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241-C-104 Tank Waste Retrieval Project Final Report of Drywell Monitoring Data (HGLP-MBL-012, Rev. 0)

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Key Words: 241-C Tank Farm, C Farm, tank 241-C-104, C-104, Leak Detection and Monitoring, LDM, high-resolution resistivity, HRR, spectral gamma logging system, SGLS, handheld neutron-moisture, HHNM, radionuclide assessment system, RAS

Abstract: Stipulated in the Tank Waste Retrieval Work Plan (RPP-22393) and part of the Leak Detection and Monitoring plan for tank 241-C-104 is the requirement to perform a final round of total depth gamma and moisture measurements in the seven drywells once retrieval operations had been completed. Waste retrieval operations for this tank began on January 8, 2010 and concluded on August 17, 2012. This report provides the results of those drywell loggings. At least five contamination incursions have been identified from gamma log data over the past 39 years. None of the drywells around tank 241-C-104 show evidence of significant changes in either gamma activity or subsurface moisture. These drywells provide no evidence of any leak or contaminant movement associated with tank retrieval operations.

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HANFORD GEOPHYSICAL LOGGING PROJECT

HANFORD TANK FARMS VADOSE ZONE MONITORING PROJECT

HGLP-MBL-012, Rev. 0

241-C-104 TANK WASTE RETRIEVAL PROJECT FINAL REPORT OF DRYWELL MONITORING DATA

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1.0 INTRODUCTION

241-C-104 is an underground radioactive waste storage tank located in the 241-C Tank Farm in the 200 East Area of the Hanford Site. This tank is a 75 ft - diameter underground domed concrete structure, with a carbon steel liner on the sides and bottom. The base of the tank is approximately 38 ft below ground surface, with about 6 ft of backfill covering the dome. Nominal capacity of the tank is 530,000 gallons. Waste retrieval for this tank began on January 8, 2010 and concluded on August 17, 2012 with the removal of all but a relatively small amount (~160 ft^3) of tank waste.

The Leak Detection and Monitoring (LDM) plan for C-104 is described in the Tank Waste Retrieval Work Plan (TWRWP) (RPP-22393). Early revisions of the TWRWP called for:

- Pre-retrieval baseline moisture and gamma logs in 8 drywells around the tank: 30-04-01, 30-04-02, 30-04-03, 30-05-06, 30-04-04, 30-04-05, 30-04-08, and 30-04-12 (Figure 1-1)
- Weekly moisture (or gamma) measurements over selected depth intervals in the eight drywells during active retrieval operations, or every six week moisture (or gamma) measurements during inactive retrieval operations
- A final round of total depth gamma and moisture measurements in the eight drywells after completion of retrieval activities.

More recent versions of the TWRWP adopt high-resolution resistivity (HRR) as the primary ex-tank leak detection method, using drywell logging as a back-up monitoring option when the HRR system is not running. Note that HRR results are not discussed in this report. In addition, post-retrieval neutron moisture measurements are no longer required under the current revision of the TWRWP, given that gamma logging is always required in the event of anomalous moisture readings. Ergo, only total depth gamma measurements are required after completion of retrieval according to the TWRWP.

All retrieval related routine gamma monitoring in drywells with the radionuclide assessment system (RAS) and handheld neutron-moisture (HHNM) measurements are performed by Tank Farms personnel with technical support and data interpretation provided by the S.M. Stoller Corporation (Stoller). When needed, logging with the neutron moisture logging system (NMLS) and high-resolution spectral gamma logging system (SGLS) is performed by Stoller personnel. All of these logging systems are calibrated on an annual basis, or as needed, by Stoller.

During August to November 2009, prior to the start of retrieval operations, these drywells were monitored for gamma activity using the RAS to establish a pre-retrieval baseline gamma profile against which to compare gamma data acquired during or after retrieval. An increase in gamma activity could be an indication of tank leakage related to retrieval activities. HHNM data acquired with a Campbell Pacific Nuclear 503DR Hydroprobe were also collected in March 2009 to establish a pre-retrieval baseline moisture profile. A significant increase in moisture content below the level of tank waste might be an indicator of leakage associated with tank retrieval operations.

