	450	46		5,850	97			
	3,380	34						
N/A			2/24/1976	600	48	N/A		
				300	84			
				5,600	97			
4/6/1976	700	55	4/6/1976	1,000	48	4/6/1976	220	93
	500	47		300	84			
	2,100	35		5,680	97			
N/A			6/2/1976	5,400	97	N/A		
				600	48			
7/12/1976	750	38	7/12/1976	750	48	7/12/1976	273	94
	640	74		640	84			
	5,580	87		5,580	97			
10/4/1976	1,100	55	N/A			11/5/1976	180	93
	650	48						
	1,100	37						
3/3/1977	1,260	55	3/3/1977	2,310	97	3/1/1977	178	93
	575	48		400	48			
	780	37						
4/1/1977	120	58.6	3/22/1977	15,000	125.5	3/22/1977	60	76.6
	74	51.6		3,600	115.5		17	21.6
	57	40.6		2,400	71.5			

Table B2-2. Tank 241-A-104 Lateral Logging Results (1974 to 1986) (5 sheets)

14-04-01			14-04-02			14-04-03		
Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]	Date	Peak (cpm)	Distance (ft)[3]
11/1/1977	88	59.6	N/A			N/A		
	67	53.6						
	28	42.6						
N/A			2/10/1978	8,100	125.5	1/4/1978	56	76.6
				5,280	115.5		7.7	18.6
				2,400	71.5			
6/8/1978	80	59.6	N/A			N/A		
	54	53.6						
	28	38.6						
12/5/1978	53	60.6	12/5/1978	2,580	125.5	12/5/1978	36	76.6
	36	54.6		2,400	115.5		23	75.6
	16	39.6		720	71.5		10.8	18.6
10/10/1979	30	59.6	10/10/1979	2,160	126.5	N/A		
	31	55.6		2,760	115.5			
	14	40.6		900	78.5			
10/16/1980	12	49.6	10/16/1980	1,320	121.5	10/16/1980	22	90.6
10/23/1981	11	54.6	10/23/1981	1,320	122.5	10/23/1981	12	90.6
N/A			N/A			1/13/1982	9	89.6
12/15/1982	< 10	N/A	12/15/1982	960	124.5	12/15/1982	< 10	N/A
8/26/1983	< 10	N/A	8/26/1983	960	122.5	8/26/1983	< 10	N/A
9/15/1983	< 10	N/A	9/15/1983	780	124.5	N/A		
11/18/1983	< 10	N/A	11/18/1983	840	124.5	N/A		
10/15/1984	< 10	N/A	10/15/1984	840	127.5	N/A		
9/16/1985	< 10	N/A	9/16/1985	720	126.5	N/A		
6/20/1986	< 10	N/A	6/20/1986	660	125.5	N/A		

cpm = counts per minute N/A = not applicable

References:

ARHCO Occurrence Report 75-39, *Leakage From Tank 104-A*.
SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

Figure B2-11. Historical Radioactivity for Tank 241-A-104 Laterals

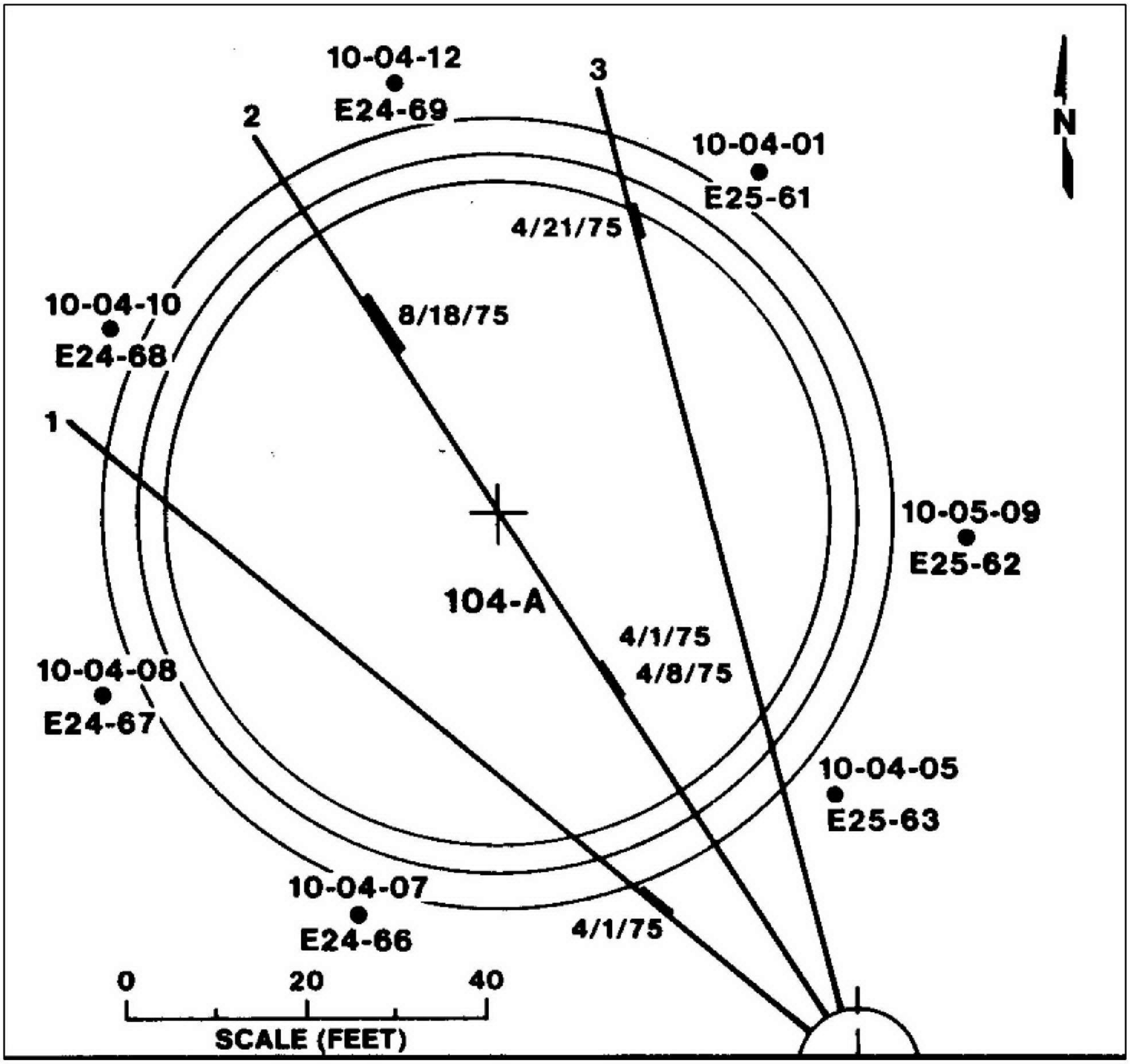


Figure B2-12. Summary Gamma Survey for Lateral 14-04-01, April 2005

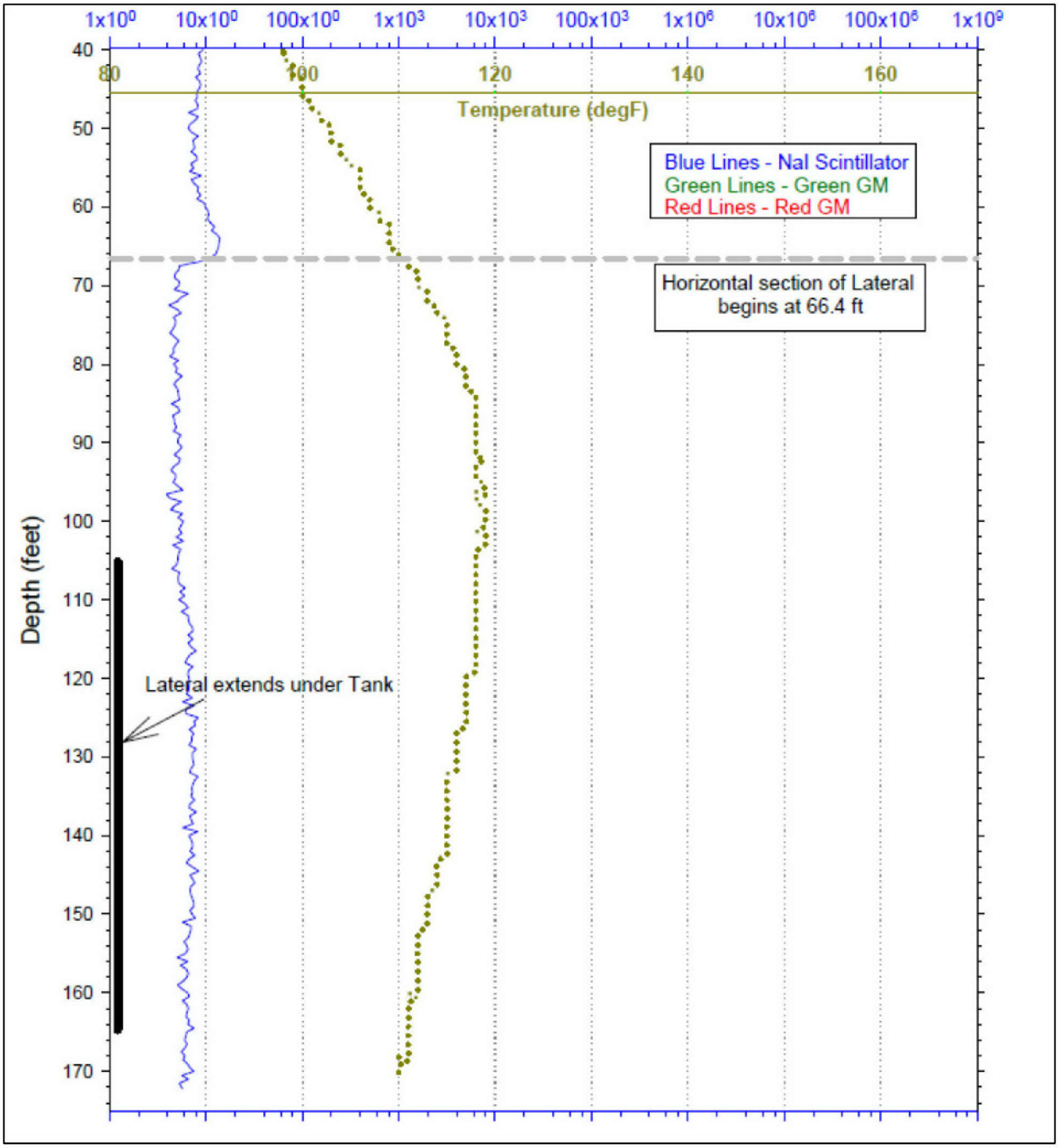
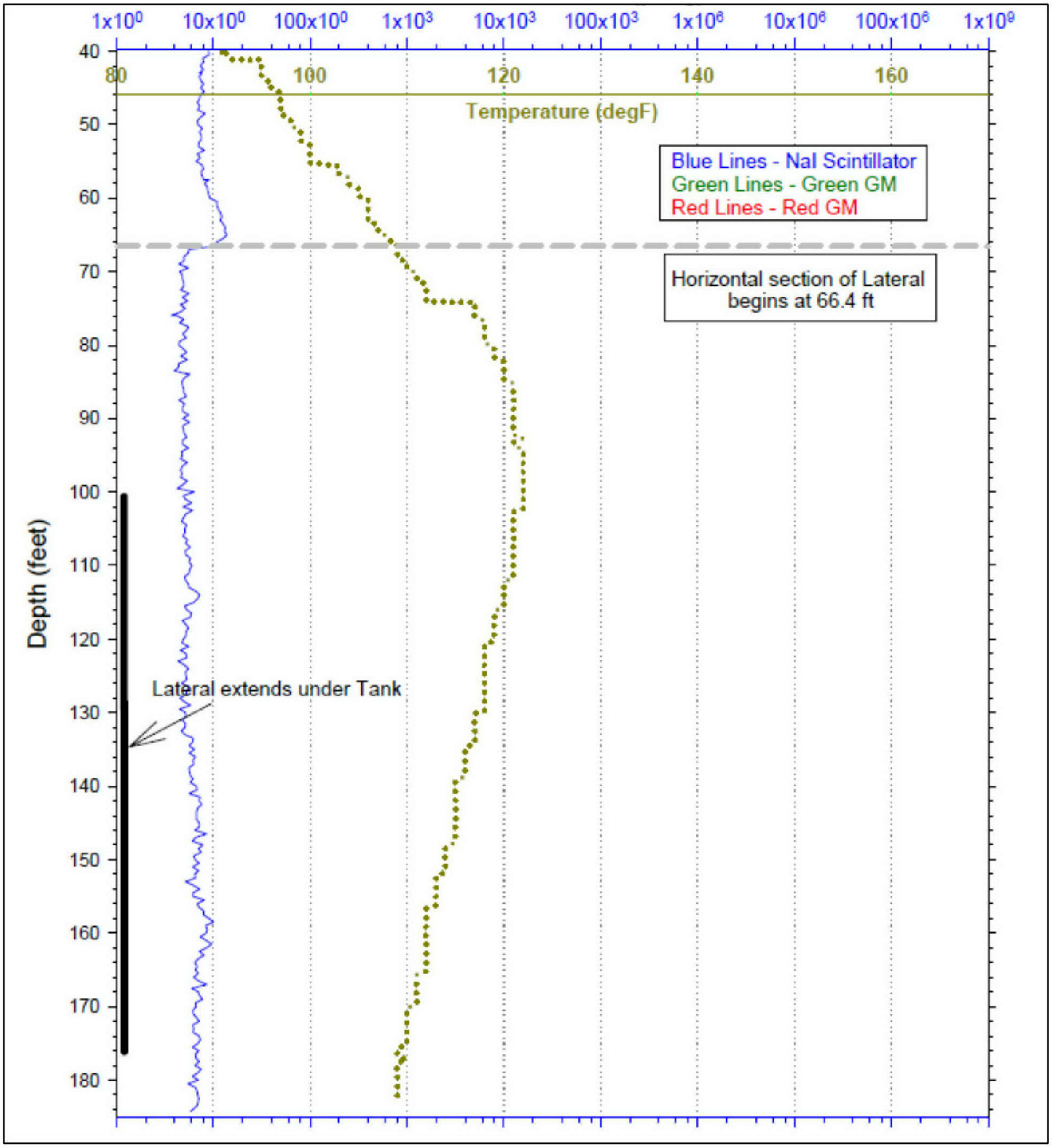


Figure B2-13. Summary Gamma Survey for Lateral 14-04-02, April 2005



B3.0 TANK 241-A-105

This section provides information on the historical waste loss event associated with tank A-105. Waste operations for tank A-105 are summarized in Figure B3-1. Figure 3-2 of the main text shows a plan view of a typical tank in A Farm with the location of the pump pit, sluice pit, spare inlet nozzles (N1-N5) and tank risers.

B3.1 TANK 241-A-105 WASTE HISTORY

The operational history for tank A-105 is summarized from 7G420-06-004 – Interoffice memorandum, 7G420-06-005 – Interoffice memorandum, and DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*.

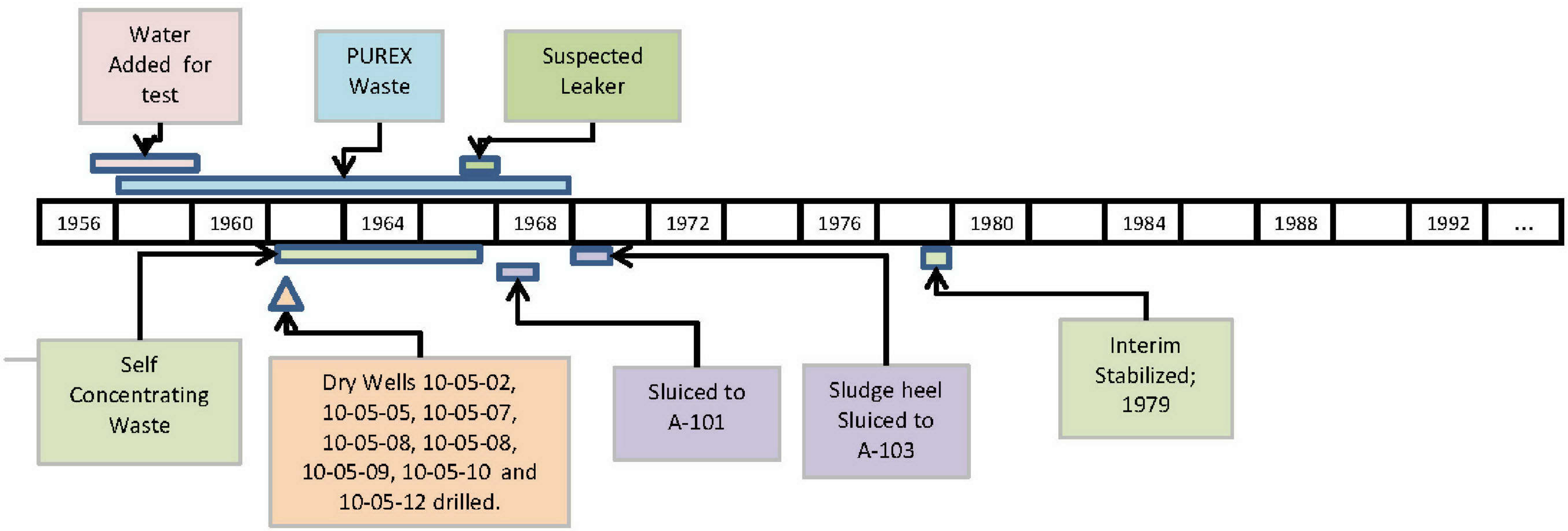
Tank A-105 initially sat unused from finish of construction until May 1962. Aged[3] PUREX HLW supernate was first added to this tank from tank A-103 in May 1962. Additional aged PUREX HLW supernate was added to tank A-105 from tank A-102 in December 1962. Then the contents of tank A-105 were pumped to tanks 241-C-103 and A-101 in January 1963, leaving a 10-in. (~27,600-gal) heel of waste in tank A-105. Thermally hot condensate was added to tank A-105 to heat the tank in preparation to receive HLW from the 202-A PUREX Plant.

Beginning in February 1963, tank A-105 began to receive HLW directly from the 202-A PUREX Plant. The PUREX HLW contained significant concentrations of fission products that resulted in the waste self-boiling. As space became available in tank A-105 as a result of waste evaporation, periodic transfers of PUREX HLW were received until January 1965, at which time it contained 866,000 gal of waste. The maximum reported waste temperature in tank A-105 was ~320 °F in March 1963, but generally was controlled to 180 °F to 260 °F from February 1963 through March 1965 (RHO-CD-1172, pp. B-39 through B-45). On November 19, 1963, there are indications that this tank developed a small leak due to radioactivity detected in lateral 14-05-03 (ARH-78). Additional waste was released from this tank during a steam expulsion event that occurred on January 28, 1965 (ARH-78).

On January 28, 1965, tank A-105 experienced a rapid pressurization event that resulted in the tank liner bulging upward. Radioactivity (250,000 to 350,000 cpm) was detected in March 1965 in a small area of lateral no. 3 beneath the tank. The activity detected in lateral no. 3 did not significantly change from March 1965 through January 1968. The tank liquid level was maintained between 850,000 and 887,000 gal through January 1968 by addition of water. As discussed in WHC-MR-0264, *Tank 241-A-105 Leak Assessment*, radioactivity was also detected in lateral no. 2 beneath tank A-105 in October 1967.

[3] The term "aged" means the short half-life radionuclides had decayed sufficiently that the waste was no longer self-boiling.

Figure B3-1. Tank 241-A-105 Waste Operations Summary



PUREX = Plutonium Uranium Extraction (Plant)

From February 1968 through August 1968, the supernate in tank A-105 was removed and the supernate heel diluted through a series of flushes using B Plant cesium ion exchange supernate (waste type CSR as defined in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) in preparation for sluicing the sludge in this tank (7G420-06-004 – Interoffice memorandum). The ^{137}Cs concentration in the CSR supernate used to flush the HLW supernate in tank A-105 was an average of 0.58 Ci/gal, decay corrected to January 2006 (7G420-06-004 – Interoffice memorandum). The tank A-105 flush solution was transferred to tank A-103, then tank AX-102 and finally to B Plant for cesium removal processing.

Following the dilution and flushing of tank A-105 supernate, two sluicing campaigns were conducted to remove the sludge from tank A-105. The first sluicing campaign, conducted from August through November 1968, used cesium denuded supernate derived from operation of the cesium ion exchange process in B Plant (7G420-06-004 – Interoffice memorandum). The ^{137}Cs concentration of the sluicing fluid was estimated to be 0.53 Ci/gal to 0.58 Ci/gal (decay corrected to January 2006). Sluicing of tank A-105 sludge was halted when little of the remaining sludge could be removed. A hard crust layer atop the remaining sludge was thought to be responsible for preventing effective sluicing. Approximately half of the sludge was removed during this first sluicing campaign.

In the second sluicing campaign, 1M sulfuric acid, containing 1,500 ppm of the inhibitor Rhodine A[4], were sprayed onto the top layer of hard sludge in tank A-105 (7G420-06-005 – Interoffice memorandum). Cesium denuded supernate, generated in B Plant and contained in tank A-103, was used as the sluicing fluid. The sludge sluiced from tank A-105 was transferred into tank A-103. No additional sludge removal activities in tank A-105 were conducted until August 25, 1970. Inhibited sulfuric acid was again used in August 25, 1970 to soften the sludge in tank A-105. The softened sludge was then sluiced using cesium denuded supernate contained in tank A-103. The sludge slurry was transferred from tank A-105 to tank A-103. Following the completion of this phase of the sludge removal from tank A-105, ~33,000 gal of supernate and 33,000 gal of sludge were reported to remain within this tank. The supernate contained in tank A-105 was described as being a mixture of B Plant cesium ion exchange waste (i.e., cesium denuded ion exchange waste) and PUREX HLW.

The cesium denuded supernate used to sluice the sludge from tank A-105 to tank A-103 was derived from cesium ion exchange processing conducted in B Plant. Sluicing conducted in July to August 1969 used the same cesium denuded supernatant solution as was used during the first tank A-105 sluicing campaign. However, tank A-105 sluicing conducted in August to November 1970 used a different source of cesium denuded supernate. The estimated concentration of the cesium denuded supernate used to conduct sluicing of tank A-105 sludge to tank A-103 from August to November 1970 is 0.51 Ci/gal, decayed to January 2006 (7G420-06-005 – Interoffice memorandum).

Following the sluicing of the waste, water was periodically added to tank A-105 from November 1970 through December 1978 for evaporative cooling of the remaining sludge. An estimated 610,000 gal of water was added to tank A-105 for cooling and flushing of the airlift

[4] Trade name of Amchem Products Corporation.

circulators (WHC-MR-0264, pp. 22). The estimated amount of water evaporated from tank A-105 from November 1970 through December 1978 is 378,000 to 410,000 gal (WHC-EP-0410, *Tank 241-A-105 Evaporation Estimate 1970 through 1978*). Therefore, an estimated 200,000 to 232,000 gal of water are unaccounted for and may have leaked from tank A-105.

Figure B3-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, LA-UR-97-311 and tank waste summary reports.

B3.2 INTEGRITY OF TANK 241-A-105

Tank A-105 is designated a confirmed leaker with an estimated loss of liquid attributed to a breach in tank liner integrity at 10,000 to 270,000 gal (HNF-EP-0182). The leak volume range for tank A-105 (10,000 to 277,000 gal) is based on the following.

a. WHC-MR-0264:

   An estimate of 5,000 to 15,000 gal for the initial leak prior to August 1968.

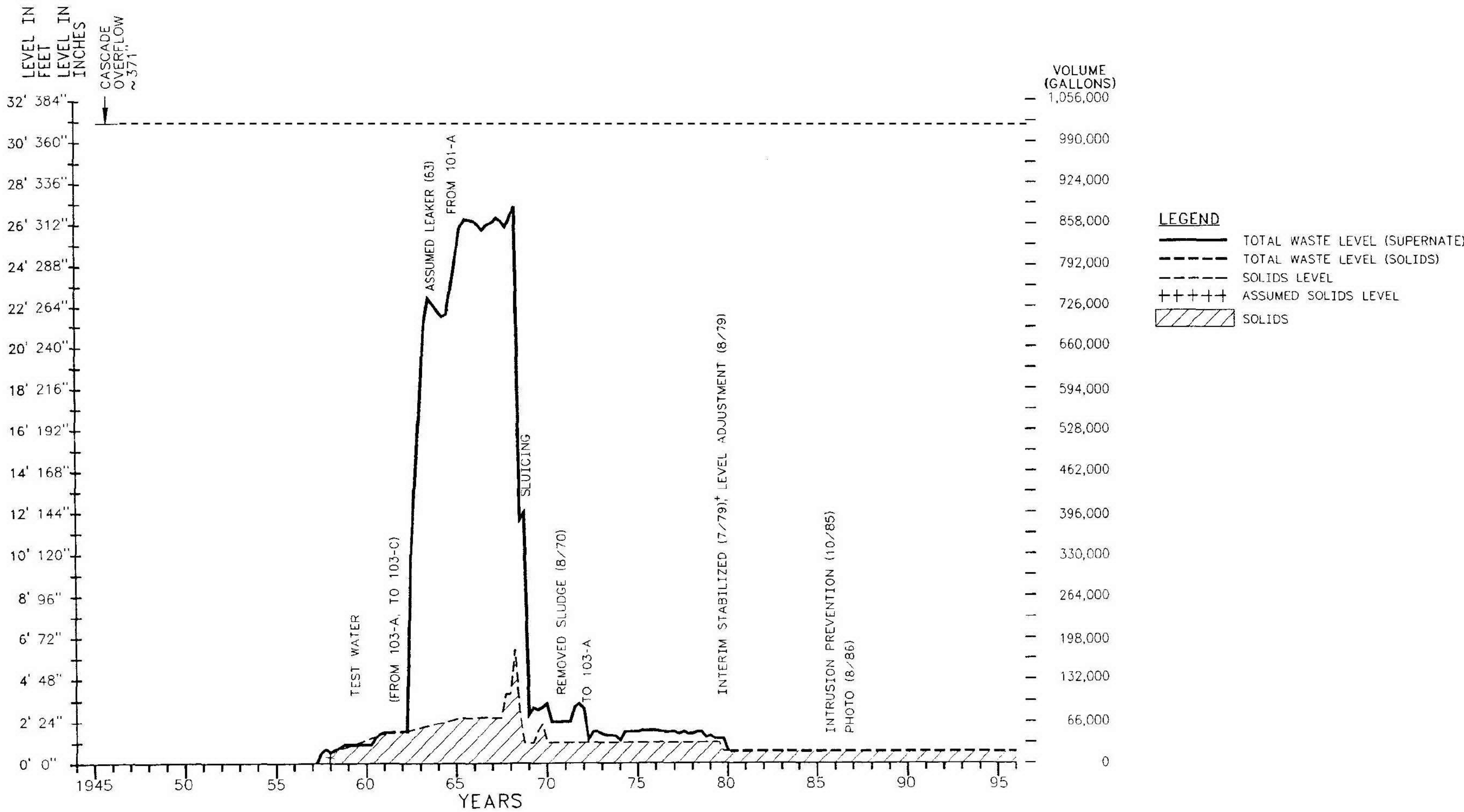
   An estimate of 5,000 to 30,000 gal for the leak while the tank was being sluiced from August 1968 to November 1970.

   An estimate of 610,000 gal of cooling water was added to the tank from November 1970 to December 1978, but it was estimated that the release from the tank was likely small during this period. "Sufficient heat was generated in the tank to evaporate most, and perhaps nearly all, of this water" (WHC-MR-0264). This result leads to an estimate of no gallons released from the tank during the period of November 1970 to December 1978.

b. WHC-EP-0410 estimates that 378,000 to 410,000 gal evaporated out of the tank from November 1970 to December 1978. Subtracting the minimum evaporation estimate from the cooling water added estimate provides a range from 0 to 232,000 gal of cooling water leakage from November 1970 to December 1978.

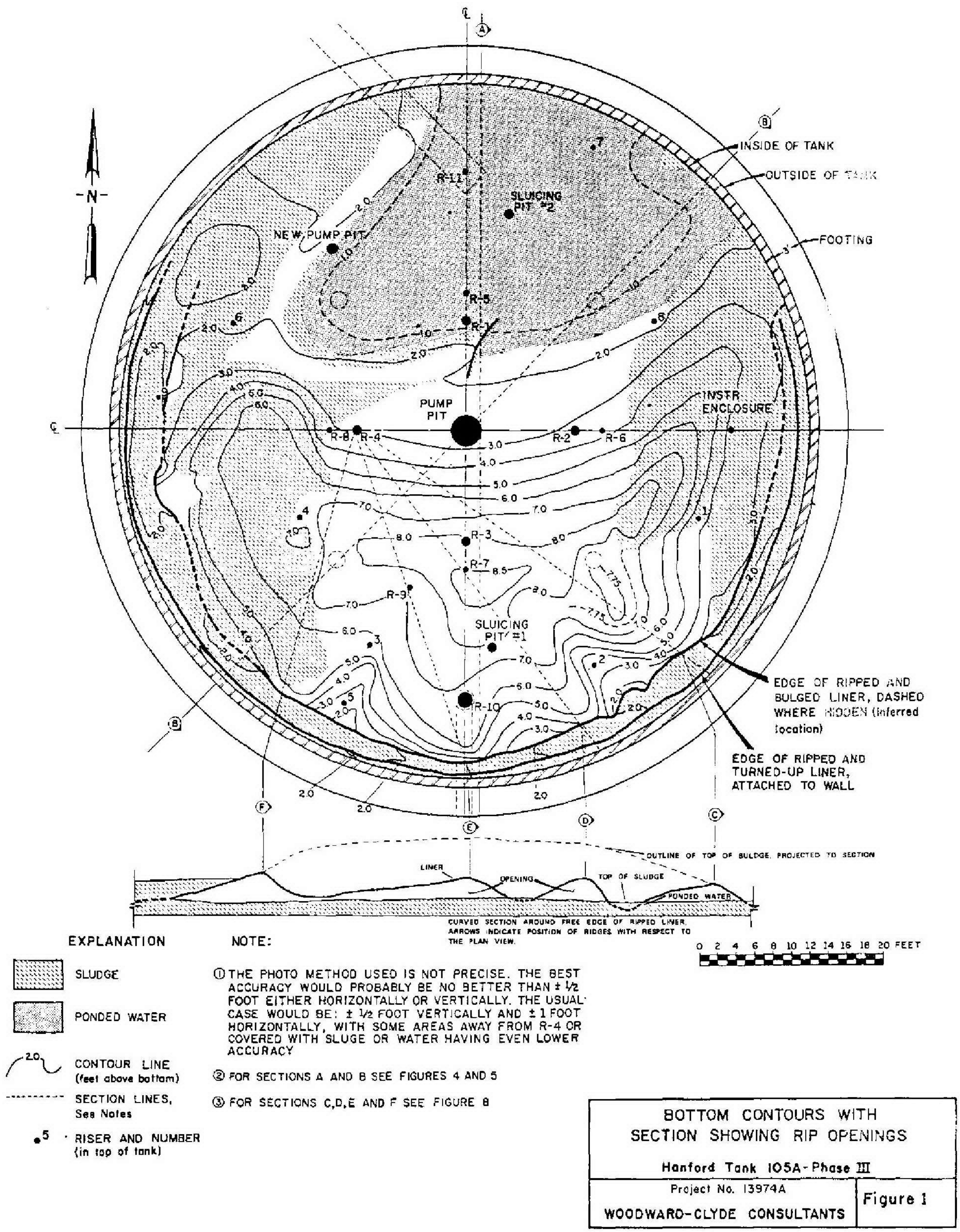
In 1977, photographs taken inside tank A-105 in 1969, 1970, and 1977 were reviewed to determine the amount of sludge remaining in the tank as well as develop a topographical map of the tank bottom (WCC Project 1397A-0300, *An Estimate of Bottom Topography, Volume and Other Conditions in Tank 105A, Hanford, Washington*). The topographical map of the tank bottom produced in 1977 is shown in Figure B3-3. This topographical map shows the bottom of the steel liner in tank A-105 is ripped and separated from the sidewall along approximately 3/4 of the tank bottom.

Figure B3-2. Tank 241-A-105 Quarterly Waste Fill History



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*.

Figure B3-3. Topographical Map of Tank 241-A-105 Bottom (1977)

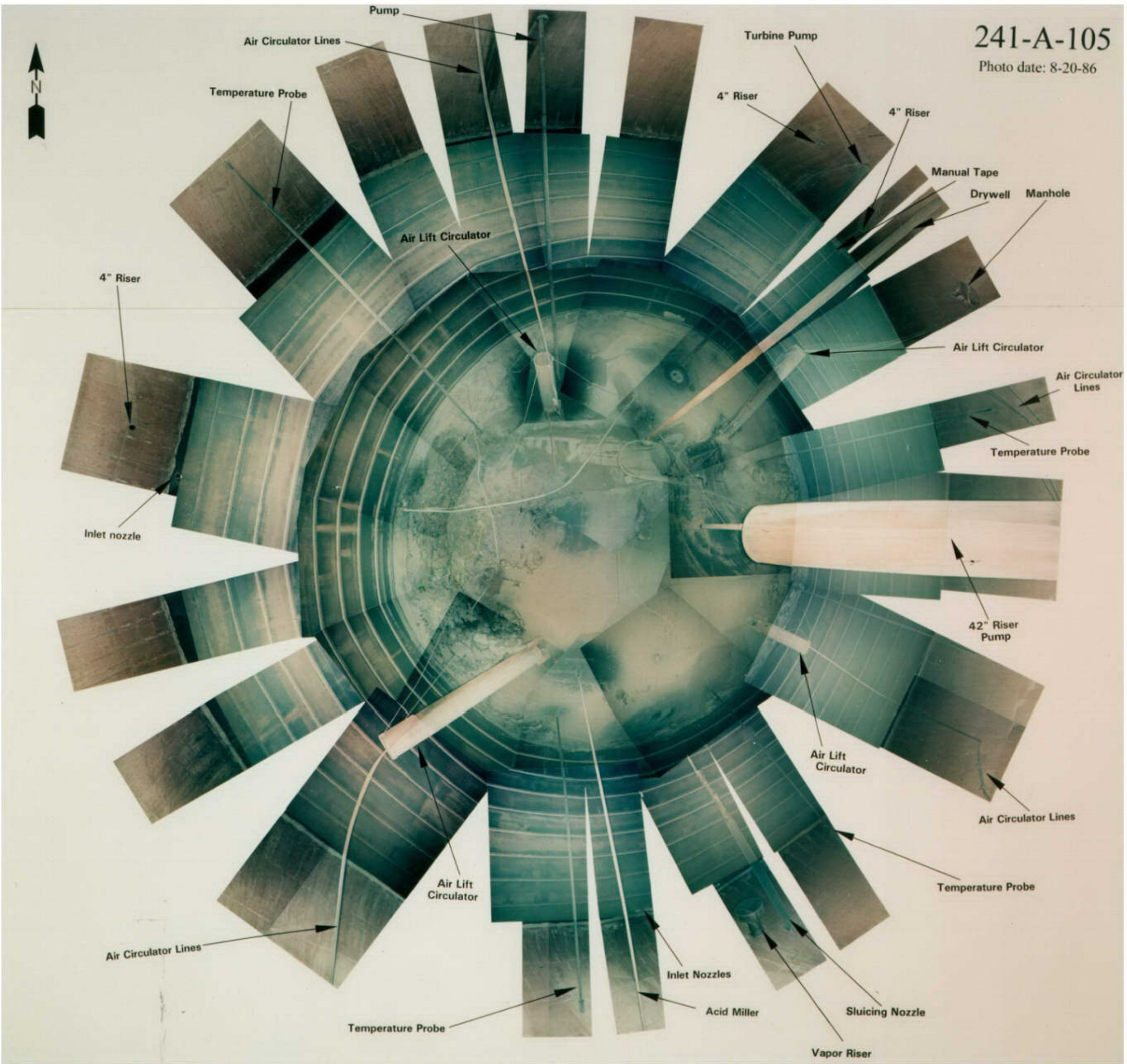


Reference: WCC Project 1397A-0300, *An Estimate of Bottom Topography, Volume and Other Conditions in Tank 105A, Hanford, Washington.*

B3.3 INTERIM STABILIZATION

Tank A-105 was declared interim stabilized effective July 31, 1979 based on a photograph evaluation dated June 21, 1979. Photographs showed "The surface appears dry with the exception of a wet spot trailing away from a circulator. The floor is approximately 40% bare metal, 30% a thin layer of sludge and the remaining 30% a heavier sludge primarily around the perimeter of the tank. The liner of the tank is almost free of scale except for a small ridge around the lower perimeter." (HNF-SD-RE-TI-178). Figure B3-4 shows a mosaic of in-tank photographs taken August 20, 1986.

Figure B3-4. Tank 241-A-105 Waste Surface Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

As of March 2014, tank A-105 is estimated to contain 37,000 gal of PUREX HLW sludge (P2); 8,200 gal between the bulged and ripped liner and the wall of the tank, 17,800 gal under the bulged liner of the tank, and 11,700 gal of sludge on the tank liner (RPP-RPT-42743, *2009 Auto-TCR for Tank 241-A-105*).

B3.4 TANK 241-A-105 TEMPERATURE HISTORY

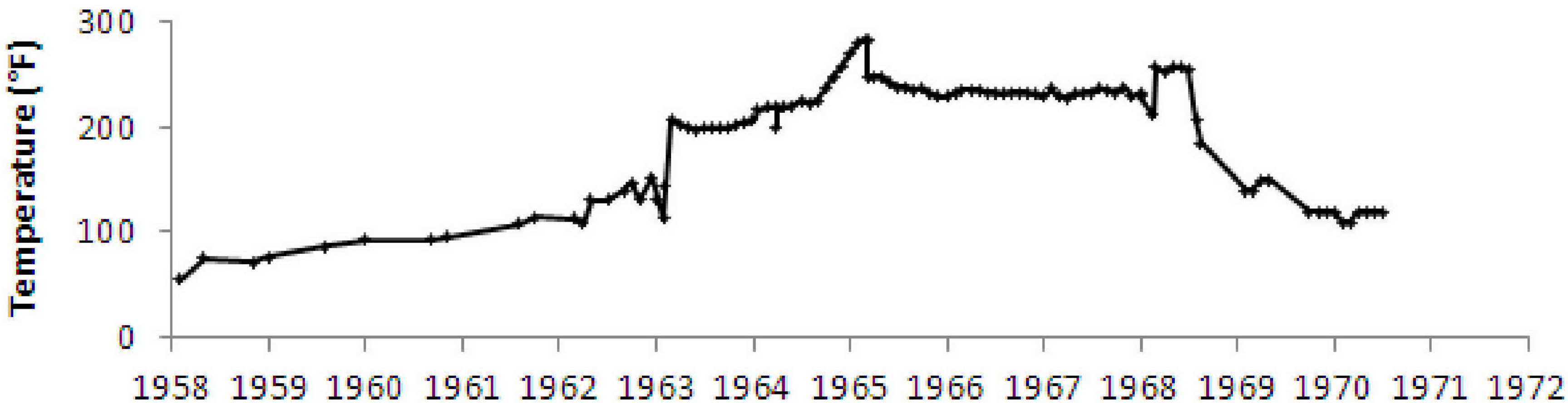
Tank A-105 was initially filled with water and sat unused until May 1962. Temperatures during this time ranged from 60 °F to 115 °F. Beginning in May 1962, tank A-105 was initially filled with aged PUREX HLW supernate and temperatures rose to ~150 °F. The tank A-105 HLW supernate was transferred out, leaving a 10-in. heel in January 1963. Beginning in January 1963, heating of tank A-105 was initiated by the addition of thermally hot condensate in preparation for receipt of PUREX self-boiling waste (WHC-MR-0264). After addition of PUREX self-boiling waste, tank A-105 reached boiling temperatures on March 5, 1963. Waste temperatures for tank A-105 were generally maintained between 180 °F to 285 °F from February 1963 through January 1965. A maximum waste temperature of 320 °F was recorded in March 1963 for tank A-105 (RHO-CD-1172, pp. B-39 to B-45). However, it appears this temperature was a reporting anomaly as temperatures were below 275 °F during this period and waste temperatures never reached above 300 °F during operation (see Figure B3-5).

On January 28, 1965, tank A-105 experienced a rapid pressurization event that resulted in the tank liner bulging. During this time, waste temperatures increased from 270 °F to the maximum temperature of ~285 °F in January and February 1965. On March 11, 1965, when the bulb thermocouple was replaced, temperatures were reported to be ~250 °F and remained relatively stable through June 1968. Temperatures then started to decline after removal of the tank A-105 supernate in preparation for the sluicing with a temperature of 120 °F recorded in June 1970. Waste temperatures for tank A-105 were recovered from May 1958 through June 1970 (Figure B3-5); no temperature data were recovered after June 1970 until 1985. Figure B3-6 shows Surveillance Analysis Computer System temperature data from 1985 to 2014. The temperature data from three risers shows that temperatures cycled annually. The temperature increased from ~130 °F in 1986 to ~150 °F in 1995 and has gradually returned to ~130 °F in 2014.

B3.4.1 Lateral Temperatures

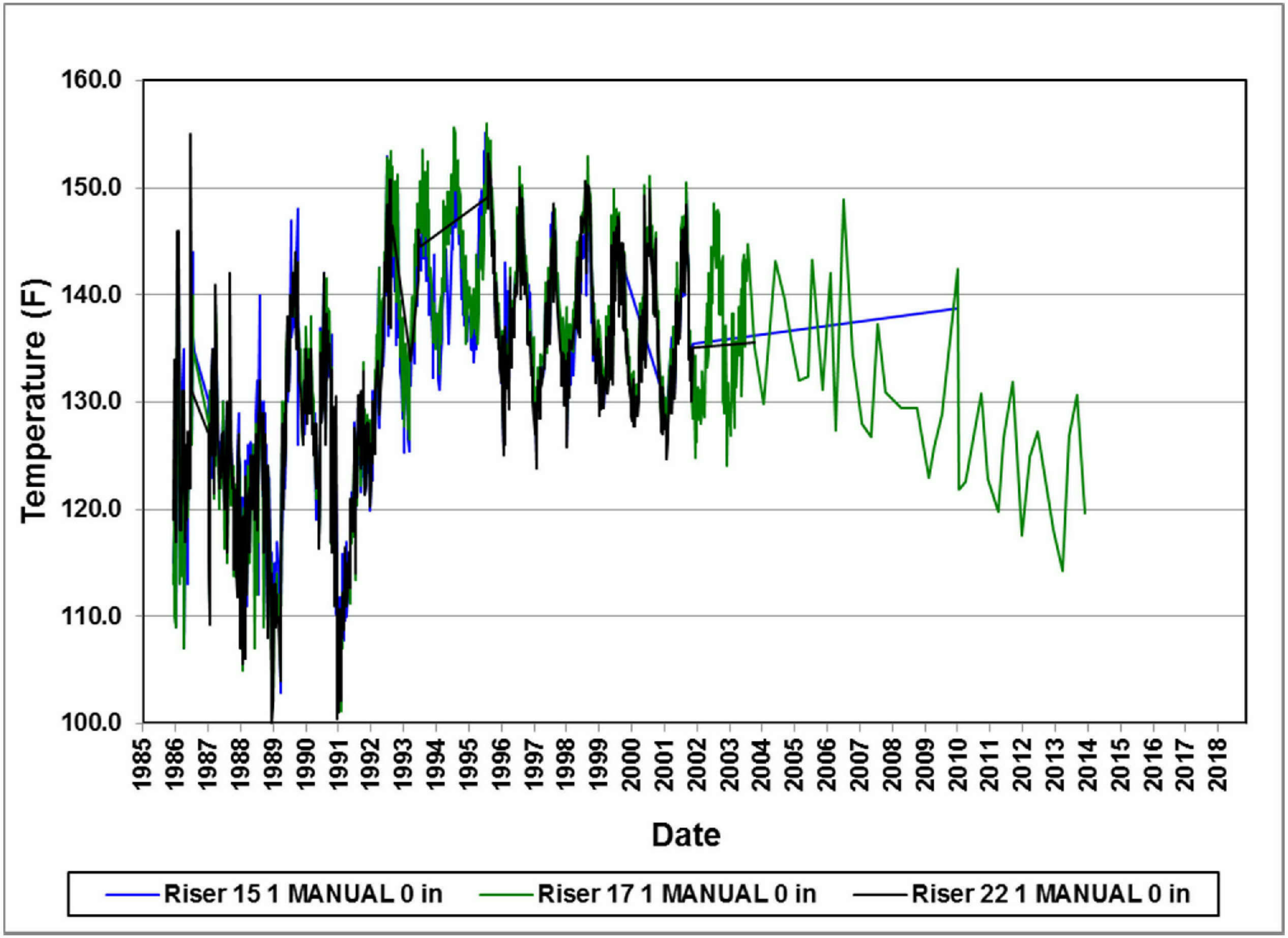
In addition to in-tank temperatures, soil temperatures were monitored in laterals ~10 ft beneath the tank (see Figure 3-6). A special probe was built to map the temperatures in the leak detection laterals (ARH-78) to better understand the accumulation of heat producing sludge under the bulged failed liner. The maximum temperature (310 °F) was found in lateral 14-05-03 in the north portion of the tank. Periodic measurements were made in all three laterals after the steam eruption in January 1965 in 1965 and 1966 and by October 1966 all three lateral maximum temperatures ranged between 205°F and 220°F.

Figure B3-5. Tank 241-A-105 Temperature History



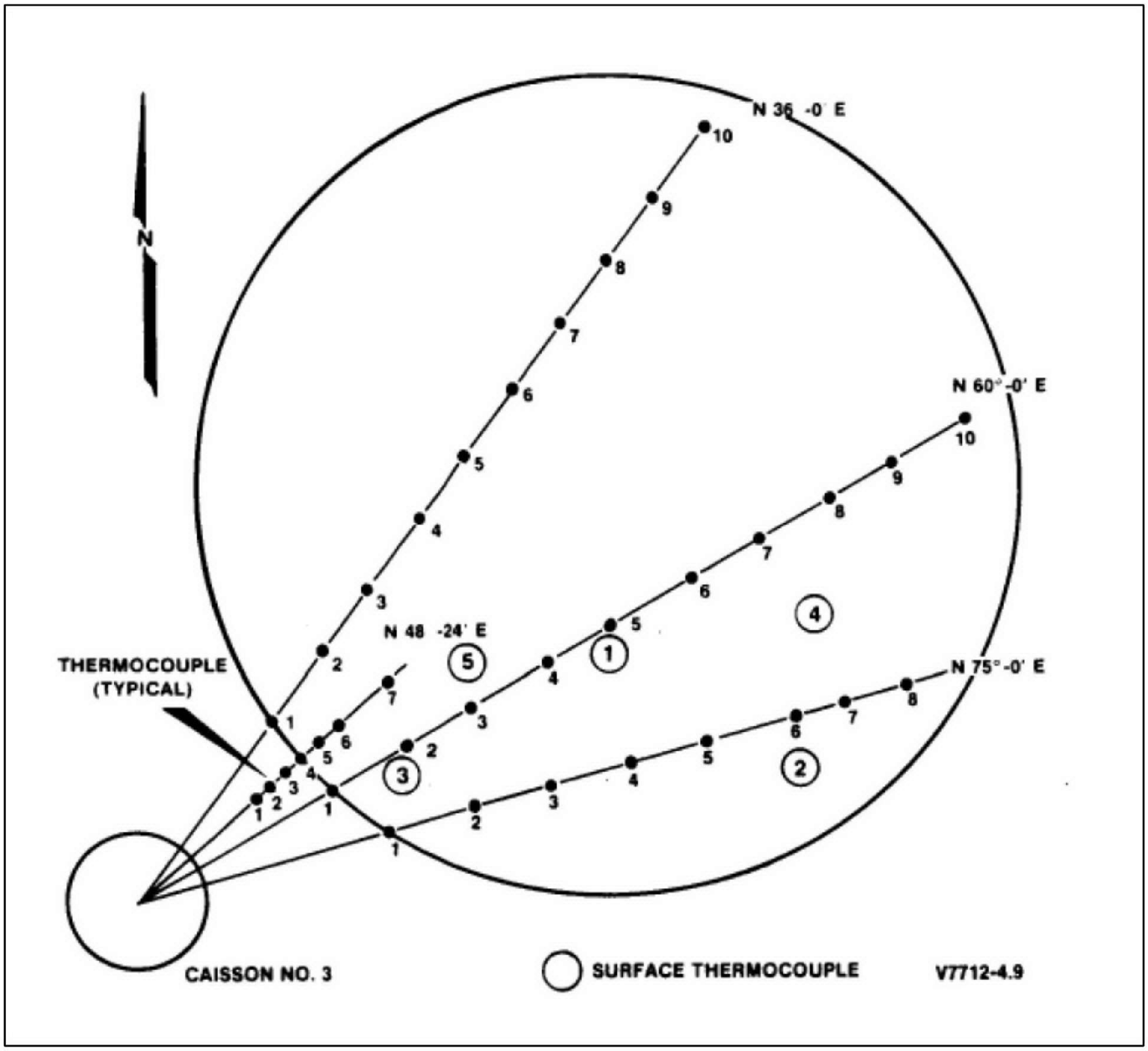
Reference: RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations - 241-A Farm*.

Figure B3-6. Tank 241-A-105 Temperature Data 1986 to 2014



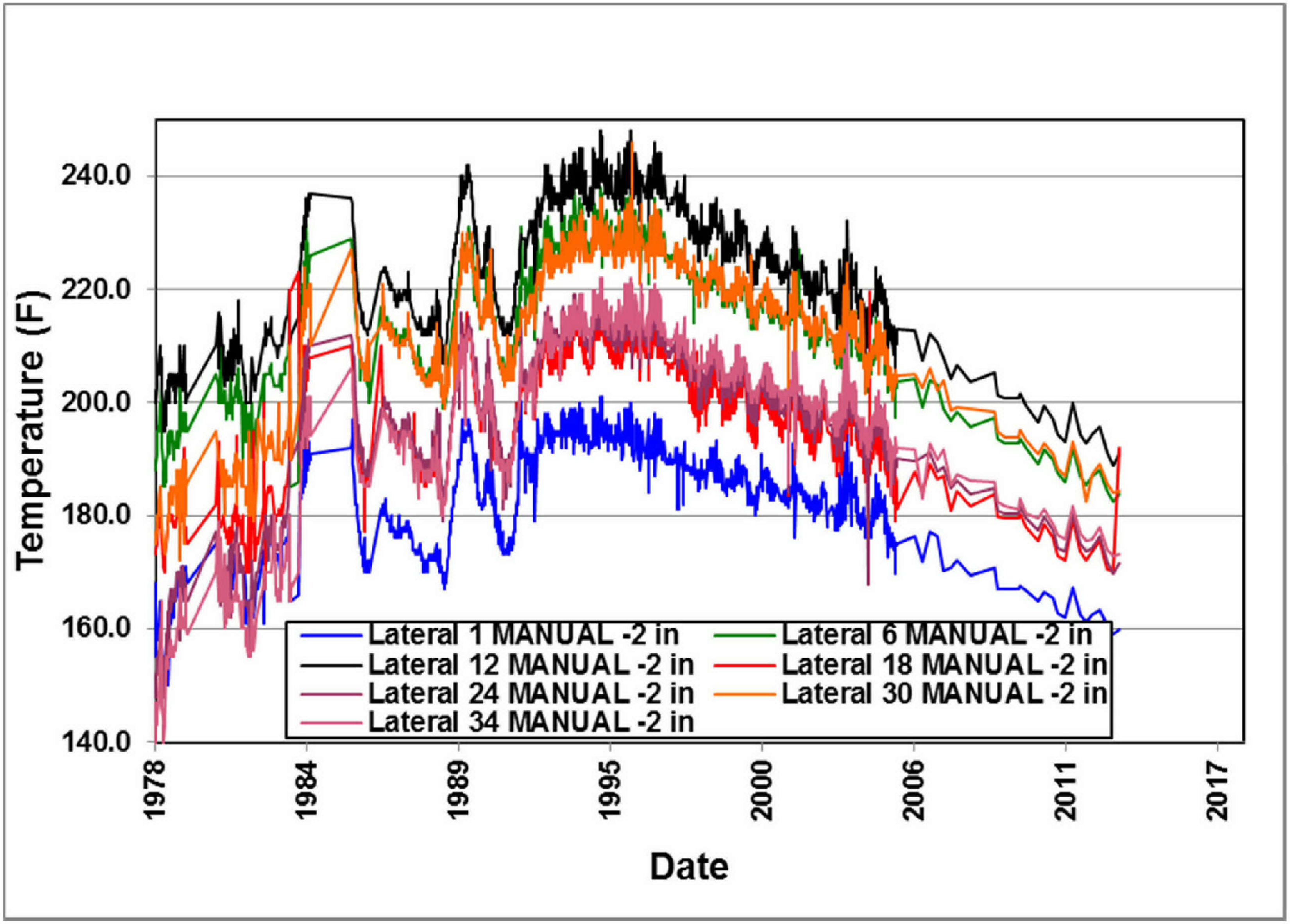
Four temperature laterals were later drilled 2 ft under tank A-105 with fixed thermocouples from caisson #3 located southwest of the tank (see Figure B3-7). Readings began in 1968, two years after the lateral temperatures mentioned above, with the highest temperature of 332 °F observed in both the number 8 and 9 thermocouples of lateral N 36°0'E.