Selected depth intervals (typically about 28 to 53 ft below ground surface) in the eight drywells in the vicinity of C-104 were monitored with the handheld moisture gauge at intervals of approximately six weeks from November 2011 to April 2012, and from October 2012 to April 2013. Since April 2013, additional moisture measurements have been made in a few drywells. During other periods, it is presumed that HRR served as primary ex-tank LDM. Moisture increases are determined to be significant when they exceed a statistical threshold here referred to as a 3-sigma criterion. The 3-sigma criterion is calculated as the mean of the data at a given depth, plus an increment equivalent to three times the standard deviation of all measurements at that depth to date. These criteria are refined as data accumulate. A chart presented as Figure 4-1 in the Process Control Plan is used to help determine the action to take in the event of an increase in moisture content above the 3-sigma criterion. This chart is reproduced as Figure 1-2 in this document. In general, if the increase is at a depth that is below tank waste level, then the moisture measurement is to be repeated as soon as practicable. Following that, if the repeat measurement confirms the moisture increase, then a follow-up gamma log is to be acquired as soon as practicable. Examples of moisture values exceeding the 3-sigma criteria can be observed in the data plots in several of the drywells (Figure 1-3a through 1-10b). When a value exceeds the 3-sigma criterion, there are several reasons why that may occur. First is an actual significant increase in soil moisture content. Second, since data are recorded by hand in the field, there are opportunities for transcription errors. Third, the detector is manually lowered down the hole and held in place at prescribed depths by "cable stops", which can result in depth errors. Depth errors tend to show up as a systematic shift in the moisture profile when compared with earlier data. Should an obvious transcription error or depth error result in moisture values exceeding 3-sigma criteria, the measurements are not repeated. Transcription errors are usually obvious. For example, a typical count rate might be 1400 counts per second (cps) at a specific depth in a drywell. If a new measurement is recorded as 3400 cps at that depth, but measurements at adjacent depths are consistent with typical values, then a transcription error is suspected. Where an increase is not obviously the result of a transcription or depth error, and it meets the criteria in the chart in Figure 1-2, then the measurement will be repeated.

A re-baseline of selected boreholes in C farm was conducted with the SGLS during 2010 and 2011 for comparison with initial baseline data acquired in 1997. Two drywells around C-104 were included in this re-baseline, and data from those drywells are included in this report.

Figure 1-1 shows the position of various drywells around Tank C-104. Drywell logging and monitoring results are summarized in Figure 1-3 through 1-10. Total gamma logs acquired after completion of retrieval operations show no evidence of increases in gamma activity that might indicate a tank leak during retrieval.