Figure B3-7. Tank 241-A-105 Caisson #3 Temperature Laterals



This indicates that the temperatures two feet under the tank were probably much higher in 1965 and 1966, which would have far exceeded the concrete temperature limit of 325 °F (RHO-CD-255, *Tank 105-A Stabilization Progress Report*). These thermocouples were no longer the hottest when the report was written in 1978, when the highest reading in lateral N 36°0'E was reported at thermocouple number 3 at 215 °F. Temperatures were later found to be higher beneath the bulged area of the tank and highest beneath the sludge pile above the liner. Figure B3-8 shows Surveillance Analysis Computer System temperatures for the laterals in Figure B3-7 from 1978 to 2014.

Figure B3-8. Tank 241-A-105 Lateral Temperatures 1978 to 2014



B3.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data, and lateral logging data for tank A-105.

B3.5.1 Tank Surface Level Measurements

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

Prior to radioactivity being detected in lateral 14-05-03, unexplained liquid level fluctuations were noted in September 1963, some increases as large as 12 in. (33,000 gal). Document WHC-MR-0264 states "This indicates that steam was probably forming under the tank liner and deforming it upward at this early date. In one case, following an unexplained rise in the tank level, the data indicated that a drop in level was associated with a temperature drop, further supporting the steam theory."

With the conclusion that the possible sidewall leak in tank A-105 had self-healed, tank A-105 was kept in service and by December 1964, the tank was filled to its calculated metric tons of uranium equivalent capacity of ~315 in. (RL-SEP-87, *PUREX Waste Tank 241-A-105 Fill Limit*).

The tank was gradually refilled with no indication of leakage and the tank was considered operational. On January 28, 1965 when the steam release occurred in tank A-105, liquid levels were reported to be between 305 in. and 320 inches. Liquid levels were apparently not a focus during this time and no reports of unexplained liquid level changes were found. The tank continued to actively store waste until February 1968 with the liquid level maintained between 850,000 to 887,000 gal by addition of water. In April 1967, a cyclic liquid level variation began to occur in tank A-105 (ARH-78). A typical cycle consisted of a 9- to 10-in. drop in liquid level in a matter of minutes followed by a relatively stable period lasting about 20 hours. The liquid level then gradually increased to its original level in about a day. No significant movement of the steel liner could be detected during this time. It was assumed the explanation for this cyclic liquid level variation was due to the area between the bulged tank liner and its concrete pad alternates between a vapor and liquid phase (ARH-78).

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

The liquid level plot in Figure B3-2 indicates the transfers into and out of the tank. The liquid levels are end of quarter levels so this figure may not reflect all significant transfers into and out of tank A-105 that occurred during the operational history of the tank. See Figure B3-9 for historical monthly liquid level readings. Table B3-1 shows surface levels and changes from 1973 to 1986 (SD-WM-TI-356) and shows that cooling water was frequently added to the tank through 1976. Figure B3-10 shows Surveillance Analysis Computer System surface level measurements after 1980. The surface levels are erratic and fluctuate between 12 and 16 in., likely due to the bulge in the tank bottom liner. An Enraf® was installed and automated Enraf® readings obtained through 2008. After 2008 only quarterly manual Enraf® measurements have been obtained.

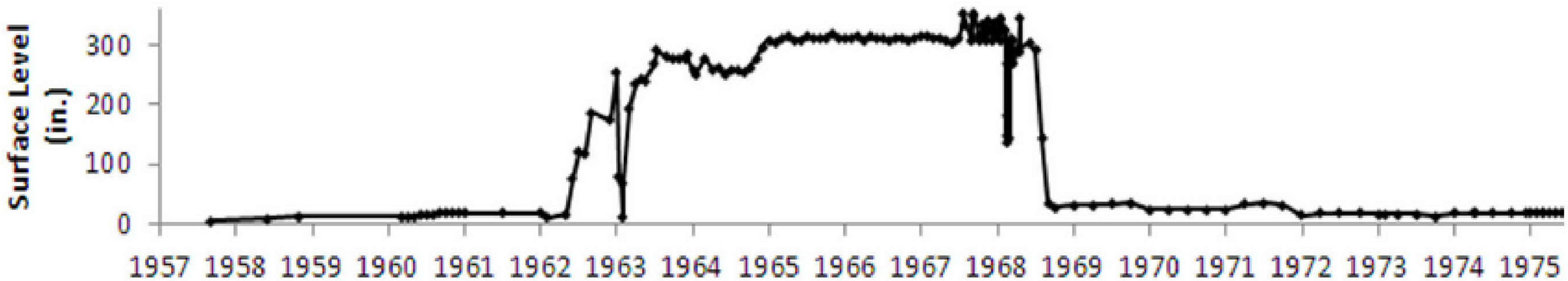
B3.5.2 Drywell Logging Data

Nine drywells surround tank A-105 (10-05-02, 10-06-09, 10-05-05, 10-05-07, 10-05-08, 10-04-04, 10-05-09, 10-05-10 and 10-05-12); Figure B3-11 shows the 1996 SGLS results for these drywells. The SGLS results are presented and discussed in GJ-HAN-110, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-105*.

Low activity ^{137}Cs (<1,000 pCi/g) was detected in the top 30 ft bgs in all of the drywells logged. A small amount of ^{154}Eu was detected at about 6 ft bgs in drywell 10-04-04. The ^{154}Eu appears to be associated with a shallow transfer pipeline. The ^{137}Cs in the drywells could have resulted from surface spills and/or pipeline leaks. Gamma radioactivity between depths of 10 and 30 ft bgs is mostly local to the drywell casing and was probably carried downward from the near-surface contaminated zone by drilling operations. Historical gamma logs (RPP-8820) indicate that near-surface gamma activity for drywells 10-05-08, 10-04-04 and 10-05-12 was present before 1975 (see Figures B3-12, B3-13 and B3-14) and some as early as 1965. Recoverable drywell readings before 1975 are presented in RPP-RPT-54912, Appendix D.2).

Low activity ^{137}Cs was also detected below 30 ft and extended to as deep as 75 ft in drywells 10-05-12, 10-05-02, 10-06-09, 10-05-05, 10-05-07, and 10-05-09; however, the contamination in this region of these drywells is probably local to the drywell casing and may have resulted from drag-down during drilling. An interval of ^{137}Cs was detected in drywell 10-05-10 from 76 to 86 ft. This contamination appears to be uniformly distributed in the soil. The presence of contamination in this interval was indicated by historical gross gamma logging before 1975 (Figure B3-15) and as early as 1972 (SD-WM-TI-356). Drywells 10-05-09 and 10-05-12 are not deep enough to have intersected this plume. Low-level ^{137}Cs contamination (less than 1 pCi/g) was encountered between 90 and 120 ft bgs in drywells 10-05-02 and 10-06-09, indicating that the plume may have extended to these drywells as well; however, the nature of the contaminant occurrence (local to the borehole or distributed in the formation) in these boreholes cannot be determined from the data available. Gamma activity detected at about 70 ft bgs before 1975 in drywells 10-05-02 and 10-06-09 (Figures B3-16 and B3-17) decayed away by 1980, indicating the presence of a short-lived, mobile isotope. In spite of the high gamma activity detected in tank laterals, very little gamma-emitting contamination was detected in the course of the SGLS logging.

Figure B3-9. Tank 241-A-105 Monthly Waste Surface Level Measurements (1957 to 1977)



Reference: RPP-RPT-54912, *Hanford Single-Shell Tank Leak Causes and Locations – 241-A Farm*.

Table B3-1. Tank 241-A-105 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 1 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
02/01/73	16.00				
	Water added continually to maintain liquid level between 18 and 20 in.				
04/15/74	18.00				
12/12/74	18.00				
03/04/75	18.50				
08/04/75	18.50				
08/05/75	22.50			N/A	4 in. water added accidentally. See OR 75-85
08/20/75	21.30				
08/28/75	20.00				
10/06/76	17.20				New minimum level of 17 in. water added as needed
05/17/78	17.00				Water added as needed. OR 78-49 written. Readings vary 17.00 to 18.00 in.
05/27/78	15.50				Level allowed to drop. New minimum of 15.00 in. established
10/12/78	15.50				Readings vary 14.50 to 16.00 in.
10/13/78	15.50				Decrease criteria removed
12/05/78	15.50				Water still added. Readings vary 14.75 to 16.00 in.
12/19/78	14.50				Water additions stopped
12/31/79	14.00		-0.50	-0.50	Slow decrease
12/08/80	14.50		+0.50		Slow increase
04/25/81	14.50				Stable
04/26/81	12.25				
05/04/81		12.25			MT in hole
05/28/81		14.50			Old tapes and obstructions under the MT--sludge readings
12/08/81		14.25	-0.25	-0.25	Readings fluctuate between 12.50 to 15.50 in.

Table B3-1. Tank 241-A-105 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 2 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
05/02/82	14.50		+0.25		Stable
05/03/82		16.00			New manual tape installed
12/08/82	15.00		-1.00	-1.00	Slow decrease
12/12/83	15.50		+0.50	-0.50	Stable
11/06/84	16.00		+0.50	0.00	Stable
09/02/85	12.00		-4.00	-4.00	Erratic decrease--readings fluctuate between 12.00 to 16.25 in.
11/04/85	12.00			-4.00	Stable
10/01/86	13.00		+1.00	-3.00	Readings fluctuate

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

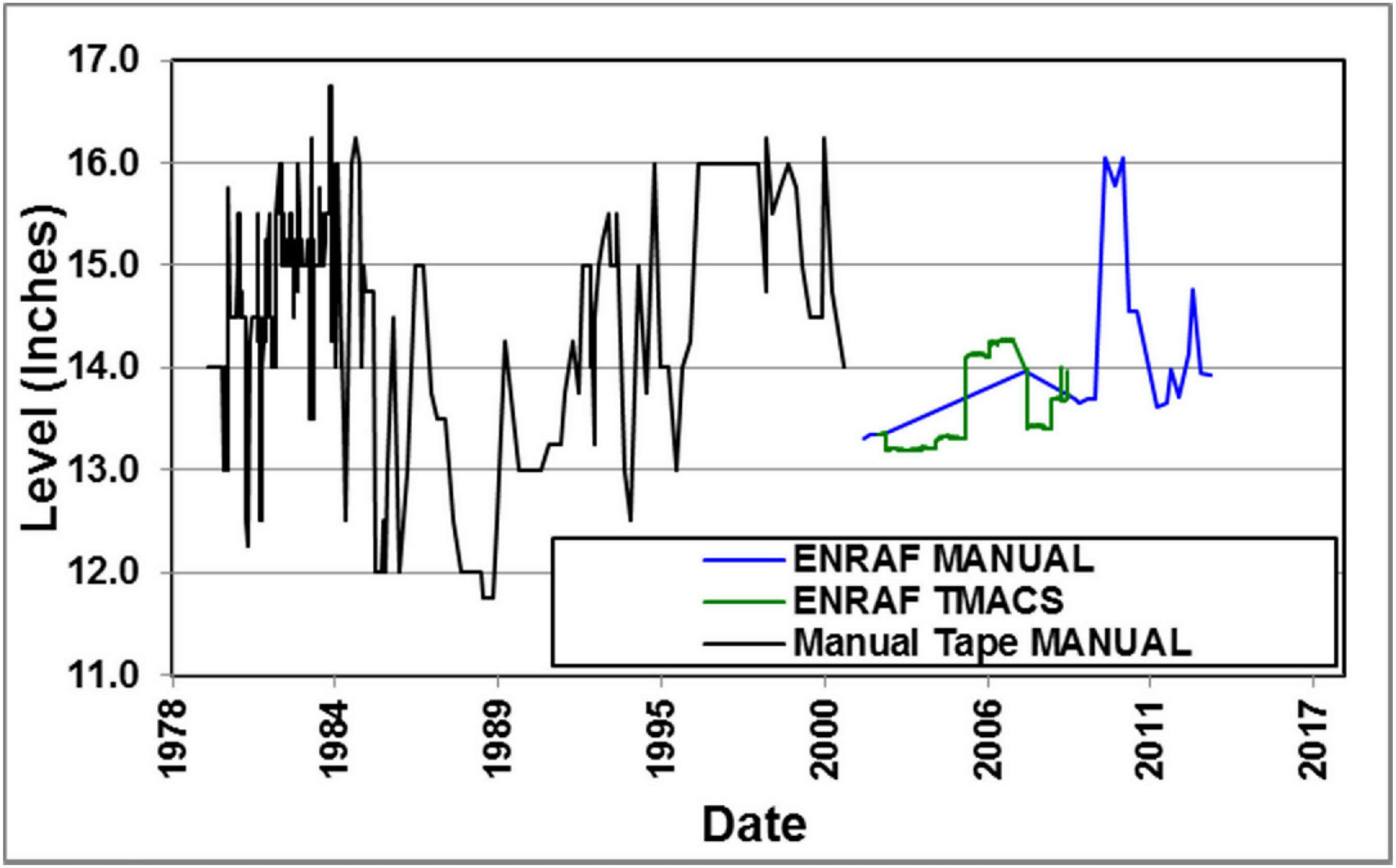
B3.5.3 Lateral Logging Data

Figure B3-18 shows the laterals beneath tank A-105 and gamma activity detected. Table B3-2 shows logging results from 1963 to 1986. The first indication of a tank A-105 leak occurred in November 1963 when elevated gross gamma levels were measured over a small segment in lateral 14-05-03 (see Appendix C2) on the southeast side of the tank. Initial readings were 17,000 cpm and continued to increase to 150,000 cpm a week later. Subsequently, radiation readings decreased to ~50,000 cpm by March 1965 indicating that the predominant gamma-emitting radionuclides were short-lived (ARH-78). During this time it was assumed that radioactivity detected in lateral 14-05-03 was due to a sidewall leak between 260 in. and 280 inches. However, after additional waste was added in 1964 bringing the waste level above 280 in., no recurrence of contamination was detected in lateral 14-05-03. If a sidewall leak had occurred, it apparently self-healed. No radioactivity was detected in the other laterals or drywells during this time.

Subsurface contamination was detected March 8, 1965 at 195,000 cpm in lateral 14-05-03 in the north portion of the tank. Three test wells were drilled near the end of lateral 14-05-03 to a depth of about 65 ft, or 10 ft below the tank bottom. Soil samples taken from the test wells showed no radioactivity (RL-SEP-509, *Chemical Processing Department Monthly Report for May, 1965*, pp. G-2) indicating contamination was likely localized.

On October 2, 1967, low-level radioactivity (~2,000 cpm) was detected in lateral 14-05-02 underneath the southeastern portion of the tank. A small leak was thought to have occurred during water additions to the 350-in. waste level (ARH-78). Gamma activity also increased in the laterals in July and August 1969 and in August 1970 (see Table B3-2).

Figure B3-10. Tank 241-A-105 Waste Surface Level Measurements



Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

Figure B3-11. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-A-105 (Sheet 1 of 2).

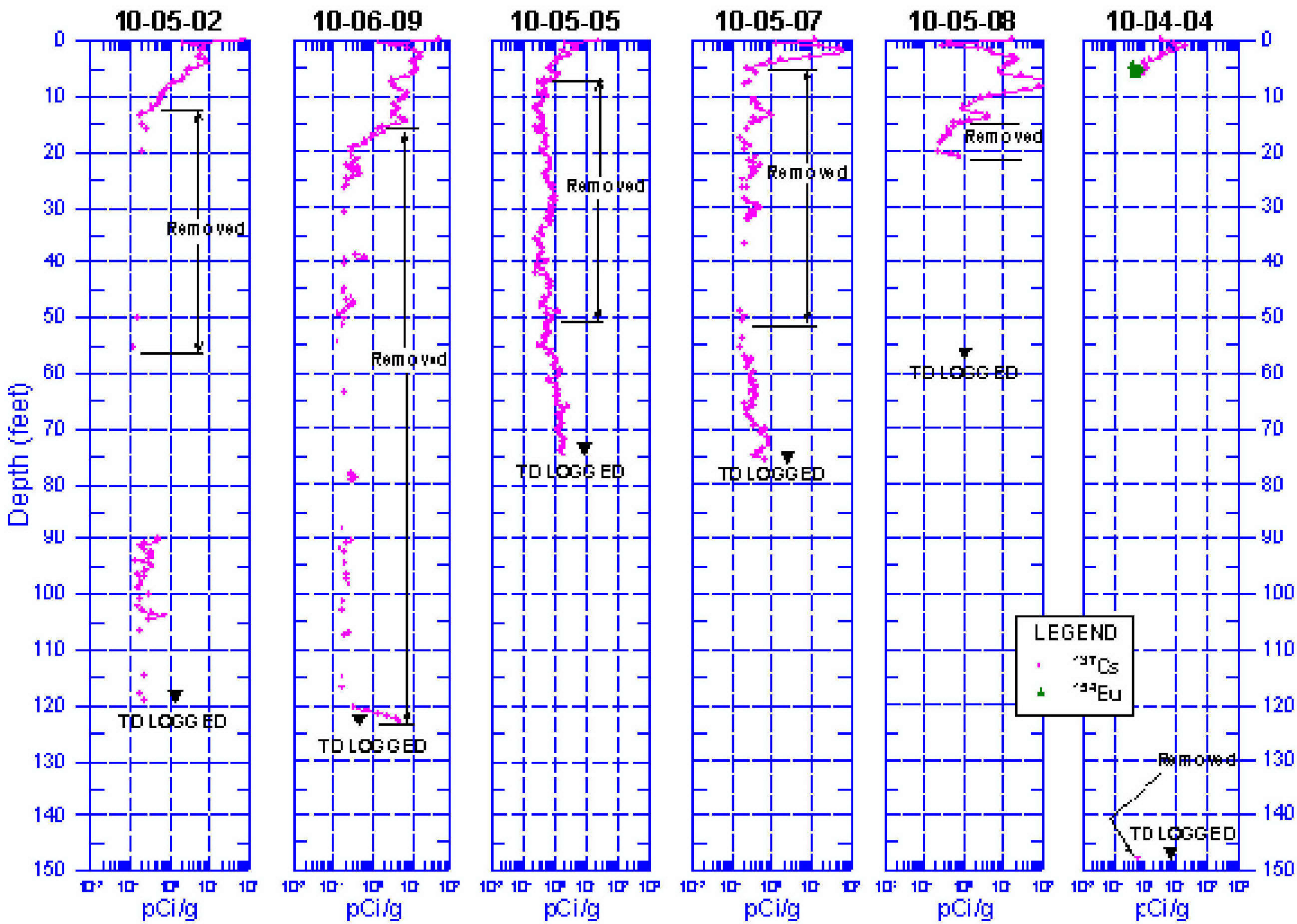
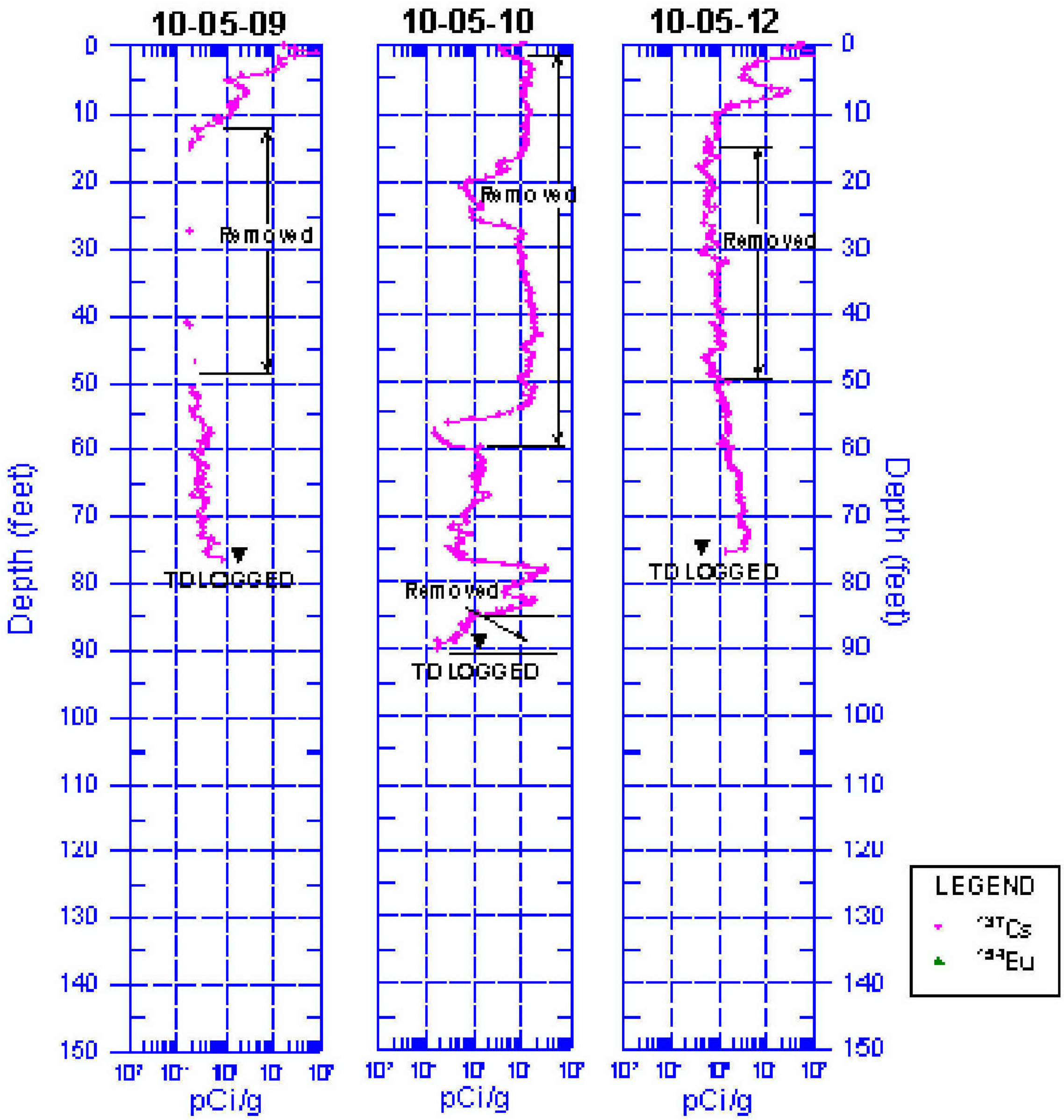


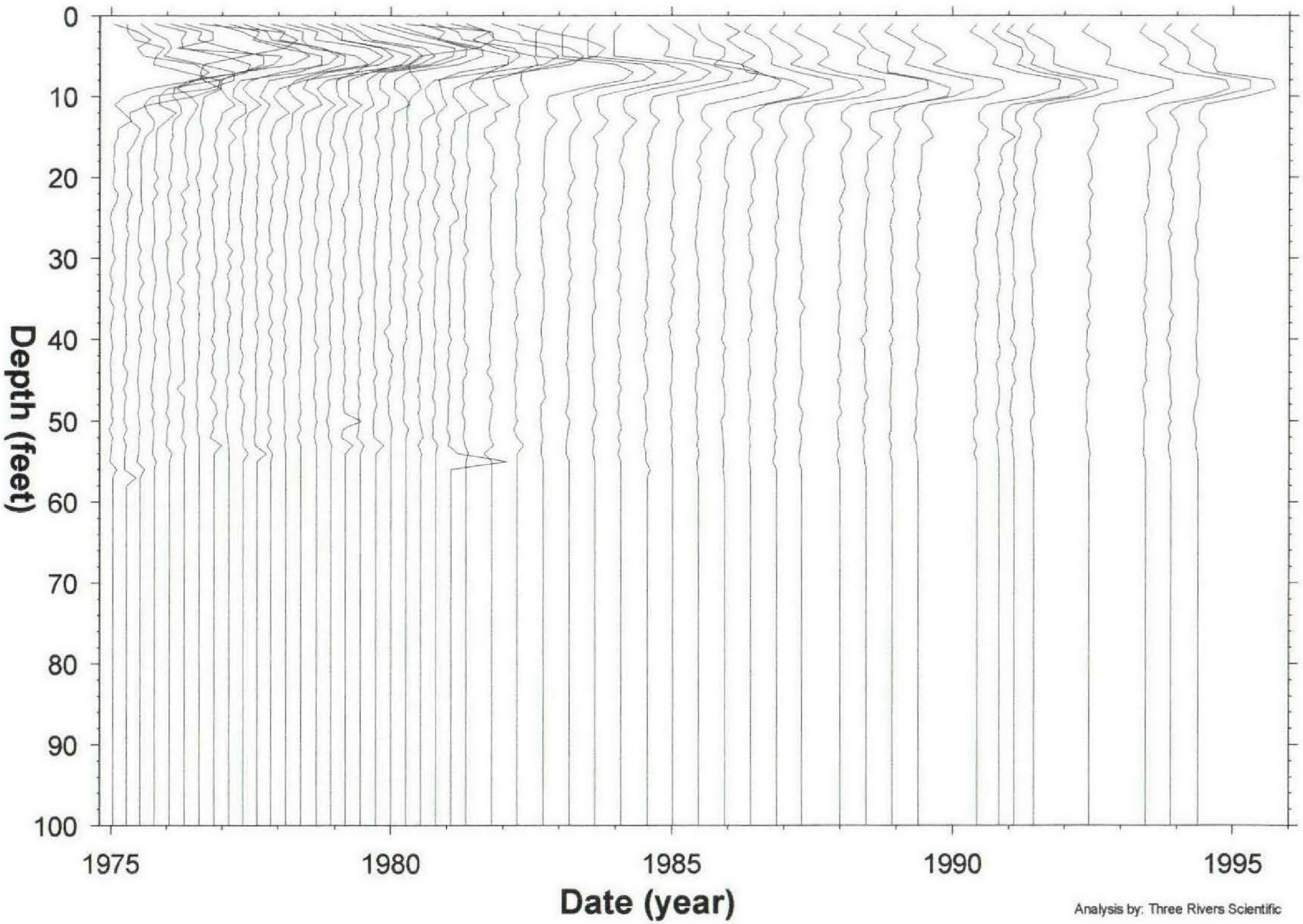
Figure B3-11. 1998 Spectral Gamma Logging Results for Drywells near Tank 241-A-105 (Sheet 2 of 2).



Note: Maximum value of log scales shown is 1,000 pCi/g.
Source: GJO-98-64-TAR/GJ-HAN-23, *Hanford Tank Farms Vadose Zone: A Tank Farms Report*.

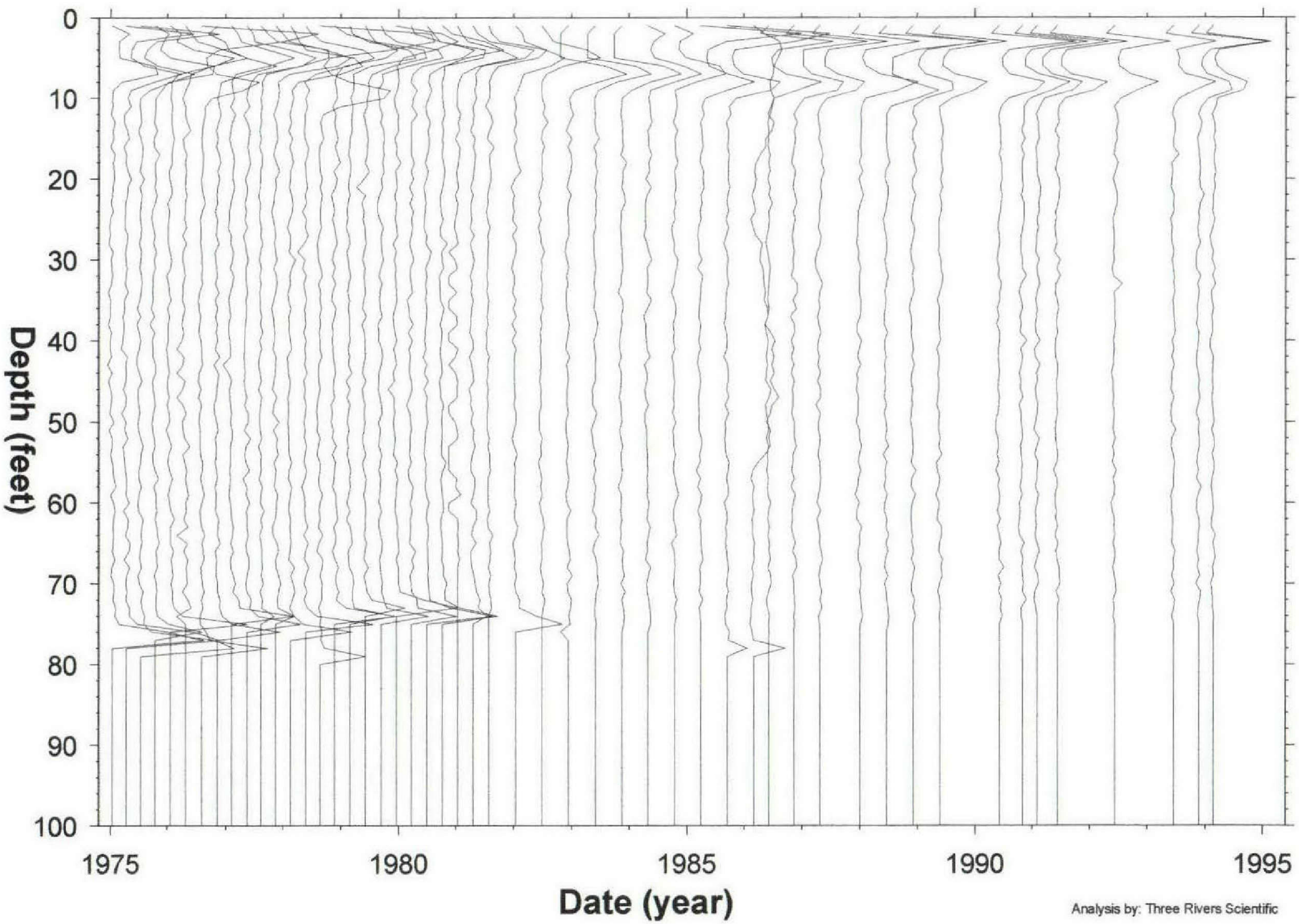
Gross gamma, sodium iodine scintillation, and temperature logging of the three laterals beneath tank A-105 was again conducted in April 2005 (RPP-RPT-27605, pp. B-15, B-17 and B-19). The logs for laterals under tank A-105 showed gamma activity along laterals 14-05-02L and 14-02-03L (Figure B3-19). These laterals interrogate the central portion (14-05-02L) and northeastern quadrant (14-05-03L) of the tank. The highest ^{137}Cs concentrations were found near the distal end of lateral 14-05-03, where cesium activity was estimated to be as high as 3.4×10^7 pCi/g, in close proximity to the highest temperature reading of 140 °F at the edge of the tank.

Figure B3-12. Tank 241-A-105 Historical Gamma Logging Results for Drywells 10-05-08



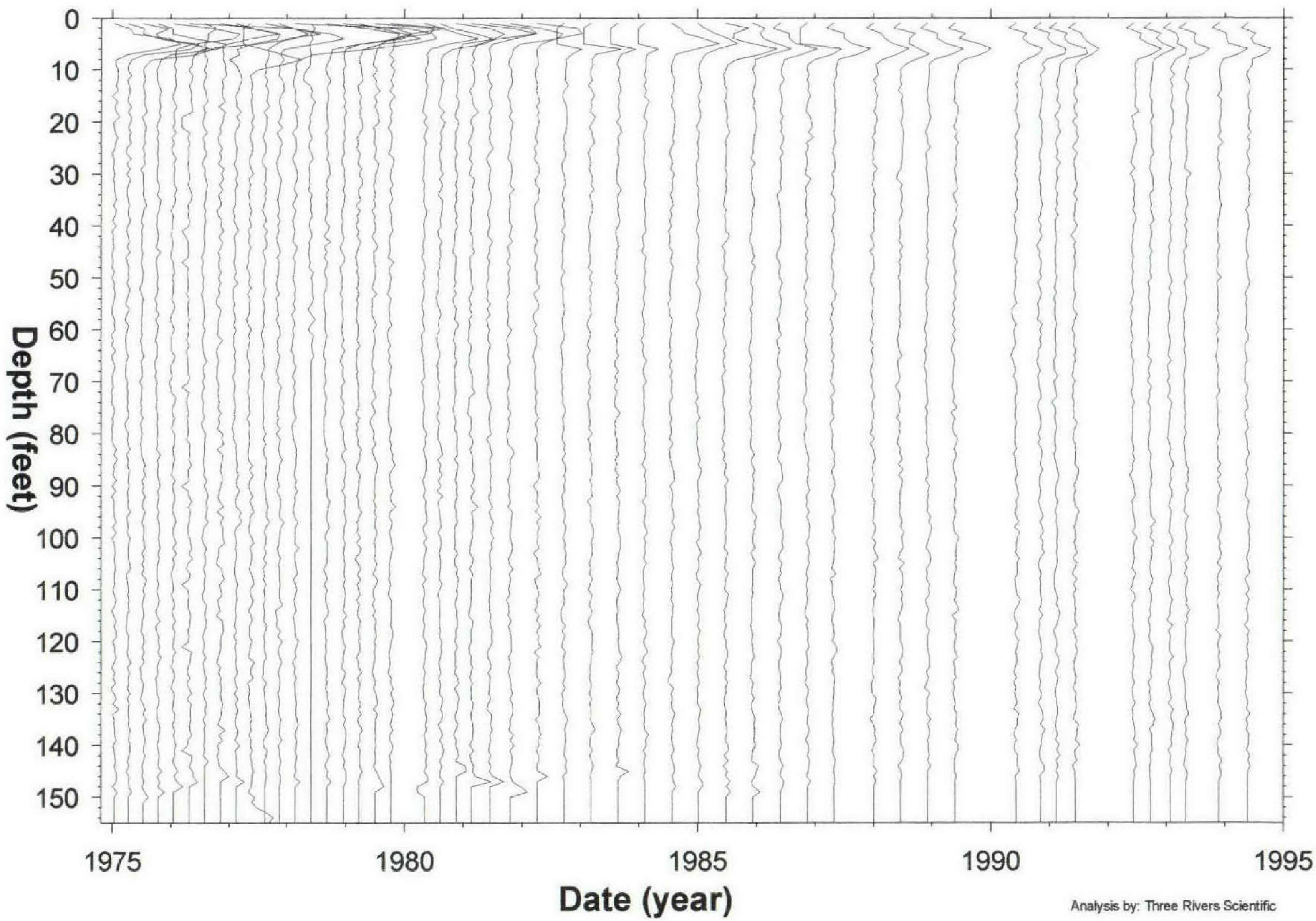
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B2-13. Tank 241-A-105 Historical Gamma Logging Results for Drywells 10-05-12



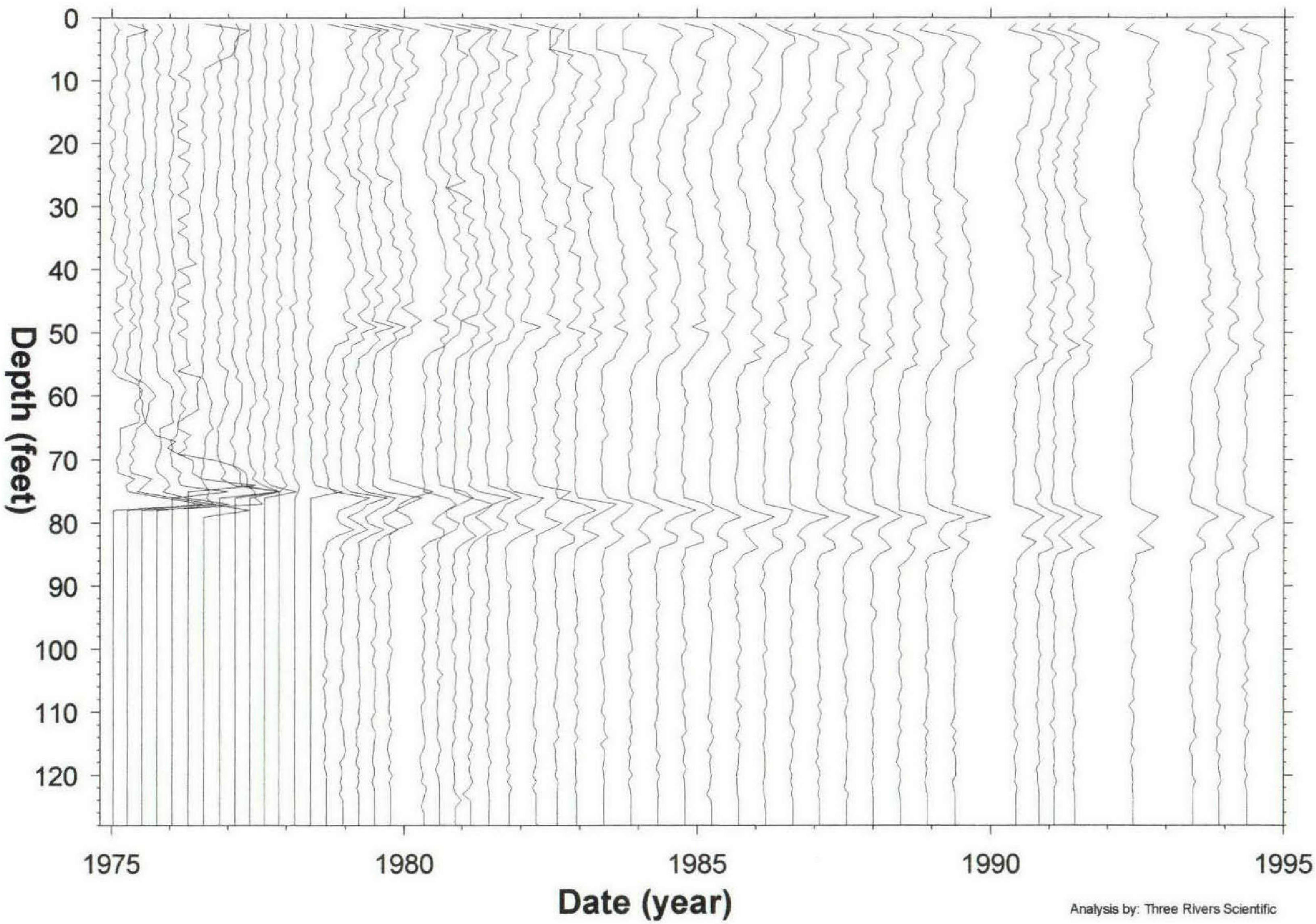
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B3-14. Tank 241-A-105 Historical Gamma Logging Results for Drywells 10-04-04



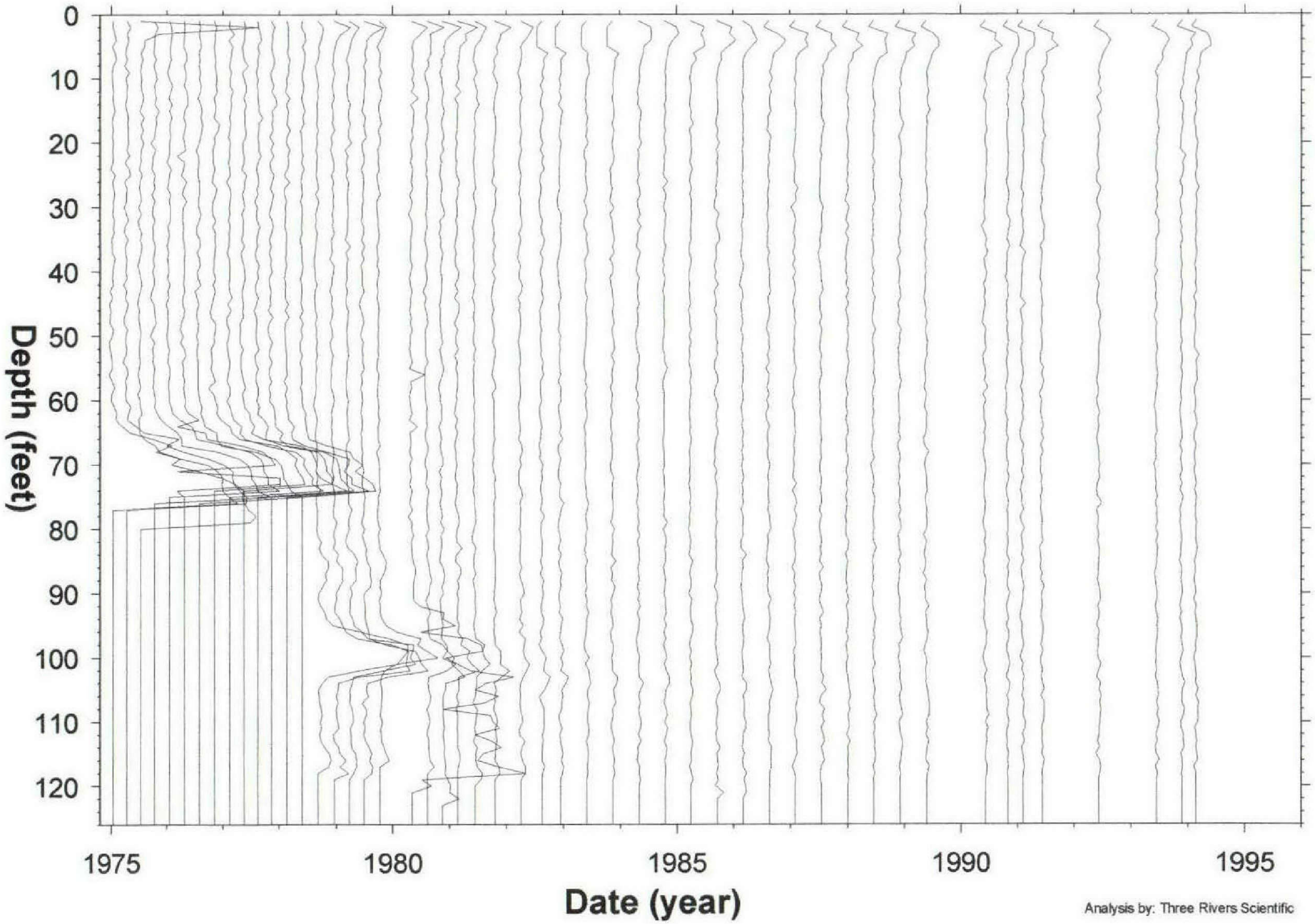
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B3-15. Tank 241-A-104 Historical Gamma Logging Results for Drywells 10-05-10



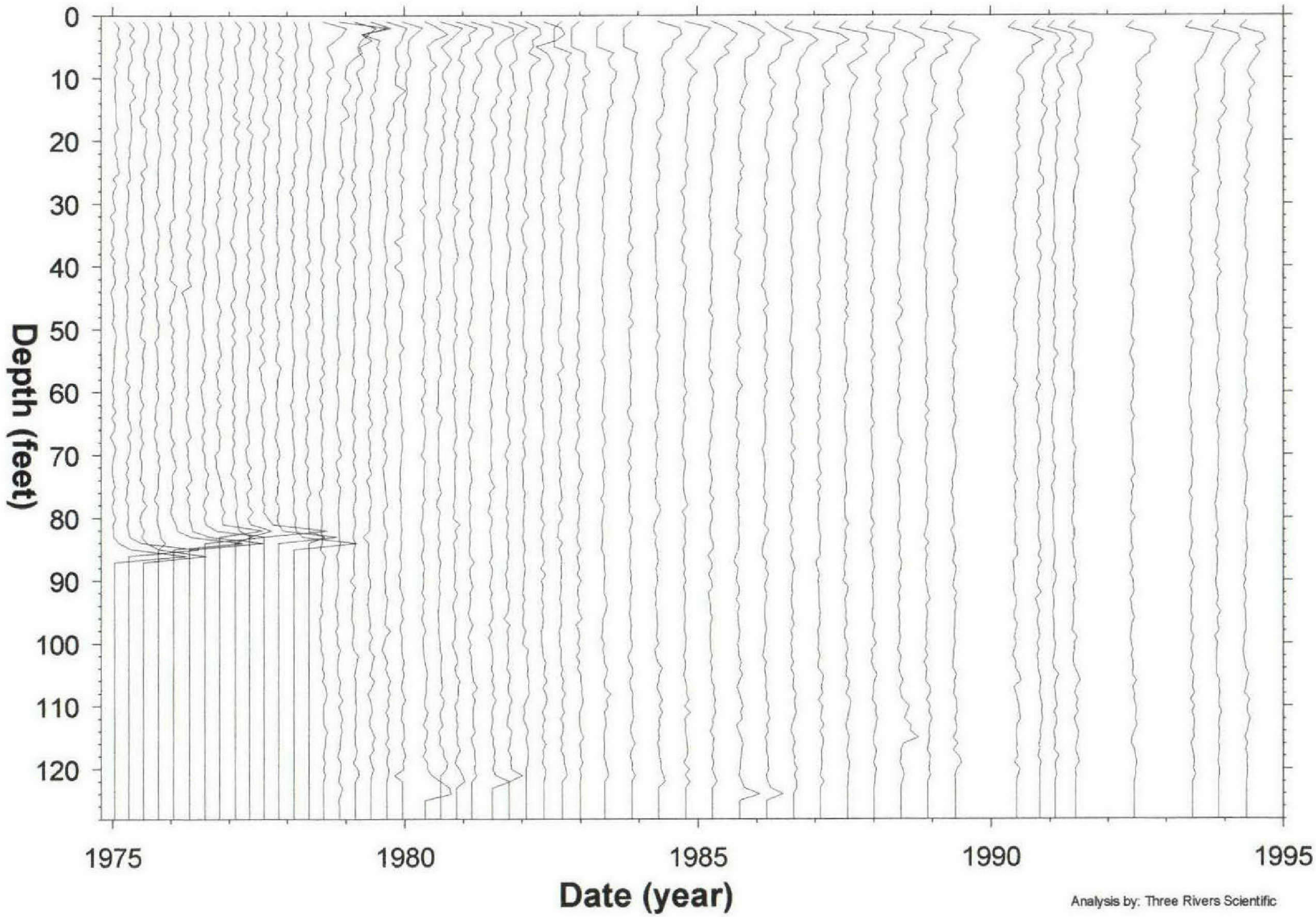
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B3-16. Tank 241-A-105 Historical Gamma Logging Results for Drywells 10-05-02



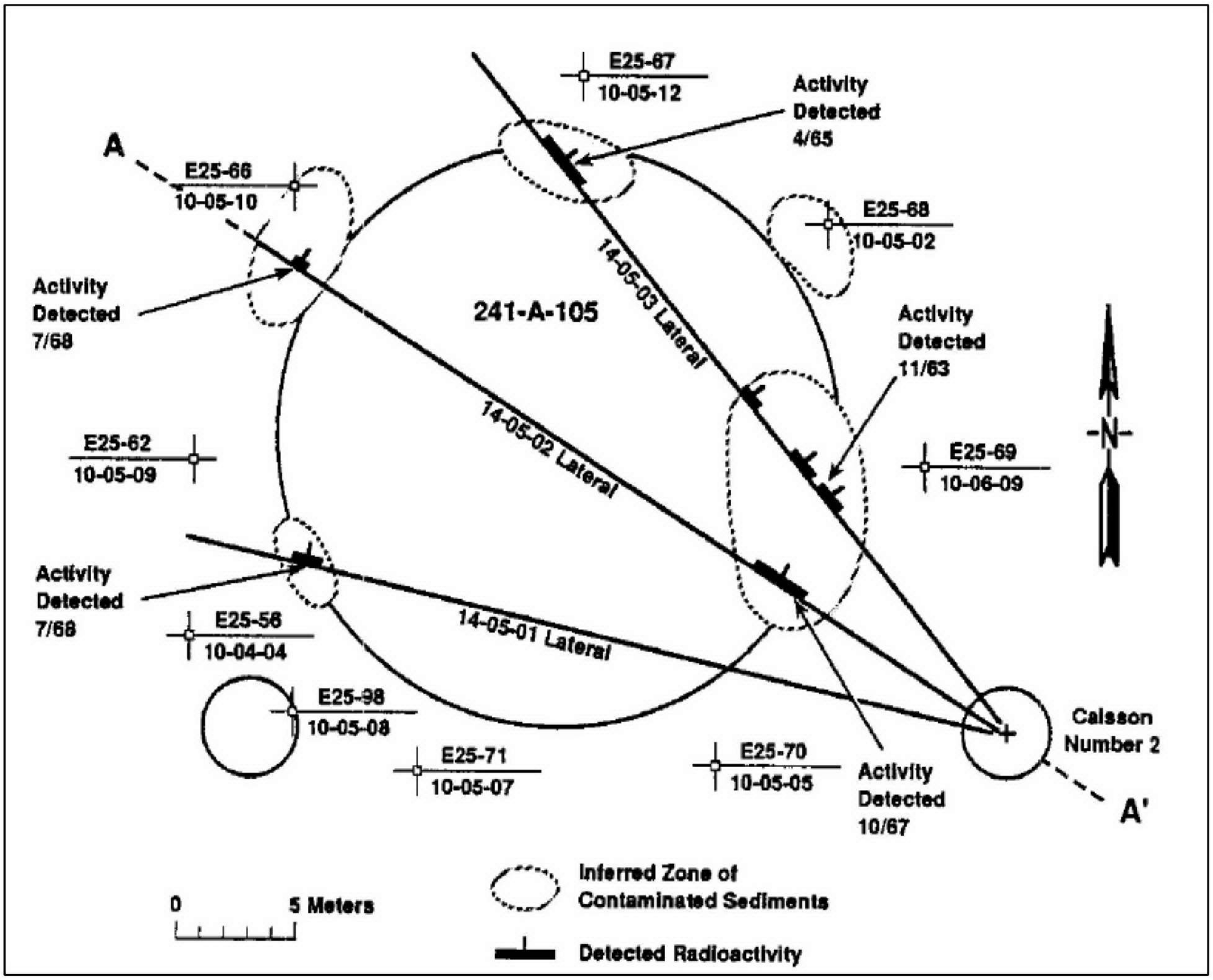
Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B3-17. Tank 241-A-105 Historical Gamma Logging Results for Drywells 10-06-09



Source: RPP-8820, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East.*

Figure B3-18. Location of Laterals and Gamma Activity for Tank 241-A-105



Note: The dates of lateral radioactivity increases and stabilization during August 1968 conflict between document WHC-MR-0264, *Tank 241-A-105 Leak Assessment* and WHC-EP-0412, *Fate and Transport of Constituents Leaked from Tank 241-A-105* and Interoffice Memorandum 7G420-06-004, "Estimation of Tank 241-A-105 Supernatant Cesium-137 Concentration During Sluicing in August 1968."

Table B3-2. Tank 241-A-105 Lateral Logging Results (1963 to 1986) (3 sheets)

14-05-01			14-05-02			14-05-03		
Date	**Peak (K cpm)**	**Length (ft)[a]**	**Date**	**Peak (K cpm)**	**Length (ft)[a]**	**Date**	**Peak (K cpm)**	**Length (ft)[a]**
N/A			N/A			11/19/63	17[b]	44.6[c]
N/A			N/A			11/26/63	150[b]	44.6[c]
N/A			N/A			3/8/65	195[b]	95.6[c]
N/A			N/A			1/31/66	225[d]	N/A
N/A			N/A			2/28/66	225[e]	N/A
N/A			N/A			3/31/66	225[r]	N/A
N/A			N/A			4/30/66	225[g]	N/A
N/A			N/A			5/31/66	225[h]	N/A
N/A			10/2/67	2[i]	N/A	N/A		
N/A			8/25/68	150	100	N/A		
N/A			9/1/68	380	100	N/A		
N/A			9/8/68	410	N/A	N/A		
10/29/68[j]	20[b]	N/A	10/29/68[j]	190[b]	N/A	10/29/68[j]	120[b]	N/A
8/70	40[b]	N/A	8/70	375[b]	N/A	8/70	960[b]	N/A
9/13/72	16.6	98	9/8/72	198	40	9/11/72	580	93
4/26/74	11.6	98	4/26/74	175	40	4/26/74	485	93
1/3/75	4.4	98	1/6/75	77	50	1/10/75	192	93
5/12/75	3.9	98	5/12/75	51	35	6/2/75	202.5	93
8/15/75	6.2	98	8/15/75	54	48	8/18/75	199.5	93

Table B3-2. Tank 241-A-105 Lateral Logging Results (1963 to 1986) (3 sheets)

14-05-01			14-05-02			14-05-03		
Date	Peak (K cpm)	Length (ft)[a]	Date	Peak (K cpm)	Length (ft)[a]	Date	Peak (K cpm)	Length (ft)[a]
1/7/76	6.3	98	1/21/76	54	48	1/5/76	198	96
6/4/76	5.8	94	8/30/76	79.3	49	8/30/76	273	94
9/10/76	7.5	94	N/A			10/4/76	347	94
12/6/76	7.7	94	12/8/76	82	49	12/8/76	356	93
3/28/77	7.3	94	3/28/77	80.7	49	3/28/77	310	93
6/9/77	23	89.6	N/A			N/A		
6/17/77	24[k]	88.6	6/17/77	195[k]	35.6	6/16/77	720[k]	97.6
9/5/77	27	89.6	9/5/77	180	28.6	9/5/77	648	95.6
12/9/77	26	89.6	12/9/77	162	28.6	12/9/77	570	95.6
N/A			N/A			3/29/78	387	95.6
N/A			N/A			5/8/78	516[b]	N/A
12/20/78	26	92.6	N/A			5/15/78	1,080[b]	N/A
N/A			6/5/78	180	28.6	6/26/78	810	95.6
N/A			N/A			9/27/78	660	95.6
N/A			N/A			12/20/78	870	95.6
12/25/79	23	92.6	12/25/79	138	28.6	12/25/79	192	96.6
12/16/80	14[l]	92.6	12/16/80	136	38.6	12/16/80	222[l]	88.6
				136[l]	28.6			
12/28/81	18	92.6	10/28/81	159	28.6	10/28/81	434	87.6
12/15/82	22	92.6	12/15/81	149	27.6	12/15/82	398	87.6

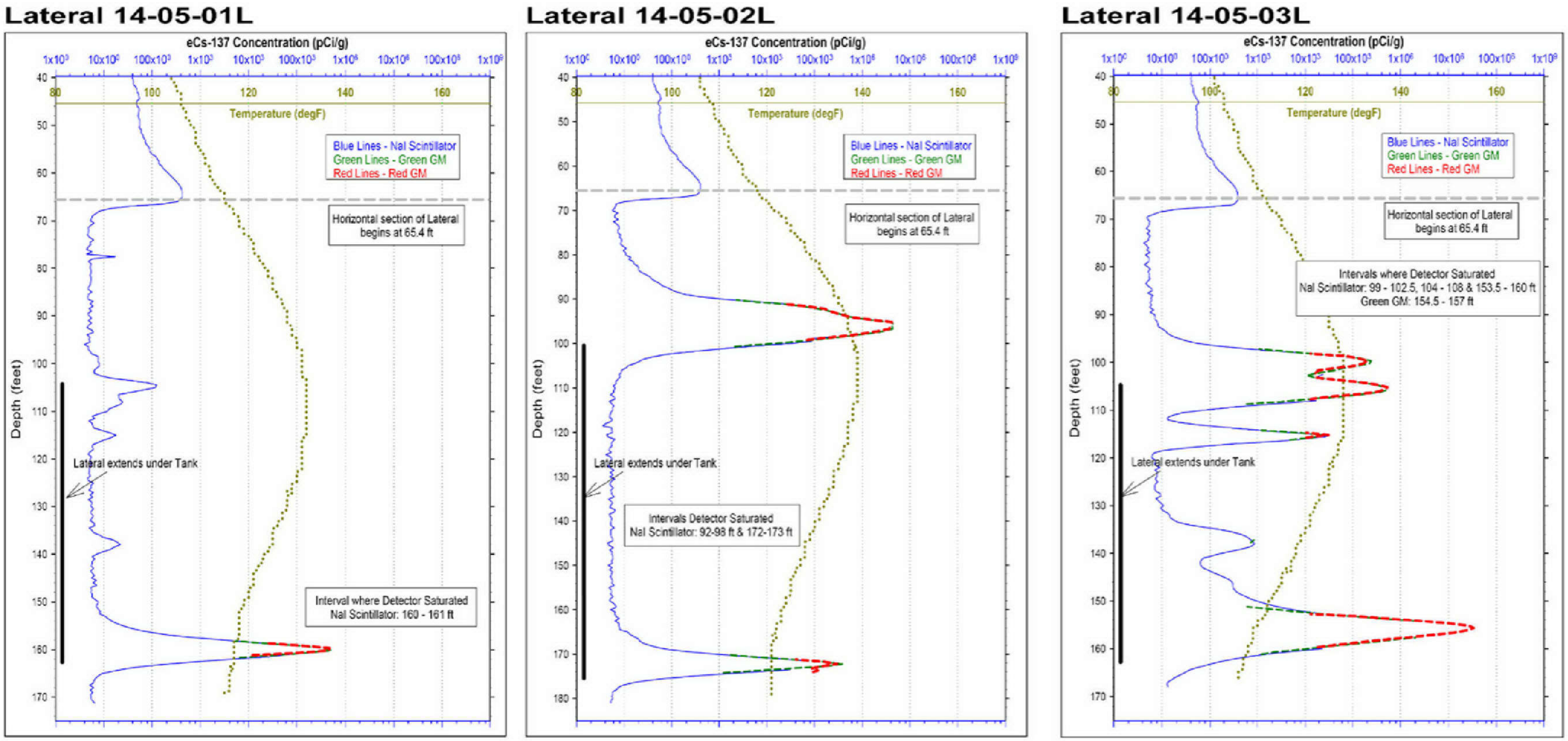
Table B3-2. Tank 241-A-105 Lateral Logging Results (1963 to 1986) (3 sheets)

14-05-01			14-05-02			14-05-03		
Date	Peak (K cpm)	Length (ft)[a]	Date	Peak (K cpm)	Length (ft)[a]	Date	Peak (K cpm)	Length (ft)[a]
8/26/83	14	93.6	8/26/83	103	40.6	8/26/83	126	88.6
9/1/83	19	96.6	9/1/83	164	41.6	9/1/83	527	86.6
11/18/83	9	94.6	11/18/83	132	40.6	11/18/83	236	88.6
10/15/84	10	94.6	10/15/84	147	41.6	10/15/84	400	88.6
9/26/85	14	94.6	9/26/85	122	42.6	9/26/85	394	89.6
6/20/86	16	97.6	6/20/86	136	41.6	6/20/86	480	89.6

N/A = Data not available

[a] Length is distance from the caisson.
[b] Referenced from WHC-MR-0264, *Tank 241-A-105 Leak Assessment*.
[c] Referenced from WHC-MR-0250, *Waste Tank 241-A-105 Supporting Documentation, Miscellaneous Reports, Letters, Memoranda, and Data*.
[d] HAN-93855 Report #1, *200 Area Monthly Report for January 1966*.
[e] HAN-93855 Report #2, *200 Area Monthly Report for February 1966*.
[f] HAN-93855 Report #3, *200 Area Monthly Report for March 1966*.
[g] HAN-93855 Report #4, *200 Area Monthly Report for April 1966*.
[h] HAN-93855 Report #5, *200 Area Monthly Report for May 1966*.
[i] Referenced from ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and Its Implications on Waste Containment and Control* and HAN-98918, *Monthly Status and Progress Report October 1967*.
[j] Activity measuring instrument repaired which corrected these values from previous readings.
[k] New monitoring equipment.
[l] New measuring method

Figure B3-19. Summary Gamma Survey for the Laterals under Tank 241-A-105



B4.0 TANK 241-AX-102

This section provides information on the historical waste loss event associated with tank AX-102. Waste operations for tank AX-102 are summarized in Figure B4-1. Figure 3-5 of the main text shows a plan view of a typical tank in AX Farm with the location of the pump pit, sluice pit, spare inlet nozzles (A, B, C and D) and tank risers.

B4.1 TANK 241-AX-102 WASTE HISTORY

Construction of SST AX-102 was completed in January 1965 (HAN-90650, *Monthly Status and Progress Report January 1965*, pp. 16).

B4.1.1 Plutonium Uranium Extraction High-Level Waste Receipt (1965 to 1967)

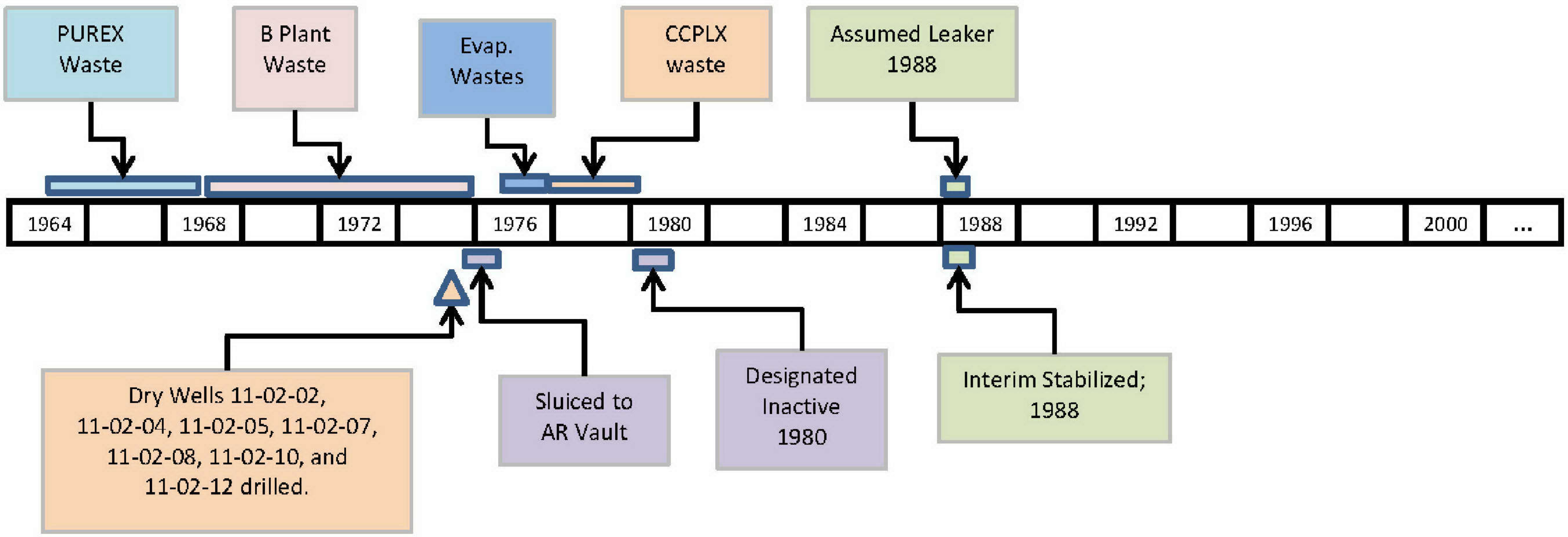
Water was added to the tank in the fourth quarter of FY 1965 (RL-SEP-821, *Chemical Processing Department Waste Status Summary July 1, 1965 through September 30, 1965*, pp. 8) and the first quarter of FY 1966 (RL-SEP-923, *Chemical Processing Department Waste Status Summary October 1, 1965 Through December 31, 1965*, pp. 8). The water added to SST AX-102 was likely done as part of the preheating procedure. The standard practice employed for the 241-AX tanks was to add water and preheat the water prior to adding boiling waste from the PUREX plant.

In the fourth quarter of 1966, SST AX-102 received HLW from the PUREX plant (ISO-538, *Chemical Processing Division Waste Status Summary July 1, 1966, Through September 30*, 1966, pp. 8). Additional PUREX plant HLW was received in the first quarter of FY 1967 as well as some concentrated PUREX HLW from SST 241-AX-101 (AX-101), which was equipped with a steam coil (ISO-674, *Chemical Processing Division Waste Status Summary October 1, 1966, Through December 31, 1966*, pp. 8 and H-2-34266, *4" Steam Condensate Line – 241-AX-101 to 241-A-417 - Plan & Det's*). Approximately 883,000 gal of PUREX HLW was contained in SST AX-102 at the end of the first quarter of FY 1967, but the tank temperature had not reached conditions for waste boiling. From January 1967 through September 1967, SST AX-102 periodically received HLW from the PUREX plant and transfers of supernate to SST AX-101 were conducted.

B4.1.2 Single-Shell Tank 241-A-105 Flushes Receipt (1968)

In the second quarter of FY 1968, the PUREX HLW supernate was transferred from SST AX-102 to SST 241-TY-103 (ARH-534, pp. 8) in order to use SST AX-102 for receiving supernate flushes from SST A-105, in preparation for sluicing SST A-105 (ARH-534, pp. 9). Tank AX-102 continued to receive SST A-105 supernate via SST A-103 in the third quarter of FY 1968 (ARH-721, *Chemical Processing Division Waste Status Summary April 1, 1968 Through June 30, 1968*, pp. 9). Periodic transfers of supernate were made from SST AX-102 to tank C-105 from the third quarter 1968 (ARH-871, *Chemical Processing Division Waste Status Summary July 1, 1968 Through September 30, 1968*, pp. 9) through the first quarter of FY 1969

Figure B4-1. Tank 241-AX-102 Waste Operations Summary



CCPLX = concentrated complexed waste
PUREX = Plutonium Uranium Extraction (Plant)

(ARH-1061, *Chemical Processing Division Waste Status Summary October 1, 1968 Through December 31, 1968*, pp. 10) to stage the PUREX supernate (P1) for cesium ion exchange processing in B Plant.

B4.1.3 221-B Plant Waste Evaporation (1969 to 1972)

Tank AX-102 was then flushed and preheated for service in the second quarter of FY 1969 to receive waste (ARH-1200 A, pp. 10). The flush solutions were transferred to SST C-105 for staging to the cesium ion exchange process in B Plant.

Tank AX-102 was reported to have reached boiling conditions in April 1969 (RHO-R-39), but documented temperature data was found for only the period of July 1969 through September 1971, which shows the waste temperature varied from 220 to 250 °F (RHO-CD-1172, pp. B-58 and B-59). Tank AX-102 received B Plant waste and small transfers of PUREX HLW in the third and fourth quarters of FY 1969 (ARH-1200 B, pp. 10 and ARH-1200 C, *Chemical Processing Division Waste Status Summary July 1, 1969 Through September 30, 1969*, pp. 10). Tank AX-102 continued to receive B Plant waste from the first quarter of FY 1970 through the second quarter of FY 1971 (ARH-1200 D, pp. 10, ARH-1666 A, *Chemical Processing Division Waste Status Summary January 1, 1970 Through March 31, 1970*, pp. 10, ARH-1666 B, *Chemical Processing Division Waste Status Summary April 1, 1970 Through June 30, 1970*, pp. 10, ARH-1666 C, *Chemical Processing Division Waste Status Summary July 1, 1970 Through September 30, 1970*, pp. 10, ARH-1666 D, *Chemical Processing Division Waste Status Summary October 1, 1970 Through December 31, 1970*, pp. 10, and ARH-2074 A, *Chemical Processing Division Waste Status Summary January 1, 1971 Through March 31, 1971*, pp. 10), as well as a transfer of waste from the 244-AR Vault in the third quarter of 1971 (ARH-2074 B, *Chemical Processing Division Waste Status Summary April 1, 1971 Through June 30, 1971*, pp. 10). The wastes received into SST AX-102 were evaporated with the condensate being routed to tank A-417 and discharged to the 216-A-24 crib.

B4.1.4 Preparations for Sluicing (1973 to 1975)

No waste transfer activities involving SST AX-102 occurred again until the second quarter of FY 1973, when the pumpable supernate was transferred to SST 241-AX-103 (AX-103) for staging to the cesium ion exchange process in B Plant (ARH-2794 A, *Chemical Processing Division Waste Status Summary January 1, 1973 through March 31, 1973*, pp. 9). Tank AX-103 contained 50,000 gal of sludge and 63,000 gal of supernate following this transfer. Tank A-417 condensate, water, and A-AX ion exchange column flushes were periodically added to SST AX-102 throughout the remainder of FY 1973, FY 1974, and through May 1975 (ARHCO Occurrence Report 75-60, *Increasing Radiation in a Dry Well Adjacent to Tank 102-AX*), as well as some PSS solution from SST A-104 sluicing operations in the fourth quarter of 1974 (ARH-CD-133C, *Production and Waste Management Division Waste Status Summary July 1, 1974 through September 30, 1974*, pp. 9). The supernate in SST AX-102 was transferred to SSTs AX-101 and AX-103 in May 1975 in preparation for sluicing the sludge (ARH-CD-336 B, *Production and Waste Management Division Waste Status Summary April 1, 1975 through June 30, 1975*, pp. 9 and ARHCO Occurrence Report 75-60). However, sluicing of SST AX-102 was postponed when an increase in radiation was detected in drywell 11-02-11.

Personnel from Atlantic Richfield Hanford Company (ARHCO) determined the Dresser coupling for SST AX-102 was the source of the activity (ARHCO Occurrence Report 75-60 and Internal letter LET-060475, "241-AX-102 Leak Detection"). No estimate was located for the estimated volume and composition of the condensate leaked from the 241-AX vapor header.

Personnel from ARHCO conducted a field test to repair the 241-AX vapor header by injecting a sealant around the Dresser couplings. Approximately 660 gal of water-based asphalt emulsion sealant were injected at a depth of 9 to 14 ft in four wells that were drilled around a suspected leaking Dresser coupling for tank AX-102. Injection of the sealant resulted in contamination coming to the surface. Six inches of contaminated soil were removed and replaced with gravel to stabilize the contaminated areas (ARH-CD-587, *Containment of the Deteriorated Vapor Exhaust Header in 241-AX Tank Farm*). However, the effectiveness of the sealant was inconclusive and migration of contamination from the vapor header continued. Personnel from ARHCO reported the results of the 241-AX vapor header sealant test to the U.S. Energy Research and Development Administration and recommended that normal operations continue in AX Farm, using continued dry well monitoring to "… provide assurance that any further vapor header leakage will be detected [Interoffice memorandum MEM-011676, "Addendum, Atlantic Richfield Hanford Company Occurrence Report 75-90, "Increase Dry Well Radiation Adjacent to Tank 102-AX" Contract E(45-1)-2130"].

B4.1.5 Sluicing (1975 to 1977)

Sluicing of the SST AX-102 sludge was initiated in late December 1975 to make this tank available for receipt of 242-A Evaporator bottoms (ARH-LD-212 B, *Atlantic Richfield Hanford Company Monthly Report December 1975*, pp. 21). Sluicing of tank AX-102 to the 244-AR Vault continued in January 1976, but was interrupted in February 1976 when a new slurry pump was needed to increase sludge removal (ARH-LD-214 B, *Atlantic Richfield Hanford Company Monthly Report February 1976*, pp. 22). Sluicing operations were then switched to SST AX-103 while the new slurry pump was being readied for installation in SST AX-102. Sluicing of SST AX-102 was resumed in December 1976 (ARH-LD-224 B, pp. 11) and was halted in March 1977 (ARH-LD-227 B, *Atlantic Richfield Hanford Company Monthly Report March 1977*, pp. 24) when the sludge removal was no longer effective. Following completion of sluicing, SST AX-102 was estimated to contain ~5,100 gal of sludge (Internal letter LET-082577, "Approval of Tank 102-AX for Salt Cake Storage").

B4.1.6 Complexed Waste (1977 to 1980)

Following completion of sluicing, SST AX-102 received dilute complexed waste from B Plant from 1978 through 1979. In April 1980, the dilute complexed waste was transferred to SST A-102 and processed in two passes through the 242-A Evaporator, with the concentrate from both passes being received back into SST AX-102 (RHO-CD-80-1045 6, *Dilute Complexed Waste Concentration 242-A Evaporator-Crystallizer Campaign 80-6 April 10 to April 27, 1980*). Table B4-1. summarizes the analyses of the complexant concentrate waste stored in SST AX-102 based on a sample obtained on April 30, 1980 (RHO-CD-80-1045 6, pp. 4 and F-1). The complexant concentrate waste was transferred from SST AX-102 to double-shell tank AY-101 in May 1980, leaving an estimated 46,000 gal of supernate, saltcake, and sludge in tank AX-102 (RHO-CD-14 May 1980, *Waste Status Summary May, 1980*). The waste volume in SST AX-102 was later revised to 52,000 gal based on in-tank photographs.

Table B4-1. Tank 241-AX-102 Complexant Concentrate Composition (April 30, 1980)

Analyte	Value	Units
SpG	1.26	gm/ml
wt% water	70	wt%
Al	0.186	M
OH	0.372	M
NO_3	1.76	M
NO_2	0.811	M
PO_4	0.0437	M
CO_3	0.937	M
Sr-89/90	5.64E-02	Ci/L
Cs-137	0.55	Ci/L
Pu	7.89E-04	gm/L

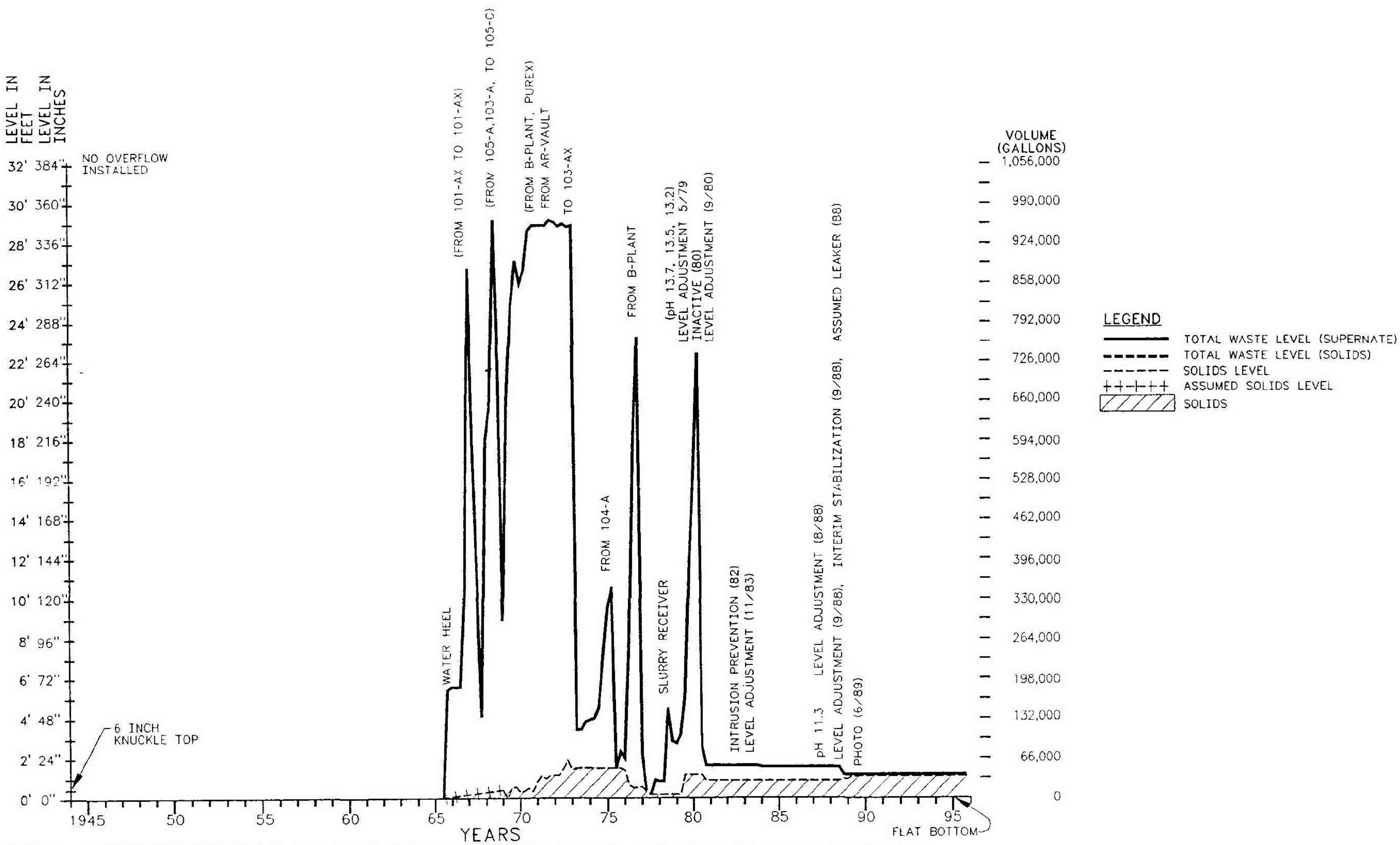
Figure B4-2 shows quarterly tank transfer levels and history. Additional tank waste transfer information is included in WHC-MR-0132, LA-UR-97-311 and tank waste summary reports.

B4.2 INTEGRITY OF TANK 241-AX-102

Tank AX-102 is currently designated an assumed leaker with an estimated leak volume of 3,400 gal based on a 1.25-in. liquid level decrease from June 18, 1984 to May 27, 1988 reported in WHC-UO-88-029-TF-04, *Unusual Occurrence Report Tank 241-AX-102 has Exceeded the 1.00 inch Decrease Criteria and Evaluations Cannot (with 95% Confidence), Show the Decrease to be Due Solely to Evaporation*. An evaluation of the integrity of SST AX-102 was conducted (Internal memorandum 13310-88-DEM-046, "Waste Tank Integrity Evaluation Peer Review – Tank 241-AX-102") and revealed the following.

- The liquid level drop in tank AX-102 was shown to be statistically significant.
- Evaporation could only account for ~25% of the waste level decline.
- The liquid level in SST AX-102 returned to 18.75 in. as of July 7, 1988, but this was discounted by the 1988 tank integrity review team.

Figure B4-2. Tank 241-AX-102 Quarterly Waste Fill History



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

- In-tank photographs from May 14, 1981, August 18, 1987, and June 6, 1988 all showed a liquid surface covered by a thin film of floating solids. However, only a small portion of the waste surface was visible, with the remainder obstructed by haze and the airlift circulators. The manual tape gauge was on the opposite side of the tank and could not be seen.

- Data for the leak detection pit and 10 external drywells associated with tank AX-102 were reviewed and the 1988 tank integrity review team deemed that the readings were termed not indicative of a typical tank release; however, no values were reported in the reference (TFS&O-EFS-88-092, *Surface Level Measurement Decrease in Single-Shell Tank 241-AX-102*).

Westinghouse Hanford Company conducted a peer review of this tank integrity assessment and concluded that the tank should be reclassified as an "assumed leaker." The U.S. Department of Energy was notified of the change in status for SST AX-102 on September 6, 1988 (Letter 8855485, "Tank 102-AX").

In February 2009, a leak integrity review of tank AX-102 was conducted in accordance with RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*. The review concluded that it was likely that the tank did not leak. Based on the review, a formal leak assessment of tank AX-102 was performed during July 2009. The method of analysis used for the formal leak assessment process was Revision B-1 of Engineering Procedure TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process."

A formal leak assessment (RPP-ASMT-42628, *Tank 241-AX-102 Integrity Assessment Report*) of tank AX-102 was performed to determine the cause of a liquid level decrease and gamma activity in drywells surrounding the tank. The consensus of the assessment team was that the 1.25-in. surface level decrease observed in the 1984 to 1988 time period was the result of evaporation and that tank AX-102 did not leak. The tank breathing rate calculated in 1988 using general atmospheric data was low compared to measured data collected in 1997. The helium tracer gas testing in 1997 measured a breathing rate of 17 cubic feet per minute (cfm) versus the 1988 calculated rate of ~1.8 cfm. The measured rate of 17 cfm could easily explain the liquid level decrease between 1984 and 1988. After reviewing the data it was determined that liquid level decreases were likely due to evaporation, and that gamma activity in drywells near the tank was a result of Dresser coupling leaks from a ventilation header. Based on the existing data, the probability of a tank leak is low and it is recommended that the tank be reclassified as "sound."

B4.3 INTERIM STABILIZATION

Tank AX-102 was declared inactive in 1980, and intrusion prevention was completed in 1982. The tank was saltwell pumped to double-shell tank AN-101 in the second quarter of FY 1983. The tank was again pumped in August 1988 using a submersible pump and 13,200 gal of supernate was pumped out before the pump cavitated. Additional pumping attempts failed to remove more liquid. A 1988 photo showed a smooth gray sludge with a pool of liquid covering ~20% of the surface. The volume of the supernate pool was estimated at ~2,750 gal

(HNF-SD-RE-TI-178, pp. 28-29). Further settling of the waste surface following interim stabilization was reported to have occurred in October 1988, prompting re-estimating of the waste level as 13.25 in. or ~36,400 gal (TFSA&S-89-48, *Tank 241-AX-102 Surface Level Measurement Decrease*). An additional decline in the waste level for SST AX-102 to 12 in. (~33,000 gal) was reported to have occurred in May 1989 and after investigation was determined to be due to further settling of the waste. The leak detection pit and the drywells associated with SST AX-102 did not show evidence of a tank waste loss (WHC-UO-89-023-TF-05, *Unusual Occurrence Report Surface Level Measurement Decrease in Single-Shell Tank 241-AX-102*).

As of March 1, 2014 the tank is estimated to contain 30,000 gal of waste consisting of 24,000 gal of A1-Saltcake from the 242-A Evaporator process and 6,000 gal of B Plant sludge (B sludge). Between 1988 and October 1, 2001, the measured surface level dropped from 14 in. to 11 in., corresponding to an estimated 8,000 gal decrease in the waste volume. The decrease was attributed to water loss (no evidence otherwise) and it is assumed that the supernate is no longer present (RPP-RPT-44740, *Derivation of Best-Basis Inventory for Tank 241-AX-102*). Figure B4-3 shows a mosaic photograph of the tank surface on June 5, 1989.

B4.4 TANK 241-AX-102 TEMPERATURE HISTORY

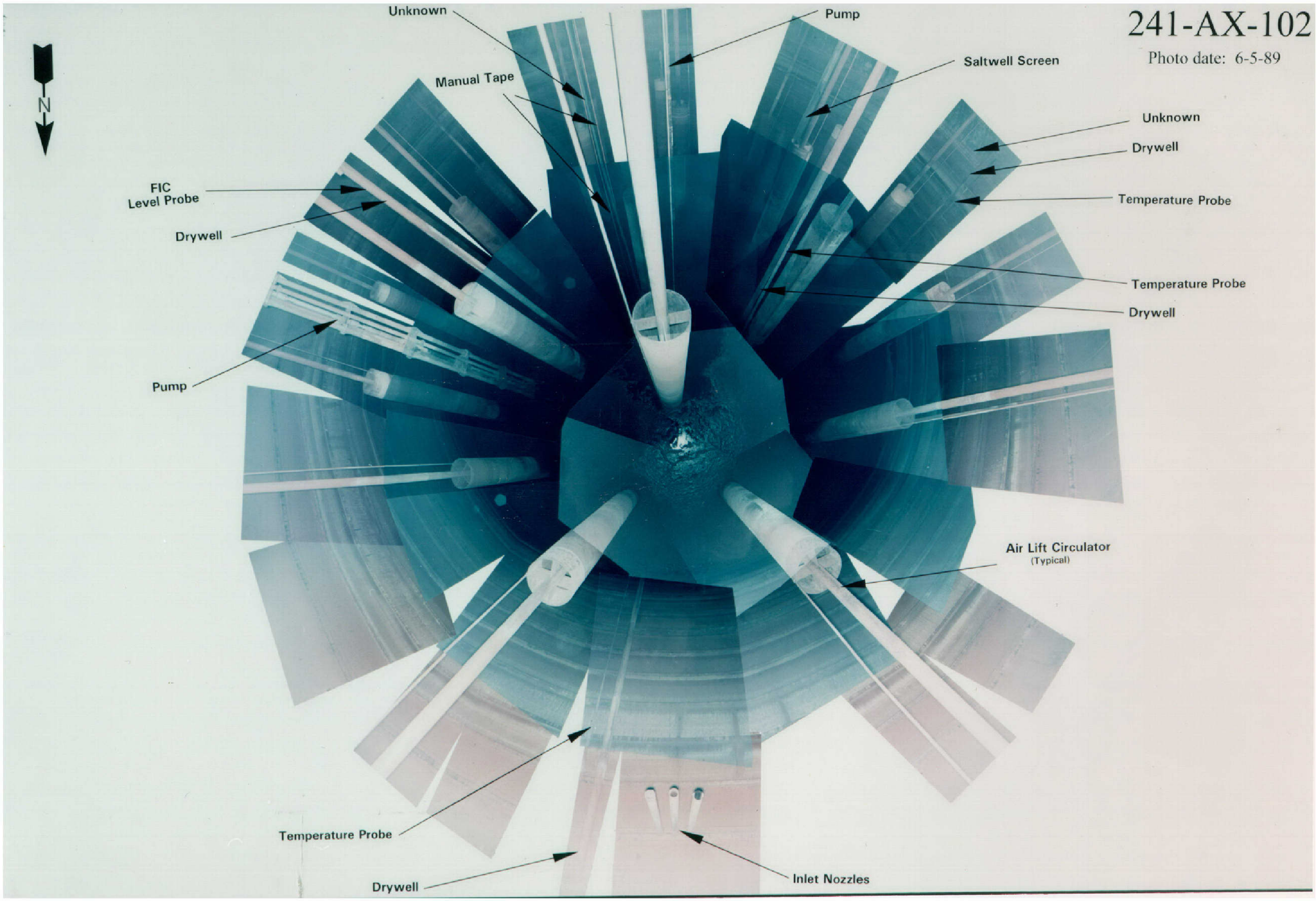
Tank AX-102 is a high heat tank currently monitored by a single thermocouple tree located in riser 9C. Tank AX-102 began receiving high level waste beginning September 1965 and was reported to have reached boiling temperature in April, 1969 (RHO-R-39). Documented temperature data was found for the period of July 1969 through September 1971, which shows the waste temperature varied from 220 to 250 °F (RHO-CD-1172, pp. B-58 and B-59).

The quantity of condensate and radionuclides is dependent on the temperature of the stored wastes, relative volatility of the radionuclides and other factors. During boiling the vapor exhaust system would have contained some condensed vapors and also radionuclides that had become entrained in the vapor as it was removed from the tank.

There was some concern that SST AX-102 was slowly leaking from January 1981 through December 1982. A decrease of 0.75 in. in waste level was observed during this period. However, the tank was connected to the 702-A ventilation system and the decrease was shown to be attributable to evaporation. After removal of the tank from the 702-A ventilation system in November 1982, the waste level was stable at 18.75 to 19 in. from January 1983 through February 1984. The temperature of the sludge in SST AX-102 was reported to be 165 ±5 °F during this period and some waste loss through evaporation is expected (Internal letter 65950-84-132, "TK-102-AX Liquid Level Decrease").

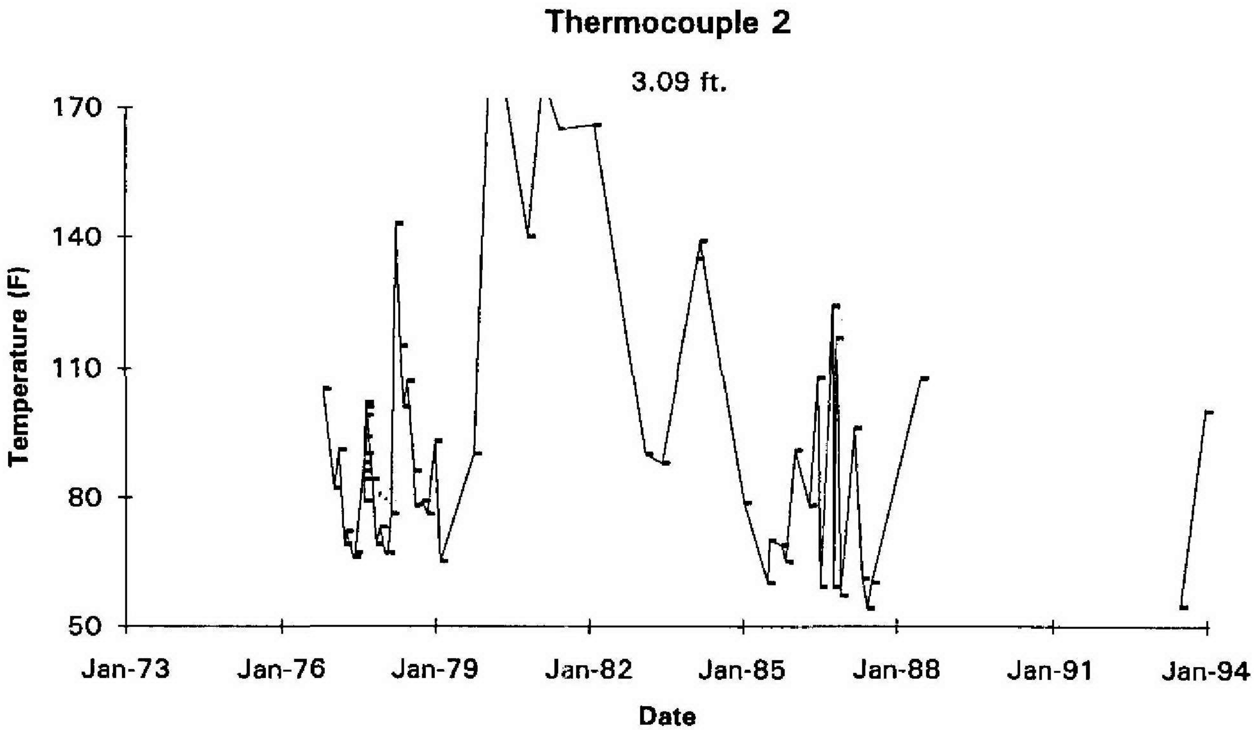
Figure B4-4 shows temperature data from 1976 to 1993 for thermocouples 2 and 5, in the waste near the base of the tank. Figure B4-5 shows Surveillance Analysis Computer System temperatures for the waste in tank AX-102 from 1993 to 2014. During this period the waste temperature was >170 °F between 1980 and 1981. The temperature dropped to < 80 °F after 1993.

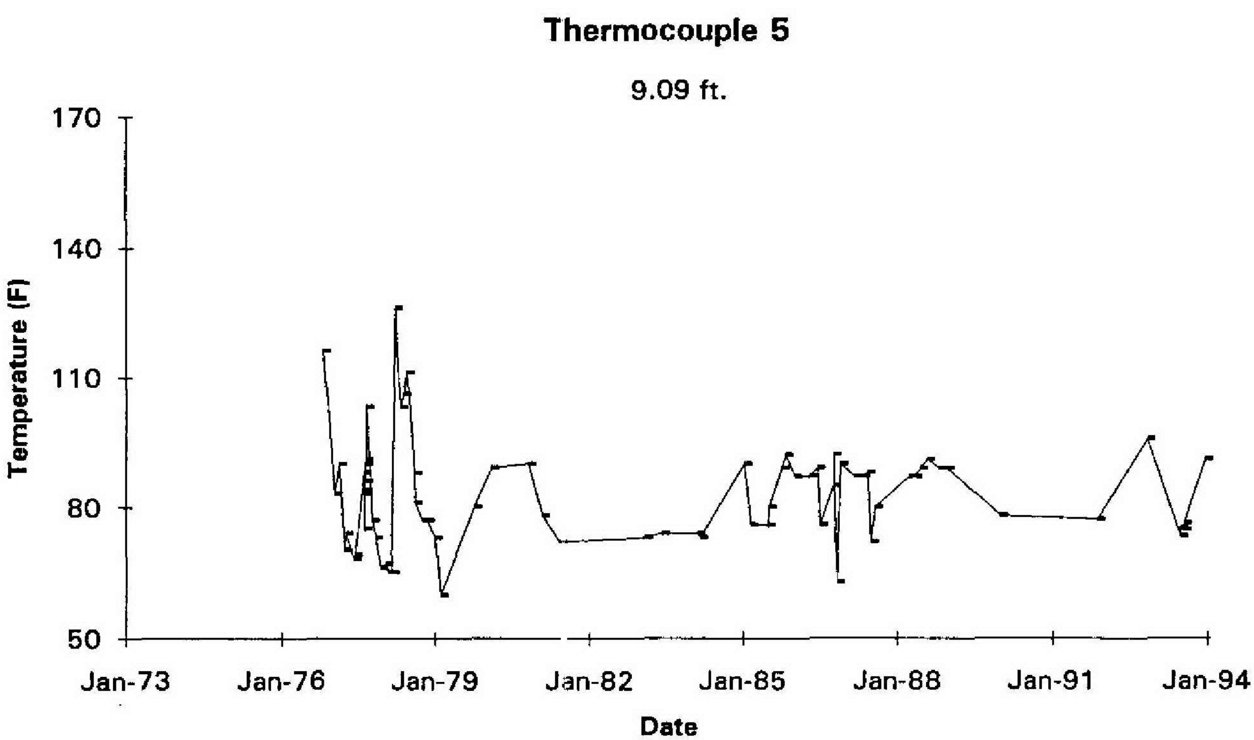
Figure B4-3. Tank 241-AX-102 Waste Surface Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

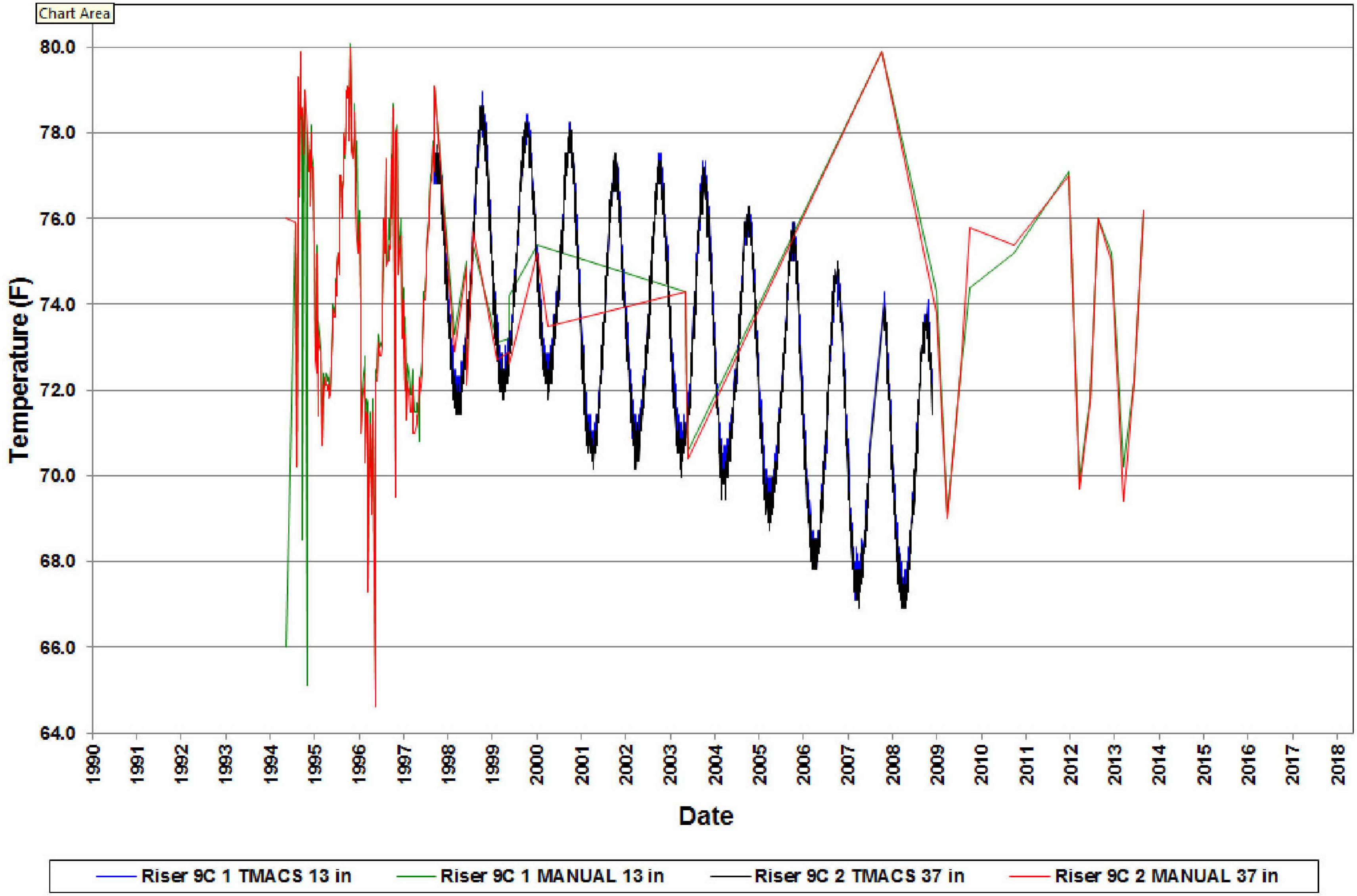
Figure B4-4. Tank 241-AX-102 Temperature, 1976 to 1994





Reference: WHC-SD-WM-ER-390, *Supporting Document for the Historical Tank Content Estimate for AX Tank Farm.*

Figure B4-5. Tank 241-AX-102 Temperature, 1993 to 2014



TMACS = Tank Monitor and Control System

B4.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data, and leak detection pit liquid level and radiation data for Tank AX-102.

B4.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B4-2). Table B4-2 shows liquid level measurements from June 1973 to December 1986 (SD-WM-TI-356). Figure B4-6 shows Surveillance Analysis Computer System waste level data for tank AX-102 from 1980 to 2014.

Four tank AX-102 liquid level decrease events were experienced between 1977 and 1989. Three of the liquid level decreases occurred between 1984 and 1989 when the tank contained complexant concentrate from the 242-A Evaporator/Crystallizer. The last two events occurred after saltwell pumping in 1988 and 1989.

The first liquid level decrease exceeding leak detection criteria occurred March 27, 1977 after tank AX-102 had been sluiced in preparation for receiving evaporator bottoms. At this time the tank contained 3.1 in. of sludge and liquid. The liquid level decrease was 0.55 in., and was confirmed to have been caused by evaporation based on psychometric data. The tank was removed from quarantine status after the evaluation was completed (Occurrence Report 77-95, *102-AX Liquid Level Decrease Exceeding Criteria*).

The second event occurred in 1984 when the manual tape liquid level reading decreased on February 14, 1984 (65950-84-132 – Letter). An engineering review of the liquid level decrease for the period from January 1, 1981 to the middle of February, 1984 was conducted using a baseline established in November, 1980. A least squares regression analysis of the liquid level data from January 1, 1981 through October 1, 1982 resulted in a calculated liquid level decrease of 0.25 in./year. This was a period just prior to disconnecting tank AX-102 from the 241-A-702 ventilation system, and the decrease was attributed to evaporation and mass transport. The measurements after disconnecting the ventilation system did not show any significant change in liquid level except for a three-day period around February 14, 1984 that was deleted from the analysis. The deletion was justified based on instrument malfunction and replacement of the gauge reel, tape, plummet, and recalibration.

In-tank photos showed a liquid surface with some floating solids. The leak detection pit and drywells showed no evidence of instability during the three-year study period. It was noted that further liquid level decreases could be expected based on self-breathing (passive breathing) and aspiration over time. The profile thermocouple probe reading had been recording a sludge temperature of ~165 °F before failing. The tank was determined to be “sound” based on these observations (65950-84-132 – Letter).