FIGURE 1-1 **TANK C-104 DRYWELL LOCATIONS**

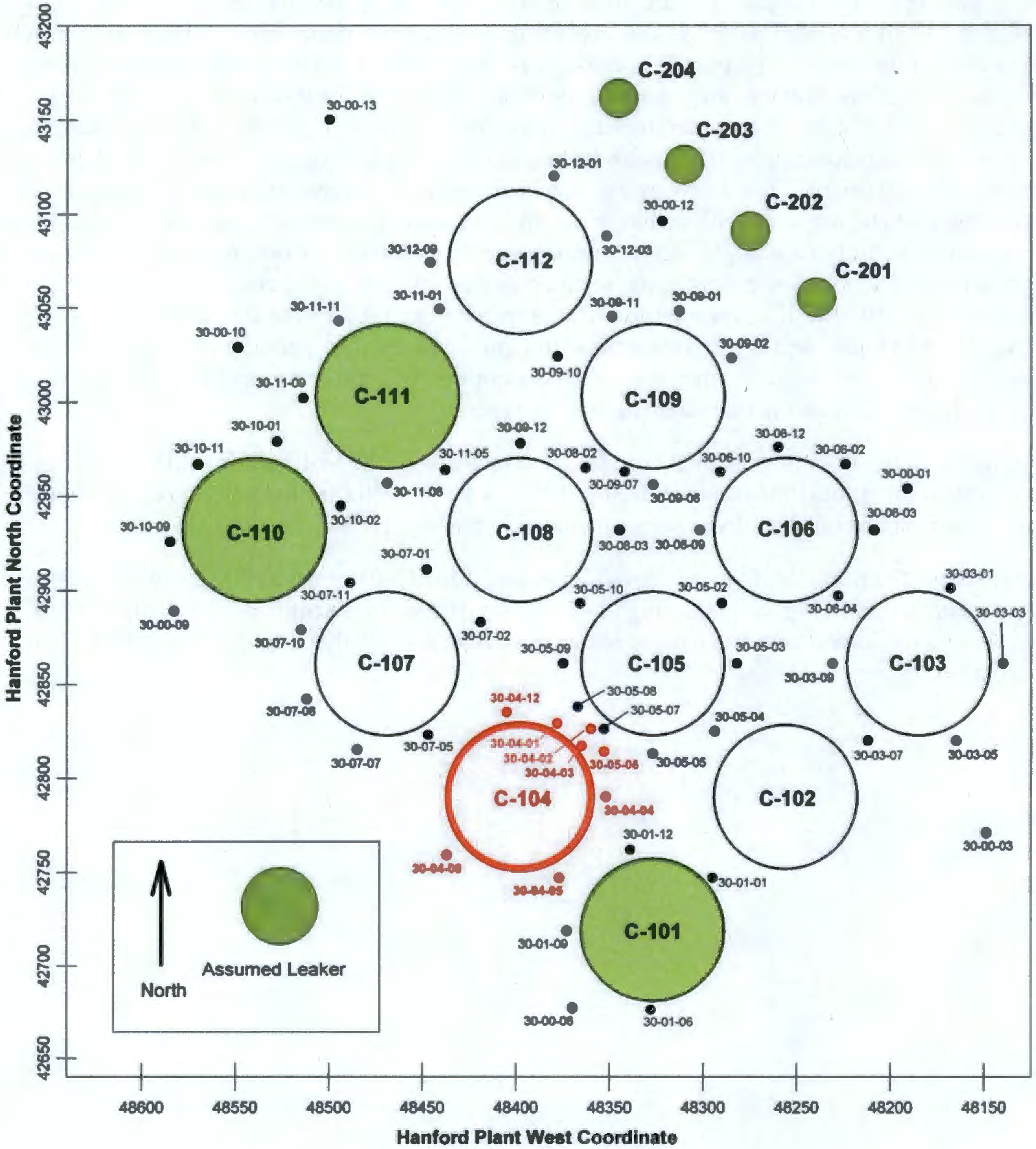
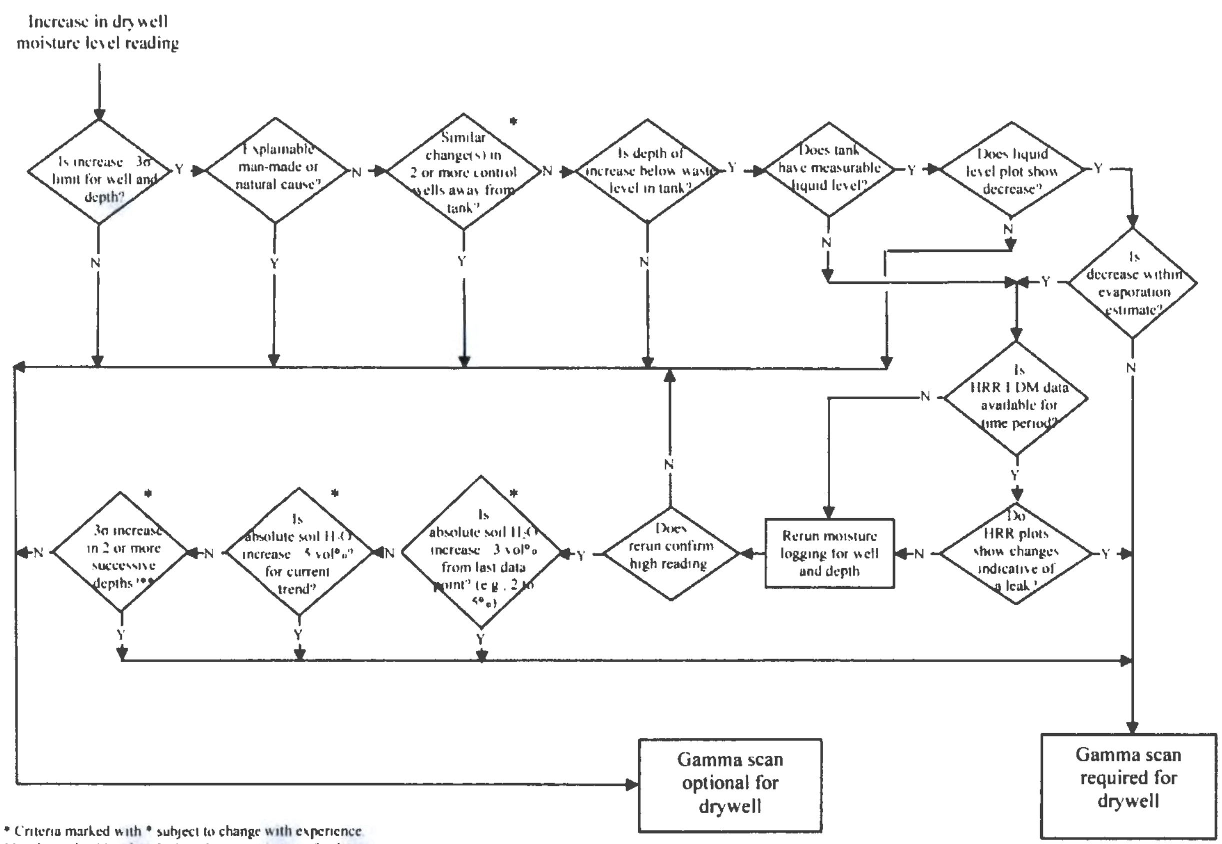


FIGURE 1-2 **RPP-PLAN-44944, REV. 2, FIGURE 4-1**

RPP-PLAN-44944 Rev. 2

Figure 4-1. Evaluation of Detected Increases in Drywell Measurements



* Criteria marked with * subject to change with experience

**Only applicable when 3σ based on a minimum of 6 data points

FIGURE 1-3A TANK C-104 BOREHOLE 30-04-01

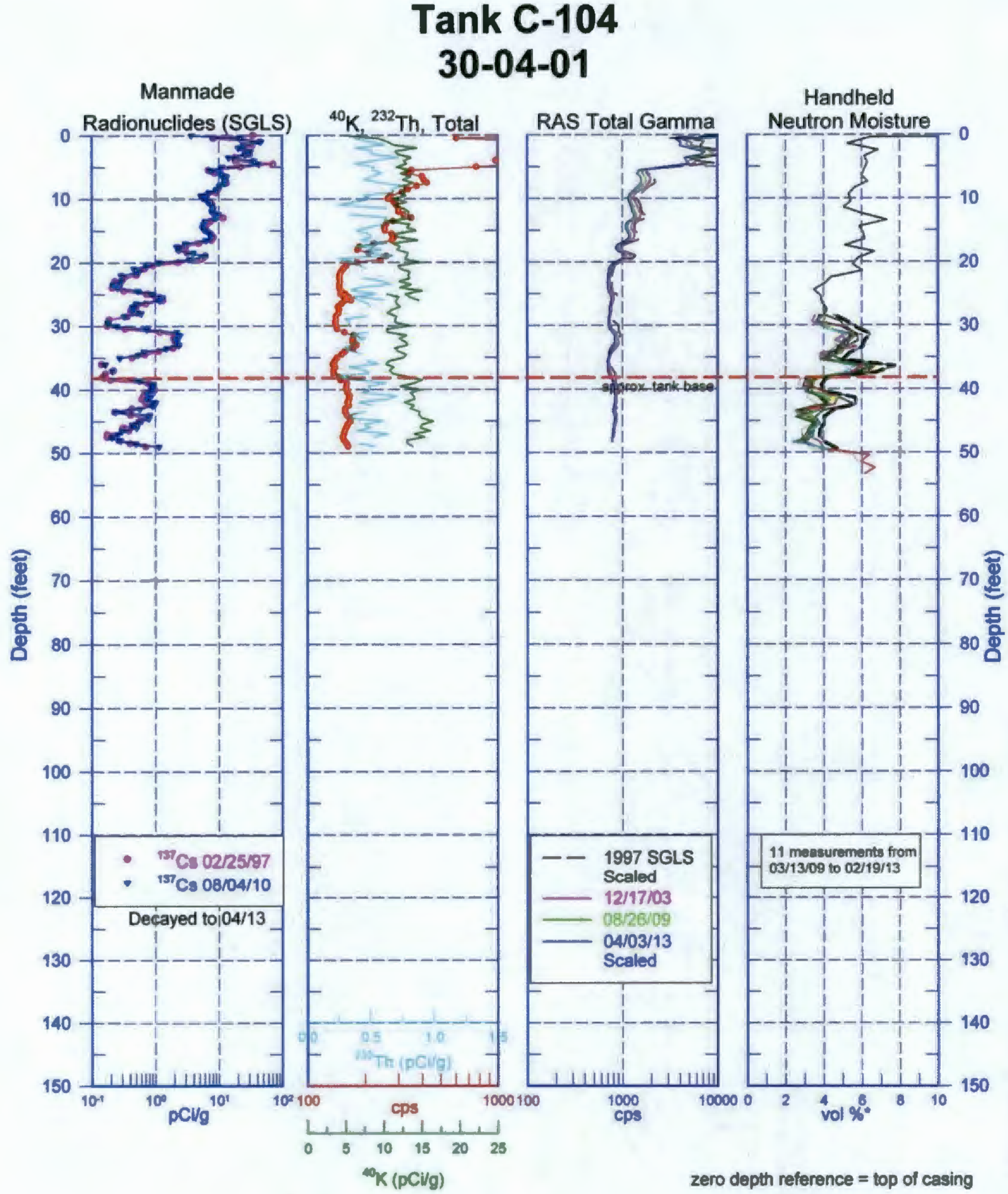


FIGURE 1-3B **30-04-01: RETRIEVAL DATA**