Table B4-2. Tank 241-AX-102 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 1 of 3)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/18/73	42.00			0.00	Manual tape
07/17/73	37.50		-4.50	-4.50	Steady decrease
07/18/73	39.00			-4.50	Transfers
09/12/73	40.50		+1.50	-3.00	Steady increase
09/13/73	47.00			-3.00	Transfers
12/05/73	40.00		-7.00	-10.00	Steady decrease
12/06/73	46.50			-10.00	Transfers
01/25/74	47.00		+0.50	-9.50	Slow increase
01/26/74	47.50			-9.50	Transfers
02/25/74	45.25		-2.25	-11.75	Steady decrease
02/26/74	45.75			-11.75	Transfers
04/09/74	48.50		+2.75	-9.00	Steady increase
04/16/74	50.25			-9.00	Transfers
07/05/74	55.25		+5.00	-4.00	Steady increase
08/13/74	81.50			-4.00	Transfers
08/27/74	82.50		+1.00	-3.00	Steady increase
08/28/74	83.50			-3.00	Transfers
09/15/74	85.00		+1.50	-1.50	Steady increase
09/17/74	85.50			-1.50	Transfers
10/07/74	86.75		+1.25	-0.25	Steady increase
10/09/74	88.00			-0.25	Transfers
10/21/74	89.00		+1.00	+0.75	Steady increase
10/25/74	104.00			+0.75	Transfer
11/13/74	105.00		+1.00	+1.74	Steady increase
11/27/74	109.00			+1.75	Transfers
12/08/74	110.00		+1.00	+2.75	Steady increase
01/23/75	116.25			+2.75	Transfers
02/02/75	117.00		+0.75	+3.50	Steady increase
03/10/75	125.50			+3.50	Transfers
03/23/75	126.00		+0.50	+4.00	Erratic increase
03/24/75	127.00			+4.00	Transfers
04/02/75	127.50		+0.50	+4.50	Erratic increase
04/03/75	128.25			+4.50	Transfers
04/30/75	131.50		+3.25	+7.75	Steady increase
05/01/75	133.25			+7.75	Transfer active
05/01/75	133.35			+7.75	New FIC installed
05/02/75	134.25			+7.75	Transfers
05/12/75	134.50		+10.35	+8.10	Erratic increase
05/21/75	16.95			+8.10	Transfers
07/07/75	6.60		-10.35	-2.25	Steady decrease
07/09/75	18.30			-2.25	Transfers
07/23/75	16.80		-1.50	-3.75	Steady decrease

Table B4-2. Tank 241-AX-102 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 2 of 3)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
07/29/75	24.25			-3.75	Transfers
08/14/75	23.05		-1.20	-4.95	Steady decrease
08/15/75	30.05			-4.95	Transfers
11/12/75	27.90		-2.15	-7.10	Slow decrease
11/13/75	28.80			-7.10	Transfers
12/08/75	28.20		-0.60	-7.70	Slow erratic decrease
05/02/76	144.50			-7.70	Sluicing and transfers
05/18/76	143.75		-0.75	-8.45	Steady decrease
07/21/76	247.50			-8.45	Transfers
08/07/76	246.80		-0.70	-9.15	Steady decrease
09/10/76	279.45			-9.15	Transfers
10/12/76	278.20		-1.25	-10.40	Steady decrease
11/11/76	19.25			-10.40	Transfers
11/18/76	19.05		-0.20	-10.60	Slow decrease
11/19/76	19.50			-10.60	Circulators flushed
12/03/76	26.50		-0.45	-11.05	Slow decrease
12/29/76	26.50			-11.05	Sluciing and transfers
01/07/77	26.15		-0.35	-11.40	Steady decrease
04/27/77	3.10			-11.40	Slucing and tranfers
06/23/77	1.00		-2.10	-13.50	Slow decrease
06/24/77	1.70			-13.50	Line check
07/05/77	0.80		-0.90	-14.40	Steady decrease
09/07/77	12.10			-14.40	Received slurry
09/20/77		11.80	-0.30	-14.70	
12/05/77	10.30			-14.70	Evaporation psychro-metric adjustment
12/06/77	10.60			-14.70	Circulators flushed
04/12/78	9.55			-14.70	Evaporation
06/05/78	344.50			-14.70	Transfers and slurry
06/20/78	344.10		-0.40	-15.20	Slow decrease
07/08/78	45.40			-15.10	Transfers
07/27/78	44.80			-15.10	Evaporation
08/01/78	35.00			-15.10	Transfers
08/04/78		34.90		-15.10	
10/08/78	33.80			-15.10	Slow decrease/ evaporation
11/14/78		32.90		-15.10	Allowed decrease
12/15/78	32.60			-15.10	Very erratic reading
01/22/79		32.00		-15.10	Allowed decrease
03/16/79	31.85		-0.15	-15.25	Slow decrease
03/17/79	37.70			-15.25	Transfers
06/23/79	37.30			-15.25	Evaporation

Table B4-2. Tank 241-AX-102 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 3 of 3)

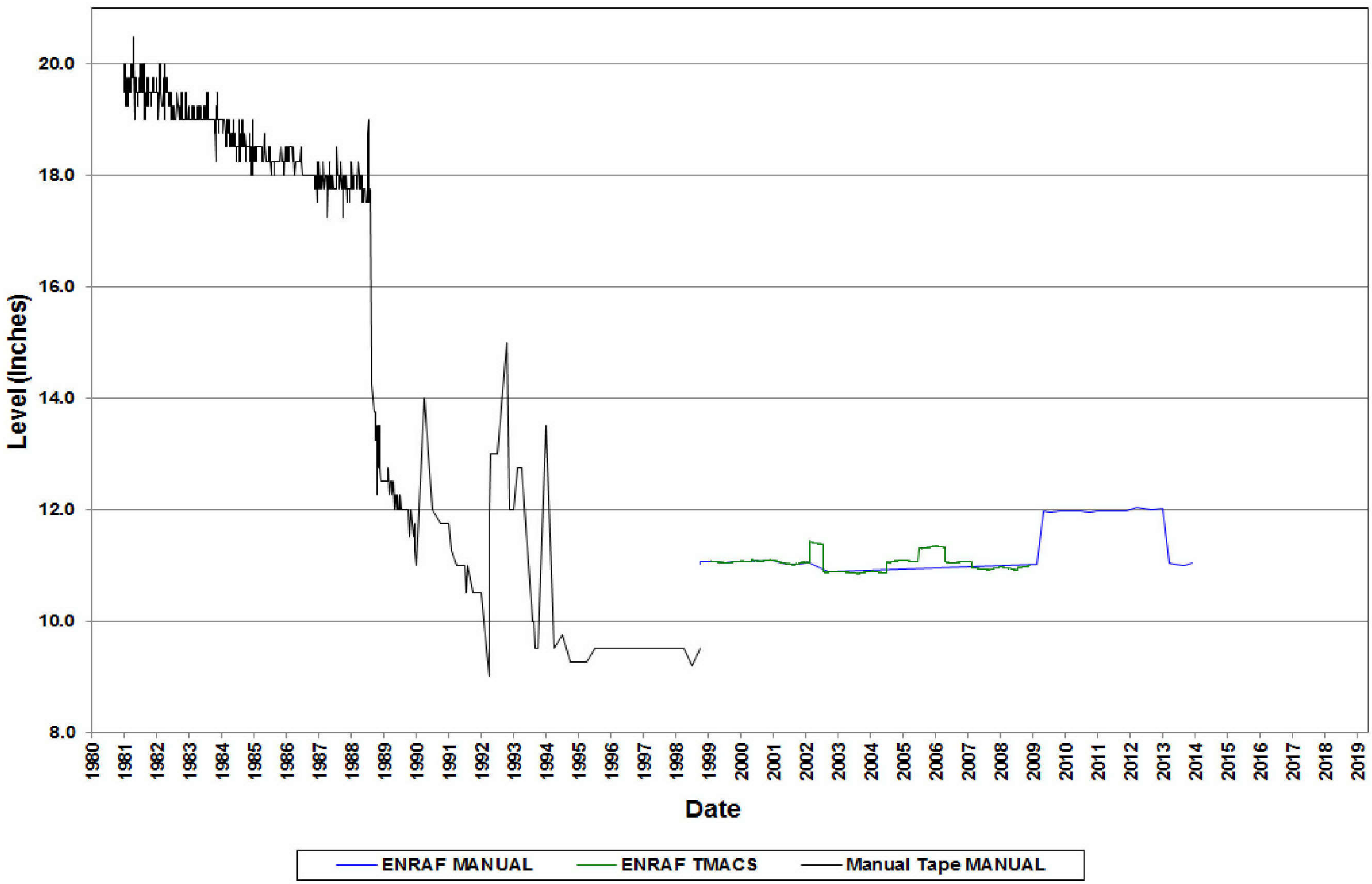
Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/24/79	60.80			-15.25	Transfers
09/12/79	60.40			-15.25	Evaporation
06/05/80	20.70	20.70		-15.25	Received slurry/ transfers
08/27/80	20.35		-0.35	-15.60	Associated with evaporation
09/01/80		19.50		-15.60	Transfers
11/15/80	19.30		-0.20	-15.80	FIC outs of service manual tape
11/17/80		19.50		-15.80	Stable
12/10/80	19.50			-15.80	Stable
12/10/81	19.50			-15.80	Stable readings; fluctuates between 19 and 19.50 in.
12/12/83	19.00		-0.50	-16.30	Stable
06/18/84		18.75		-16.30	Evaporation
11/14/84	18.50		-0.25	-16.55	Stable
12/18/84	o/s			-16.55	No tape
12/19/84	18.25		-0.25	-18.80	Tape repaired
11/18/85	18.25			-18.80	Stable, readings vary from 18.00 to 19.00 in.
12/29/86	18.00		-0.25	-19.05	

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

The third event was a 1.25-in. liquid level decrease in May 1988 that exceeded the 1.00-in. leak detection criteria. The leak detection pit and the drywells remained stable throughout the period. An analysis (Internal memorandum 13331-88-442, "Engineering Investigation: Liquid Level Decrease in Tank 241-AX-102") determined that self-breathing coupled with the air purge from the FIC amounted to ~1.8 cfm. This corresponded to an evaporative liquid level decrease of 0.26 in. for the 4.4-year evaluation period. Since the evaluation did not show that the decrease was due to evaporation, the tank was declared an "assumed leaker" (WHC-UO-88-029-TF-04).

The passive breathing rate is an important parameter in evaporative calculations, and the 1.8 cfm rate used for the 1988 investigation was very low compared with an actual rate of 17 cfm measured in 1997 (PNNL-11683, *Measurements of Waste Tank Passive Ventilation Rates Using Tracer Gases*). An evaporation study was conducted as part of the 2009 assessment. It indicated that a 16 cfm rate – lower than the 17 cfm measured rate – could potentially explain the liquid level decrease. A review of engineering flow diagrams and construction drawings for AX Farm did not indicate any infrastructure changes that would affect the tank AX-102 passive breathing rate between the time of the calculated passive breathing rate (1988) and the measured rate (1997). It was therefore considered valid to apply the measured rate to the 1984 to 1988 liquid level decrease (see the discussion on passive breathing for details of both breathing rate determinations).

Figure B4-6. Tank 241-AX-102 Waste Surface Level Measurements



TMACS = Tank Monitor and Control System

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A fourth liquid level decrease of 1.25 in., exceeding the leak detection criteria limit of 1.00 in., occurred on May 8, 1989. In-tank photos taken September 2, 1988 and June 4, 1989 determined that tank AX-102 was pumped down to an exposed solids level with isolated puddles that were smaller in the June 4, 1989 photographs. The surface level measurement device was not visible in either set of photos. Drywell radiation profiles were stable and the leak detection pit liquid level and radiation levels had been maintained within criteria limits. The decrease in surface level was attributed to tank contents settling after pumping – a common occurrence. The tank remained classified as an "assumed leaker" (Event Fact Sheet TF-EFS-89-047, "Surface Level Measurement Decrease in Single-Shell Tank 241-AX-102;" WHC-UO-89-023-TF-05).

B4.5.2 Drywell Logging Data

Ten drywells surround tank AX-102 (11-02-01, 11-02-02, 11-02-03, 11-02-04, 11-02-05, 11-02-07, 11-02-10, 11-02-22, 10-02-11 and 11-02-12); Figure B4-7 shows the 1996 SGLS results for these drywells. The SGLS results are presented in GJ-HAN-50, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-102*.

The primary indication of tank waste loss began in May 1975, when an increase in gross gamma levels from 38 to 152 counts per second (c/s) occurred at ~55 ft bgs in drywell 11-02-12. By September 1975, the gamma level increased to 1,021 c/s and stayed at that level through December 1976. Significant contamination was encountered throughout the drywell, as shown in Figure B4-8. Additional drywells 11-02-12 and 11-02-22 were constructed shortly after May 1975, but only drywell 11-02-12 showed anomalous radiation levels. Drywell 11-02-12 was drilled near one of the underground vapor exhaust header dresser couplings that was suspected of leaking. A radiation peak a few feet below the elevation of the dresser coupling was detected in the new drywell. Four auger drillings adjacent to the suspect dresser couplings detected high radiation in three of the four positions, including the coupling between drywells 11-02-11 and 11-02-12.

Current spectral gamma analyses for drywells 11-02-12 show ^{137}Cs as the dominant gamma emitter at ~12 ft bgs and only ^{60}Co at ~0.1 pCi/g from 30 to 45 ft bgs. Other short-lived gamma emitters present in 1975 would have decayed below detection limits by the mid-1990s, when these measurements were taken. Because the ^{137}Cs concentration saturated the SGLS detector, drywell 11-02-12 was re-logged in 1999 using a high rate logging system. The high rate logging system showed a peak ^{137}Cs concentration at 12 ft bgs of ~5,000 pCi/g (Figure B4-9).

Other drywells nearby SST AX-102 do not show any significant contamination, as shown in Figure B4-7. Migration of ^{137}Cs contamination down the inside or outside of the drywell casing is suspected to have affected the distribution of some of the contamination detected in the drywells. Much of the bias of the drywell log data that is due to drywell migration effects was removed from the surveys and is designated as "removed" in these figures.

Figure B4-7. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-AX-102 (Sheet 1 of 2).

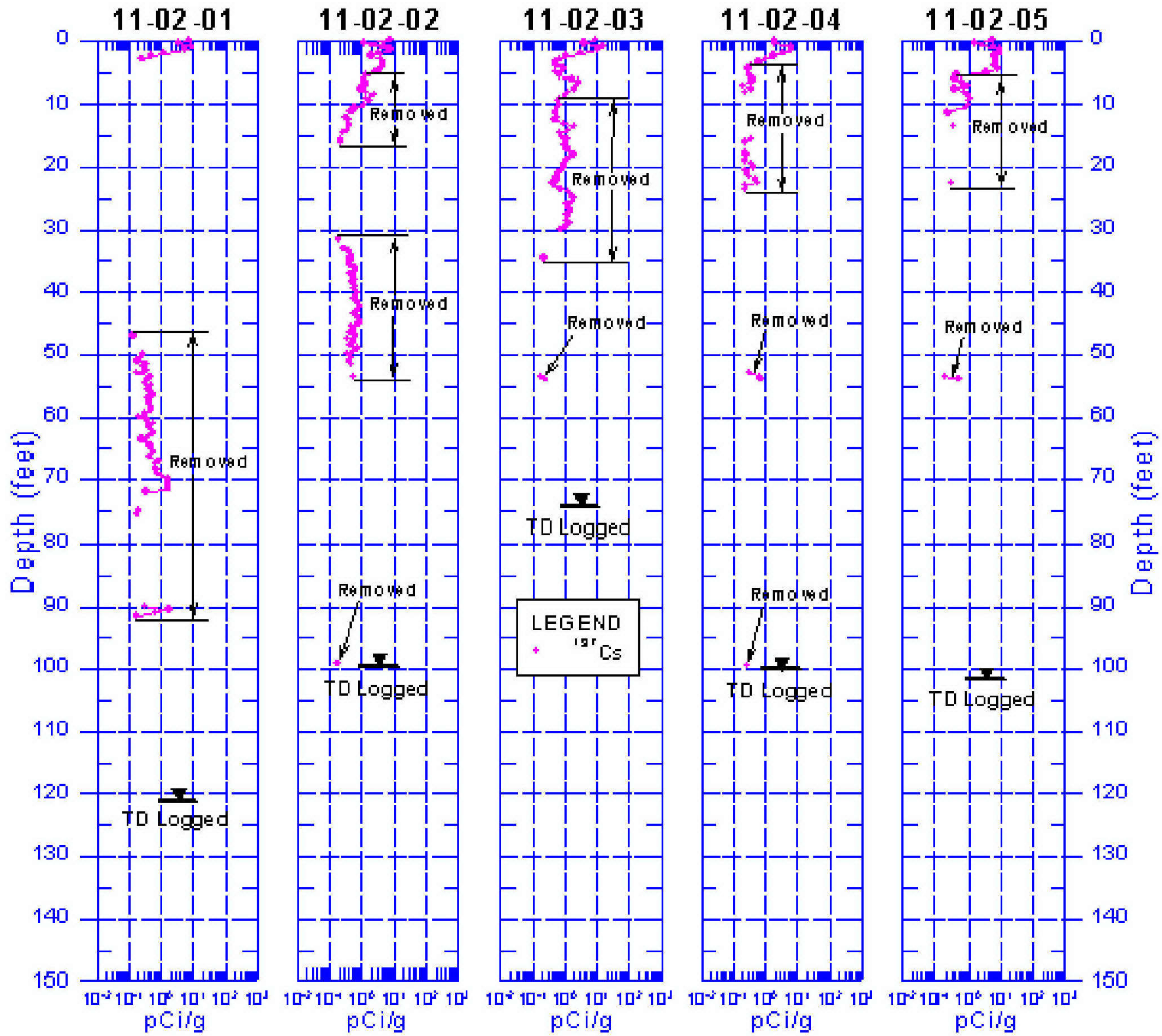
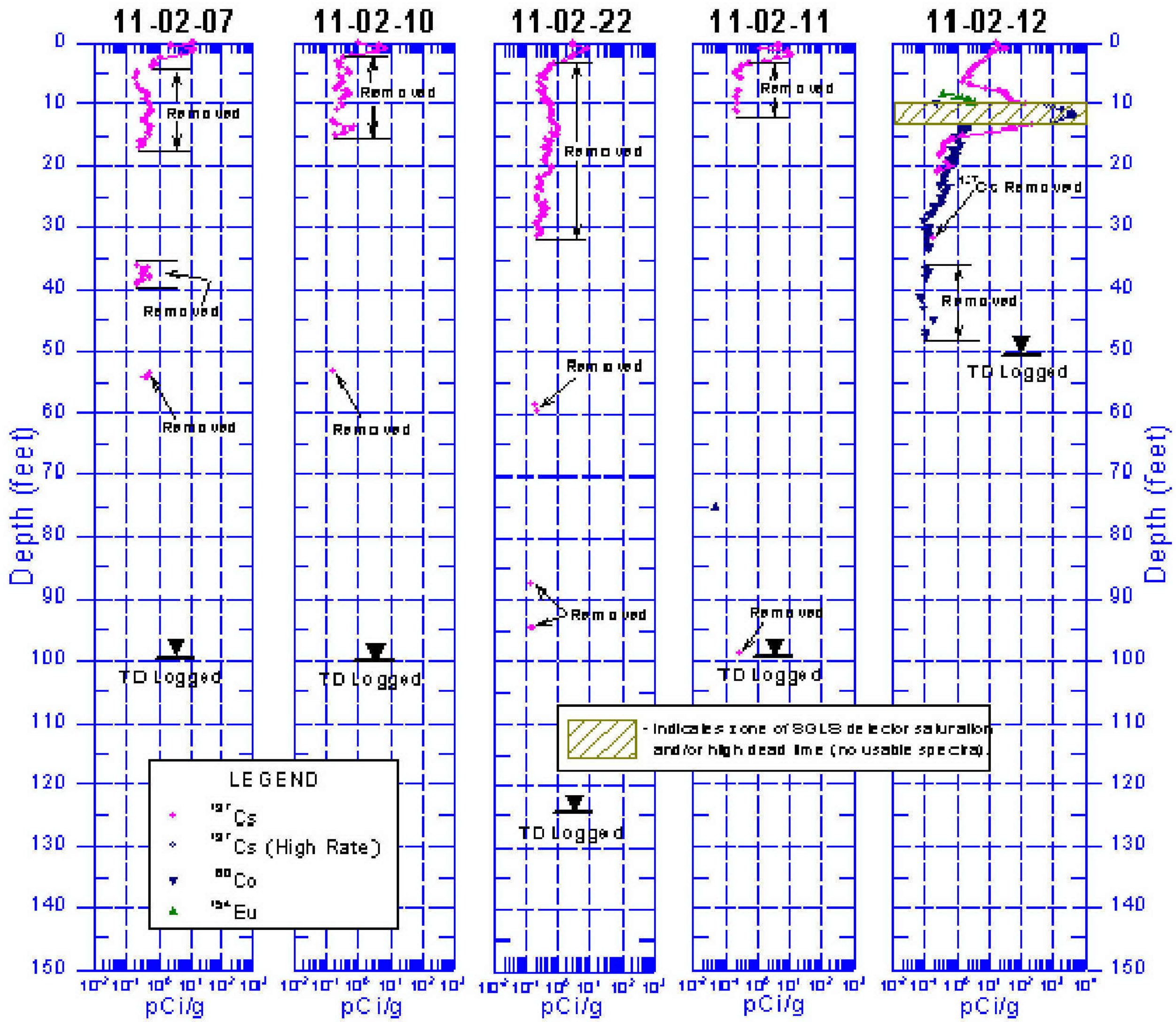


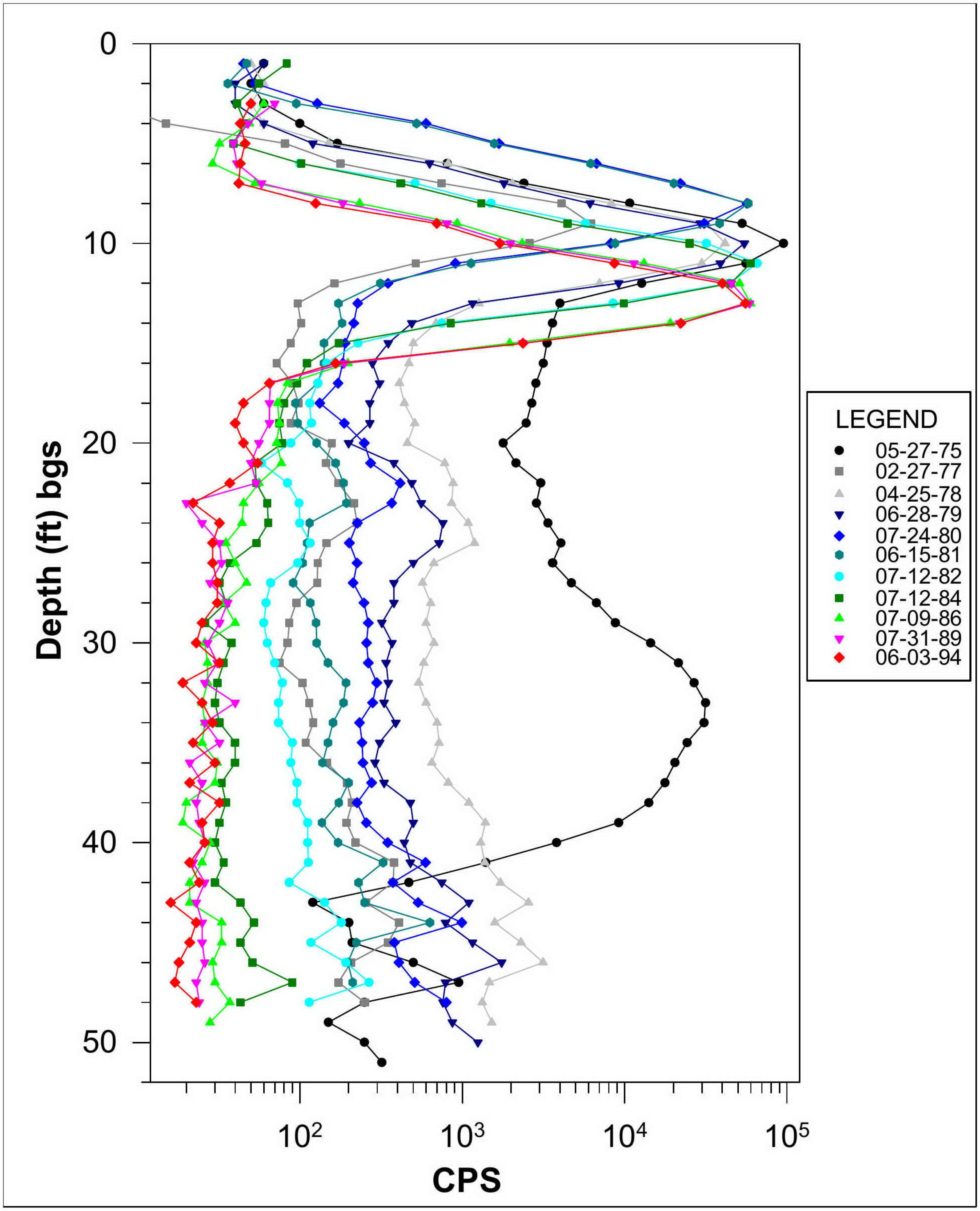
Figure B4-7. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-AX-102 (Sheet 2 of 2).



Note: Except for drywell 11-02-12, maximum value of log scales shown is 1,000 pCi/g; 10,000 pCi/g for 11-02-12.

Reference: GJO-97-14-TARA/GJO-HAN-12, *Hanford Tank Farms Vadose Zone: Addendum to the AX Tank Farm Report.*

Figure B4-8. Tank 241-AX-102 Historical Gamma Logging Results for Drywell 11-02-12



cps = counts per second

Reference: RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX.*

B4.5.3 Leak Detection Pit Data

In addition to drywell data, AX Farm has leak detection pits as described in Section 3.2.

Both surface level and radiation measurements are available from the leak detection pits. Table B4-3 shows liquid and radiation levels in the AX-102 leak detection pit from 1973 to 1986 and Figure B4-10 shows liquid levels in the leak detection pit from 1995 to 2006. The AX-102 leak detection pit monitoring was discontinued after October 2006.

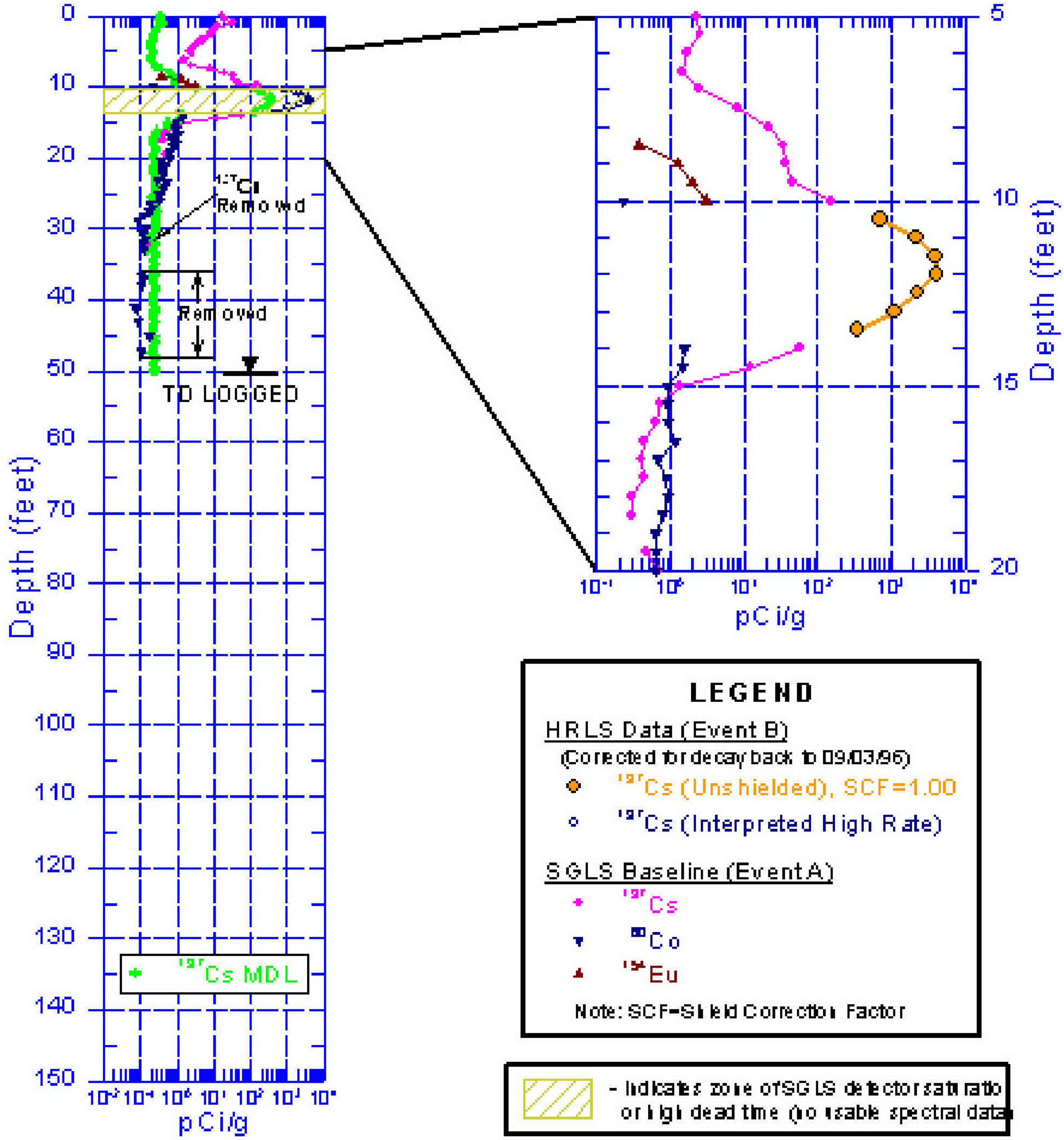
The leak detection pit for SST AX-102 was reported in May 1975 to be contaminated and possibly leaking (ARHCO Occurrence Report 75-60). Efforts to isolate the pit and fill the seal pot line connecting the leak detection pit to the 241-AX vapor header did not stop this leak. Initially, the leak rate from the pit was 0.3 gal per day in May 16, 1975, but increased to 1.2 gal per day by June 24, 1975. The leak rate seems to be related to the depth of the liquid in the leak detection pit. No radioactivity was detected in samples of water taken from the AX-102 leak detection pit in 1975. However, contamination was detected later (March 1976) in this leak detection pit (ARH-LD-215 B, *Atlantic Richfield Hanford Company Monthly Report March 1976*, pp. 14). The contamination was not sufficient to be attributable to waste loss from SST AX-102. The source of contamination was attributed to the pump-out header for all of the 241-AX leak detection pits which connects to the same header used to transfer waste from the 241-AX tanks. Any drainage from this header could cause contamination of the leak detection pits (Internal letter ARHCO 1977, "Radiation in AX Leak Detection Pits").

In December 1977, the 102-AX leak detection pit radiation readings radically increased. At first, instrument malfunction was suspected; however, the increase continued from 1,200 cpm on December 15, 1977 to 2,700 cpm on January 8, 1978. This increase is attributed to evaporation of the water known to have been present in the pit. The water had acted as shielding against fixed contamination. Swab samples taken on January 4, 1978 show approximately equal amounts of ^{90}Sr and ^{137}Cs (SD-WM-TI-356).

Operating Limit Deviation Report 79-6, *Increased Radiation Reading 102-AX Leak Detection Pit* was issued in May 1979 due to an increased radiation reading in the AX-102 leak detection pit. The increase was attributed to the discriminator having been improperly set.

In RPP-ASMT-42628 it was stated that due to evaporation through the exhaust header and potential sources of radioactivity other than a tank leak, detection of contaminants in the leak detection pits may be misleading for tank monitoring during retrieval operations. It was also contended that the swab sample results obtained from the leak detection pits in May 2014 showing very low gamma activity in the pits may be misleading because fixed waste at the bottom of the pit may not be detected by the sampling method used. All of the leak detection pits except for tank AX-102 contained liquids and wet swab samples were obtained; the samples were scanned, then dried and scanned again. The swab was weighted down so it could be lowered and contacted with the bottom of the pit. Radioactivity in the liquid or at the bottom of the pit should have been detected by the swab sample. No gamma or alpha radioactivity was detected in dry swab samples from the AX-102 leak detection pit. The leak detection pits for tanks AX-101 and AX-103 showed 200 and 400 cpm respectively and the AX-104 leak detection pit showed ~1,000 cpm.

Figure B4-9. 1999 High Rate Logging System Results for Drywell 11-02-12



HRLS = high rate logging system SGLS = spectral gamma logging system

Reference: GJO-97-14-TARA/GJO-HAN-12, *Hanford Tank Farms Vadose Zone: Addendum to the AX Tank Farm Report*.

Table B4-3. Tank 241-AX-102 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 1 of 3)

Date	Liquid level (in.)	Radiation level (c/min)	Comments
07/02/73	4.0	200	
09/15/73	0.0	200	
12/15/73	13.0	200	
04/15/74	21.0	300	
09/01/74	8.0	50	
12/12/74	4.0	50	
05/15/75	0.0	70	
05/16/75	30.0	950	Water added to check for pit leak. More sensitive probe installed
05/24/75	23.9	700	Instrument adjustment/probe
06/01/75	25.0	700	
06/15/75	21.6	750	
06/24/75	22.0	600	New probe
06/30/75	19.4	550	
07/15/75	17.2	550	
07/24/75	16.8	550	
08/15/75	16.4	600	
09/15/75	15.1	600	
10/15/75	13.8	600	
11/15/75	12.5	800	
12/15/75	8.2	700	
01/08/76	3.0	900	
01/14/76	0.0	1,050	High reading due to evaporation of water
02/14/76	0.0	1,450	
03/15/76	0.0	1,500	
03/25/76	26.7	405	Water added
03/26/76	28.0	410	
03/31/76	23.8	400	
04/30/76	21.0	300	
05/29/76	19.0	350	
06/30/76	17.0	600	
07/30/76	15.8	400	
08/31/76	15.0	300	
10/02/76	14.5	400	
11/02/76	14.0	600	
12/05/76	13.0	400	

Table B4-3. Tank 241-AX-102 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 2 of 3)

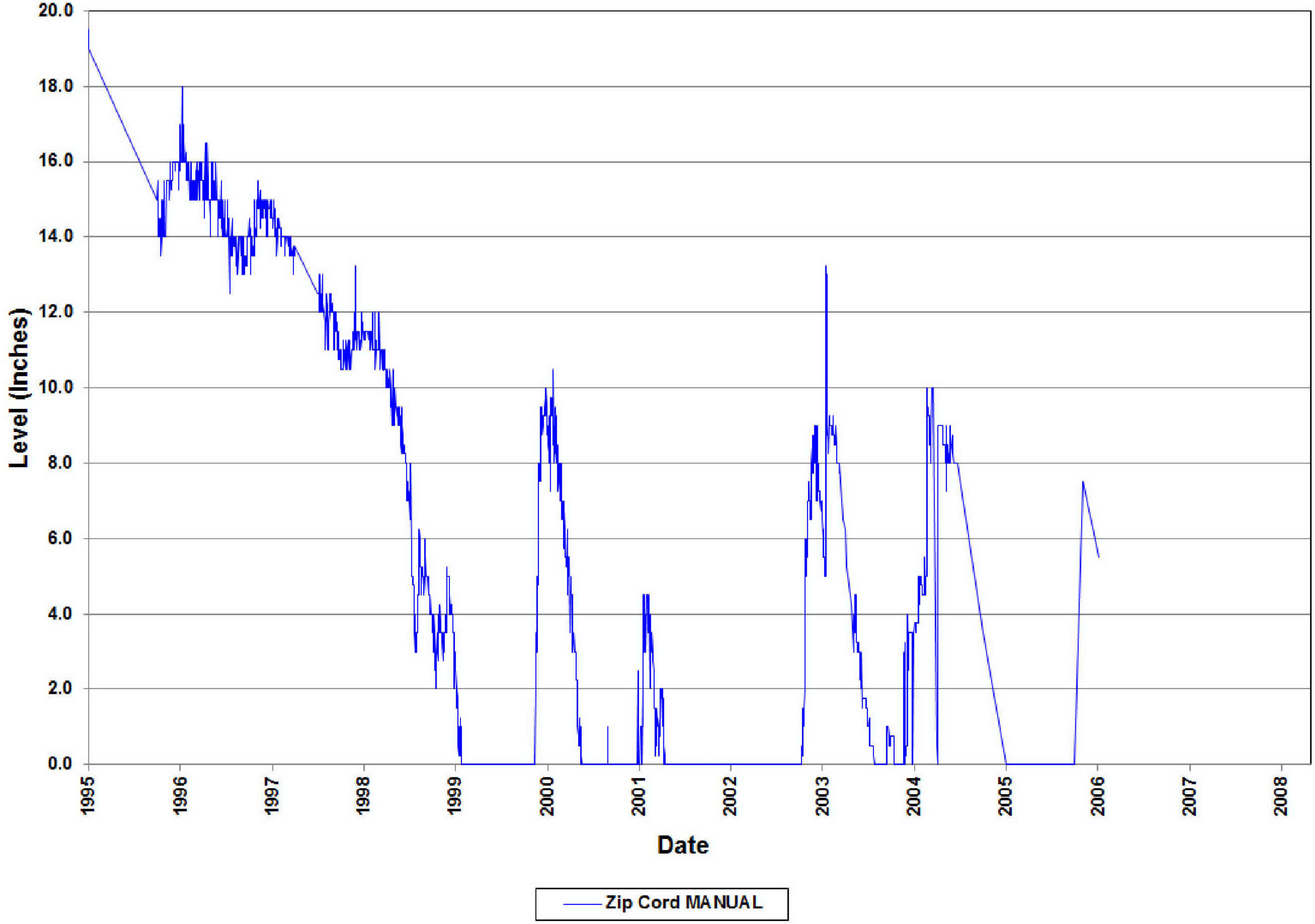
Date	Liquid level			Radiation level (c/min)	Comments
	Gage	Base-line ref.	Weight factor (in.)		
01/07/77	3.5		12.0	350 to 650	Slow LL decrease
01/08/77	4.8		17.5	350	Water added
03/20/77	3.9		13.0	150 to 630	LL slow decrease
03/21/77	5.0		20.0	500	Water added
06/19/77	5.0		21.0	275 to 650	LL stable
12/20/77	1.0		5.0	1,000 to 1,300	Radiation level increased 12/11/77
01/06/78	0.0		1.0	2,700	Liquid level decreased, radiation increased
03/08/78	0.0		0.0	2,700	Stable
03/21/78	0.0		0.5	510	Erratic radiation decrease, improper discriminator setting
05/11/78	0.0		0.0	400	Stable
09/01/78	2.6		14.0	250	Slow LL increase, radiation decrease
11/30/78	0.0		0.0	110	Slow LL, radiation decrease
12/19/78	0.0		0.0	280 to 1,900	Radiation increase, improper discriminator setting corrected
08/17/79	3.5		14.0	150	Water added
12/31/79	3.5		13.0	100 300	LL stable
12/11/80	2.8		10.0	400	LL slow decrease
02/04/81	1.5		5.0	600	LL slow decrease, radiation increase
02/27/81			20.0	250	Water added
10/30/81	1.0		6.0	500	Water bailed from pit, radiation increase
11/30/81	0.5		1.5	1,200	LL decrease, radiation increase
12/02/81	1.5		7.0	700	Water added
01/05/82	0.3		1.0	1,400	LL decrease, radiation increase
01/06/82	2.2	2.2	10.5	600	Water added
03/19/82	0.3		2.0	1,200	LL decrease, radiation increase
03/20/82	0.2		8.2	500	Water added
10/02/82	0.0		0.0	400	LL readings vary from 0 to 2.5 in. due to evaporation and water additions
10/08/82	0.0		0.0	450	LL dial and chart o/s

Table B4-3. Tank 241-AX-102 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 3 of 3)

Date	Liquid level			Radiation level (c/min)	Comments
	Gage	Base-line ref.	Weight factor (in.)		
10/09/82	0		0	450	Zip cord installed, 9.25 in.
12/07/82	0		0	600	Zip cord, 5.0 in. Steady decrease, radiation increase
04/01/83	0		0	375	Zip cord 11.50 in., steady increase
04/05/83	0		0	350	Pumped, zip cord 3.0 in.
05/10/83	0		0	1,000	Zip cord 0.00, radiation increase
02/22/84	0		0	900	Stable, zip cord 0.00
02/23/84	0		0	200	Water added, 50 gal
03/02/84	0		0	350	New zip cord installed 13.00 in.
11/14/84	0		0	320	Zip cord 10.00 in., slow decrease
04/18/85	0		0	350	Zip cord 8.00 in., slow decrease
04/20/85	0		0	350	New zip cord 6.50 in.
07/19/85	0		0	500	Zip cord 1.00 in., slow decrease
07/20/85	0		0	500	Zip cord broken
08/06/85	0		0	400	New zip cord 5.00 in.
09/11/85	0		0	475	Zip cord 0.00
10/17/85	0		0	750	Water added, zip cord 3.00 in.
11/19/85	0		0	400	Zip cord 4.50 in.
12/01/85	0		0	400	New zip cord installed
03/11/86	0		0	500	Zip cord 5.00 in.
04/19/86	0		0	500	Zip cord 1.00 in.
04/24/86	0		0	600	Zip cord 16.25 in. Water added
12/31/86	0		0	250	Zip cord 15.00 in.

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

Figure B4-10. Tank 241-AX-102 Leak Detection Pit Liquid Level (1996 to 2006)



B5.0 TANK 241-AX-104

This section provides information on the historical waste loss event associated with tank 241-AX-104 (AX-104). Waste operations for tank AX-104 are summarized in Figure B5-1. Figure 3-5 of the main text shows a plan view of a typical tank in AX Farm with the location of the pump pit, sluice pit, spare inlet nozzles (A, B, C and D) and tank risers.

B5.1 TANK 241-AX-104 WASTE HISTORY

Tank AX-104 originally received PUREX HLW from 1965 through 1969. Additionally, SST AX-104 received 37,000 gal of B Plant waste in the third quarter of 1969. The tank was operated as a boiling waste tank to evaporate excess water and concentrate the PUREX HLW. The tank experienced a temperature excursion lasting from February 1970 through June 1970, reaching a maximum temperature of 233 °C (~451 °F) in the sludge. In an effort to reduce the waste sludge temperature, ~98,000 gal of supernate were transferred from SST AX-104 to tank A-101 on March 18, 1970 and 198,000 gal of water at 65 °C were added to SST AX-104 (PR-REPORT MAR70, *Monthly Status and Progress Report March 1970*, pp. AIV-5, PR-REPORT MAY70, *Monthly Status and Progress Report May 1970*, pp. AIV-6 and ARH-1666 A, pp. 10). This action became necessary when the increasing localized temperatures in the outer periphery of the tank did not respond to a remedial treatment of varying the air flow to the nearby airlift circulators and a slight dilution of the tank contents to the maximum operating temperature. Conditions of the tank integrity are therefore unknown.

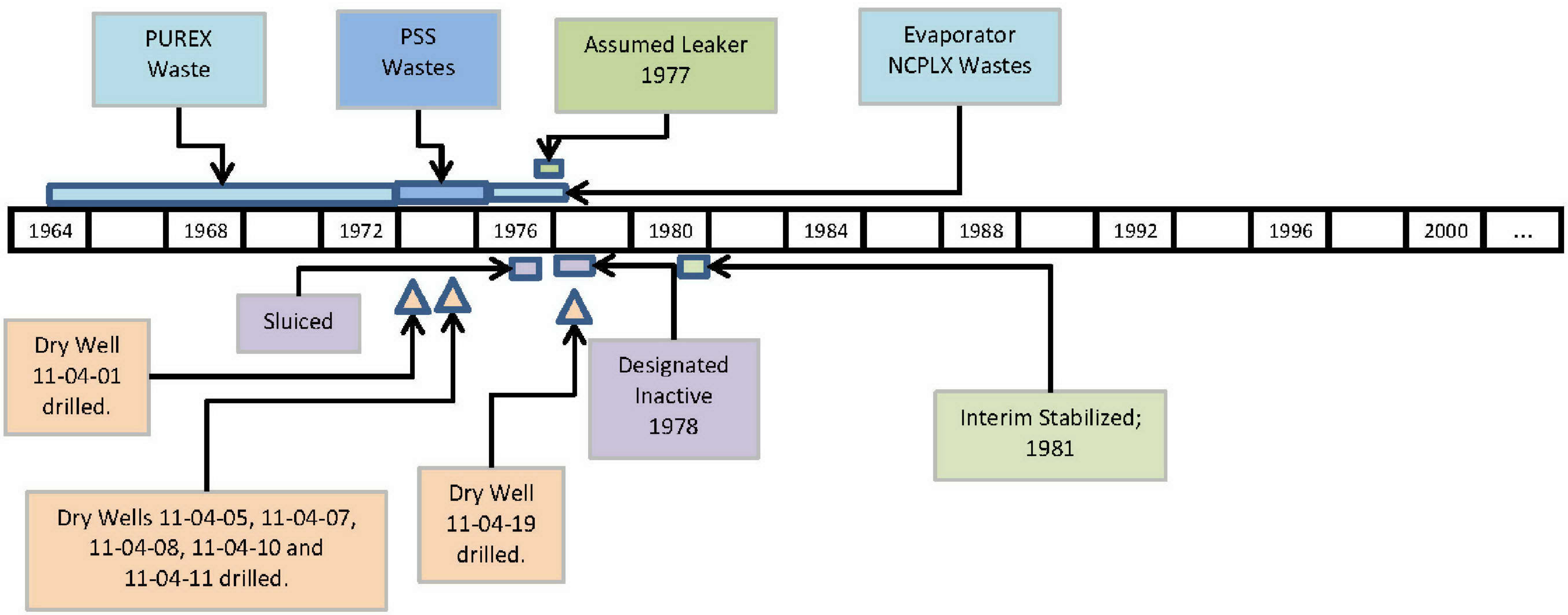
Supernate was again removed from SST AX-104 in 1972 for cesium ion exchange processing in B Plant. Tank AX-104 was then refilled from October 1972 through March 1973 with PSS from SST A-102 to allow entrained solids to settle before transferring the supernate to B Plant for cesium ion exchange processing. Tank AX-104 also received PSS from sluicing tank A-104 in September 1974 and PSS from sluicing tank A-103 in the second quarter of FY 1976.

The PSS was transferred from SST AX-104 in February 1977 for cesium ion exchange processing in B Plant and to prepare the tank for sluicing. The sludge in SST AX-104 was sluiced from March 31, 1977 through April 20, 1978. During sluicing, no increased radiation was reported to have been detected in the leak detection pit for SST AX-104.

B5.1.1 Plutonium Uranium Extraction High-Level Waste Receipt (1965 to 1969)

Single-shell tank AX-104 construction was completed in January 1965 (HAN-90650, pp. 16). Water was added to the tank in the fourth quarter of FY 1965 (RL-SEP-821, pp. 8) and the third quarter of FY 1966 (ISO-404, *Chemical Processing Division Waste Status Summary April 1, 1966 Through June 30, 1966*, pp. 8). The water added to SST AX-104 was likely done as part of the preheating procedure. The standard practice employed for the 241-AX tanks was to add water and preheat the water prior to adding boiling waste from the PUREX plant.

Figure B5-1. Tank 241-AX-104 Waste Operations Summary



NCPLX = non-complexed waste
PSS = Plutonium Uranium Extraction sludge supernate
PUREX = Plutonium Uranium Extraction (Plant)

In the fourth quarter of 1966, SST AX-104 began to receive HLW from the PUREX plant (ISO-538, pp. 8). Tank AX-104 continued to receive PUREX HLW through the third quarter of FY 1968 (ARH-721, pp. 9). Tank AX-104 was reported to have reached boiling conditions in October 1966 (RHO-CD-1172, pp. B-54 and ISO-674, pp. 2). Tank AX-104 continued to evaporate excess water due to the radiolytic decay heat, resulting in the removal of 2,042,000 gal of condensate from October 1966 through the fourth quarter of FY 1968 (ARH-871, pp. 3).

Tank AX-104 also received 37,000 gal of B Plant waste and 37,000 gal of PUREX HLW waste in the second quarter of FY 1969 (ARH-1200 A, pp. 10) and an additional 3,000 gal of PUREX waste in the third quarter of FY 1969 (ARH-1200 B, pp. 10).

B5.1.2 Plutonium Uranium Extraction Sludge Supernate Receipt (1972 to 1976)

In September 1972, 678,000 gal of supernate were transferred from SST AX-104 to tank AX-103 and then to tank C-105 for cesium ion exchange processing in B Plant (PPD-493-9-DEL, *Monthly Status and Progress Report September 1972*, pp. AIV-13 and ARH-2456 C, pp. 9). This transfer was conducted to ready SST AX-104 to receive the PSS from sluicing SST A-102 (PPD-493-9-DEL, pp. AIV-17). From October 1972 through March 1973, ~843,000 gal of PSS were transferred from 244-AR Vault to SST A-104 and then to SST AX-104 to allow entrained solids to settle (ARH-2456 D, pp. 9 and ARH-2794 A, pp. 9). From October 1972 through June 1973, ~878,000 gal of PSS were transferred from SST AX-104 to tank AX-103 and then to SST C-105 for eventual cesium ion exchange processing in B Plant (ARH-2456 D, pp. 9; ARH-2794 A, pp. 9; and ARH-2794 B, pp. 9).

Tank AX-104 again received PSS in September 1974. Tank AX-104 received 146,000 gal of water and 446,000 gal of PSS via 244-AR Vault from sluicing of SST A-104, filling the tank to ~763,000 gal (ARH-CD-133C, pp. 9). The supernate slowly evaporated from September 1974 through March 1975, reducing to ~504,000 gal, including an estimated 44,000 gal of sludge (ARH-CD-702 A, pp. 9), as indicated by the steady decline in waste surface level and temperature of the waste.

Tank AX-104 received 29,000 gal and 9,000 gal of PSS from sluicing SST AX-103 and 244-AR Vault, respectively, in the second quarter of FY 1976 (ARH-CD-702 A, pp. 9). Approximately 234,000 gal of PSS were transferred to SST C-105 for staging to the cesium ion exchange process in B Plant in the second quarter of FY 1976. Tank AX-104 again received PSS from sluicing SST AX-103 in September 1976 (ARH-LD-221 B, *Atlantic Richfield Hanford Company Monthly Report September 1976*, pp. 12), October 1976 (ARH-LD-222 B, pp. 13), and November 1976 (ARH-LD-223 B, *Atlantic Richfield Hanford Company Monthly Report November 1976*, pp. 11). Then, the heel in SST AX-103 was sluiced to SST AX-104 in December 1976 (ARH-LD-224 B, pp. 11).

B5.1.3 Sluicing (1977 to 1978)

On February 25, 1977 through March 3, 1977, the supernate in tank AX-104 was transferred to SST AX-101 (~771,400 gal) in preparation for sluicing (Occurrence Report 77-36, *Liquid Level Decrease Exceeding Criteria for Tank 101-AX*). Sluicing of the SST AX-104 sludge was initiated on March 31, 1977 to remove the high-heat-generating strontium and cesium isotopes and make this tank available for receipt of 242-A Evaporator bottoms (ARH-LD-227 B, pp. 27). The AX-104 sludge was easily sluiced to 244-AR Vault, but the sludge proved difficult to process due to its highly insoluble nature. More than three-fourths of the sludge was stated as being insoluble in nitric acid (ARH-LD-229 B, *Atlantic Richfield Hanford Company Monthly Report May 1977*, pp. 31). Sluicing of the tank AX-104 sludge was conducted every month except for October from March 31, 1977 through November 5, 1977. A volume assessment following the sluicing campaign revealed that additional waste removal was needed because the volume and thickness of the waste remaining in the tank could still potentially produce thermal hot spots (HNF-SD-HTI-ER-001, *241-AX-104 Residual Waste Volume Estimate*). A second sluicing campaign was initiated in March 2, 1978 and continued through April 20, 1978 (Occurrence Report 77-202, *Radiation Peak in Dry Well 11-04-08 Exceeding Increase Criterion* and SD-WM-TI-302).

Following completion of sluicing, the residual sludge in tank AX-104 was photographed and a map of the tank bottom made in July 1978 showing sludge location was prepared (Internal letter 60414-78-026, "Additional Information for Tank 104-AX").

Figure B5-2 shows quarterly surface level measurements for tank AX-104.

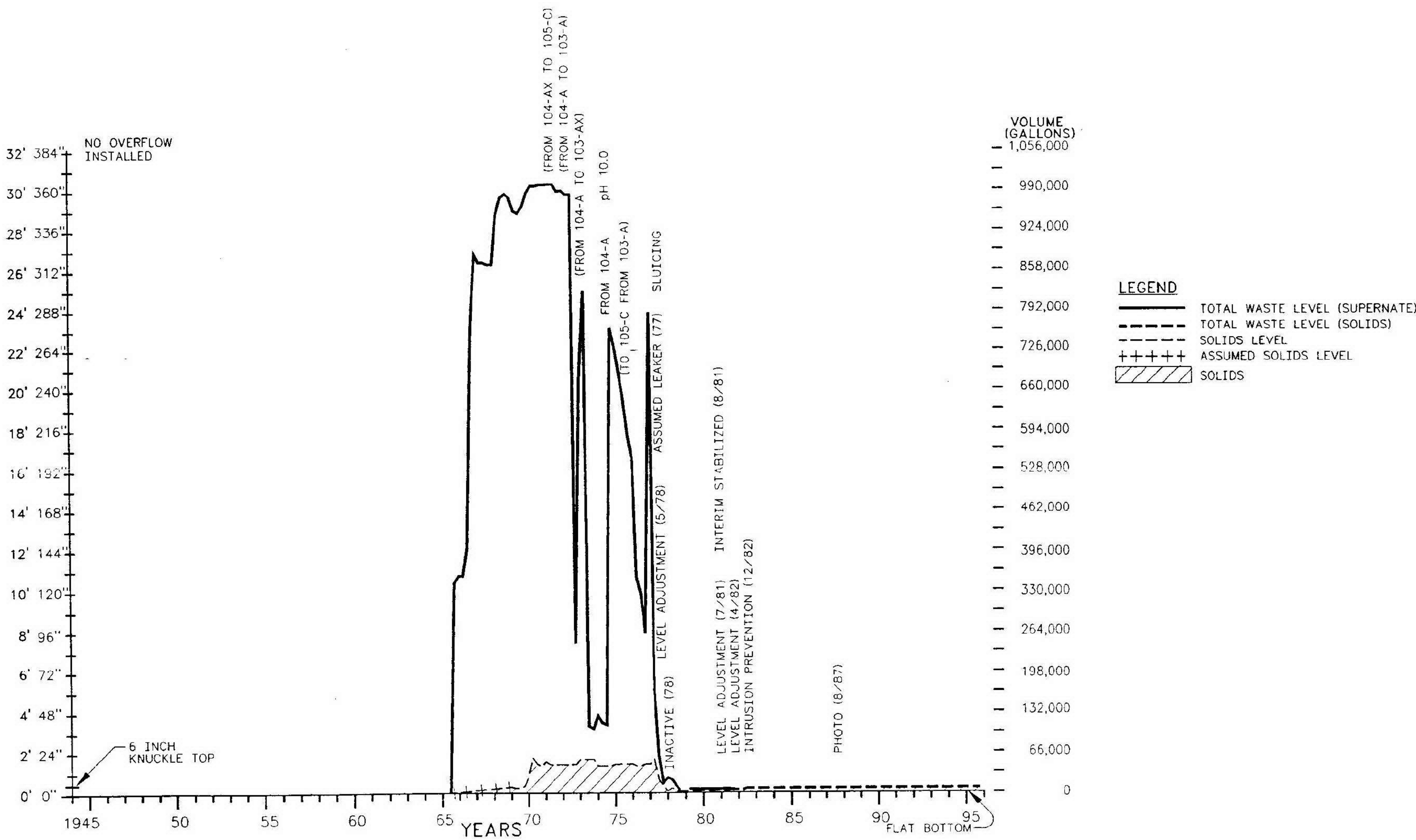
B5.2 INTEGRITY OF TANK 241-AX-104

Tank AX-104 was classified as "questionable integrity" and removed from active service in August 1978 as a result of the radioactivity detected in drywell 11-04-08 (Occurrence Report 77-202). However, the source of the radioactivity detected in drywell 11-04-08 could not be determined. The strongest gamma radiation signal was detected due east, toward tank AX-104, which led personnel in 1988 to suspect the integrity of the tank. The estimated waste loss from tank AX-104 was assumed to be ~8,000 gal based on the average waste loss from 18 other SSTs for which a liquid level decrease was reported (Letter 8901832B R1, "Single-Shell Tank Leak Volumes"). This assumed leak loss volume has a high uncertainty associated with it and cannot be verified.

B5.3 INTERIM STABILIZATION

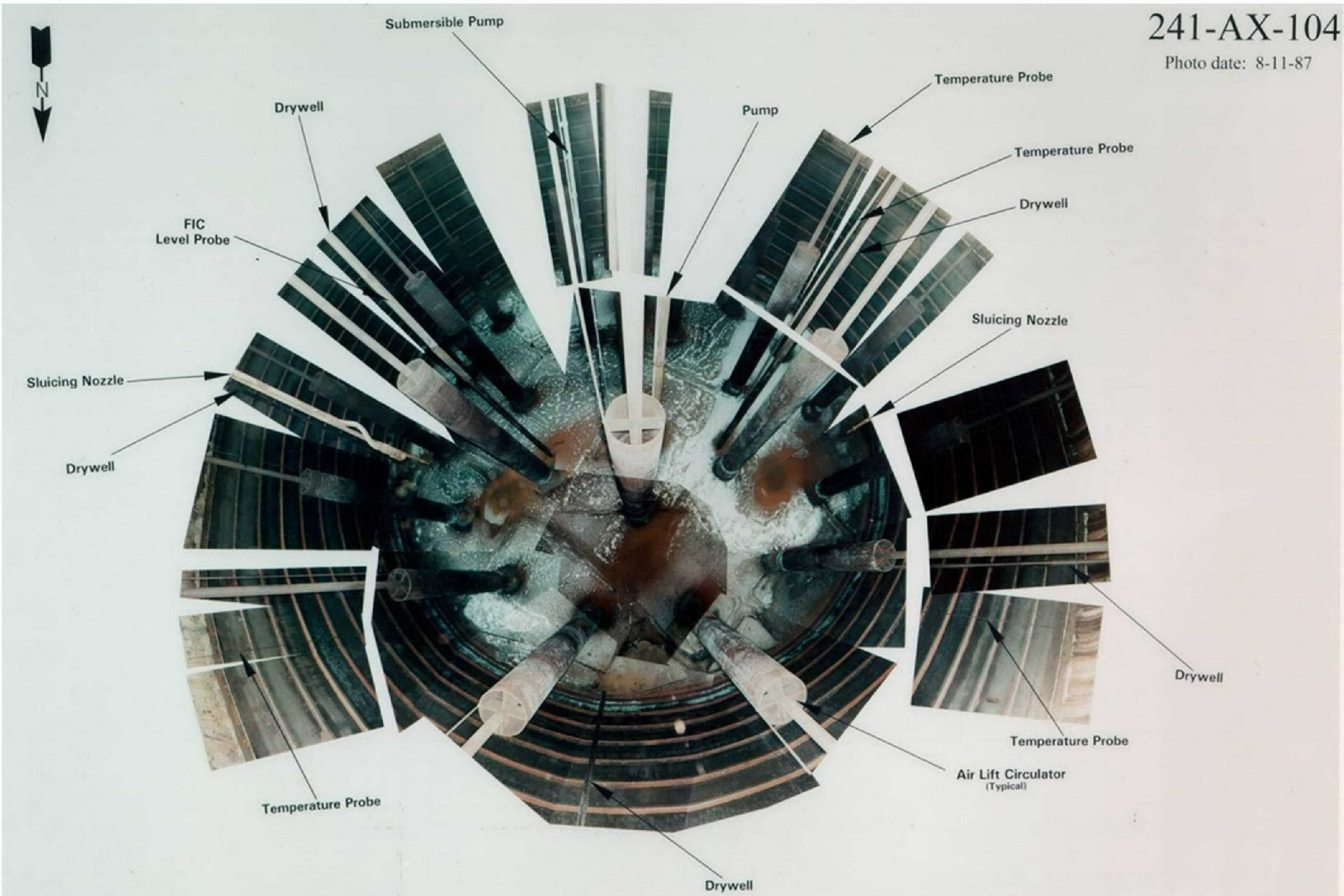
Tank AX-104 was declared interim stabilized effective August 10, 1981 based on review of in-tank photographs obtained on May 14, 1981 (HNF-SD-RE-TI-178, pp. 32). No supernate was estimated to be present in the tank. The four valve and service pit drain lines connecting to the tank were removed during August 1981 to prevent water intrusion (HNF-SD-RE-TI-178, pp. 32). The in-tank photographs were observed to "… show a series of corrugation ridges in the tank bottom liner and no discernable liquid pools. There is no definable pattern to this buckling configuration. In addition, areas of mounded dry sludge are seen at random locations about the tank" (HNF-SD-RE-TI-178, pp. 32). However, a tank composite photograph taken in August 11, 1987 (Figure B5-3) does <u>not</u> show the reported ridges or tank bottom buckling pattern. The entire tank bottom is visible in the August 11, 1987 photograph, which shows weld plates for the airlift circulators and a small amount of sludge and a sludge swirl pattern.

Figure B5-2. Tank 241-AX-104 Quarterly Waste Fill History



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

Figure B5-3. Tank 241-AX-104 Waste Surface Photo Mosaic



Reference: WHC-SD-WM-ER-349, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area.*

As of March 1, 2014 the tank is estimated to contain 7,500 gal of PUREX HLW sludge (P2) (as details are reported in RPP-RPT-42918, *2009 Auto-TCR for Tank 241-AX-104*). Figure B5-3 shows a mosaic photograph of the tank surface on August 11, 1987.

B5.4 TANK 241-AX-104 TEMPERATURE HISTORY

Tank AX-104 is a high-heat tank currently monitored by a single thermocouple tree located in riser 9C. Temperature data were found for tank AX-104 from 1966 to present. Figure B5-4 shows temperature data from 1966 to 1972 and Figure B5-5 shows Surveillance Analysis Computer System temperature data at several elevations near the bottom of the tank from 1976 to 2010.

The waste temperature in SST AX-104 began to increase from ~260 °F in September 1969 to ~340 °F in May 1970 (RHO-CD-1172, pp. B-57), which is above the maximum operating limit of 300 °F. The waste temperature had been between 260 and 280 °F for ~3 years. Air flow to the airlift circulators was adjusted and the temperature of the sludge was reduced in all but one location below the operating limit of 150 °C (300 °F); the eastern periphery of the tank reached 158 °C (~316 °F) in February 1970 (PR-REPORT FEB70, *Monthly Status & Progress Report February 1970*, pp. AV-3). By March 1970 the maximum temperature in the tank had reached 213 °C (~415 °F) and the temperature was increasing at a rate of 2 to 3 °C per day. Two other peripheral temperatures also exceeded the operational limit of 150 °C. The localized hot spots near the tank sidewall have not caused the sidewall differential temperatures to exceed the operational limit of 17 °C per foot of concrete (PR-REPORT MAR70, *Monthly Status & Progress Report March 1970*, pp. AIV-5). Supernate was transferred and water added to the tank in an effort to reduce the temperature to mitigate any tank structural damages.

The maximum temperature in the tank AX-104 sludge continued to rise after the dilution and reached a maximum of 225 °C (~437 °F) in April 1970 (PR-REPORT APR70, *Monthly Status & Progress Report April 1970*, pp. AIV-5). The sludge temperature then began to increase again and reached 233 °C (~451 °F) in the western sector of the tank periphery in May 1970 (PR-REPORT MAY70, *Monthly Status & Progress Report May 1970*, pp. AIV-6). This prompted transfer of an additional 198,000 gal of supernate (~20% of total) from SST AX-104 to tank A-101 and 195,000 gal of water at 65 °C were added to SST AX-104 to reduce the sludge temperature (PR-REPORT MAY70, pp. AIV-6 and ARH-1666 B, pp. 10). The calculated sodium molarity in SST AX-104 was only 3M following this transfer. The maximum temperature across the concrete wall of the tank exceeded the recommended operational limit of 25 by 6 °C. Excessive differential temperatures across the concrete wall of the tank can lead to cracking of the concrete.

The dilution of tank AX-104 waste in May 1970 resulted in a gradual decrease in tank temperature. No additional waste or water additions to SST AX-104 were reported again until September 1972.

Figure B5-4. Tank 241-AX-104 Temperature, 1966 to 1970 (Sheet 1 of 3)

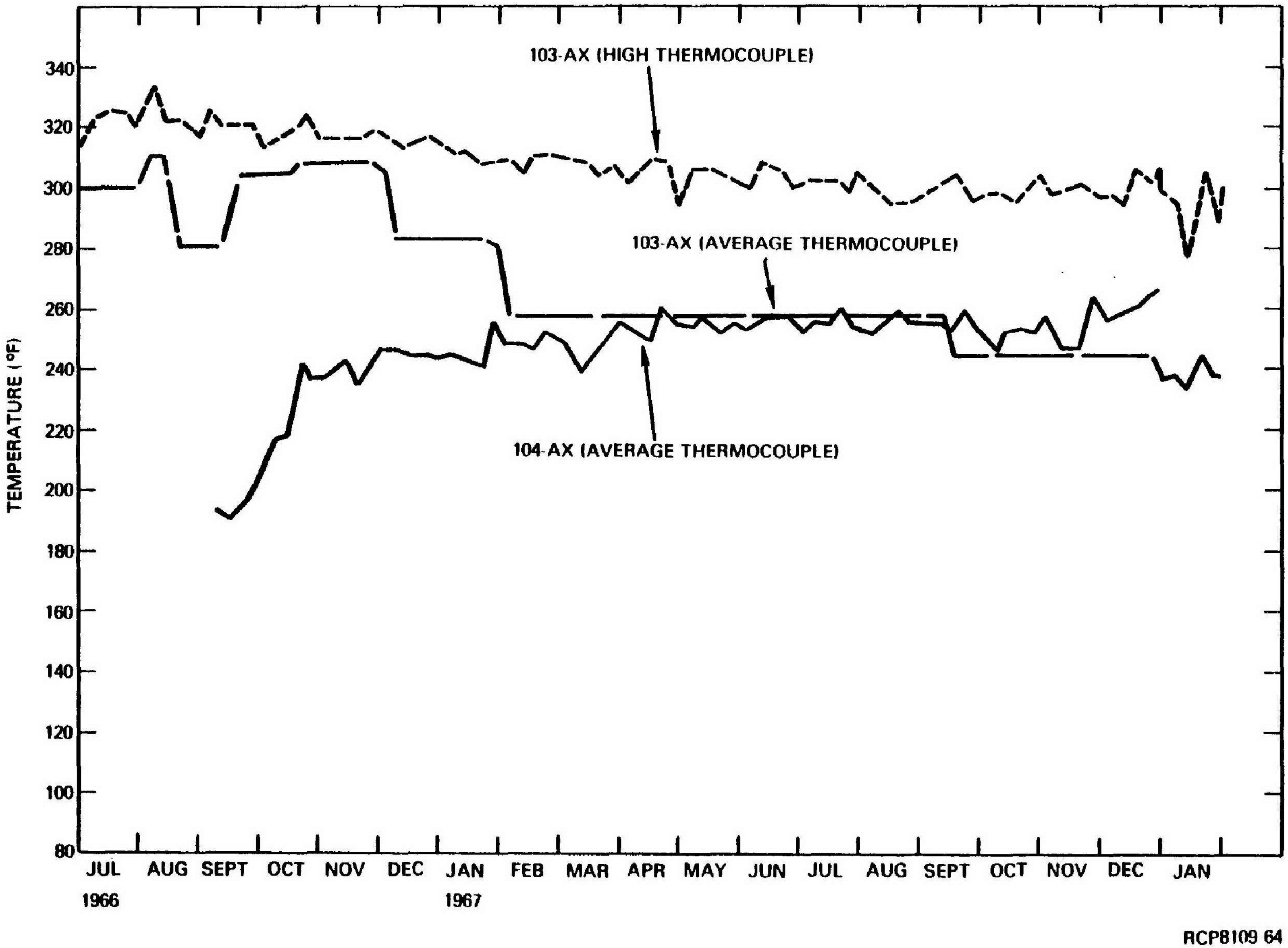


Figure B5-4. Tank 241-AX-104 Temperature, 1966 to 1970 (Sheet 2 of 3)

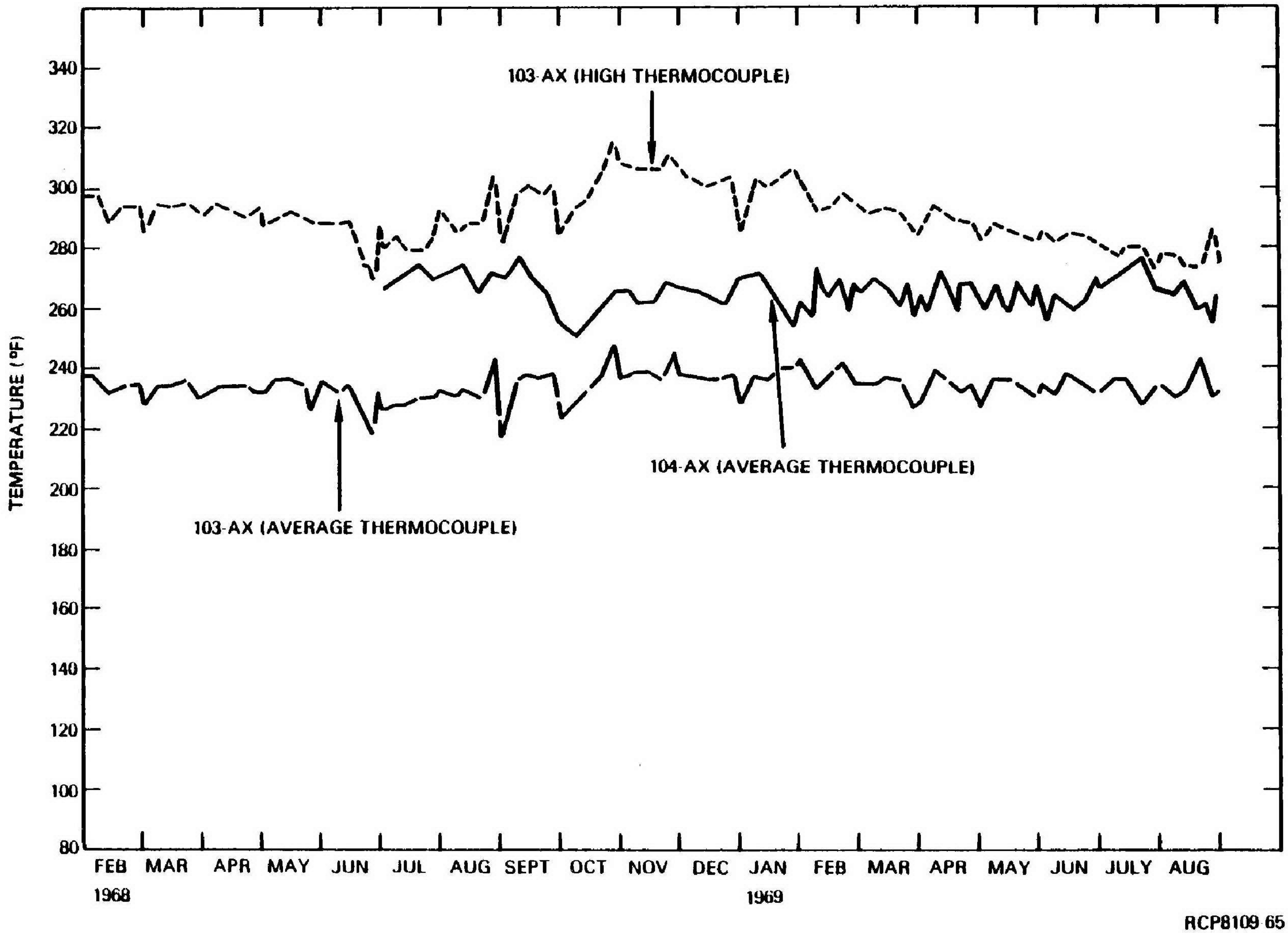
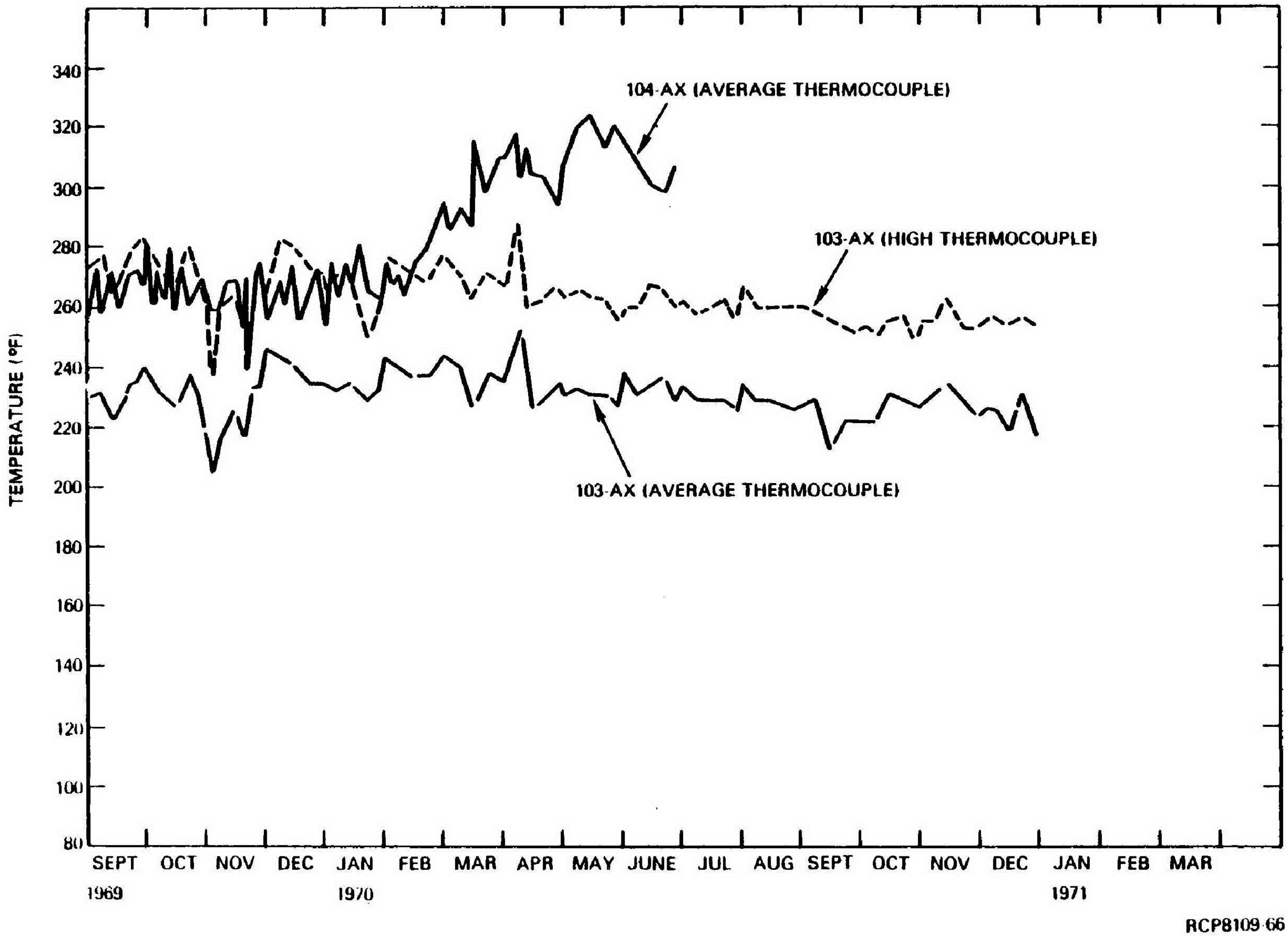
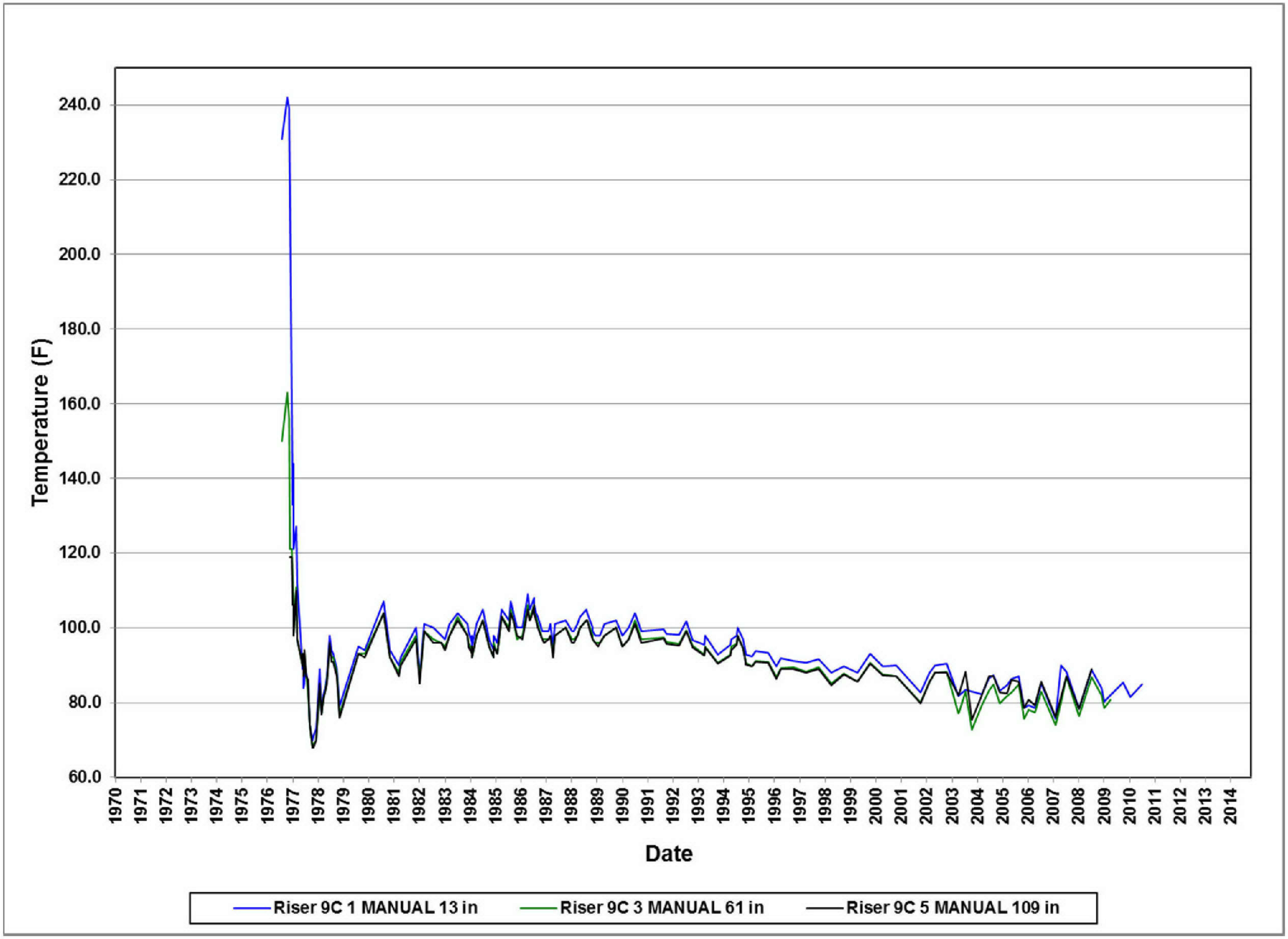


Figure B5-4. Tank 241-AX-104 Temperature, 1966 to 1970 (Sheet 3 of 3)



Source: RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*.

Figure B5-5. Tank 241-AX-104 Temperature, 1976 to 2010



Additional temperature data was not available until October 1976. Between February 1977 and January 1978 a rapid decrease in the waste temperature was observed, due to transfer liquids and final sluicing of the tank during this period.

B5.5 DATA REVIEW AND OBSERVATIONS

The following sections contain discussions of the tank surface level, drywell logging data, and leak detection pit liquid and radiation data for tank AX-104.

B5.5.1 Tank Surface Level Measurements

Tank liquid level measurements before 1973 were not available, other than from the transfer data in waste process reports (Figure B5-2). Table B5-1 shows liquid level measurements from June 1973 to December 1986 (SD-WM-TI-356). Figure B5-6 shows Surveillance Analysis Computer System waste level data for tank AX-104 from 1980 to 2014. There was no unexplained liquid level decrease in this tank attributed to a tank leak. One occurrence report (Occurrence Report 77-19, *Liquid Level Decrease Exceeding Action Criteria in Tank 104-AX*) was issued for a liquid level decrease in January 1977 exceeding the action level criteria of 1.00-in. decrease in 72 hours. Occurrence Report 77-19 notes that a filter was installed on January 26, 1977 in a 6-in. tank riser to improve air cooling in the tank. This action increased the evaporation rate in excess of criteria.

B5.5.2 Drywell Logging Data

Eight drywells surround tank AX-104 (11-04-01, 11-02-10, 11-04-05, 11-04-07, 11-04-19, 11-04-08, 10-04-10 and 11-04-11); Figure B5-7 shows the 1996 SGLS results for these drywells. The SGLS results are discussed in GJ-HAN-52, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-104*.

Several occurrence reports were issued for increased radiation in drywells near tank AX-104. In April 1975, ARHCO Occurrence Report 75-47, *Increasing Dry Well Radiation Adjacent to Tank 104-AX* reported increased radiation in drywell 11-04-11 (later reports determined that drywell 11-04-11 was referenced incorrectly, and the increased radiation was actually in drywell 11-04-01) at the 40-ft level since the drywell was drilled in January 1975. The report states that neither the tank liquid level nor leak detection pit liquid level or radiation monitoring give any indications of a tank leak. The source of the radiation around the drywell was not identified; ARHCO Occurrence Report 75-47 noted that past experience has shown shallow contamination to be the result of failed transfer lines, surface spills or other direct buried facility features. ARHCO Occurrence Report 75-47 also states “action taken to attempt sealing leaky vapor header will determine further action.”

Table B5-1. Tank 241-AX-104 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 1 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
06/18/73	37.50			0.00	Manual tape
07/16/73	36.75		-0.75	-0.75	Steady decrease
07/17/73	38.00			-0.75	Transfer
07/30/73	37.50		-0.50	-1.25	New tape installed
08/03/73	37.25		-0.25	-1.50	Steady decrease
11/09/73	42.00			-1.50	Transfer
12/03/73	38.00		-4.00	-5.50	Steady decrease
12/19/73	42.50		+4.50	-1.00	Steady increase
01/05/74	48.75			-1.00	Transfers
01/22/74	46.00		-2.75	-3.75	Steady decrease
02/01/74	50.00			-3.75	Transfers
07/08/74	40.00		-10.00	-13.75	Steady decrease
08/10/74	282.25			-13.75	Transfers
04/30/75	248.00			-13.75	Steady decrease evaporation
05/01/75	246.80			-13.75	FIC installed
03/10/76	185.15			-13.75	Steady decrease/ associated with evaporation
03/26/76	129.15			-13.75	Transfers
04/13/76	125.85			-13.75	Steady decrease/ evaporation
04/24/76	132.70			-13.75	Transfers
09/08/76	102.35			-13.75	Steady decrease/ evaporation
03/03/77	58.65			-13.75	Transfers
03/28/77	52.15			-13.75	Steady decrease/ evaporation
08/24/77	7.10			-13.75	Sluicing and transfers
09/23/77	3.15			-13.75	Steady decrease/ evaporation, now using manual tape
11/07/77	11.50			-13.75	Sluicing and transfers
12/04/77	10.00			-13.75	Steady decrease/ evaporation
12/05/77	10.50			-13.75	Water added-- circulators
01/23/78	9.00			-13.75	Steady decrease/ evaporation
02/02/78	11.70			-13.75	Now using FIC gage
02/28/78	10.90			-13.75	Slow decrease/ evaporation

Table B5-1. Tank 241-AX-104 Liquid Level Measurements and Changes (1973 to 1986) (Sheet 2 of 2)

Date	Liquid level (in.)	Baseline ref.	Change from previous reading (in.)	Cumulative change (in.)	Comments
04/26/78	5.60			-13.75	Sluicing and transfers
05/08/78	5.00		-0.60	-14.35	Steady decrease
05/11/78		1.70		-14.35	Transfers
05/24/78	1.20		-0.50	-14.85	Slow decrease
06/06/78		3.70		-14.85	Transfer and leaking valve
11/10/78	0.80			-14.85	Slow decrease/ evaporation
03/11/79	1.40		+0.60	-14.25	Erratic readings
03/16/79		2.50		-14.25	Leak in AX-B pit
07/29/79	1.00			-14.25	Slow decrease/ evaporation
07/30/79				-14.25	FIC o/s
07/31/79	2.00			-14.25	Manual tape installed
09/05/79		2.50	+0.50	-13.75	Slow increase
12/10/80	2.50			-13.75	Stable
12/12/81	2.50			-13.75	Stable
10/07/82	2.50			-13.75	Stable
12/12/82	1.50			-13.75	Readings fluctuate between 1.50 and 2.50 in.
11/07/83		2.25		-13.75	New MT installed
12/12/83	2.75		+0.50	-13.25	Stable
10/04/84	2.25		-0.50	-13.75	Stable
10/04/85	2.50		+0.50	-13.50	Stable
10/01/86	2.50			-13.50	Stable

Reference: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria.*

In January 1976, ARHCO Occurrence Report 76-08, *Radiation Increase Monitored by Tank Dry Well* was issued for a gradual increase in the radiation peak at 32 ft in drywell 11-04-01. The report states that "The increased radiation … is considered normal migration of radionuclides transported by the unusually high moisture content in the ground. A program is being implemented … to prevent further contamination leakage from the exhaust header system." All further actions have not identified the source of the contamination. The report also suggests that the vapor header leak was a past leak, and, "Corrective action is planned if and when vapor header exhaust gives evidence of renewed leakage." ARHCO Occurrence Report 76-59, *Monitoring Dry Well Has Shown Increase in Radiation Exceeding Action Criteria*, issued in April 1976, notes that the exhaust header is located at a depth of 10 ft and ~10 to 15 ft from drywell 11-04-01. SD-WM-TI-356 states "through subsequent investigation the source of the contamination has been determined to be the tank's 20-in vapor line at points above the tank and at the line tied into the 24-in vessel vent header."

Figure B5-6. Tank 241-AX-104 Waste Surface Level Measurements

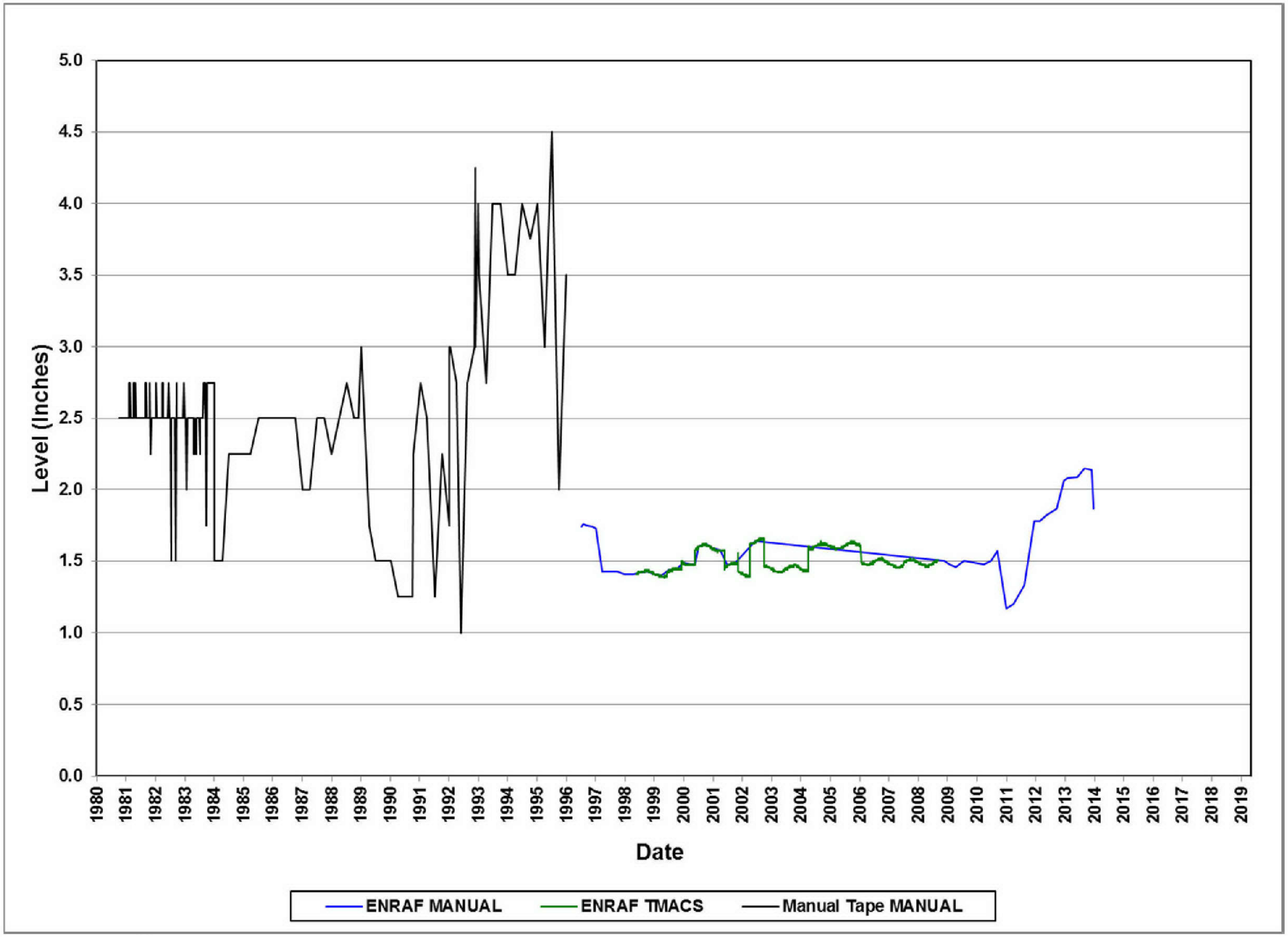


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Figure B5-7. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-AX-104 (Sheet 1 of 2)

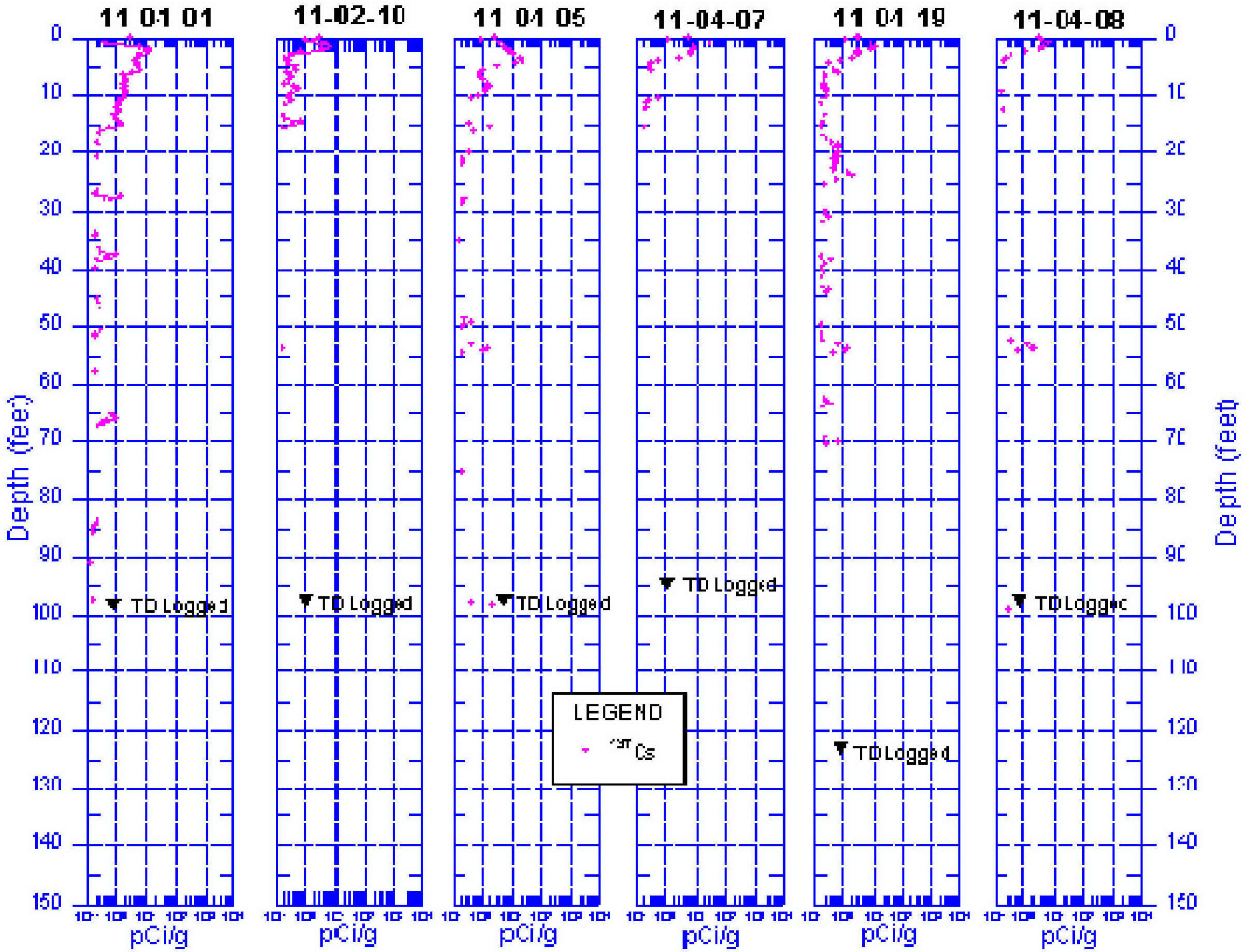
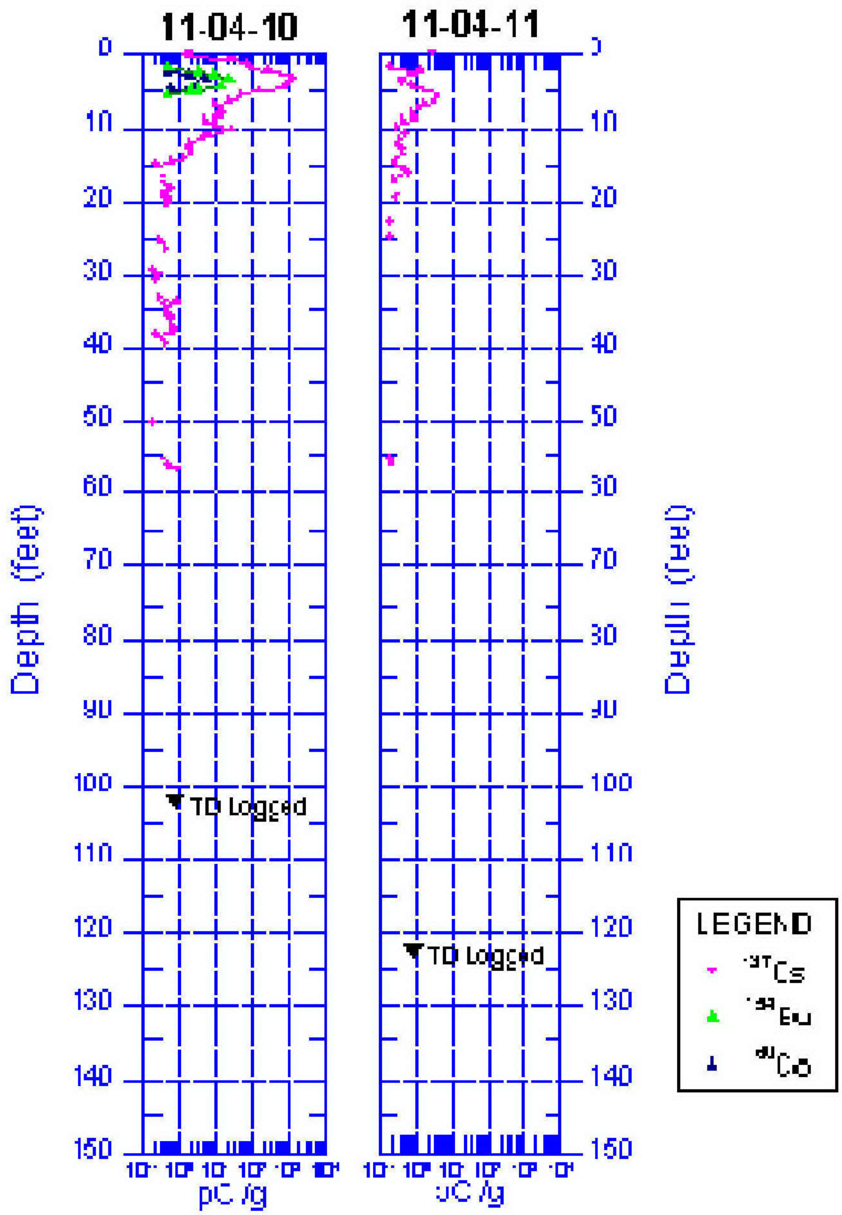


Figure B5-7. 1996 Spectral Gamma Logging Results for Drywells near Tank 241-AX-104 (Sheet 2 of 2)



Note: Maximum value of log scales shown for drywells 11-04-10 and 11-04-11 is 10,000 pCi/g.
Source: GJO-97-14-TAR/GJ-HAN-12, *Vadose Zone Characterization Project at the Hanford Tank Farms: AX Tank Farm Report*.

On November 11, Occurrence Report 77-202 was issued when drywell 11-04-08 was observed to have an increase in radiation above background reaching a peak of 247 cps at 64 ft bgs. The increase in radiation began in May 1976, but did not exceed background levels until August 1976. The radioactivity in this drywell decreased to 204 cps on March 8, 1978 but then began to increase again, reaching 287 cps on April 19, 1978 (similar to that depicted in Figure B5-8 for drywell 11-04-11). Four possible sources of radiation were investigated: 1) a dresser coupling leak in the exhaust header system between tanks AX-103 and AX-104, 2) a leak in the AX-102 to AX-103 exhaust header system, 3) a process piping leak south of AX-104, 4) a leak in tank AX-104. A specific apparent cause was not determined at that time and the normal surveillance of the tank continued.

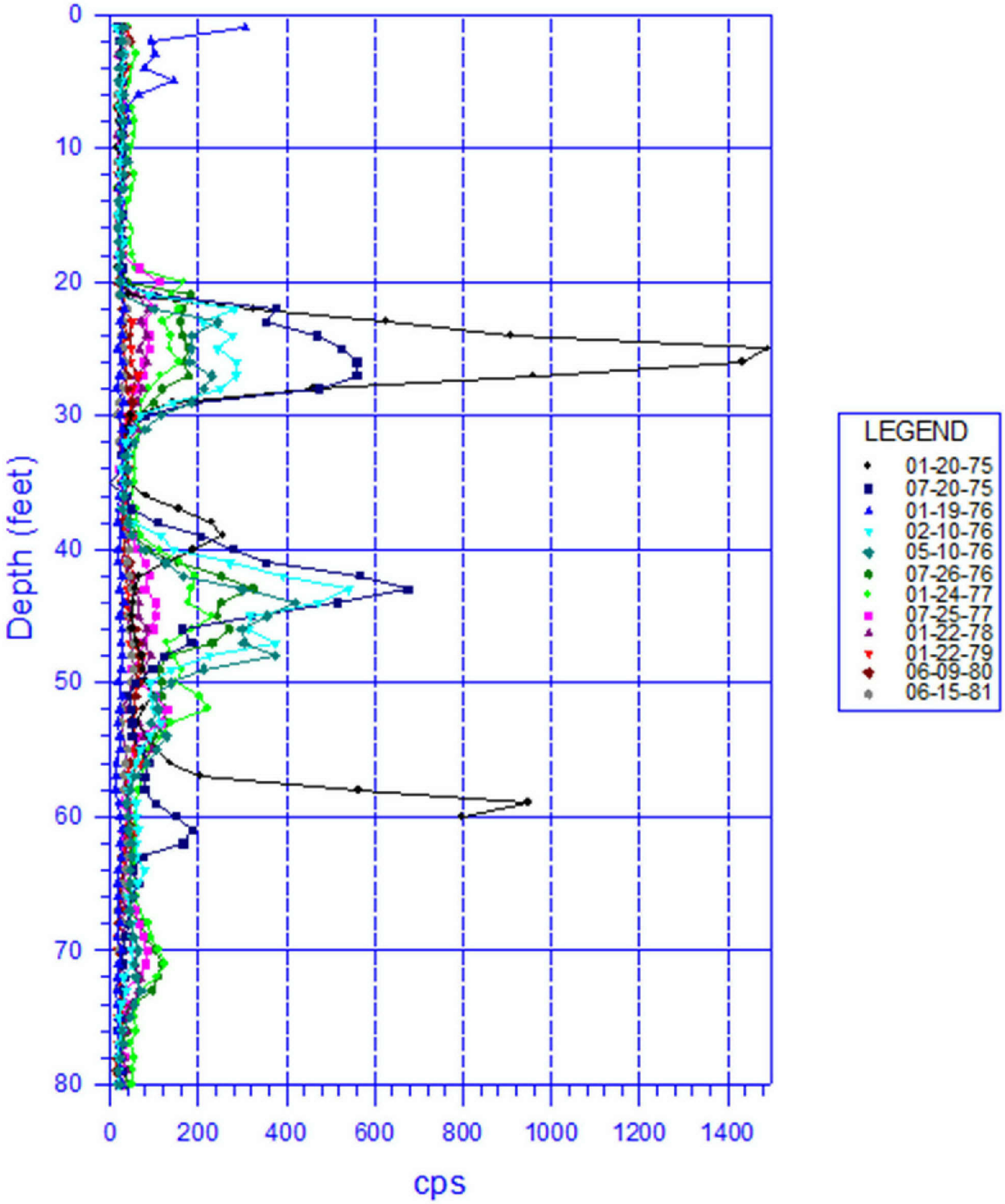
A new drywell, 11-04-19, was installed in March 1978 to investigate the potential for tank AX-104 to have leaked waste. Drywell 11-04-19 is situated between drywells 11-04-08 and 11-04-07 and is closer to tank AX-104. Initially, the radioactivity detected in drywell 11-04-19 was less than the detection limit of 50 cps (SD-WM-TI-356, pp. 11-04-10). The radioactivity detected in drywell 11-04-19 reached a maximum of ~200 cps in 1978 and then slowly decreased. The radioactivity detected in drywell 11-04-08 was subsequently correlated to a short-lived decay rate for ^{106}Ru, known to be a mobile isotope in Hanford soils (RPP-8821, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-AX Tank Farm – 200 East*, pp. 36-40).

Drywells nearby SST AX-104 currently do not show any significant contamination associated with a tank leak, as shown in Figure B5-7. Migration of ^{137}Cs contamination down the inside or outside of the drywell casing is suspected to have affected the distribution of some of the contamination detected in the drywells. Much of the bias of the drywell log data that is due to drywell migration effects was removed from the surveys and is designated as "removed" in Figure B5-7.

B5.5.3 Leak Detection Pit Data

In addition to drywell data, AX Farm has leak detection pits as described in Section 3.2. Both surface level and radiation measurements are available from the leak detection pits. Table B5-2 shows liquid and radiation levels in the AX-104 leak detection pit from 1973 to 1986 and Figure B5-9 shows liquid levels in the leak detection pit in 1995 and from 2000 to 2006 based on weight factor measurements. The AX-104 leak detection pit monitoring was discontinued after April 2006. The liquid level spike shown in Figure B5-9 in 2004 appears to be an anomaly.

Figure B5-8. Tank 241-AX-104 Historical Gamma Logging Results for Drywell 11-04-11



cps = counts per second

Reference: RPP-35484, *Field Investigation Report for Waste Management Areas C and A-AX.*

Table B5-2. Tank 241-AX-104 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 1 of 3)

Date	Liquid level (in.)	Radiation level (c/min)
06/15/73	24	300
09/15/73	24	0
12/15/73	24	0
04/15/74	24	0
05/15/74	23	0
06/15/74	23	0
07/15/74	22.8	0
08/15/74	21.1	0
09/15/74	20.7	0
10/15/74	21.1	0
11/15/74	21.1	0
12/15/74	20.7	0
01/15/75	21.1	0
02/15/75	20.7	0
03/15/75	20.7	0
04/15/75	21.1	0
05/15/75	20.7	0
06/15/75	20.7	0
07/15/75	21.1	0
08/15/75	21.1	0
08/25/75	21.6	0
09/21/75	21.1	0
12/18/75	21.6	0
12/28/75	21.1	0
01/08/76	21.6	0
03/31/76	21.0	0
04/26/76	22.0	0
05/26/76	22.5	0
06/26/76	21.0	0
09/15/76	21.5	0
10/29/76	16.0	0
11/03/76	16.0	0
12/05/76	15.0	0

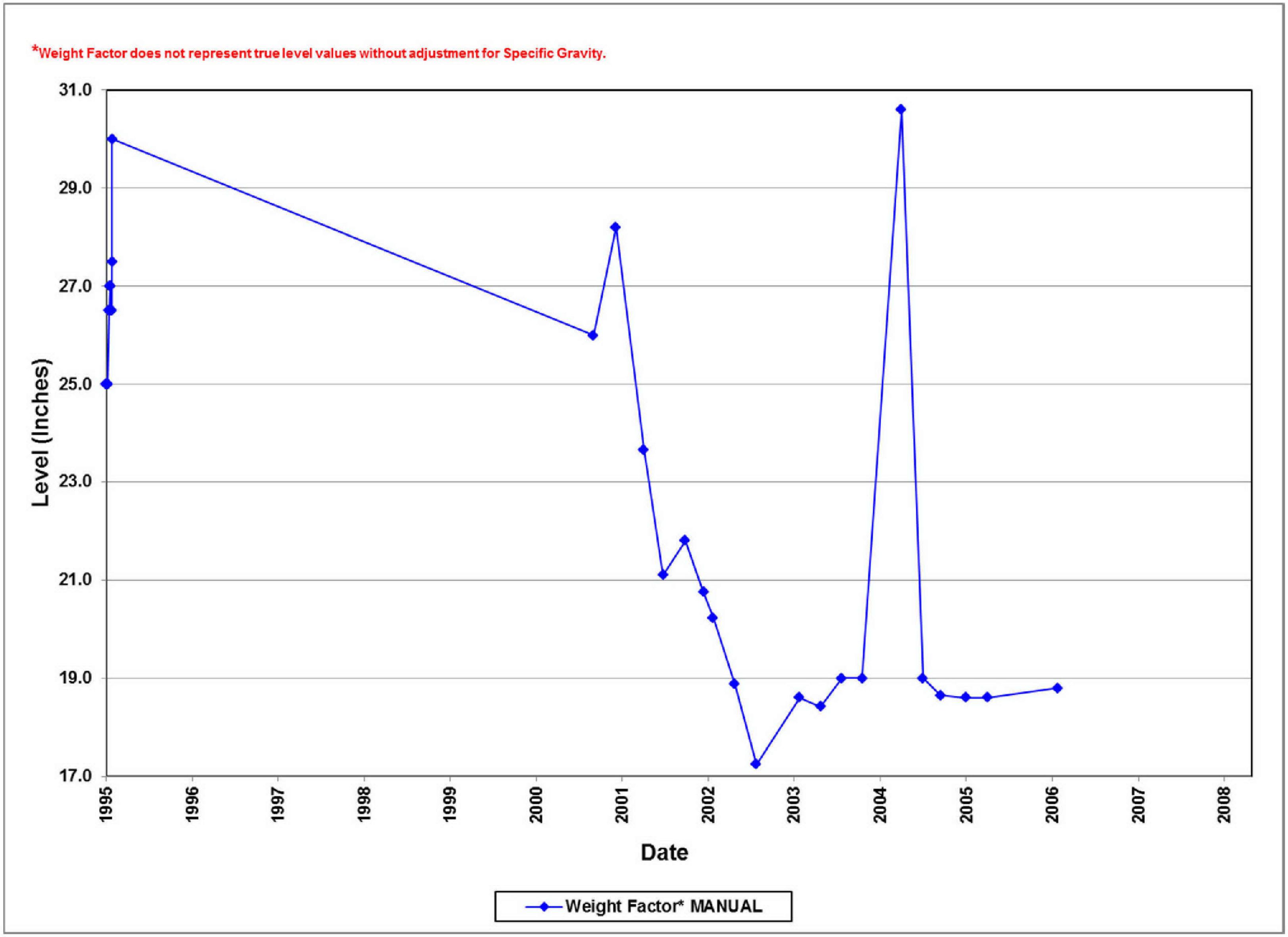
Table B5-2. Tank 241-AX-104 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 2 of 3)

Date	Liquid level		Radiation level (c/min)	Comments
	Gage	Weight factor (in.)		
12/27/76		14.0	0	LL slow decrease
12/28/76	4.8	0.0	<40	Radiation pen jumping
12/29/76	4.9	0.0	1	
12/30/76	5.0	21.0	1 to 4	Radiation pen erratic
12/30/76	5.0	21.0	<30	Radiation pen erratic
01/05/77		16.5	8 to 20	LL decrease
01/06/77	4.9	0.0	8	
01/07/77	4.9	20.0	10	
07/09/77	4.5	17.0	1 to 25	LL very slow decrease
10/26/77	0.0	0.0	0 to 30	LL steady decrease
03/02/78	0.0	0.0	2 to 60	LL stable at 0 in., radiation erratic
03/03/78	0.0	0.0	580	Radiation increase
03/29/78	0.0	0.0	500	Stable
03/30/78	0.0	0.0	800	Radiation increase
12/20/78	0.0	0.0	850	Radiation varies 600 to 1,000 c/min
08/21/79	1.0	6.5	100	Water added
12/31/79	1.0	2.0	107	Stable
12/11/80	0.8	1.5	200	LL slow decrease
01/25/81	0.0	0.0	400	LL steady decrease, radiation increase
01/27/81	1.5	6.5	80	Water added
02/25/81	1.0	3.0	150	LL steady decrease, radiation increase
02/26/81	2.5	10.5	100	Water added
05/13/81	0.5	0.0	3	LL steady decrease, radiation increase
05/14/81	2.2	9.0	120	Water added
09/23/81	0.0	0.0	300	LL steady decrease, radiation increase
09/24/81	2.5	10.0	200	Water added
01/13/82	1.0	1.0	100	LL steady decrease, radiation stable
01/14/82	3.0	12.5	90	Water added
04/18/82	3.0	8.5	100	LL stable, radiation stable
12/12/82	3.5	17.0	90	Readings vary from 0.3 to 3.8 in. due to evaporation, water additions, and rain. Radiation stable

Table B5-2. Tank 241-AX-104 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 3 of 3)

Date	Liquid level		Radiation level (c/min)	Comments
	Gage	Weight factor (in.)		
03/25/83	9.5	30.0	140	Rain, radiation stable
03/29/83	0.5	0.0	120	Pumped
07/01/83	4.8	18.0	100	Added water
07/21/83	4.8	18.0	160	Stable
07/26/83	1.0	1.5	70	Bailed out
08/25/83	2.1	10.0	100	Added water
12/12/83	3.5	16.0	100	LL increase/radiation stable
02/04/84	2.0	3.2	100	Pumped
07/25/84	2.5	6.0	120	LL increase
07/26/84	0.0	0.0	100	Instrument calibration
10/20/84	1.0	3.0	80	Water added
11/14/84	1.2	4.0	95	LL slow increase
02/19/85	3.8	16.0	60	Ll slow increase
02/20/85	1.1	4.4	65	Pumped
08/19/85	2.0	8.0	55	LL erratic increase
10/24/85	0.5	3.0	50	LL erratic decrease
10/27/85	1.5	7.5	50	Water added
11/19/85	1.5	7.5	60	Stable
01/20/86	3.5	18.0	40	Water added
01/21/86	16.5	18.0	40	New dial gage
03/07/86	14.0	14.0	50	LL slow decrease
03/08/86	9.0	9.0	40	Pumped
05/19/86	14.0	15.0	50	LL slow increase
05/20/86	3.5	4.0	60	Pumped
06/22/86	0.0	0.0	100	LL slow decrease
07/08/86	7.0	8.0	40	Water added
08/20/86	3.0	3.0	60	LL slow decrease
08/21/86	9.3	9.0	30	Water added
11/08/86	0.0	0.0	175	LL slow steady decrease
11/13/86	8.5	9.0	150	Water added
12/13/86	2.2	2.5	60	LL slow steady decrease

Figure B5-9. Tank 241-AX-104 Leak Detection Pit Liquid Level (1996 to 2006)



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APPENDIX C

241-A TANK FARM INFORMATION SUMMARIES: FOR TANKS CLASSIFIED AS SOUND (HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014*)

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Abbreviations and Acronyms

BBI	Best Basis Inventory
CASS	Computer Automated Surveillance System
CY	calendar year
DSSF	double-shell slurry feed
FIC	Food Instrument Corporation (gauge)
HLW	high-level waste
LOW	liquid observation well
OWW	organic wash waste
PUREX	Plutonium Uranium Extraction
TMACS	Tank Monitor and Control System

Units

Ci	Curie
kgal	kilogallon (10^3 gallons)

Waste Type Abbreviations

A1-Saltcake	saltcake from the first 242-A Evaporator campaign using 241-A-102 feed tank (1977-1980)
PSS	PUREX sludge supernate
SRR	221-B Plant strontium recovery process waste

C1.0 TANK 241-A-101

C1.1 HISTORY

Tank 241-A-101 (A-101) is located in the 200 East Area 241-A Tank Farm (A Farm) on the Hanford Site. According to HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2014*, tank A-101 has a tank integrity classification of "sound," indicating that no loss of liquid was attributed to a breach in tank liner integrity. HNF-EP-0182 also identified that tank A-101 contains retained gas in saltcake. The Current Best Basis Inventory (BBI) for tank A-101 indicates an overall waste volume of 320,000 gal including 46,000 gal of volume attributed to retrained gas.

The waste in tank A-101 consists primarily of saltcake and saturated liquid produced by the 242-A Evaporator. A small layer of sludge (~3,000 gal) with higher concentrations of silicon, iron and ^{90}Sr is also present. Waste transfer records show that tank A-101 was initially filled with a combination of Plutonium Uranium Extraction (PUREX) high-level waste (HLW) and organic wash waste (OWW). Condensates from this self-boiling waste tank were routed to cribs. The remaining supernate was removed from the tank in the first quarter of 1968, after which the tank was sluiced for the first time. Sludge was retrieved from the tank in 1968 and 1969. Following this first sluicing, the tank received primarily strontium recovery supernate (SRR) from 221-B Plant (B Plant) and supernates from the sluicing of other HLW tanks in 241-A and 241-AX Tank Farms. The tank was re-sluiced in 1975 and 1976 and additional sludge was removed.

Tank A-101 was used to stage feed for the 242-A Evaporator and to interim store the first-pass evaporator salt slurries starting in the third quarter of 1976. Some of these feeds/slurries contained dilute concentrations of complexant waste. Salt accumulated in the tank as the result of the storage of these solutions. The tank was saltwell pumped (removing interstitial liquid waste) in 2003.

Two core samples were taken in July 1996. The BBI is primarily sample-based, augmented with radionuclide and chemical component data from modeling.

C1.2 SURFACE LEVEL DATA

Figure C1-1 shows historical quarterly waste levels for tank A-101 from 1946 to 1996 (WHC-MR-0132, *A History of the 200 Area Tank Farms*). Additional surface level data showing more frequent measurements is available for tank A-101 from 1973 to 1986 (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*) and from 1980 to present (Figure C1-2). Some or all of the liquid-level increases were determined as a result of slurry growth (SD-WM-TI-356). A Food Instrument Corporation (FIC) gauge, in the automatic mode, was used to monitor the waste surface level in tank A-101 until May 10, 1982. A manual tape was used to monitor the waste surface level in tank A-101 until July 3, 1995. A manual

Enraf®[5] system was used to begin taking readings on September 12, 1995 through riser 6. On November 25, 1996, the waste surface level was 345 in., as measured by the manual Enraf® system.

Twelve occurrence reports were issued for tank A-101, four dealing with surface level and inadvertent additions.

Occurrence Report 76-73, *Monitoring of a Periphery Drywell Near 101-A was not Performed on the Scheduled Monthly Cycle* resulted when the 30-day drywell surveillance schedule was exceeded in monitoring drywell 10-00-08. The drywell that was ready to scan was inaccessible due to a drilling rig left with equipment in the well. The drywell access was cleared and monitored on May 21, 1976. No indication of any change was detected in the drywell.

Occurrence Report 77-125, *Tank 101-A Liquid Level Rate of Decrease Exceeding Criterion* was issued when the tank 101-A surface level decreased greater than the criterion of 0.5 inches. This resulted from tank 101-A receiving slurry from 242-A Evaporator which increased the waste temperatures, and thus increasing the rate of evaporation.

Occurrence Report 78-01, *Tank 101-A Liquid Level Increase Exceeding Criterion* was issued when the liquid level increased slightly above the 2-in. increase baseline as a result of discrepancies resulting from a dry heavy waste crust buildup on the FIC plummet.

Occurrence Report 81-03, *Radiation Peak in Dry Well 10-01-04 Exceeding the Increase Criterion* was issued on January 12, 1981 as the result of a radiation peak reading in drywell 10-01-04 of 207 counts per second at the 40-ft level. This increase exceeded the increase criteria by being greater than two hundred counts per second and three times the background radiation activity. The cause of the activity is the result of radionuclides being leached down from past soil contamination around the 241-A-01B pit area.

EM-RL--WHC-TANKFARM-1990-0315, *Lateral Radiation Readings under Tanks 241-A-101, 241-A-102 and 241-A-105 not Monitored as Required* was issued because equipment failure prevented monitoring from being performed weekly as required by SD-WM-TI-357, *Waste Storage Tank Status and Leak Detection Criteria*, Rev. 1C. Situation was rectified.

RL--WHC-TANKFARM-1993-0055, *Operator Experienced Symptoms (Headache) Due to Unknown Odor While Performing Respiratory Posting of 101-A Breather Filter Exclusion Zone* was issued as a result of an odor reported on June 17, 1993. It was determined that the unknown odor should have no adverse health effects.

RL--WHC-TANKFARM-1996-0056, *Electrical Spark While Bonding Camera Equipment* was issued because an electrician observed a small electrical spark between a bonding wire and the bounding bus. Based on the initial troubleshooting results, the light stand was disconnected and returned to the maintenance shop.

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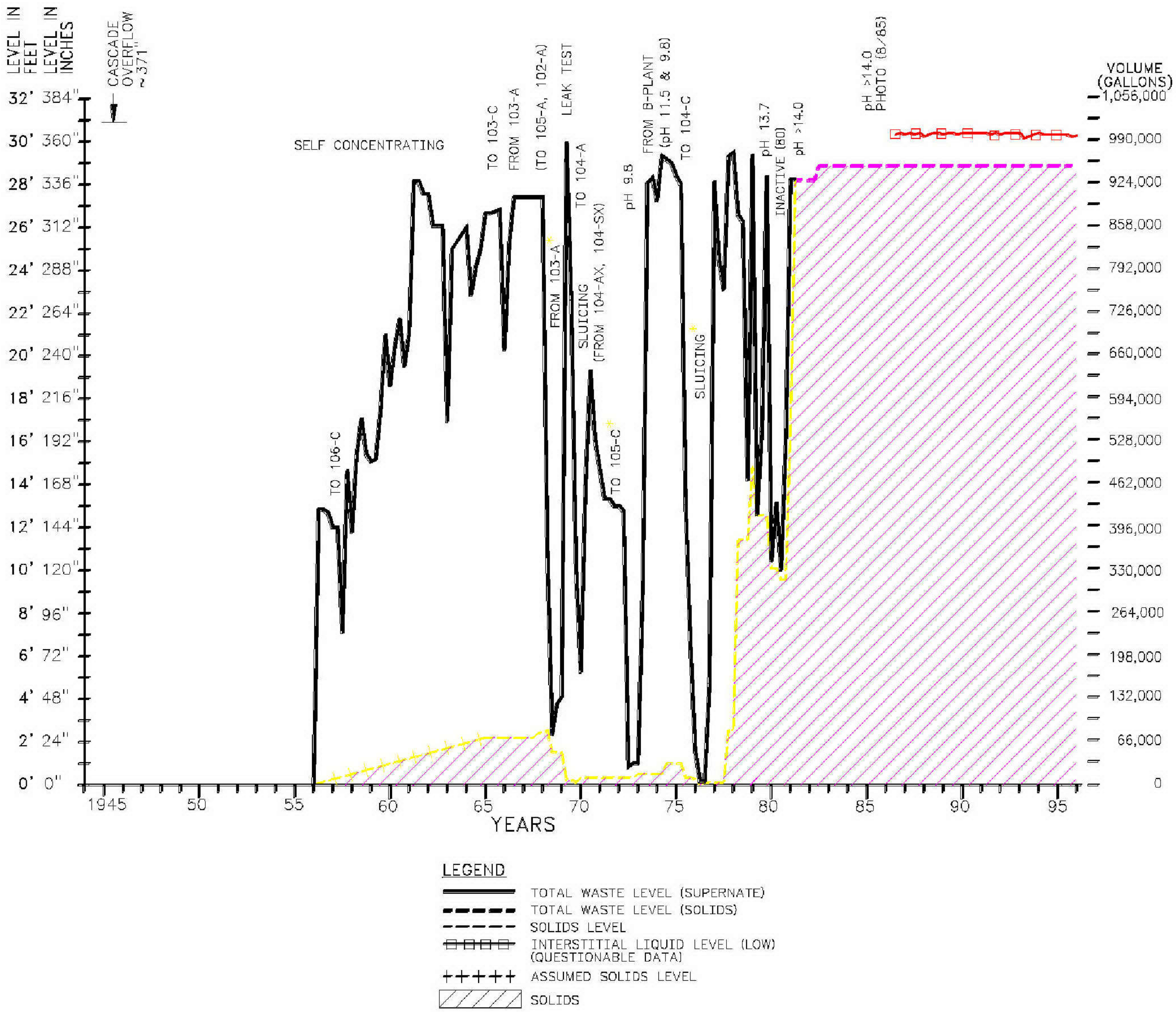
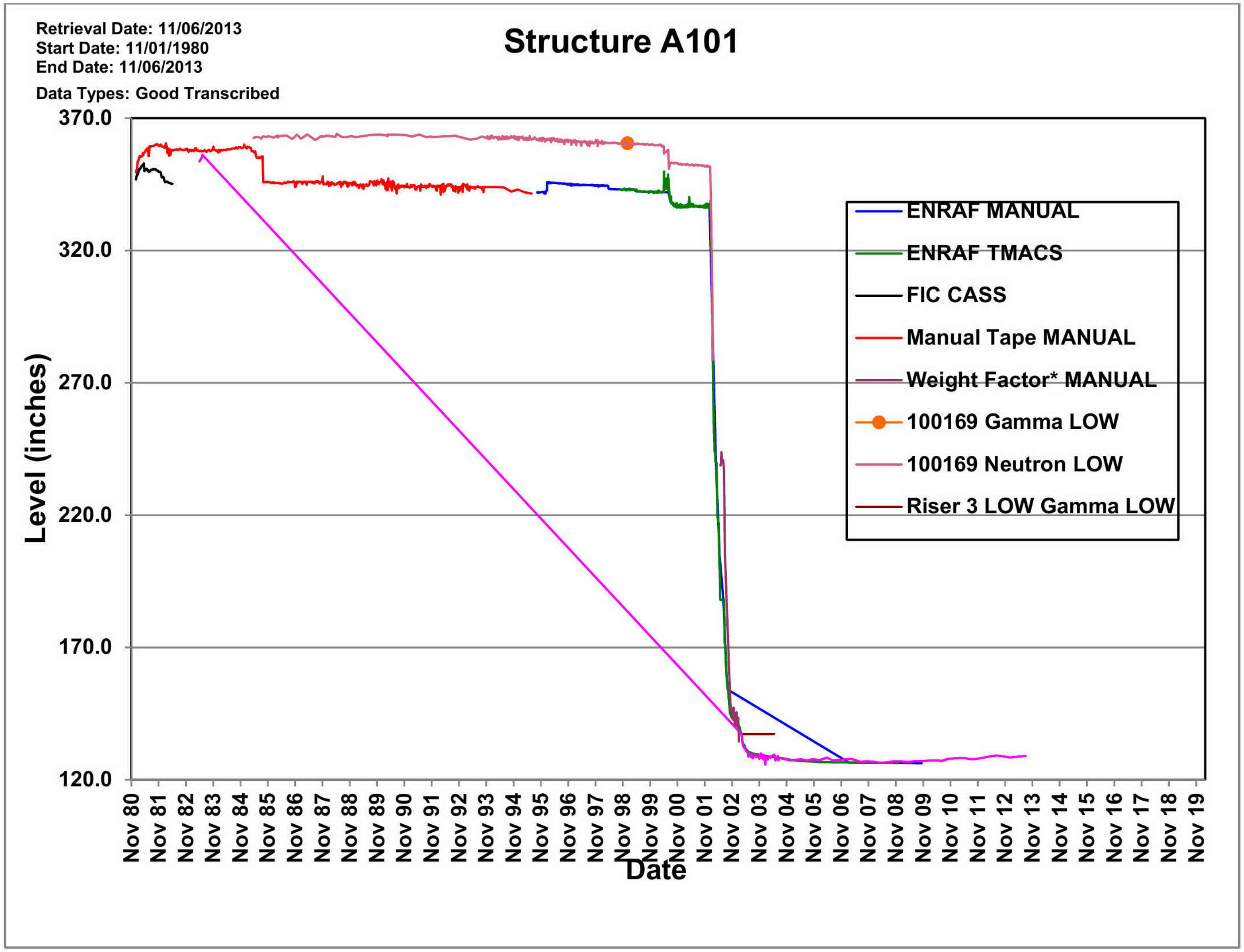
[5] Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

Figure C1-1. Tank 241-A-101 Quarterly Surface Levels



Source: RPP-RPT-42739, *2009 Auto-TCR for Tank 241-A-101.*

Figure C1-2. Tank 241-A-101 Surface Level Data



CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

RP--CHG-TANKFARM-2000-0033, *241-A-101 Water Lance Failure During Installation* was issued due to a crane coupling failure during the installation of an Interim Stabilization water lance; the equipment swung free, resulting in the end of the section hitting the ground. Corrections were made in design and fabrication of the replacement lance.

RP-CHG-TANKFARM-2000-0049, *Clothing Contamination Following 241-A-101 Saltwell Pump Removal* was issued when two radiation workers were found to have contaminated clothing. The situation was corrected and direction was provided to ensure effective packaging is used in the future.

RP--CHG-TANKFARM-2002-0030, *Completion of Surveillance Requirement 3.1.6.2 Exceeds 365 Days for 241-A-101 Saltwell Pumping* was issued because the backflow preventer on the dilution injection system continued to operate past the due date for Surveillance Requirement 3.1.6.2 per Tank Farms Technical Safety Requirements Limiting Condition for Operations 3.1.6. The process to input into shift instructions was revised.

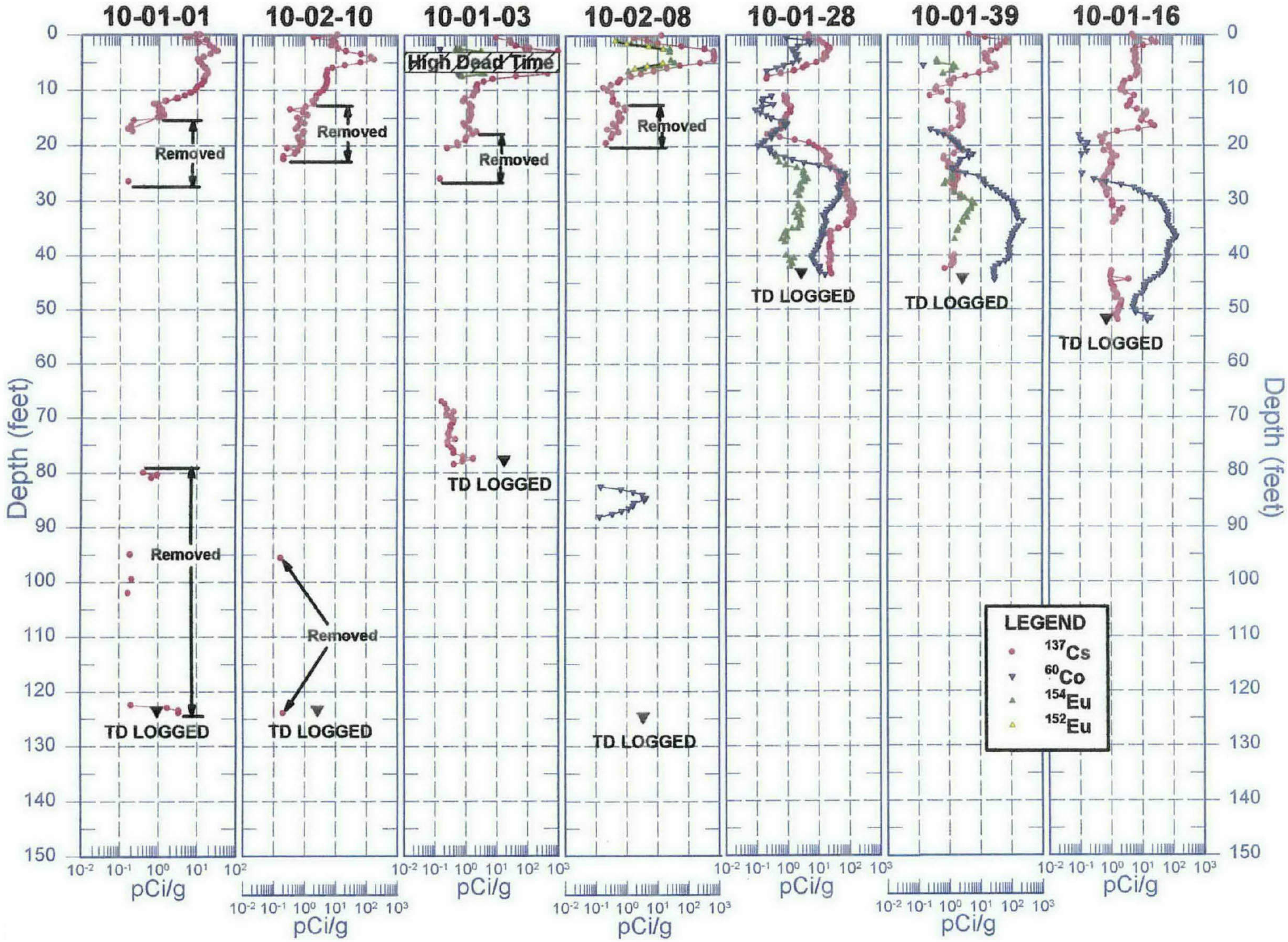
RP--CHG-TANKFARM-2002-0086, *Unauthorized Water Addition to Single-Shell Tank 241-A-101* was issued when on August 8, 2002, an operator discovered the raw water supply was inadvertently left connected with the isolation valve cracked open. As a result, ~686 gal of water was added to tank A-101. The situation was resolved and additional training was undertaken.

RP--CHG-TANKFARM-2002-0117, *Electrical Arc Observed by Employee Connecting Flush Hoses in Support of Waste Pumping Activities at Tank 241-A-101* was issued as a result of an employee observing and arc while connecting a flush hose. The cause of the arc was determined to be an exposed heat trace wire located on the hose connection. The hose was repaired.

C1.3 DRYWELL DATA

Drywells that surround tank A-101 are 10-01-01, 10-02-10, 10-01-03, 10-02-08, 10-01-28, 10-01-39, 10-01-16, 10-01-04, 10-01-05, 10-00-07, 10-01-06, 10-01-08, 10-00-08, 10-01-09, 10-01-10, and 10-01-11. The first two digits of the drywell name indicate the tank farm in which the drywell is located, the second two digits indicate the associated tank, and the last two digits indicate the clock position relative to the northernmost tangent to the tank. The near-surface higher level ^{137}Cs and ^{60}Co regime consists of relatively higher-level ^{137}Cs contamination (10 to 1,000 pCi/g) as well as minor ^{60}Co, ^{154}Eu, and ^{152}Eu (less than 1 pCi/g to almost 30 pCi/g). The contaminants of this regime occur within the upper 5 ft of boreholes 10-01-03, 10-02-08, 10-01-28, 10-01-39, 10-01-05, 10-00-07, and possibly 10-01-06 and 10-02-10. This contamination probably leaked from the 241-A-01B Sluice Pit, located within the southeast quadrant of the tank, and subsequently spread out in the near-surface backfill to the vicinity of these boreholes. Figure C1-3 shows the monitoring readings observed in the drywells surrounding tank A-101 (GJO-98-64-TAR/GJO-HAN-23, *Hanford Tank Farms Vadose Zone: A Tank Farm Report*).

Figure C1-3. 1998 Spectral Gamma Logging System Logging Near Tank 241-A-101



Source: GJO-98-64-TAR/GJO-HAN- 23, *Hanford Tank Farms Vadose Zone: A Tank Farm Report*.

The contaminant plume located to the southeast of the tank and extending to below the base of the tank, as stated before, probably originated from the 241-A-01B Sluice Pit; however, a leak from tank A-101 or from associated facilities, such as a cascade line or the cascade line coupler on tank A-101, cannot be completely ruled out. The areal extent of the plume is well defined by data acquired in numerous monitoring boreholes in the vicinity. The limited areal and depth extent of the plume and the lack of confirmatory tank contents level data indicate that if a leak has indeed occurred, the total leak volume was small. Piping about tank A-101 is shown in Figure C1-4.

Figure C1-4. Tank 241-A-101 Piping Arrangement

Source: H-2-63100, *101-A TK. ARR'G'T. As Built.*

C2.0 TANK 241-A-102

C2.1 HISTORY

According to HNF-EP-0182, tank 241-A-102 (A-102) has a tank integrity classification of sound. The Current BBI for tank A-102 indicates an overall waste volume of 40,000 gal including 3,000 gal of supernate.

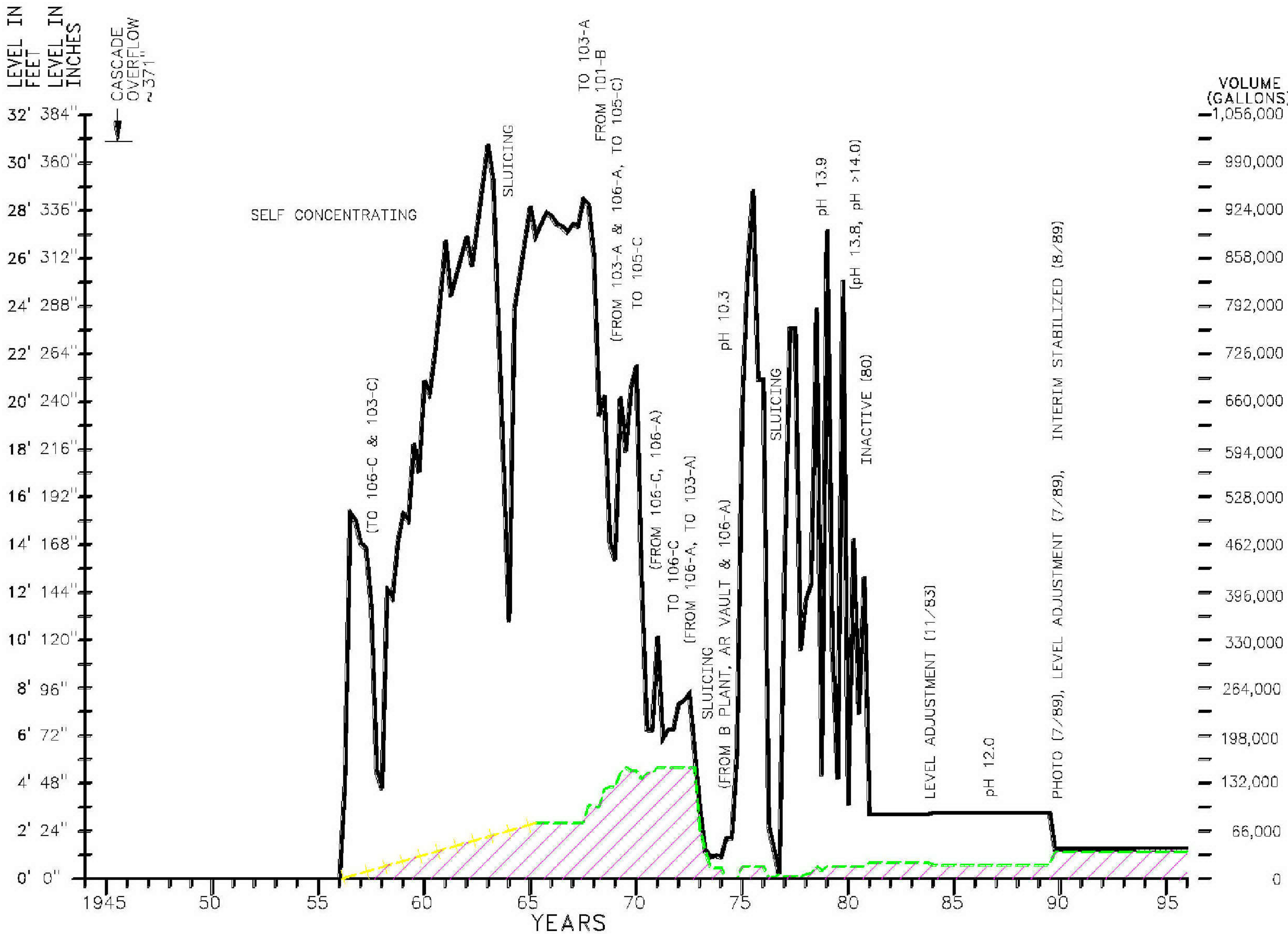
Tank A-102 was put into service in 1956 and received organic wash water waste from PUREX. Later in 1956, the tank began receiving PUREX HLW. The transfers of organic wash water waste ceased in 1963, while the receipts of PUREX HLW continued until 1980. In 1964, tank A-102 was the sludge accumulation tank and liquid feed tank for the sluicing process test in tank 241-A-103 (A-103). Tank farm records indicate many transfers both in and out of tank A-102 from 1963 to 1972, recognizing that there is a slight uncertainty in mass balance determination from such aspects as symmetry of the transferring tanks and flow measurement instrument error. Tank A-102 was sluiced in 1972, 1973, and 1974 in support of strontium recovery at B Plant. Sludge was removed to a 1- to 2-in. heel to allow saltcake storage. After sluicing, tank A-102 received strontium recovery waste from B Plant. The tank was sluiced again in 1976 to tank 241-A-106 (A-106), leaving a heel. Over its service life, the tank also received supernatant waste from various tanks, PUREX sludge, B Plant strontium recovery waste, B Plant HLW, and evaporator feed waste. Starting in 1976 the tank became the primary feed tank for the 242-A Evaporator. As the 242-A Evaporator Crystallizer feed tank, tank A-102 was in near continuous use from 1976 to 1980, staging various supernates for concentration and declared inactive in 1980. During this time period solids from various evaporator products accumulated in tank A-102, including evaporator feed, non-complexed waste, complexed waste, and double-shell slurry feed (DSSF). Supernate was pumped from the tank to 241-AN-101 in 1989. Intrusion prevention was completed in 1982 and interim stabilization completed in August 1989. Review of the tank A-102 sluicing records (SD-WM-TI-302, *Hanford Waste Tank Sluicing History*) indicate that tank A-102 had a 4.8 kL heel remaining after a 1976 sluicing campaign. In further review of the documentation, the estimated quantity of sludge was determined to be provisional and a minor amount; therefore, it is assumed that all solids in tank A-102 are described as A1-SaltCake.

A core sample was obtained in 1986. Two auger samples were obtained in 1996 from a riser different from that used for the core sample. One of the auger samples was analyzed for chemicals and the associated laboratory results incorporated into the tank BBI.

C2.2 SURFACE LEVEL DATA

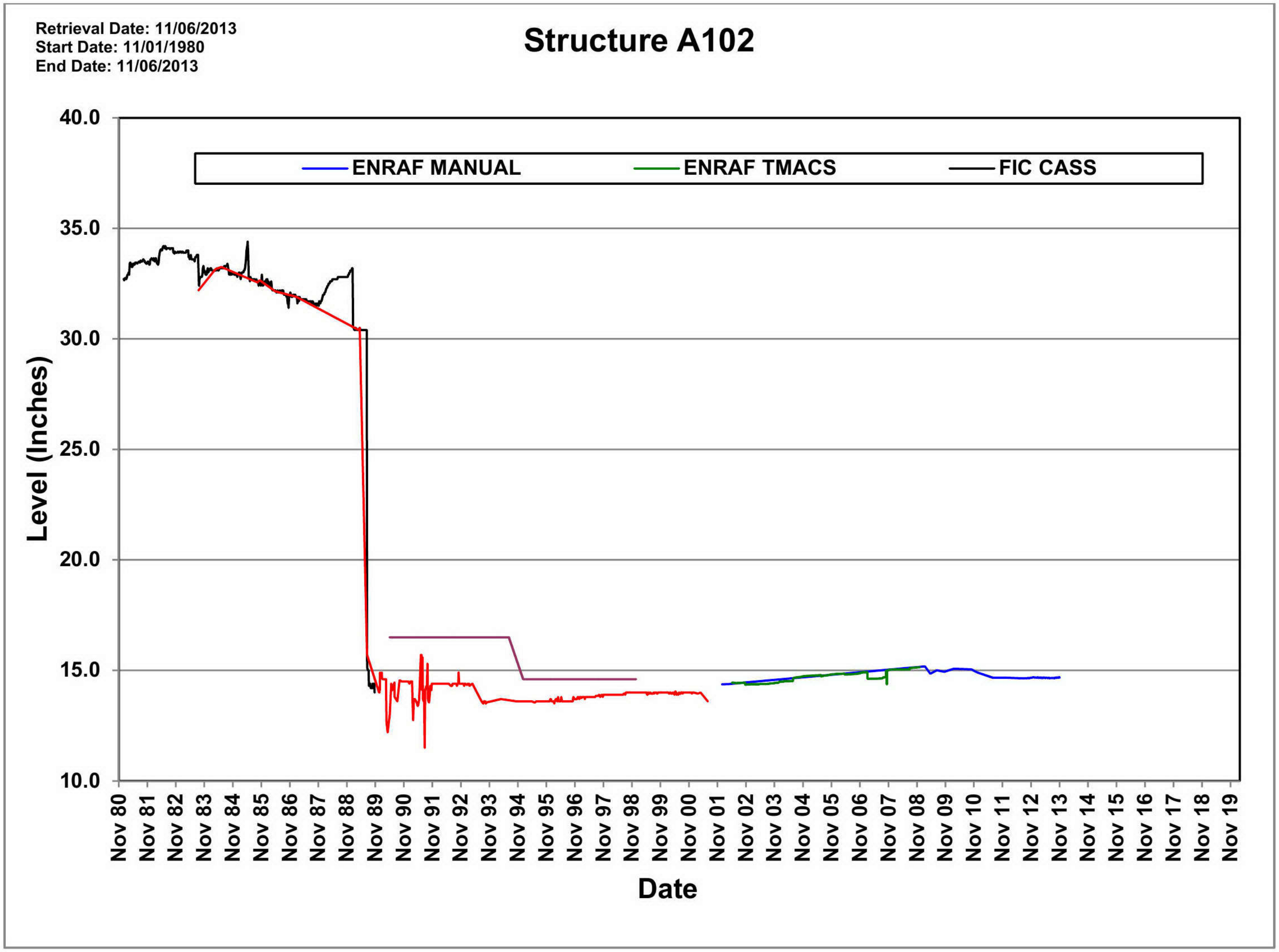
Figure C2-1 shows historical quarterly waste levels for tank A-102 from 1956 to 1996 (WHC-MR-0132). Additional surface level data showing more frequent measurements is available for tank A-102 from 1973 to 1986 (SD-WM-TI-356) and from 1980 to present (Figure C2-2). Some or all of the liquid-level increases were determined as a result of slurry growth (SD-WM-TI-356).

Figure C2-1. Tank 241-A-102 Quarterly Surface Levels



Source: RPP-RPT-42740, *2009 Auto-TCR for Tank 241-A-102*.

Figure C2-2. Tank 241-A-102 Surface Level Data



CASS = Computer Automated Surveillance System FIC = Food Instrument Corporation (gauge) TMACS = Tank Monitor and Control System

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Three occurrence reports were issued, with two due to liquid level changes in tank A-102.

Occurrence Report 75-97, *Unplanned Solution Routing due to Improper Electrical Connection*: The tank A-102 pump was unintentionally activated resulting in ~500 gal of waste transferred to tank A-101. Correction was made and additional locking devices were fabricated to avoid future mishaps.

Occurrence Report 75-99, *102-A Sluicer Removal Contamination of Personnel and Equipment*: During the removal and placement of a sluicer from the 102-A 02B pit, contamination was discovered; contamination was cleaned. Procedural review was undertaken with operating personal.

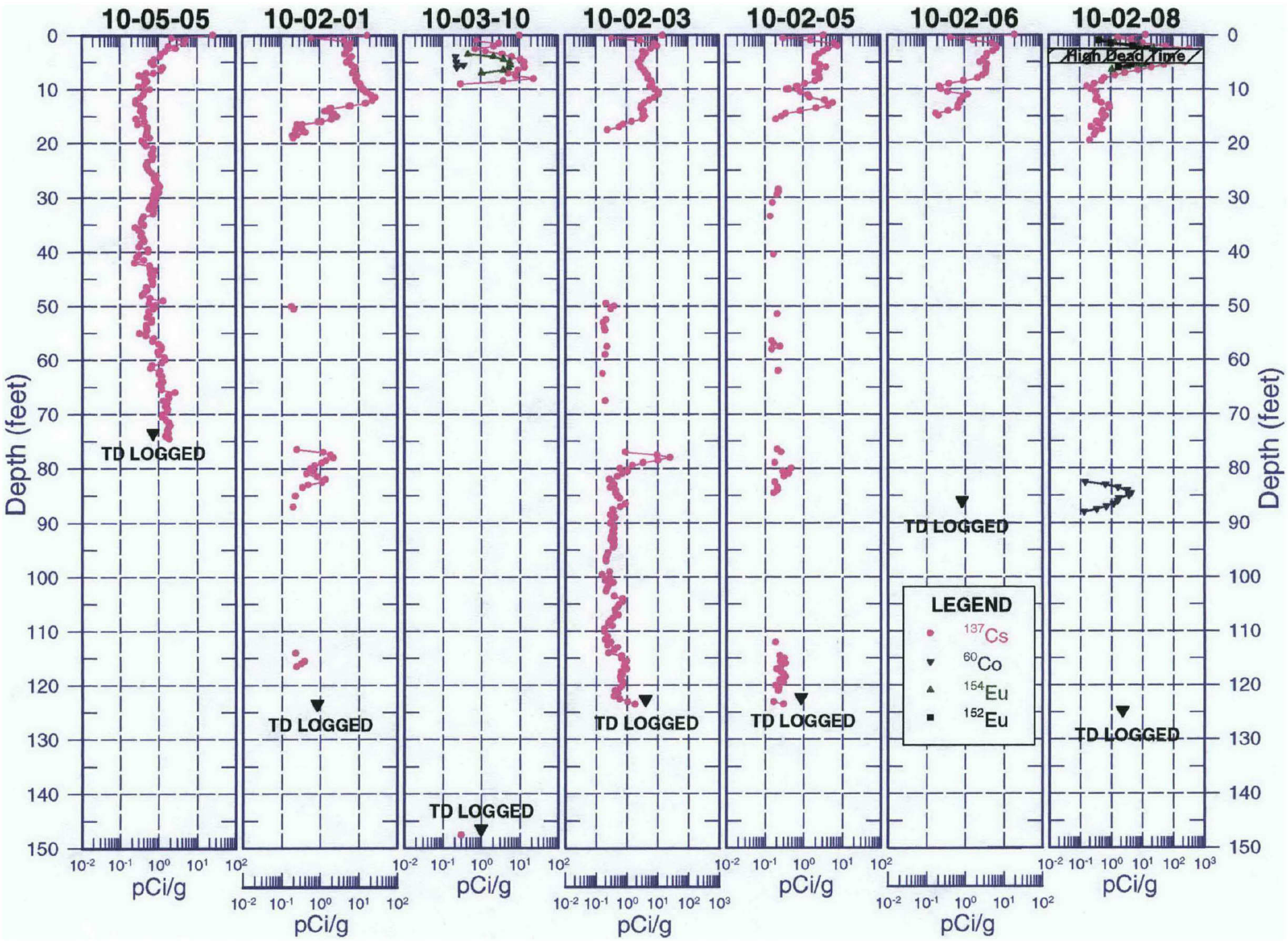
WHC-UO-89-009-TF-03, *Surface Level Measurement Decrease in Single-Shell Tank 241-A-102*: On January 21, 1989 the surface level measurement in tank A-102 decreased 2.7 in., exceeding the 1-in. decrease criteria (suggesting the possibility of an entrained gas release or a waste surface measurement obstruction), following a slow ~2-in. increase starting in November 1987. Waste was pumped in July 1989 resulting in the residual waste volume meeting interim stabilization criteria.

C2.3 DRYWELL DATA

Ten drywells are located around tank A-102: 10-05-05, 10-02-01, 10-03-10, 10-02-03, 10-02-05, 10-02-06, 10-02-08, 10-01-03, 10-02-10, and 10-02-11. Past drywell readings between 1975 and 1986 have remained stable (SD-WM-TI-356). The profile of the gamma activity measured in drywells surrounding tank A-102 (Figure C2-3) shows that relatively deep (82.5 to 88 ft) ^{60}Co contamination exists near borehole 10-02-08. Based on increases in gross gamma activity in the historical data, it appears that ^{60}Co contamination increased in this interval after 1986. In addition, surface spills and possibly leaks from shallow subsurface pipelines have occurred around this tank. Figure C2-3 shows the monitoring readings observed in the drywells surrounding tank A-102 (GJ-HAN-107, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-102*).

Cesium-137 contamination was detected in the upper 15 to 19 ft of drywells 10-02-01, 10-02-03, 10-02-05, and 10-02-11. Anomalously high gross gamma activity was identified in the upper 10 ft of drywells 10-02-01, 10-02-05, and 10-02-11 immediately after these drywells were deepened. The ^{137}Cs contamination was detected in the upper portions of drywells 10-02-01, 10-02-05, and 10-02-11 when temporary 8-in. starter casings were installed. This explanation also applies to the ^{137}Cs contamination detected around the upper 18 ft of drywell 10-02-03. Piping about tank A-102 is shown in Figure C2-4.

Figure C2-3. 1998 Spectral Gamma Logging System Logging Near Tank 241-A-102



Source: GJ-HAN-107, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-102.*

Figure C2-4. Tank 241-A-102 Piping Arrangement

Source: H-2-73390, *Piping Waste Tank Isolation 241-A-102.*

C3.0 TANK 241-A-103

C3.1 HISTORY

In 1987, tank A-103 was classified as an "assumed leaker" single-shell tank based on waste surface fluctuations over the 1981 to 1987 period. In 2009 a formal leak assessment panel (RPP-ASMT-42278, *Tank 241-A-103 Leak Assessment Report*) reviewed the 1981 to 1987 information and additional data collected since that time. It was concluded that the most likely causes of the surface level changes observed during the six-year period were the episodic accumulation and release of trapped gas in the waste combined with waste evaporation, and measurement errors created by the irregular waste surface. Although slurry growth in 242-S Evaporator/Crystallizer concentrated waste had already been observed in 200 West Area tanks, in the late 1980s there was no technical consensus on the cause. The mechanism for creating gas release events was not understood until the 1990s. This report documents the 2009 formal leak assessment and the panel's conclusions.

Tank A-103 received PUREX waste starting in May 1956. The waste temperature reached boiling (102 °C) in June 1956 and the tank continued to receive PUREX HLW, periodic additions of water and organic wash waste through July 1960 to maintain the volume of self-concentrating waste. Plutonium Uranium Extraction HLW supernate was transferred to tank 241-A-105 (A-105) in May 1962 and more in July 1962. Water was then added to tank A-103 to soften the sludge and the sludge was sluiced to tank A-102 from March through November 1964.

In 1965 and 1966, tank A-103 received waste from the 244-CR Vault and tank 241-C-103, as well as PUREX organic wash waste. The supernate in tank A-103 was transferred to tank A-101 in March and April 1966 to flush the tank. Sluicing was again conducted intermittently between October 1966 and February 1967. From February 1968 through November 1968, tank A-103 received PUREX HLW supernate from tank A-105. Tank A-103 received sludge slurry from sluicing tank A-102, then received waste from B Plant in 1973. Supernate was transferred from tank A-103 to tank 241-A-104 in 1974. The sludge in tank A-103 was sluiced to 244-AR Vault beginning in early 1974 and completed in September 1974.

Tank A-103 collected PUREX sludge supernate (PSS) from various single-shell tanks and B Plant waste in the fourth quarter of calendar year (CY) 1974 through first quarter of CY 1976. From October 1976 through early December 1976 the sludge in tank A-103 was sluiced to tank A-106. Tank A-103 was reported to contain 2,080 gal of sludge following completion of this last sluicing campaign.

The 242-A Evaporator was operated using tank A-103 as a slurry receiver and feed tank from early 1977 through April 1980. Tank A-103 received DSSF and concentrated complexed waste during this period. No further waste additions to tank A-103 occurred after these 242-A Evaporator campaigns.

Tank A-103 was saltwell pumped from May 16, 1987 and completed on May 24, 1987. A total of 111,000 gal of liquid waste were removed from tank A-103 to stabilize this tank (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*). The saltcake volume was calculated by subtracting the supernate and sludge from the total volume. Volume of the saltcake liquid was estimated to be 338 kL (89,000 gal) by applying the average porosity for saltcake of 0.24 (calculated in HNF-2978, *Updated Pumpable Liquid Volume Estimates and Jet Pump Durations for Interim Stabilization of Remaining Single-Shell Tanks*) to the total saltcake volume. Even after accounting for capillary effects on the saltcake and sludge, the interstitial drainable liquid volume is much higher than that in HNF-SD-RE-TI-178. The Current BBI for tank A-103 indicates an overall waste volume of 379,000 gal, including 4,000 gal of supernate (saltcake liquid 89,000 gal) (RPP-RPT-42741, *2009 Auto-TCR for Tank 241-A-103*).

C3.2 SURFACE LEVEL DATA

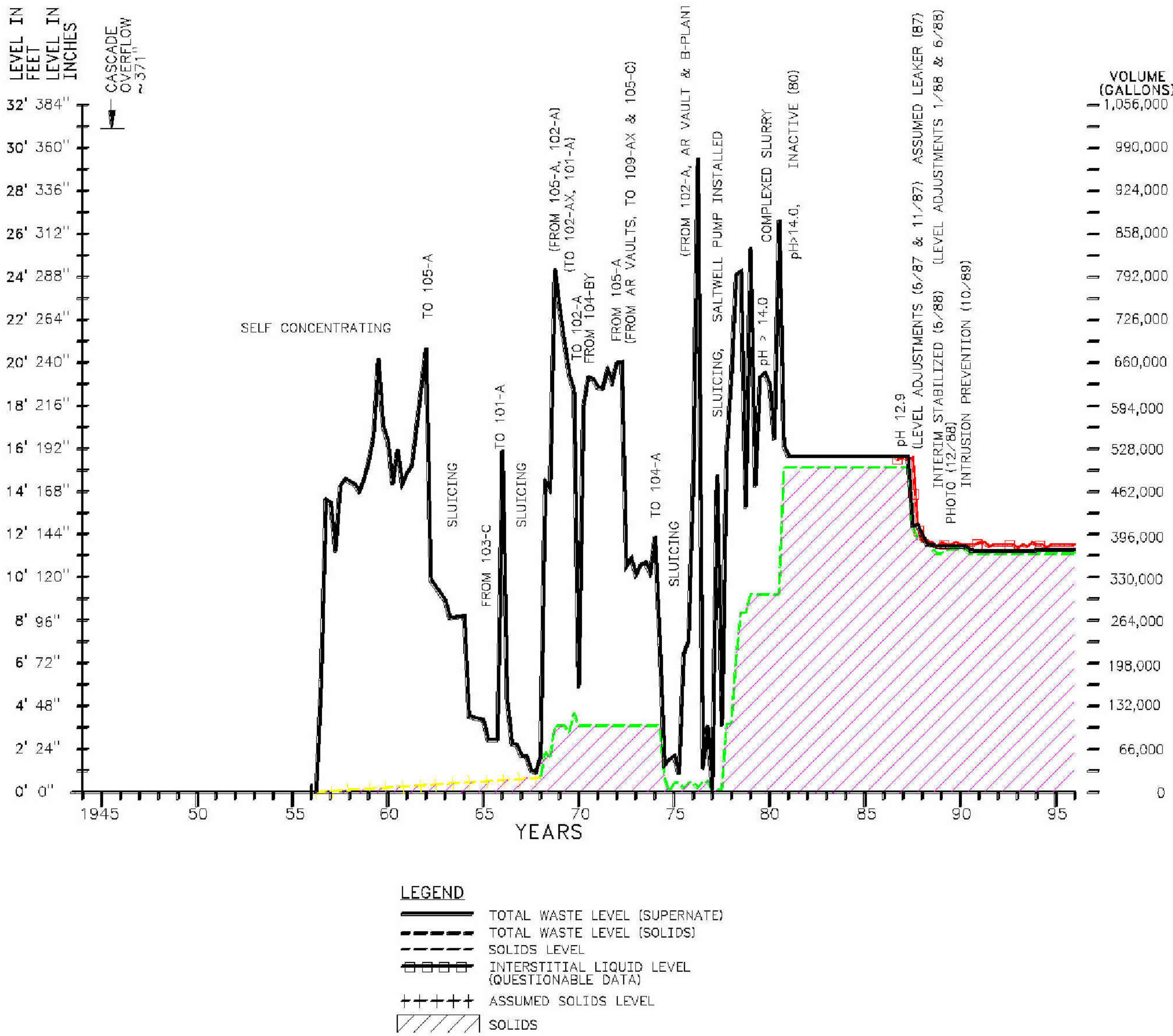
Figure C3-1 shows historical quarterly waste levels for tank A-103 from 1956 to 1996 (WHC-MR-0132). Additional surface level data showing more frequent measurements is available for tank A-103 from 1973 to 1987 (SD-WM-TI-356) and from 1980 to present (Figure C3-2). During the 1956 to 1974 period when tank A-103 experienced high operating temperatures and repeated filling and sluicing, there are no reports of suspect surface level behavior indicating a leak from the tank was occurring. In-tank photographs showed that the tank was not overfilled.

The first report of anomalous surface level behavior occurs after tank A-103 was converted to a slurry receiver for the 242-A Evaporator/Crystallizer in early 1977. After the bottoms conversion and the storage of 242-A Evaporator/Crystallizer concentrate began, eight of the nine reported occurrences address surface level changes that exceed surveillance baselines. Since the occurrences began coincident with the use of the tank to store gas-retaining, concentrated evaporator waste, it is very likely that the occurrences reflect waste properties.

Occurrence Report 77-141, *Tank 103-A Liquid Level Exceeding Decrease Criterion*: The allowable rate of surface level decrease exceeded the 0.5 in. per week criterion; between August 9, 1977 and August 16, 1977, the surface level decreased from 194.5 in. to 193.6 inches. The apparent cause of the decrease was dissolution of surface foam that had been observed after the last slurry transfer into the tank on August 6, 1977. A sample of the tank's surface taken on August 10, 1977 was comprised solely of foam (SD-WM-TI-356).

Occurrence Report 78-15, *Tank 103-A Liquid Level Decrease Exceeding Criterion*: Following receipt of 242-A Evaporator/Crystallizer slurry on November 29, 1977, tank A-103 surface level measurement became erratic, with readings varying from 232.80 in. to 236.10 inches. Between January 18, 1978 and January 22, 1978 the surface level decreased from 234.7 in. to 233.95 in., exceeding the allowable decrease rate of 0.50 in. per week. Photographs on January 27, 1978 showed the FIC plummet was suspended over an uneven crust varying several inches in height within a 1-ft radius. Drywells and laterals showed no significant changes.

Figure C3-1. Tank 241-A-103 Quarterly Surface Levels



Source: RPP-RPT-42741, *2009 Auto-TCR for Tank 241-A-103*.

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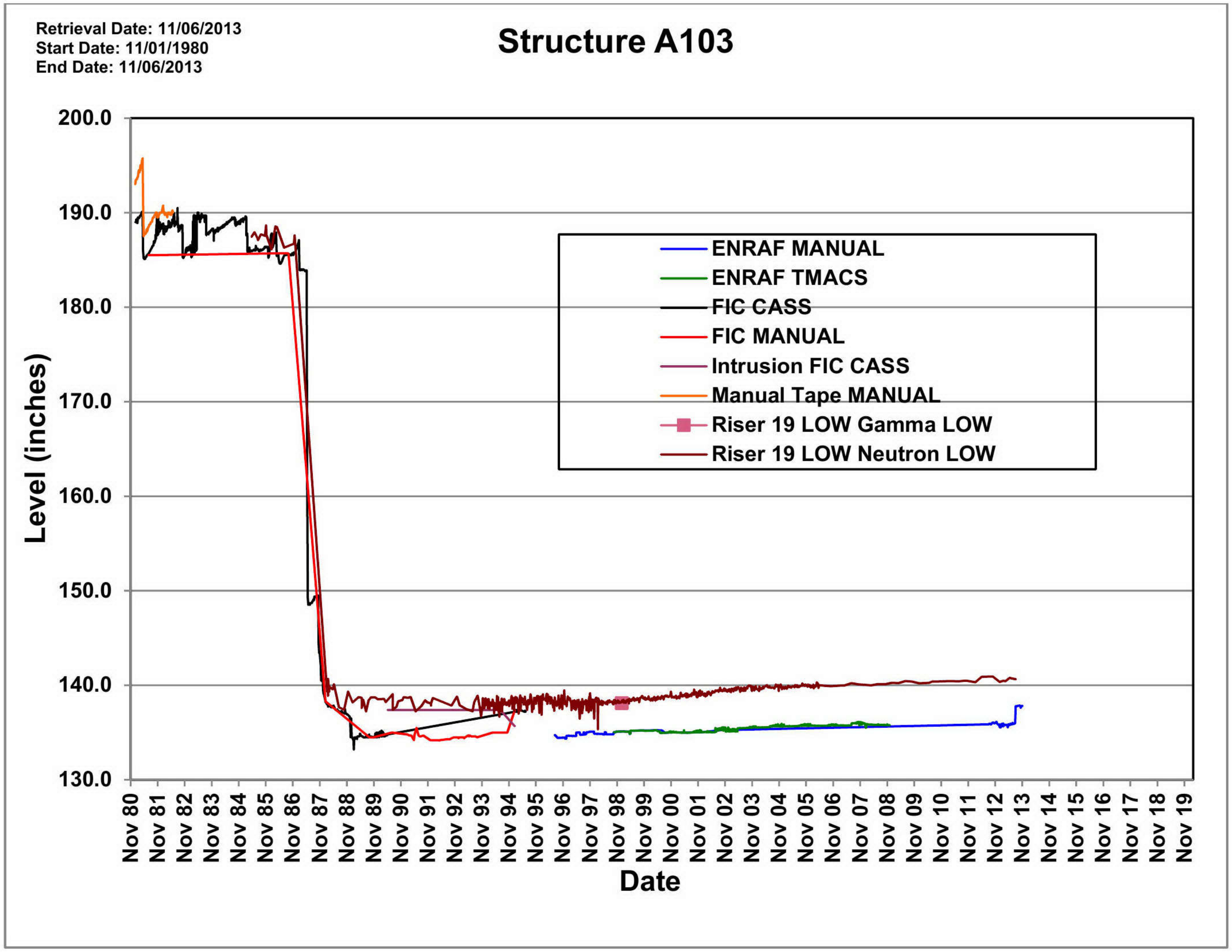
Figure C3-2. Tank 241-A-103 Surface Level Data



CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

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Occurrence Report 79-118, *Tank 103-A Liquid Level Decrease*: A surface level baseline of 235.20 in. was established for tank A-103 on October 5, 1979. On November 29, 1979, the FIC measurement decreased 4 in. to 231.40 in. in approximately five hours. The manual tape dropped 3.5 inches. The drop exceeded the allowable 0.5-in. decrease criterion. The apparent cause of the decrease was crust slumping. The tank had been filled with concentrated complexant waste from the 242-A Evaporator/Crystallize during March and April 1979. Almost immediately the surface level began to rise. An investigation revealed that the waste exhibited a slurry growth phenomenon similar to growth patterns that had been observed in the 241-SX tanks and tank 241-SY-103. Three surface level baseline changes had been authorized between July and October 1979 to compensate for the slurry growth (SD-WM-TI-356).

Occurrence Report 80-82, *Tank 103-A Liquid Level Decrease*: A surface level baseline of 193.40 in. had been established for tank A-103 on August 14, 1980. On September 4, 1980, the FIC surface level measurement dropped 3.30 in., down to a level of 190.00 in. in 11 hours. The manual tape dropped a total of 3.50 in. during the same period. The FIC drop exceeded the allowable 1.0-in. decrease criterion. The FIC subsequently stabilized at 187.40 ± 0.1 inches. Tank A-103 supernate had been transferred to tank 241-AX-101 (AX-101) between August 7 and August 12, 1980 in order to deactivate the tank. The decrease was eventually attributed to the mixing of dissimilar solids in the tank, causing a net volume decrease (SD-WM-TI-356).

Operating Limit Deviation Report 81-02, *Tank 103-A Surface Level Decrease*: A surface level decrease of 3.30 in. occurring during the period September 9, 1980 and May 8, 1981 (SD-WM-TI-356) was attributed to slurry growth followed by collapse of the surface crust. Drywells and laterals remained stable during the review period and were the primary means of leak detection because of surface solids. Surface level measurement fluctuations ranged from 185.10 in. to 190.35 in., and remained within the allowable decrease criterion.

Environmental Protection Deviation Report 87-02, *Tank 103-A Surface Level Measurement (FIC) Exceeding the Two-Inch Decrease Criteria*: Over a span of ~5.5 years (October 8, 1981 to March 5, 1987), the surface level in tank A 103 was observed to have decreased from 187.5 in. (517,520 gal) to 184 in. (507,860 gal). As of March 5, 1987, tank A-103 contained an estimated 8,800 gal of supernate, 208,000 gal of drainable interstitial liquid and 499,000 gal of solids. In-tank photographs showed the FIC plummet contacting liquid, and this raised questions about the tank's leak integrity.

TF-EST-88-0151, "Surface Level Measurement Decrease in Single Shell Tank 241-A-103": Following recalibration of the FIC on December 22, 1988, a surface level reading of 135.10 in. was obtained, 2.3 in. from the 137.40 in. baseline for the tank, which exceeded the 2.00-in. decrease criterion. A slow decrease of 0.7 in. over a six-month period had been observed since the baseline was established. Photographs taken on December 28, 1988 and May 24, 1988 showed the FIC plummet to be contacting solids in a depression, and the later photos showed the depression to have multiple elevations. The conclusion was that plummet contacts at different elevations were the cause of the erratic readings. The FIC was converted to the intrusion mode, and the installed liquid observation well (LOW) became the primary interstitial liquid level surveillance device. Drywell and LOW data were stable. Tank A-103 had been declared interim stabilized in June 1988.

RL--WHC-TANKFARM-1991-1070, *Single-Shell Tank 103-A Lateral Radiation Detecter Data Exceeds Baseline:* On December 4, 1991, quarterly surveillance of one of the three laterals identified a 76 count per second peak; the baseline was 5 counts per second. The radiation logging was repeated and the same results obtained. Subsequent evaluation showed that the detector had not been correctly positioned at the end of the lateral to begin logging; when the logging was correctly performed there was no change from the baseline readings.

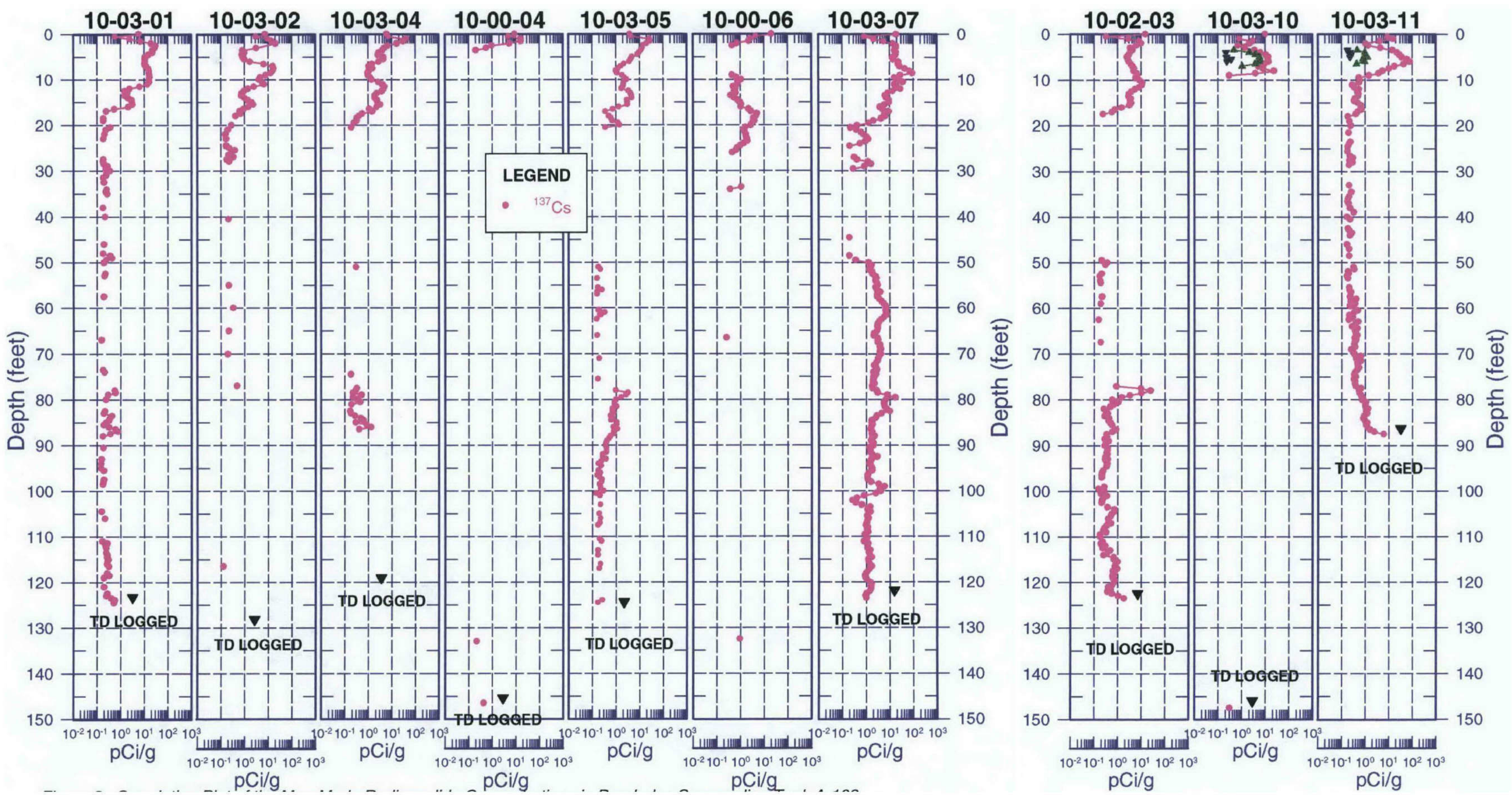
C3.3 DRYWELL DATA

Drywells 10-03-01, 10-03-02, 10-03-04, 10-00-04, 10-03-05, 10-00-06, 10-03-07, 10-02-03, 10-03-10, and 10-03-11 surround tank A-103. The data indicate that a plume of ^{137}Cs contamination is present from about 75 to 80 ft beneath tank A-103. The source of this contamination is not certain. The source of the contamination could be a number of tanks in the vicinity of tank A-103, including tank A-103 itself. Surface spills have also occurred near the tank, and leaks from a shallow subsurface pipeline near the tank are a possibility. Although there is evidence of low levels of ^{137}Cs soil contamination around some of the tank A-103 drywells, there is no evidence of soil contamination at the base of the tank. An increase in the number of the contamination intervals, and the dates of highest measured contamination, seem to coincide with the 1978 drilling campaign to deepen the drywells, indicating contamination drag-down may have been a factor. Radiation monitoring in the three laterals beneath the tank from 1977 to 1991, and again in 2005, detected no evidence of tank leakage. Figure C3-3 shows the monitoring readings observed in the drywells surrounding tank A-103 (GJ-HAN-108, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-103*).

Cesium-137 contamination was detected in the upper 10 to 20 ft in boreholes 10-03-01, 10-03-02, 10-03-04, 10-03-05, 10-03-07, and 10-02-03. On the basis of the historical gross gamma logs available for these boreholes, anomalously high gamma activity was present in this interval of these boreholes prior to borehole deepening activities in 1978, but increased in many in these intervals following borehole deepening. It is thought that the contamination in this interval comes both from surface spills that infiltrated the backfill material and contamination carried down during borehole deepening activities. Contamination was most likely placed around the boreholes when the temporary 8-in. starter casing was installed, or the contamination was mixed in with the grout.

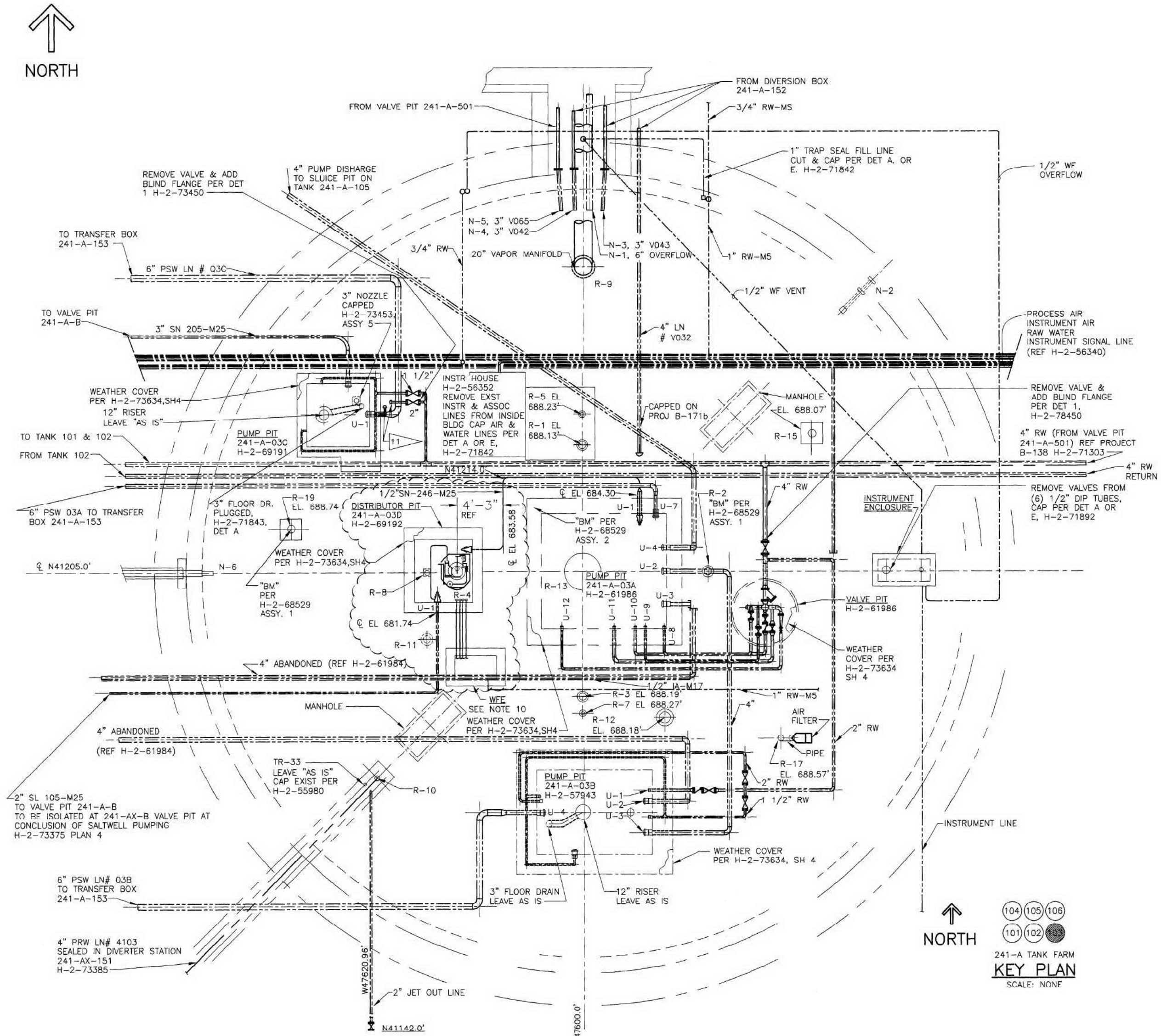
The ^{137}Cs contamination detected in drywells 10-03-01, 10-03-04, 10-03-05, 10-03-07, and 10-02-03 at depths near 75 to 80 ft is probably correlatable. In drywells 10-03-04, 10-03-05, 10-03-07, and 10-02-03, where ^{137}Cs concentrations were high enough to support shape factor analysis, the analysis results indicate that the ^{137}Cs contamination is distributed in the formation sediments around the drywells. The ^{137}Cs contamination in these boreholes near 75 to 80 ft probably resulted from a tank leak and migrated downward into the formation materials around the tank to these depths. Piping about tank A-103 is shown in Figure C3-4.

Figure C3-3. 1998 Spectral Gamma Logging System Logging Near Tank 241-A-103



Reference: GJ-HAN-108, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-103.*

Figure C3-4. Tank 241-A-103 Piping Arrangement



Source: H-2-73392, *Piping Waste Tank Isolation Tank 241-A-103.*

C4.0 TANK 241-A-106

C4.1 HISTORY

According to HNF-EP-0182, tank A-106 has a tank integrity classification of "sound." Tank A-106 received and transferred PUREX process (P) waste from 1957 through 1973. Tank A-106 first received waste condensate from tanks A-101 and A-103 in 1957. Tank A-106 became the condensate collect for A Farm and in 1962 received PUREX waste as well as carbonate (OWW). The highest in-tank temperature noted was 312 °C (594 °F) in tank A-106 on May 15, 1963 (RHO-CD-1172, *Survey of the Single-Shell Tank Thermal Histories*). The tank waste temperature remained high. In the 1960s, tank A-106 received OWW and carbonate waste. In 1969, tank A-106 received sludge from tank 241-A-104 and P1 waste. Tank A-106 was first sluiced in 1970 (as part of the B Plant strontium recovery campaign) to the AR Vault with sluicing complete in 1972. Starting in 1974, tank A-106 received B Plant waste and waste from the AR Vault. Tank A-106 was again sluiced in 1977 and received various designated evaporator wastes. Tank A-106 received 242-A Evaporator bottoms saltcake from 1976 through 1978. The tank was labeled inactive in August 1980 (RPP-RPT-42744, *2009 Auto-TCR for Tank 241-A-106*). The tank was administratively interim stabilized in August 1982 (HNF-SD-RE-TI-178).

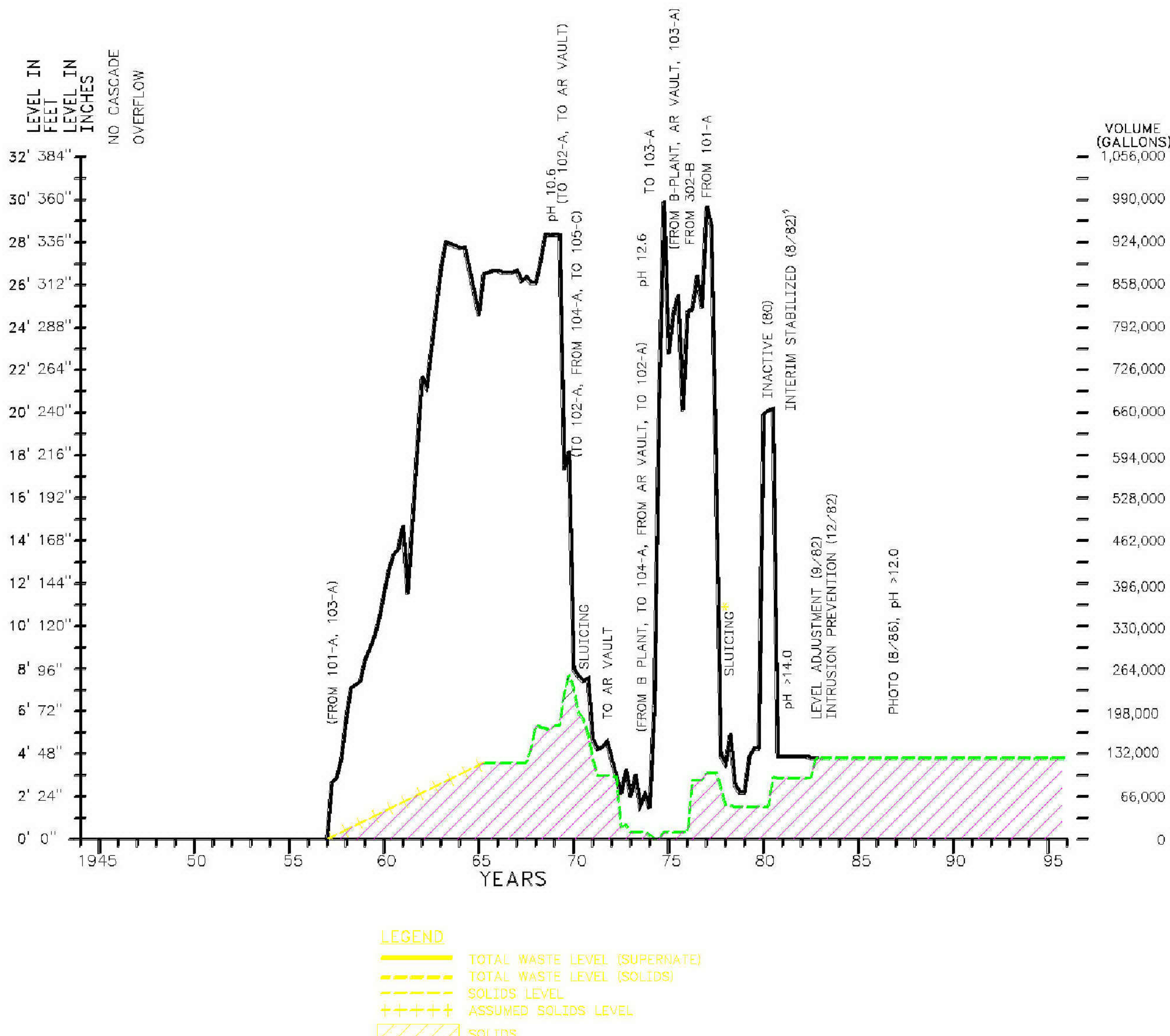
The Current BBI for tank A-106 indicates an overall waste volume of 79,000 gal. The BBI shows that the 50,000 gal of sludge is comprised of SRR and washed PUREX HLW sludge (AR) with a total waste inventory of ~450,000 Ci of ^{90}Sr. Tank A-106 inventory has not changed since the core sample was taken in 1986.

C4.2 SURFACE LEVEL DATA

Figure C4-1 shows historical quarterly waste levels for tank A-106 from 1946 to 1996. Additional surface level data showing more frequent measurements is available for tank A-106 from 1973 to 1987 (SD-WM-TI-356) and from 1980 to present (Figure C4-2).

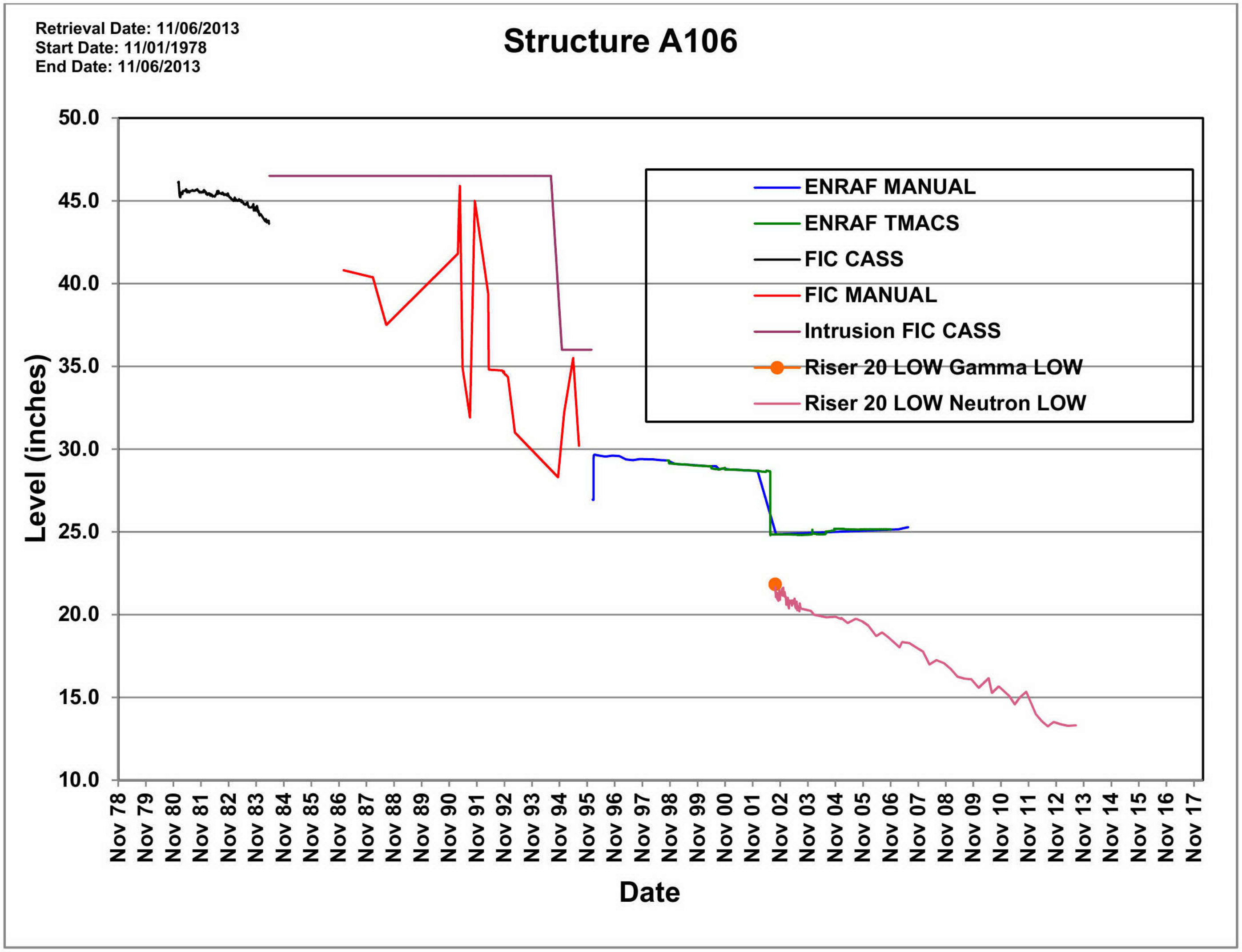
SD-WM-TI-356 shows an accumulated surface level decrease from April 1976 through August 1977. Tank A-106 auto and manual Enraf® readings on January 1, 2001 were 28.76 in., corresponding to 299 kL (79,000 gal). Readings taken October 1, 2005 indicate a tank waste level of 25.14 inches. On June 25, 2002, there was a calibration shift as a result of calibrating and flushing of the measurement weight assembly. This sudden shift essentially accounted for the difference in the measurements. The shift in level measurements was likely due to a localized surface depression caused by the water flush. Liquid observation well measurement on August 1, 2005 was 19.2 inches. Past waste level decreases, in conjunction with the routine unmetered water flushes of the air-lift circulators, is part of the evaporation loss to the vessel ventilation system of <0.2 gal/min. Temperature data indicated a change of 80 °F in the first 2 ft from the bottom of the tank (SD-WM-TI-356).

Figure C4-1. Tank 241-A-106 Quarterly Surface Levels



Source: RPP-RPT-42744, *2009 Auto-TCR for Tank 241-A-106.*

Figure C4-2. Tank 241-A-106 Surface Level Data



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FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

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Two of the four occurrence reports identified with tank A-106 described waste surface level anomalies.

ARHCO Occurrence Report 74-144, *Contamination Spread*: After removing failed jumpers from the tank A-106 pump pit, due to the high dose rate of up to 25 R/hr a nearby instrument house was used to perform the work. During the operation an area of approximately 10 ft by 10 ft was contaminated up to 18 R/hr. The area was cleaned and covered.

Occurrence Report 77-108, *Tank 106-A Liquid Level Decrease Exceeding Criterion*: On June 30, 1977 tank A-106 surface level measurement decreased one inch in 24 hours. The apparent cause is increased evaporation due to an additional exhauster placed on tank AX-101, which began operating on June 29, 1977. The exhauster draws ~6,000 cfm from A Farm as well.

ARHCO Occurrence Report 74-150, *Low-Level Contamination Outside of a Radiation Zone*: At the completion of a pump installation, low-level contamination was found on personnel. They were cleaned immediately and Radiation Monitoring found five vehicles were contaminated. The vehicles and parking area were cleaned and normal operations were resumed.

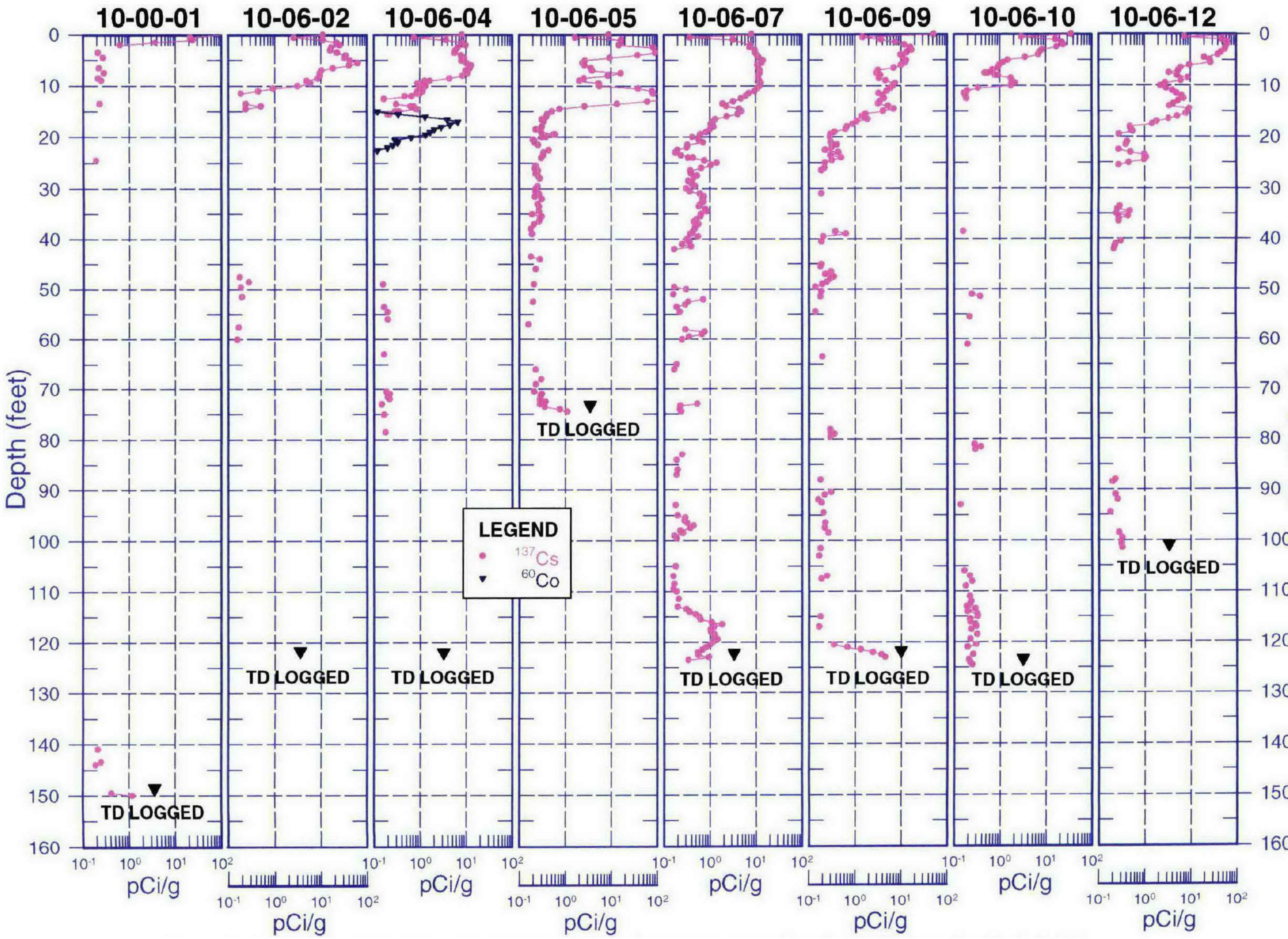
Environmental Protection Deviation Report 82-05, *Tank 106-A Surface Level Decrease*: Waste surface level measurements began to fluctuate 3.90 in. on March 22, 1982. The erratic waste surface measurements were associated with the FIC plummet contacting surface solids, confirmed by in-tank photographs taken April 7, 1982. The surface level decrease action level was changed from 2 in. to 5 inches.

C4.3 DRYWELL DATA

Eight drywells are located around tank A-106 in clockwise order: 10-00-01, 10-06-02, 10-06-04, 10-06-05, 10-06-07, 10-06-09, 10-06-10, and 10-06-12. Past drywell readings between 1975 and 1986 have remained stable (SD-WM-TI-356). The profile of the gamma activity measured in drywells surrounding tank A-106 (Figure C4-3) shows near-surface activity (above 25 ft in depth). Most of the contamination detected around this tank consists of near-surface and shallow subsurface ^{137}Cs that probably originated as surface contamination that was carried downward during the installation of temporary surface casings during drywell deepening activities. Numerous zones of low-level ^{137}Cs contamination detected deeper in the vadose zone were assumed to be carried down during drilling activities. Figure C4-3 shows the monitoring readings observed in the drywells surrounding tank A-106 (GJ-HAN-111, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-106*).

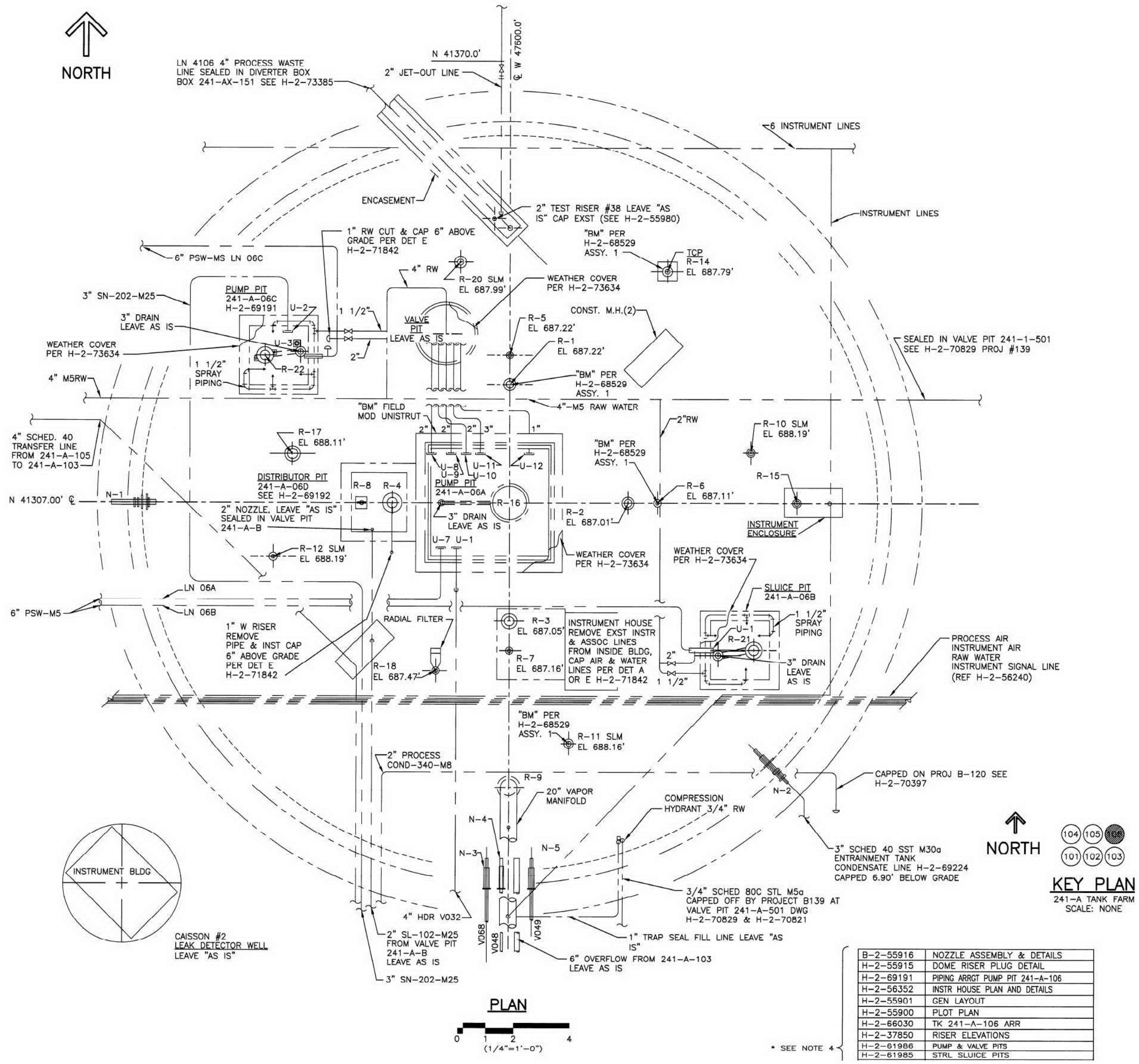
The drywell data and the geologic and historical information available from other sources do not identify any leaks from tank A-106. No significant contaminant plumes were identified in the deeper regions of the vadose zone below the base of the tank. However, the data indicate that surface spills and leaks from a shallow subsurface pipeline have probably occurred. The pipeline leak has been active as recently as 1988. Piping about tank A-106 is shown in Figure C4-4.

Figure C4-3. 1998 Spectral Gamma Logging System Logging Near Tank 241-A-106



Source: GJ-HAN-111, *Hanford Tank Farms Vadose Zone Tank Summary Data Report for Tank A-106*.

Figure C4-4. Tank 241-A-106 Piping Arrangement



Source: H-2-73394, *Piping Waste Tank Isolation 241-A-106*.

C5.0 TANK 241-AX-101

C5.1 HISTORY

According to HNF-EP-0182, tank AX-101 has a tank integrity classification as "sound." The Current BBI for tank AX-101 indicates an overall waste volume of 357,000 gal.

Tank AX-101 was put into service in 1965. Transfer records indicated that between startup in 1965 and sluicing in 1976, tank AX-101 was used to store various wastes generated by PUREX and Waste Fractionation. In 1976 tank AX-101 was sluiced to a 11.4 kL heel. This met the sludge heel requirement for tanks scheduled to be used for saltcake storage (a 2.5- to 5-cm [1- to 2-in.] sludge heel). The requirement was based on radiolytic heating temperature control limits.

After sluicing, tank AX-101 received product slurry from the 242-A Evaporator (1976 through 1980). Several evaporator products were added to tank AX-101 including Evaporator Bottoms, Hanford Defense Residual Liquid, and DSSF. The tank also received complex waste. By the end of 1977, 673,000 gal of solids had accumulated in the tank. The solids are identified as EVAP, RESID, and DSSF. These are all evaporator concentrates made from tank waste supernate. At the end of 1979, supernate from tank AX-101 was sent to the 242-A Evaporator. Evaporator product, potentially from a different source, was returned to the tank. In 1980, the tank was used to stage supernate and first pass slurry to the 242-A Evaporator. The solids level was measured as 289,000 gal. At the end of 1980, the tank was filled with DSSF, bringing the solids level to 525,000 gal. From 1980 to the present, cooling of the waste caused additional salt precipitation, bringing the solids level to 748,000 gal. A more detailed description of the quantities of waste discharged to tank AX-101 is given in the Hanford Defined Waste model waste transaction database.

The types of solids accumulated in tank AX-101, described in various reports, consist of the following waste types: B Plant waste, complexed waste, DSSF, Evaporator feed, fission product waste, non-complexed waste, OWW, PUREX neutralized HLW, PUREX low-level waste, PSS, and strontium recovery waste. The major portion of the waste and associated waste types (identified above) were expected to have been removed when the tank was sluiced in 1976. Therefore, the remaining heel in the tank is thought to be just SRR sludge after the tank was sluiced.

Tank AX-101 waste was comprised of a thick crust over a saturated liquid salt region, prior to saltwell pumping. Saltwell pumping of tank AX-101 was initiated in August 2000. The tank was interim stabilized in December 2003 (HNF-SD-RE-TI-178). Two sampling events characterize the tank AX-101 waste; a 1998 core sampling event and the 1997 grab sampling event (RPP-RPT-42915, *2009 Auto-TCR for Tank 241-AX-101*).

C5.2 SURFACE LEVEL DATA

Figure C5-1 shows historical quarterly waste levels for tank AX-101 from 1956 to 1996 (WHC-MR-0132). The waste level was above the cascade line in 1954 and 1955. Additional surface level data showing more frequent measurements are available for tank AX-101 from 1973 to 1987 (SD-WM-TI-356) and from 1980 to present (Figure C5-2). The waste surface in tank AX-101 is a dry, flaky, crystalline, yellowish-white saltcake with a fairly uniform surface of large cracks created as the waste surface dried as a result of saltwell pumping. The Enraf® plummet reads ~130 inches. The tank waste surface is essentially flat with a depression around the saltwell screen. The LOW gamma source readings indicate an interstitial liquid level of 0 inches.

Of the eight occurrence reports issued, five are due to liquid level changes in tank AX-101.

Occurrence Report 75-142, *Release of Contamination Within a Radiation Zone*: Spots of radioactive contamination were found in the northeast corner of the 241-AX Tank Farm (AX Farm) and attributed to a contaminated crane hook used during diversion box work.

Occurrence Report 77-36, *Liquid Level Decrease Exceeding Criteria for Tank 101-AX*: The liquid level decreased at a rate exceeding the 0.5 in. per week action criteria. The large volume of warm liquid from tank 241-AX-104 was believed to be the cause for an increase in the rate of evaporation and the decrease in the waste surface level.

Occurrence Report 77-139, *Liquid Level Exceeding Decrease Criterion*: The liquid level decrease criteria for tank AX-101 was exceeded. The FIC plummet was flushed, stabilizing the waste surface measurement.

Operating Limit Deviation Report 80-07, *Level Decrease Following a Transfer into Tank 101-AX*: On February 23, 1980, ~30,000+ gal of condensate water from tank 417 was transferred to tank AX-101. The waste surface level in tank AX-101 exhibited a decreasing liquid level trend. The investigation revealed the decrease was the result of the mixing of significant amounts of water with the dried waste solids. The mixing of the material and some foaming dissipated, resulting in a net surface decrease.

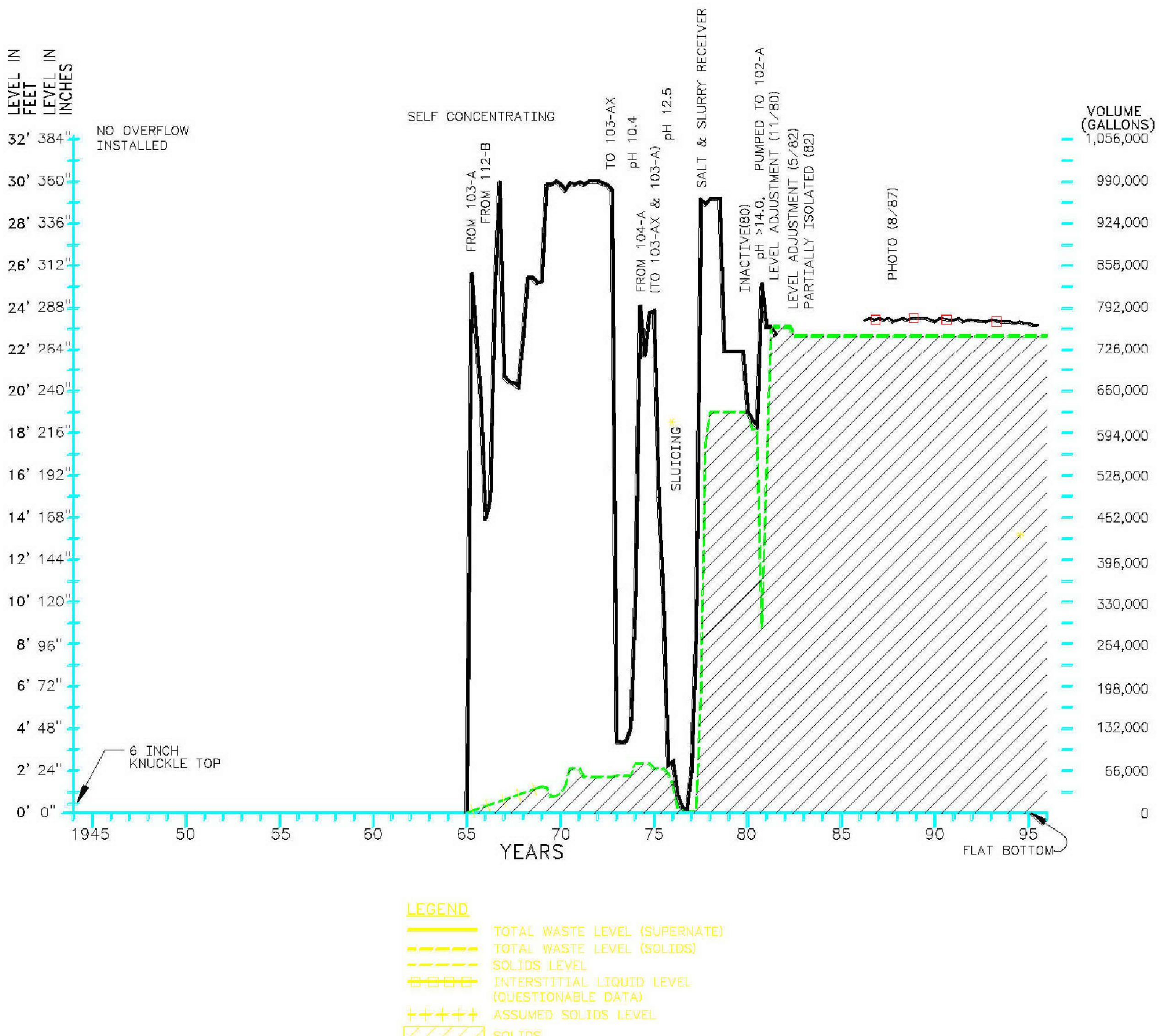
TF-EST-89-051, "Weight Factor (Liquid Level) and Radiation Level Exceeds the Increase Criteria Limits in Tank 241-AX-101 Leak Detection Pit": On March 22, 1989 the liquid level reading in the tank AX-101 leak detection pit exceeded the operating limit and the radiation level exceeded the baseline criteria. Drywells were checked and shown to be stable; continued checks showed no change above what was originally found.

RL--PHMC-TANKFARM-1997-0051, *Personnel Contamination/AX-101 Saltwell Screen Installation*: The contamination was removed.

RL--PHMC-TANKFARM-1998-0039, *Potential Unreviewed Safety Question Exists with Respect to Single Shell Tank 241-AX-101 Flammable Gas Inventory*: DOE-RL declared a safety question exists. An Engineering Change Notice was submitted to revise the Authorization Basis to reflect the new flammable gas controls category of tank AX-101.

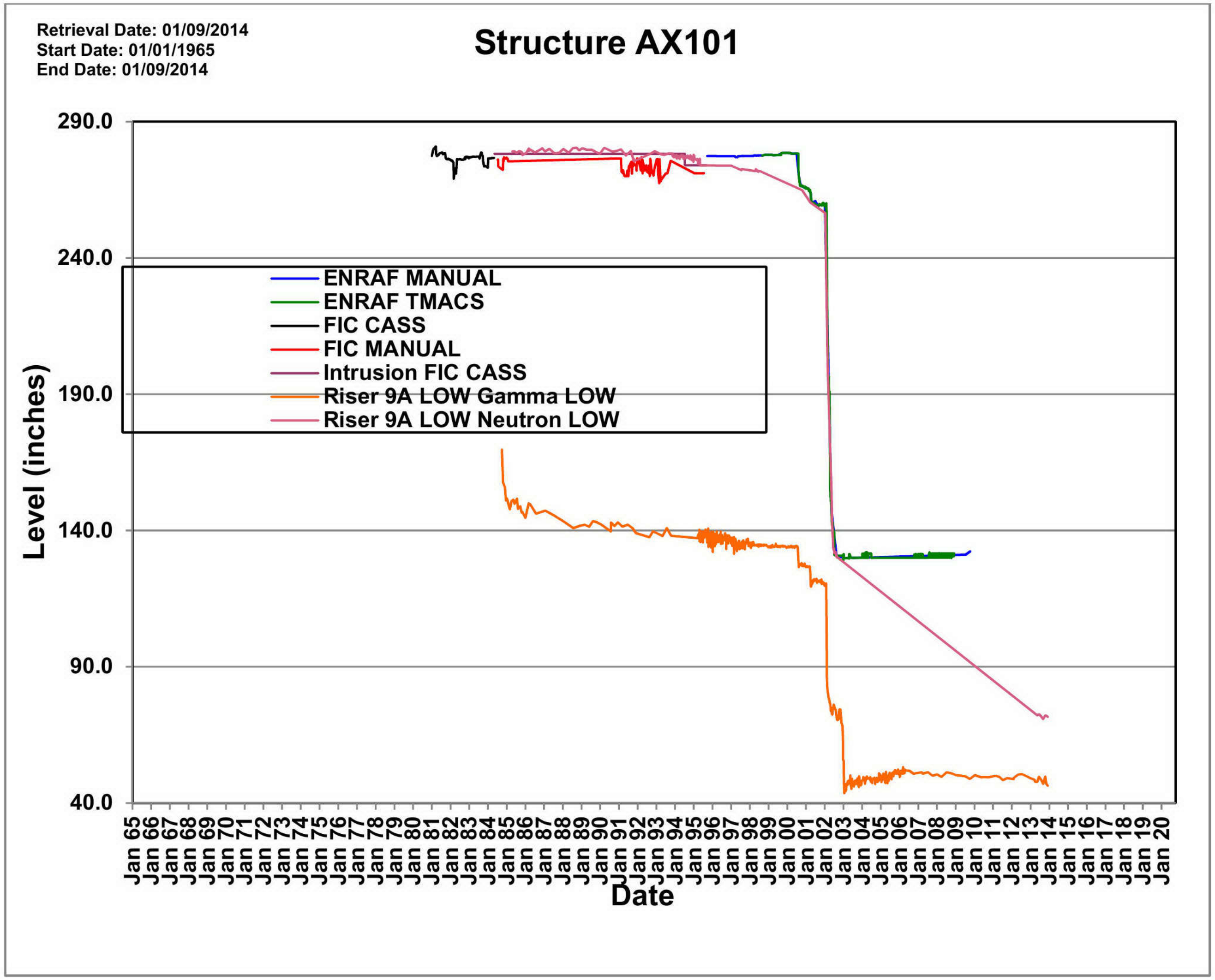
RP--CHG-TANKFARM-2002-0066, *Inadvertent Dilution Water Spill in 241-AX Tank Farm*: Overflow of 30 gal occurred from the tank AX-101 saltwell dilution tank; the source was isolated, appropriate notifications were made, and repair of the autofill device was made.

Figure C5-1. Tank 241-AX-101 Quarterly Surface Levels



Source: RPP-RPT-42915, *2009 Auto-TCR for Tank 241-AX-101*.

Figure C5-2. Tank 241-AX-101 Surface Level Data



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C5.3 DRYWELL DATA

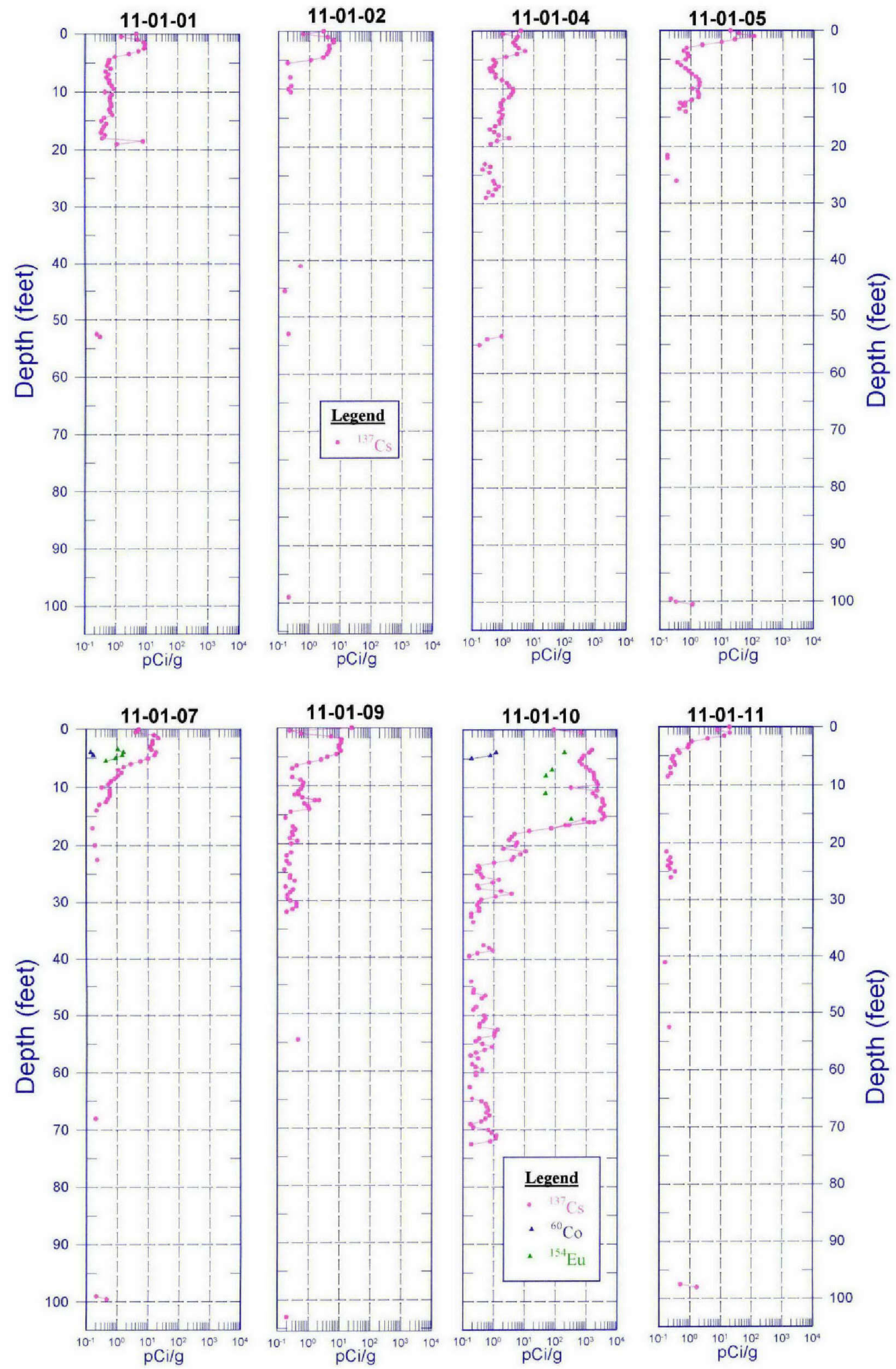
Drywells 11-01-01, 11-01-02, 11-01-04, 11-01-05, 11-01-07, 11-01-09, 11-01-10, and 11-01-11 surround tank AX-101. All the drywells are within 10 ft of the tank. Seven of the drywells were drilled between late 1974 and early 1975, each to a depth of 100 ft. Drywell 11-01-10 was drilled in 1978 to a depth of 73 ft. The shallow zone of highly concentrated ^{137}Cs contamination detected in drywell 11-01-10 is probably associated with a surface spill. Results from the initial gross gamma logging event indicated that the contamination was present before the initial logging effort, likely due to a surface spill in the vicinity of tank AX-101 in January 1968 while attempting to unplug a transfer line with a high-pressure hose. Also, ground contamination was reported between tanks AX-101 and 241-AX-102 in October 1975. Except for drywell 11-01-10, ^{137}Cs activity less than 1,000 pCi/g (Figure C5-3) was observed in the top 20 ft below ground surface in drywells surrounding tank AX-101 (GJ-HAN-49, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-101*).

The historical gross-gamma data suggest that much of this contamination existed prior to the installation of the drywells. The small amounts of ^{137}Cs detected at the base of the tank farm excavation may represent a contaminant plume that accumulated on top of undisturbed fine-grained sediments that underlie the tank farm back-fill materials. This plume may have originated from the spills or leaks occurring between the ground surface and the base of the tanks that have migrated downward in the back-fill materials until impeded by the zone of reduced hydraulic conductivity at the tank farm base. Piping about tank AX-101 is shown in Figure C5-4.

C5.4 LEAK DETECTION PIT DATA

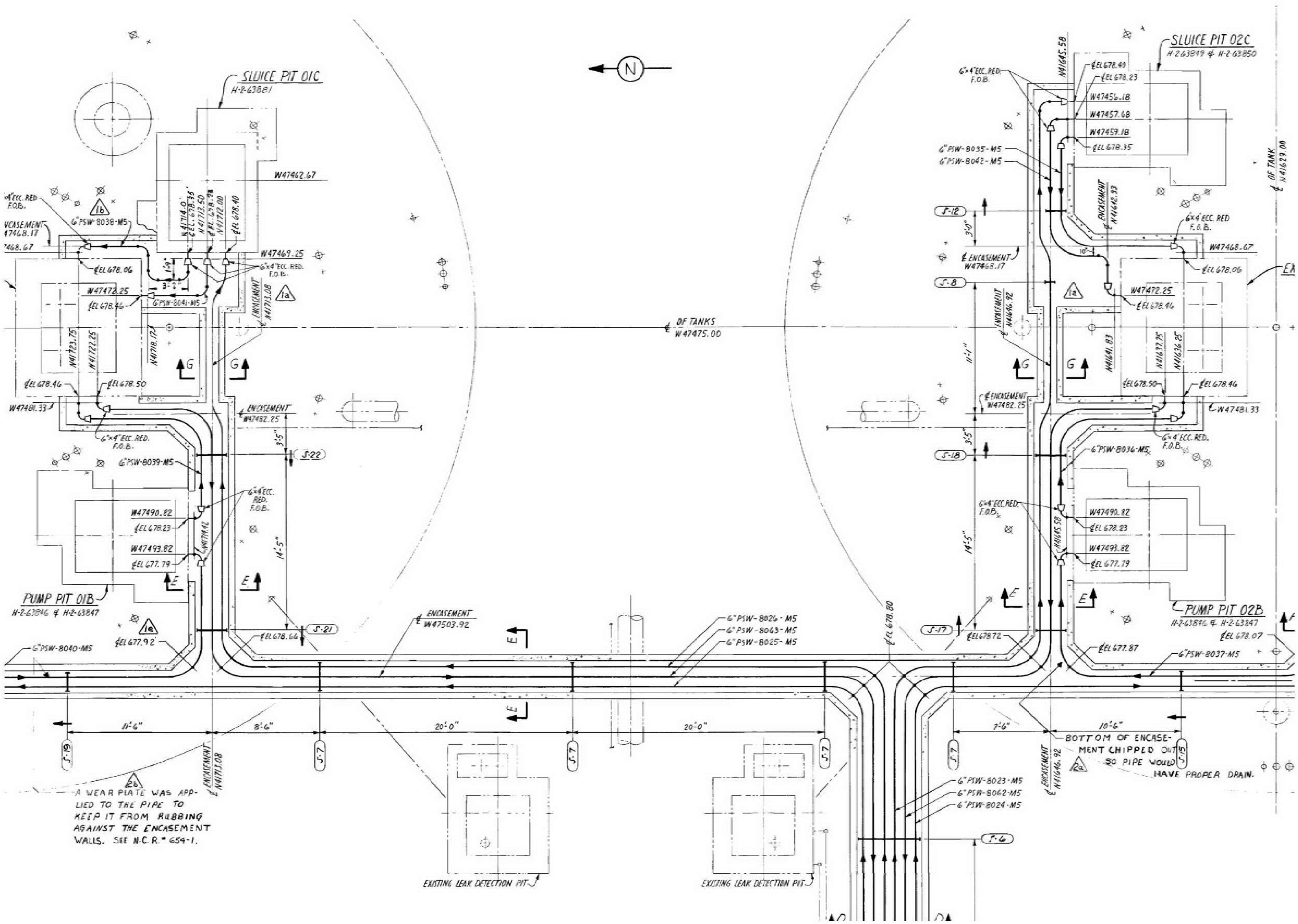
In addition to drywell data, AX Farm has leak detection pits as described in Section 3.2. Both surface level and radiation measurements are available from the leak detection pits. Table C5-1 shows liquid and radiation levels in the AX-101 leak detection pit from 1973 to 1986 (SD-WM-TI-356) and Figure C5-5 shows liquid levels in the leak detection pit from 1995 to 2006. The AX-101 leak detection pit monitoring was discontinued after October 2006.

Figure C5-3. 1997 Spectral Gamma Logging System Logging Near Tank 241-AX-101



Source: GJ-HAN-49, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-101*.

Figure C5-4. Piping Between Tanks 241-AX-101 and 241-AX-102



Source: H-2-63839, *241-AX Tank Farm Piping Plan TK-101 & 102 Encased Sluice Lines*.

Table C5-1. Tank 241-AX-101 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 1 of 3)

101-AX

Leak Detection Pit.

Date	Liquid level (in. w.g.)	Radiation level (c/min)	Comments
07/02/73	21	100	
09/15/73	21	100	
12/15/73	21	100	
04/15/74	21	100	
05/15/74	21	0	
06/15/74	21	0	
07/15/74	21	0	
08/14/74	21	0	
09/14/74	21	30	
10/14/74	21	20	
11/14/74	21	0	
12/14/74	21	50	
01/14/75	21	0	
02/14/75	21	10	
03/14/75	21	10	
04/14/75	21	10	
05/14/75	21	0	
06/14/75	20.7	5	
07/14/75	20.3	10	
08/14/75	19.8	10	
09/14/75	18.5	0	
10/14/75	17.2	0	
11/14/75	16.8	0	
12/14/75	13.8	0	
01/08/76	13.8	0	
03/01/76	8.6	0	
05/04/76	0.0	0	
11/03/76	0.0	10	
12/05/76	0.0	40	Radiation readings have been erratic, 10-40 c/min

Table C5-1. Tank 241-AX-101 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 2 of 3)

101-AX

Leak Detection Pit.

Date	Liquid level: Gage	Liquid level: Weight factor (in.)	Radiation level (c/min)	Comments
01/07/77	0	0	6	Radiation reading erratic, 2 to 40 c/min
01/08/77	4.5	17.3	6	Water added--now reading weight factor (WF) also
03/08/77	4.5	19.0	1	Stable
03/23/77	3.8	13.0	5	Liquid level (LL) erratic decrease
03/24/77	12.5	53.5	0	Water added
04/13/77	12	52	2	LL slow decrease
04/14/77	6	25	2	Transfer
06/25/77	4.8	20.0	2 to 8	LL slow decrease
07/29/77	4.5	21.0	2 to 20	LL comparatively stable
12/13/77	4.7	19.9	1 to 8	LL comparatively stable
02/16/78	4.6	12.0	0 to 20	LL erratic
03/20/78	4.7	15.5	0 to 510	Erratic radiation increase
06/14/78	4.5	20.0	100	Slow radiation decrease
12/19/78	4.5	21.0	30 to 150	LL stable
10/22/79	4.5	21.0	30 to 150	LL stable
10/23/79	0	0	20 to 100	Instrument malfunction
11/10/79	6.0	26.0	20 to 100	Instrument repair
12/31/79	5.5	23.0	20 to 100	Slow decrease
12/10/80	4.5	20.0	20 to 100	Slow decrease
12/08/81	4.5	20.0	80 to 160	LL stable
05/04/82	4.5	18.5	40 to 160	LL stable
05/11/82	1.5	6.5	120 to 220	Pumped
10/04/82	2.9	13.5	20 to 120	LL steady increase
10/05/82	2.0	8.5	60 to 100	Bailed out
03/29/83	6.6	29.0	80 to 100	LL steady increase
03/30/83	1.0	3.5	80 to 100	Pumped
04/26/83	2.4	12.0	80 to 130	LL steady increase
06/09/83	0.2	3.0	80 to 400	Pumped
06/30/83	1.0	7.0	60 to 100	Water added
12/12/83	3.8	18.0	30 to 100	LL steady increase
03/22/84	0.5	3.0	30 to 100	Pumped
11/14/84	3.7	17.0	30 to 100	LL steady increase

Table C5-1. Tank 241-AX-101 Leak Detection Pit Liquid and Radiation Levels (1973 to 1986) (Sheet 3 of 3)

101-AX

Leak Detection Pit.

Date	Liquid level		Radiation level (c/min)	Comments
	Gage	Weight factor (in.)		
02/15/85	6.5	28.5	120	LL steady increase
02/16/85	1.5	8.0	200	Pumped
07/18/85	3.9	19.5	40	LL steady increase
07/25/85	2.0	9.0	50	Pumped
11/01/85	3.9	15.0	50	LL steady increase
11/02/85	0.3	1.0	50	Pumped
11/19/85	1.9	8.5	40	LL steady increase
01/20/86	4.5	19.0	40	LL steady increase
01/21/86	20.0	18.5	40	**New dial gage**
01/29/86	10.0	8.0	40	Pumped
04/22/86	19.0	20.5	25	LL steady increase
04/24/86	7.5	7.0	25	Pumped
06/07/86	12.0	11.0	0	LL steady increase
09/23/86	3.5	3.0	360	LL slow decrease
09/24/86	7.0	7.0	450	Water added
12/31/86	10.4	11.0	100	LL slow increase

Source: SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*.

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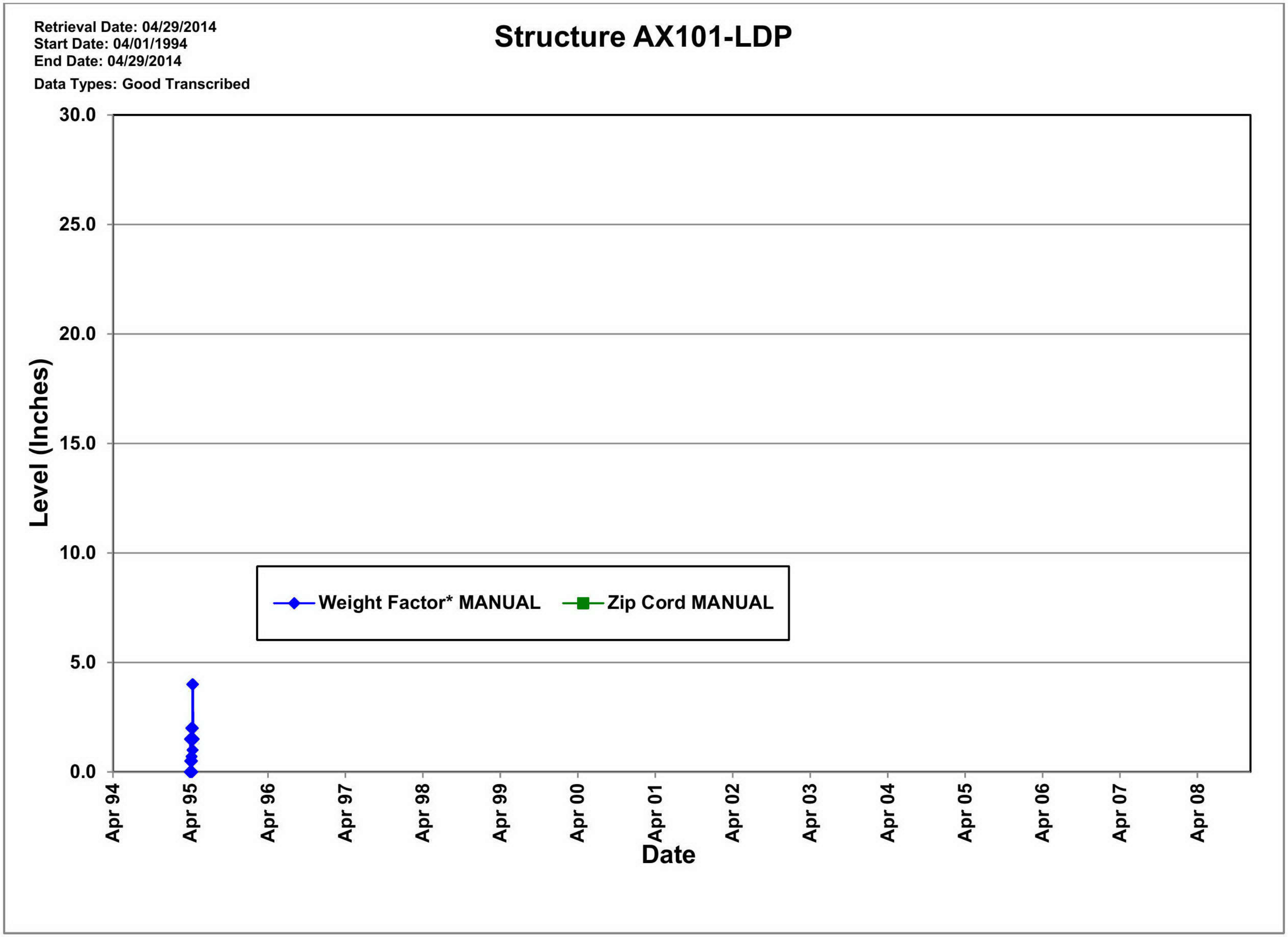
Figure C5-5. AX-101 Leak Detection Pit Liquid Level (1996 to 2006)



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C6.0 TANK 241-AX-103

C6.1 HISTORY

According to HNF-EP-0182, tank 241-AX-103 (AX-103) has a tank integrity classification as "sound." The Current BBI for tank AX-103 indicates an overall waste volume of 107,000 gal.

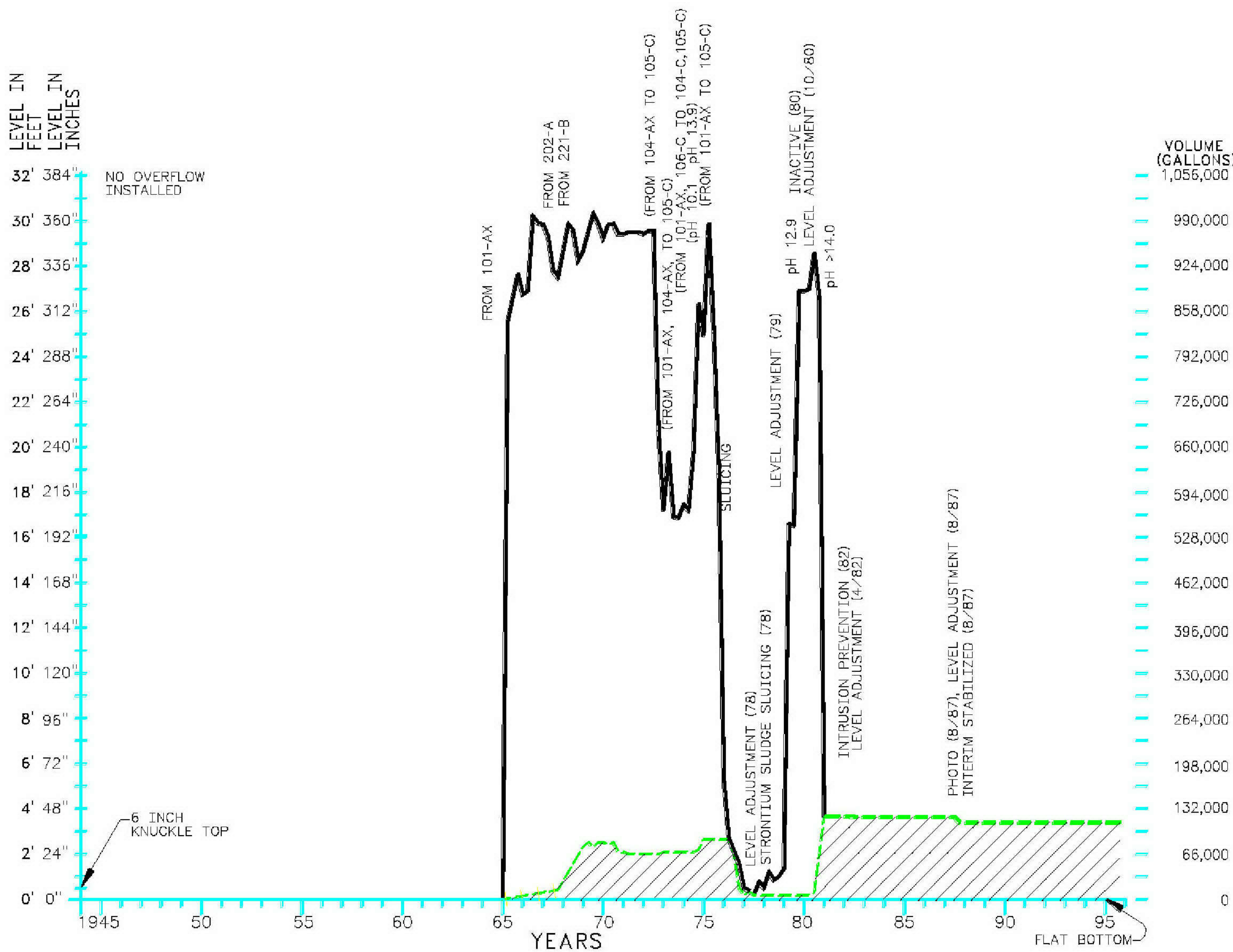
Waste was initially added to tank AX-103 in the first quarter of 1965, consisting of inorganic wash waste from PUREX. The tank received inorganic wash waste from PUREX from the first quarter of 1965 to the second quarter of 1966. From the first quarter of 1965 to the second quarter of 1968, the tank received OWW from PUREX. In 1965, the tank also received supernatant waste from tank AX-101. In the first quarter of 1965, tank A-102 was used to transfer supernatant waste into tank AX-103. Supernatant waste was transferred into tank A-102 from the third quarter of 1965 to the first quarter of 1969. In 1968 and 1969, the tank received B Plant strontium recovery waste, B Plant low-level waste, and low-level waste from PUREX. Supernatant transfers to and from tank A-106 occurred in 1969. The tank again received B Plant strontium recovery waste in 1972. Before being sluiced in 1976, many tanks transferred waste into and out of the tank. During that time, the tank also received flush water from various sources and some of the waste evaporated. In 1975, the tank received waste from the AR Vault. Some of the waste sluiced from the tank in 1976 was used for strontium recovery. After the tank was sluiced, transfers of evaporated waste into and out of the tank occurred, but with a much smaller number of tanks. Supernate was pumped from the tank in 1980 (SD-WM-TI-356 and WHC-MR-0132).

Intrusion prevention for tank AX-103 was completed in 1982 and interim stabilization completed in August 1987. In 1991 tank AX-103 was placed on the Flammable Gas Watch List. In March 1995 a hydrogen monitoring system went into service in tank AX-103. The hydrogen monitoring system was removed in August 1997. The tank was removed from the Flammable Gas Watch List in 2001. Two core samples were collected from tank AX-103 in 1997, and it was considered to be a bounding tank for the Organic Complexant Safety Issue (RPP-RPT-42917, *2009 Auto-TCR for Tank 241-AX-103*). It was found that no exotherms were detected in any of the subsamples from the cores. An analysis of variance on Total Organic Carbon data indicated the tank is safe with respect to organic complexant.

C6.2 SURFACE LEVEL DATA

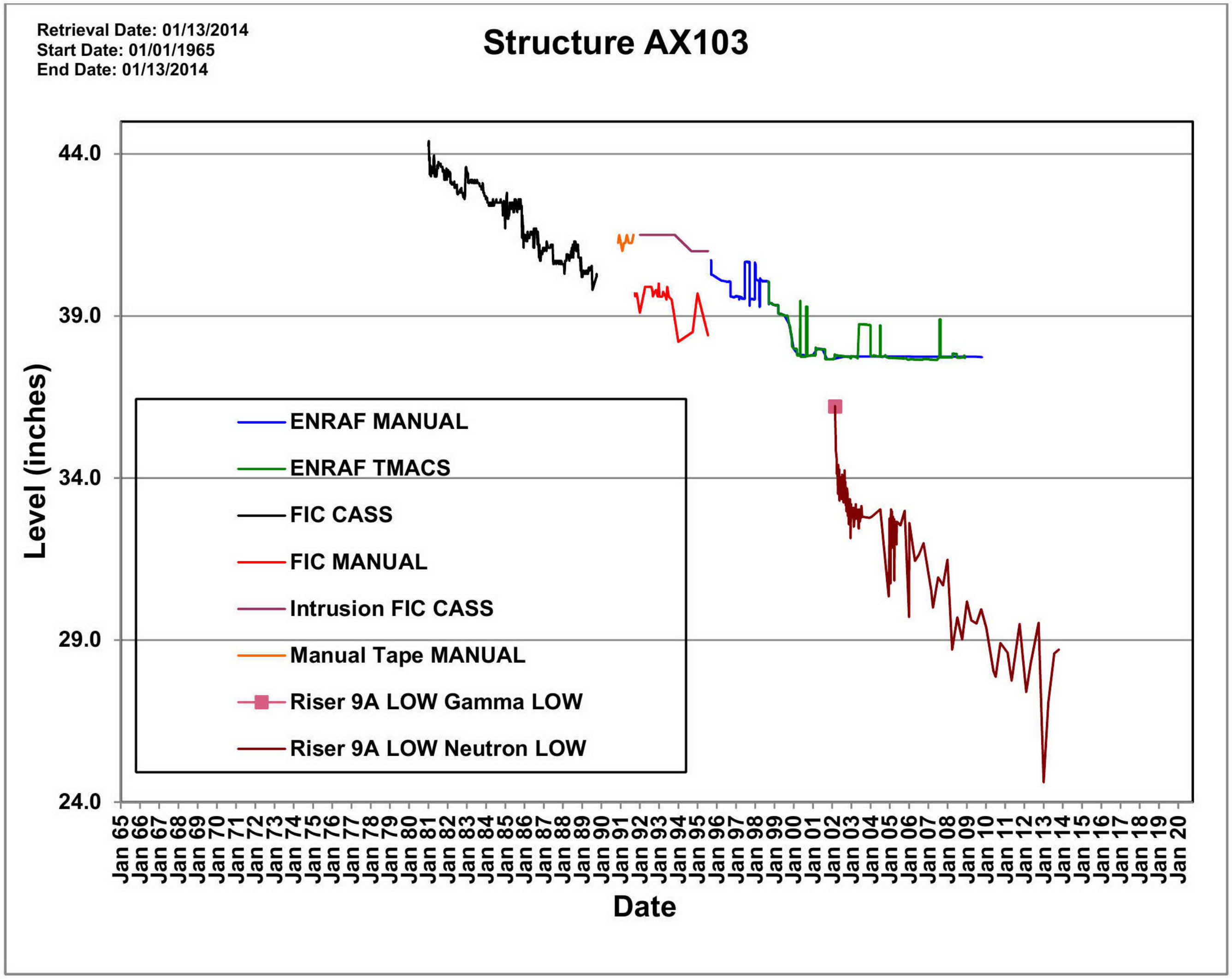
Figure C6-1 shows historical quarterly waste levels for tank AX-103 from 1946 to 1996 (WHC-MR-0132). Additional surface level data showing more frequent measurements is available for tank AX-103 from 1973 to 1987 (SD-WM-TI-356) and from 1980 to present (Figure C6-2). The tank bottom in tank AX-103 has bulged in several places, and the sludge layer is uneven; however, there are no indications that the tank liner has been breached. Otherwise, there are no unique chemical, physical, historical, operational, or other characteristics of this tank or its contents.

Figure C6-1. Tank 241-AX-103 Quarterly Surface Levels



Source: RPP-RPT-42917, *2009 Auto-TCR for Tank 241-AX-103.*

Figure C6-2. Tank 241-AX-103 Surface Level Data



CASS = Computer Automated Surveillance System
FIC = Food Instrument Corporation (gauge)
LOW = liquid observation well
TMACS = Tank Monitor and Control System

Honeywell Enraf® is a registered trademark of Honeywell International Inc., Corporation Delaware, 101 Columbia Road Morristown, New Jersey.

The Auto Enraf® reading on July 1, 2003 was 38.75 in., corresponding to a total waste volume of 403 kL (106,000 gal). This is also consistent with zip cord measurements of the waste level taken at the time of core sampling (July 23, 1997) that indicate 38.6 in. of waste at riser 9A and 38.8 in. of waste at riser 9F. The volume of saltcake interstitial liquid was 75 kL (20,000 gal) based on a 32.94 in. LOW measurement on June 30, 2003 of the saturated liquid level in the tank.

Four occurrence reports were issued and three due to liquid level changes in tank AX-103.

Occurrence Report 77-141, *Liquid Level Exceeds Decrease Criteria*, in August 1977 the waste level in tank AX-103 decreased 0.9 inches in one week (criteria was a decrease of 0.5 inches in a week). The apparent cause of the surface level decrease was the dissolution of foam observed during the prior slurry transfer.

Occurrence Report 79-39, *Liquid Level Increase in the 103-AX Leak Detection Pit*: In March 1979 there was an increase in the tank AX-103 detection pit liquid level. It was determined that the most probable cause of the liquid level increase was water seepage through the drain bellow assembly into the leak detection pit. The seepage was attributed to higher than normal snow fall and the associated thaw.

Operating Limit Deviation Report 80-09, *Liquid Level Decrease in Tank 103-AX*: In April 1980 ~30,000 gal of condensate water from tank 417 was transferred to tank AX-103. This resulted in a waste surface level decrease. The cause was attributed to the slow erosion of slurry material from the FIC plummet.

RP--CHG-TANKFARM-2004-0070, *Tank 241-AX-103 Liquid Waste Level Below Established Baseline*: During a quarterly inspection of tank AX-103, site personnel determined that the LOW liquid waste level was ~2.7 in. below the established baseline. Management initiated tank-leak assessment procedure and subsequently adjusted the baseline to reflect actual waste level data.

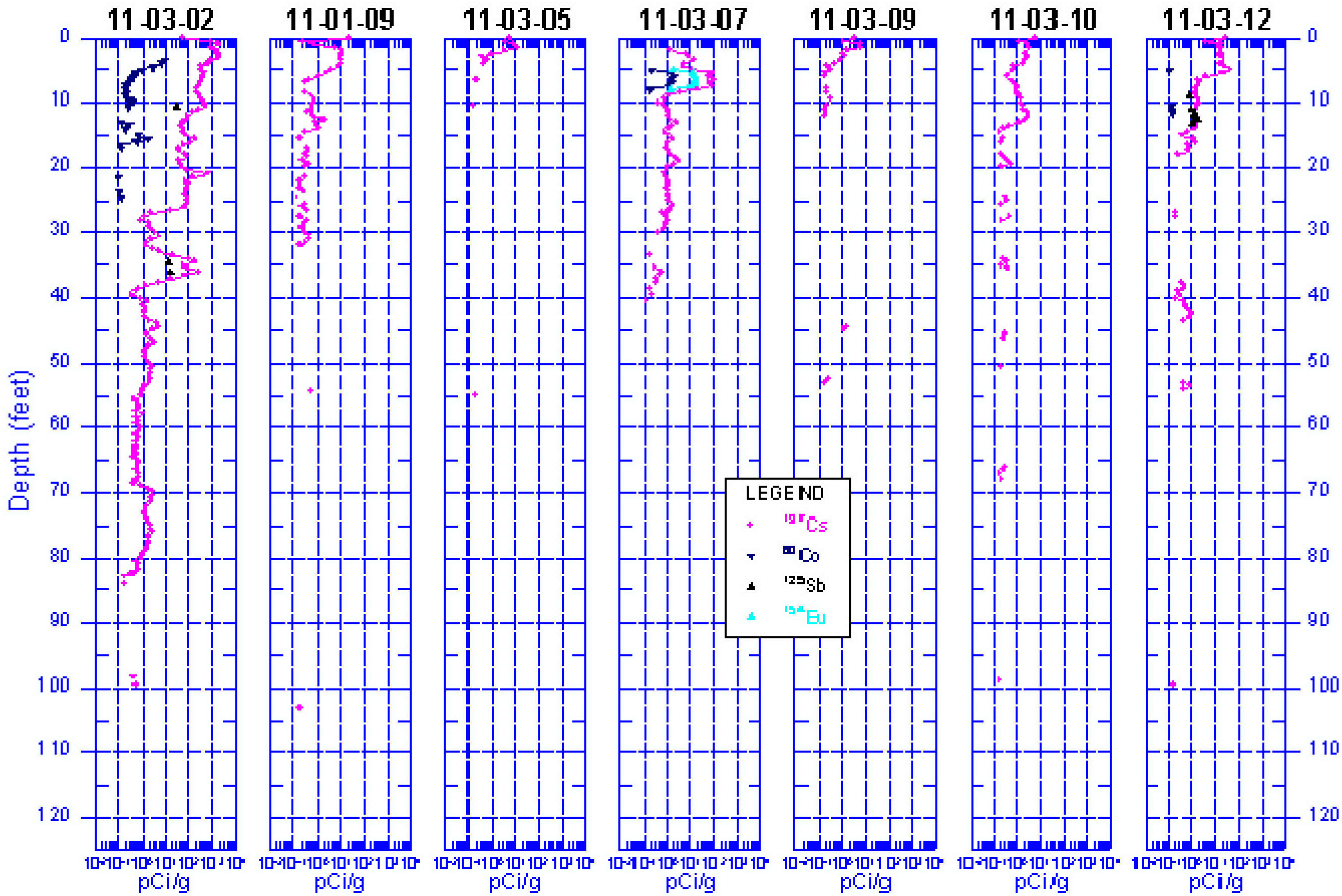
C6.3 DRYWELL DATA

Drywells 11-03-02, 11-01-09, 11-03-05, 11-03-07, 11-03-09, 11-03-10, and 11-03-12 surround tank AX-103. All the drywells are within 10 ft of the tank. Seven of the drywells were drilled between late 1974 and early 1975; six to a depth of 100 ft and drywell 11-03-09 was completed to a depth of 120 ft. The shallow subsurface zone of contamination consists of ^{137}Cs, ^{60}Co, and ^{125}Sb in drywells 11-03-02 and 11-03-12 and ^{137}Cs in drywell 11-01-09. The contamination plume appears to extend eastward and may include drywell 11-01-10. The contamination between the ground surface and 5 ft probably resulted from surface spills that migrated down into the backfill surrounding the drywells. The contamination detected in the deeper portions of the backfill (below 5 ft) is probably the result of a subsurface release from a transfer line or connection points near the tank. Except for drywell 11-03-02, ^{137}Cs activity less than 1,000 pCi/g (Figure C6-3) was observed in the top 20 ft below ground surface in drywells surrounding tank AX-103. The historical data indicate that in the vicinity of drywell 11-03-02 the contamination existed prior to or shortly after the installation of the drywell (GJ-HAN-51, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-103*). Piping about tank AX-103 is shown in Figure C6-4. The measureable peak of activity between 33.5 and 37 ft shown in the readings of borehole 11-03-02 may have been the result of a leak at the approximate level of the transfer line nozzles on the tank.

C6.4 LEAK DETECTION PIT DATA

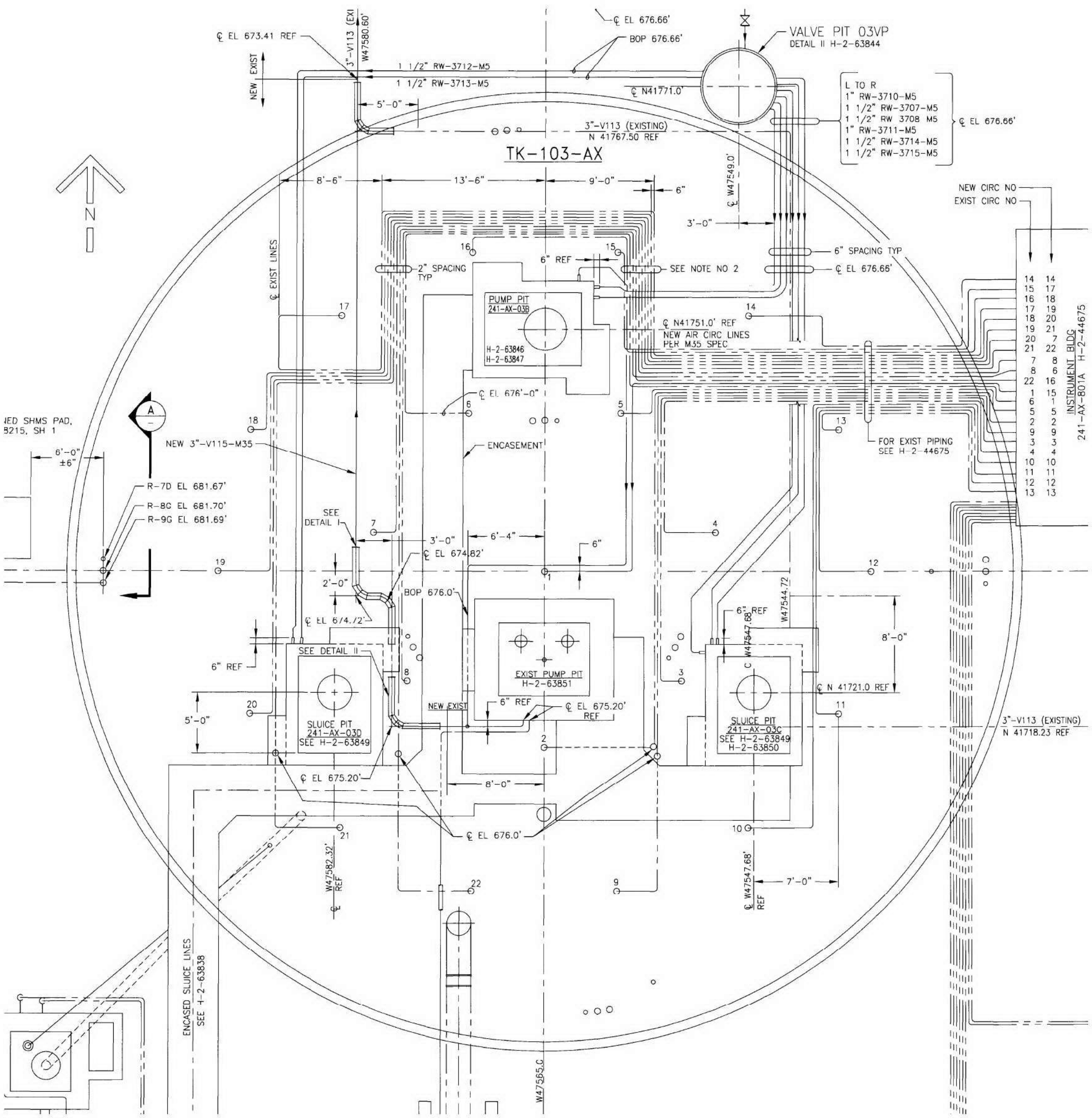
In addition to drywell data, AX Farm has leak detection pits as described in Section 3.2. Both surface level and radiation measurements are available from the leak detection pits. Table C6-1 shows liquid and radiation levels in the AX-101 leak detection pit from 1973 to 1986 (SD-WM-TI-356) and Figure C6-5 shows liquid levels in the leak detection pit from 1995 to 2006. The AX-103 leak detection pit monitoring was discontinued after October 2006.

Figure C6-3. 1997 Spectral Gamma Logging System Logging Near Tank 241-AX-103



Reference: GJ-HAN-51, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank AX-103*.

Figure C6-4. Tank 241-AX-103 Piping Arrangement



Source: H-2-63842, *Piping Plan 241-AX Tank Farm TK-103*.

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Table C6-1. Tank AX-103 Leak Detection Pit liquid and Radiation Levels (1973 to 1986) (Sheet 1 of 3)

103-AX

Leak Detection Pit.

Date	Liquid level (in.)	Radiation level (c/min)
07/02/73	22.0	500
09/15/73	22.0	0
12/15/73	22.0	0
04/15/74	22.0	0
05/15/74	21.6	0
06/15/74	21.6	0
07/15/74	21.6	0
08/15/74	21.6	0
10/15/74	21.6	0
12/15/75	21.6	0
02/15/75	21.6	0
04/15/75	21.6	0
06/15/75	21.6	0
07/21/75	22.0	0
08/15/75	21.6	0
01/18/76	21.6	0
03/31/76	20.0	0
04/27/76	18.0	0
05/24/76	16.0	0
06/23/76	13.0	0
07/22/76	11.0	0
08/23/76	8.0	0
09/23/76	2.0	0
10/04/76	1.0	0
10/10/76	0.0	0
11/03/76	0.0	10
12/05/76	0.0	20

Table C6-1. Tank AX-103 Leak Detection Pit liquid and Radiation Levels (1973 to 1986) (Sheet 2 of 3)

103-AX

Leak Detection Pit.

Date	Liquid level		Radiation level (c/min)	Comments
	Gage	Weight factor		
01/07/77	0.0		0 to 20	
01/08/77	4.2	17.3	1	Water added
03/20/77	3.2	12.5	0 to 11	LL slow decrease
03/21/77	5.0	20.5	1	Water added
07/01/77	5.2	19.0	0 to 2	Stable
12/20/77	2.0	10.0	0 to 54	Erratic radiation readings
02/16/78	0	1.0	5 to 50	Slow LL decrease
02/17/78	0	1.5	105	Radiation increase
09/12/78	0	0.0	100	Stable
12/20/78	0	0.0	450	Radiation increase
03/08/79	0	0.0	120	LL stable
03/29/79	2.0	10.0	150	LL slow increase (OR 79-39)
05/09/79	2.3	0.0		Instrument malfunction on weight factor gage
08/14/79	2.5	3.5	25	Instrument malfunciton on weight factor gage
12/31/79	3.5	8.5	20	LL slow increase
01/24/80	3.9	15.1		Weight factor instrumentation repaired
04/26/80	4.7			
12/11/80	5.0	28.0	50	LL increase due to rain
12/14/80	2.9	17.0	60	LL decrease
01/12/81	5.0	21.0	100	Instrument recalibration
10/27/81	5.0	20.0	95	LL stable, radiation stable
10/28/81	1.5	6.5	90	Bailed water from pit
12/12/81	1.7	7.5	80	LL slow increase
05/12/82	3.1	13.0	120	LL steady increase, radiation stable
05/13/82	1.2	5.0	100	Bailed water from pit
06/29/82	0.3	3.0	100	LL steady decrease
06/30/82	2.5	11.0	200	LL water added
08/10/82	2.0	9.0	50	LL steady decrease
10/28/82	2.0	10.0	o/s	LL stable, radiation counter o/s
12/12/82	4.0	17.0	75	LL increase due to rain, radiation stable
03/28/83	13.5	54.5	90	LL steady increase/ radiation stable
03/30/83	1.6	7.0	100	Pumped

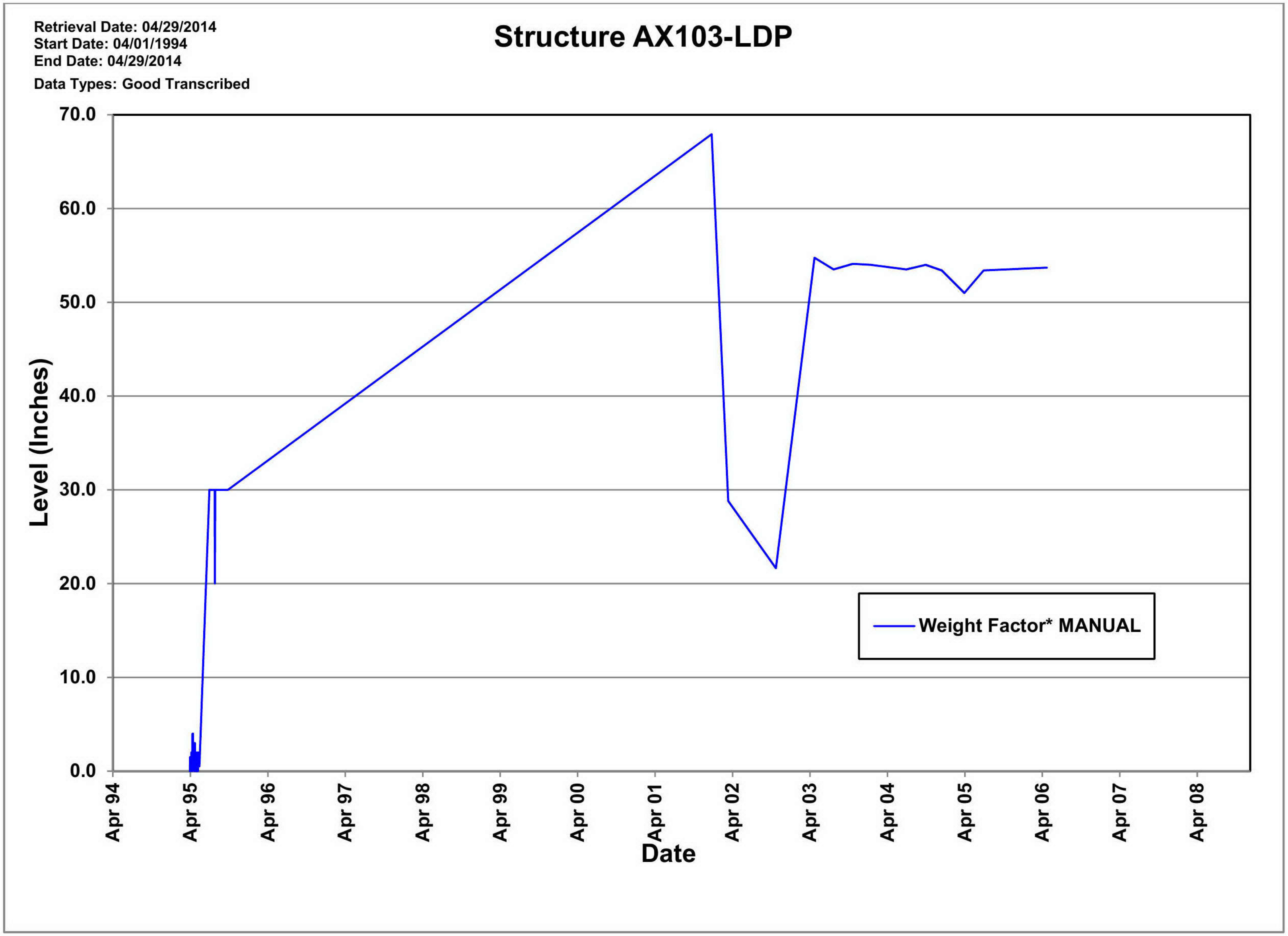
Table C6-1. Tank AX-103 Leak Detection Pit liquid and Radiation Levels (1973 to 1986) (Sheet 3 of 3)

103-AX

Leak Detection Pit.

Date	Liquid level		Radiation level (c/min)	Comments
	Gage	Weight factor		
06/02/83	3.0	13.0	10	LL steady increase
06/03/83	0.7	3.0	10	Pumped
07/01/83	2.0	9.5	80	Water added
10/28/83	0.0	0.0	100	LL decrease (erratic readings)
01/15/84	0.0	43.0	0	
02/09/84	0.0	6.0	150	Pumped
03/22/84	3.1	15.5	o/s	LL steady increase, radiation instrument o/s
03/23/84	1.0	7.0	o/s	Pumped
05/21/84	2.0	13.0	60	LL steady increase, radiation instrument back in service
05/26/84	1.1	3.5	80	Pumped
11/14/84	1.2	5.5	95	LL erratic readings
08/05/85	4.2	18.0	80	LL steady erratic increase
08/07/85	2.3	12.0	80	Pumped
12/10/85	2.0	9.0	100	Measurement anomalies experienced
01/20/86	3.5	16.0	100	LL slow increase
01/21/86	13.5	16.5	115	New dial gage
04/23/86	20.5	21.0	60	LL steady increase
04/24/86	4.5	6.0	60	Pumped
07/05/86	1.0	0.0	360	LL steady decrease
07/07/86	9.0	9.0	200	Water added
08/20/86	2.8	3.0	200	LL steady decrease
08/21/86	9.2	9.1	220	Water added
10/29/86	0.0	0.5	110	LL steady decrease
11/13/86	9.0	10.0	250	Water added
12/31/86	5.2	5.0	48	LL steady decrease

Figure C6-5. AX-103 Leak Detection Pit Liquid Level (1996 to 2006)



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