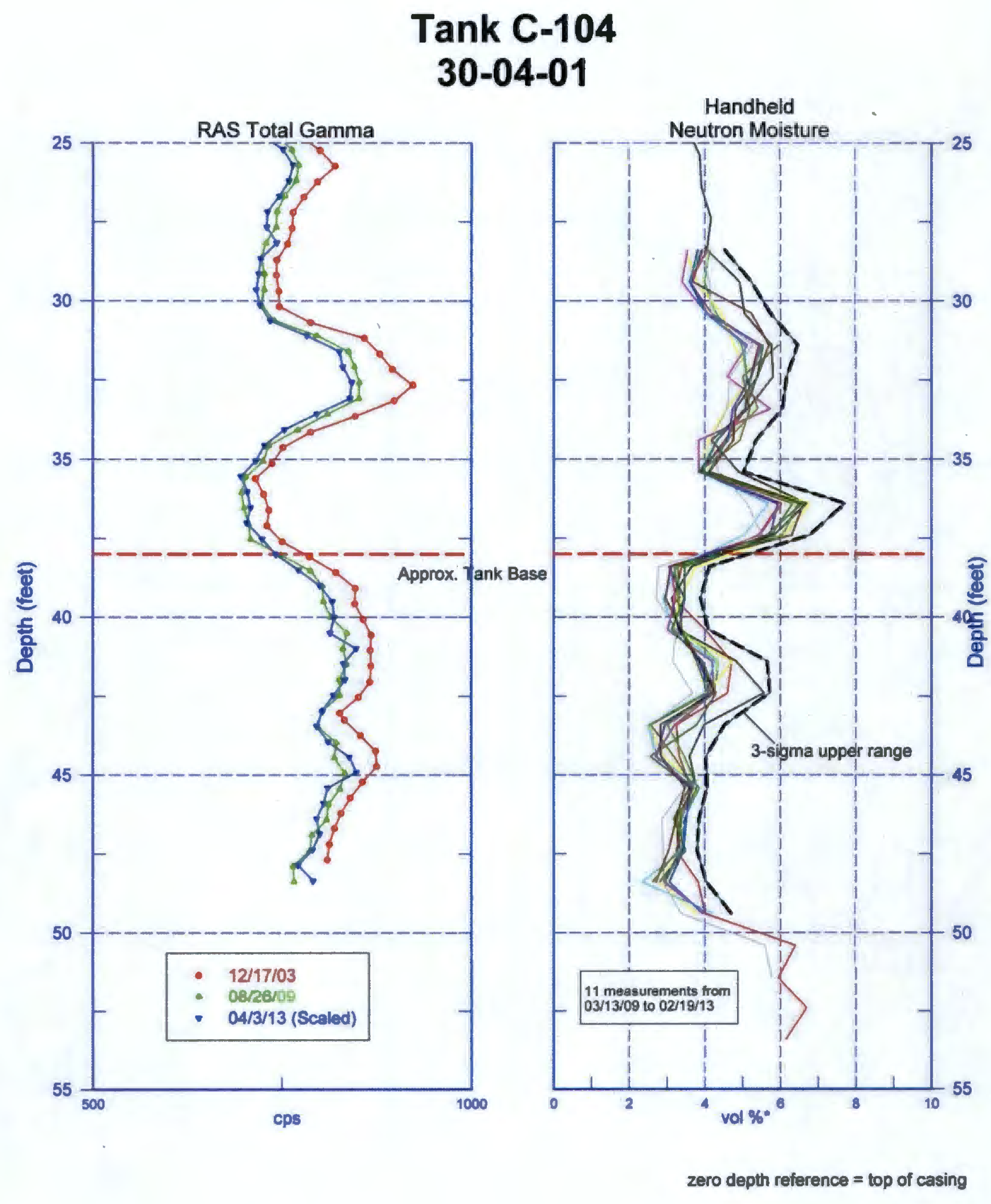


FIGURE 1-4A **TANK C-104 BOREHOLE 30-04-02**

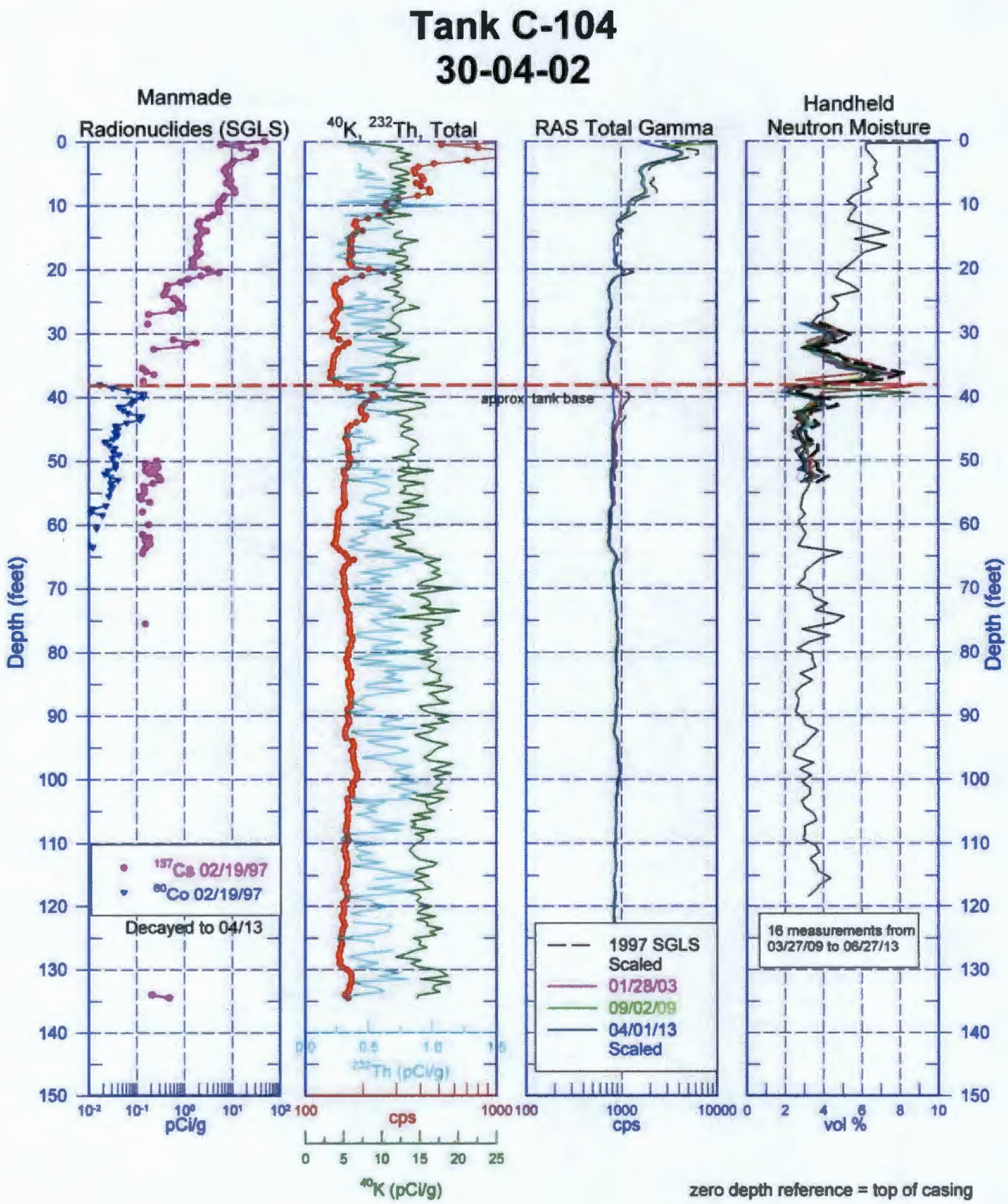


FIGURE 1-4B **30-04-02: RETRIEVAL DATA**

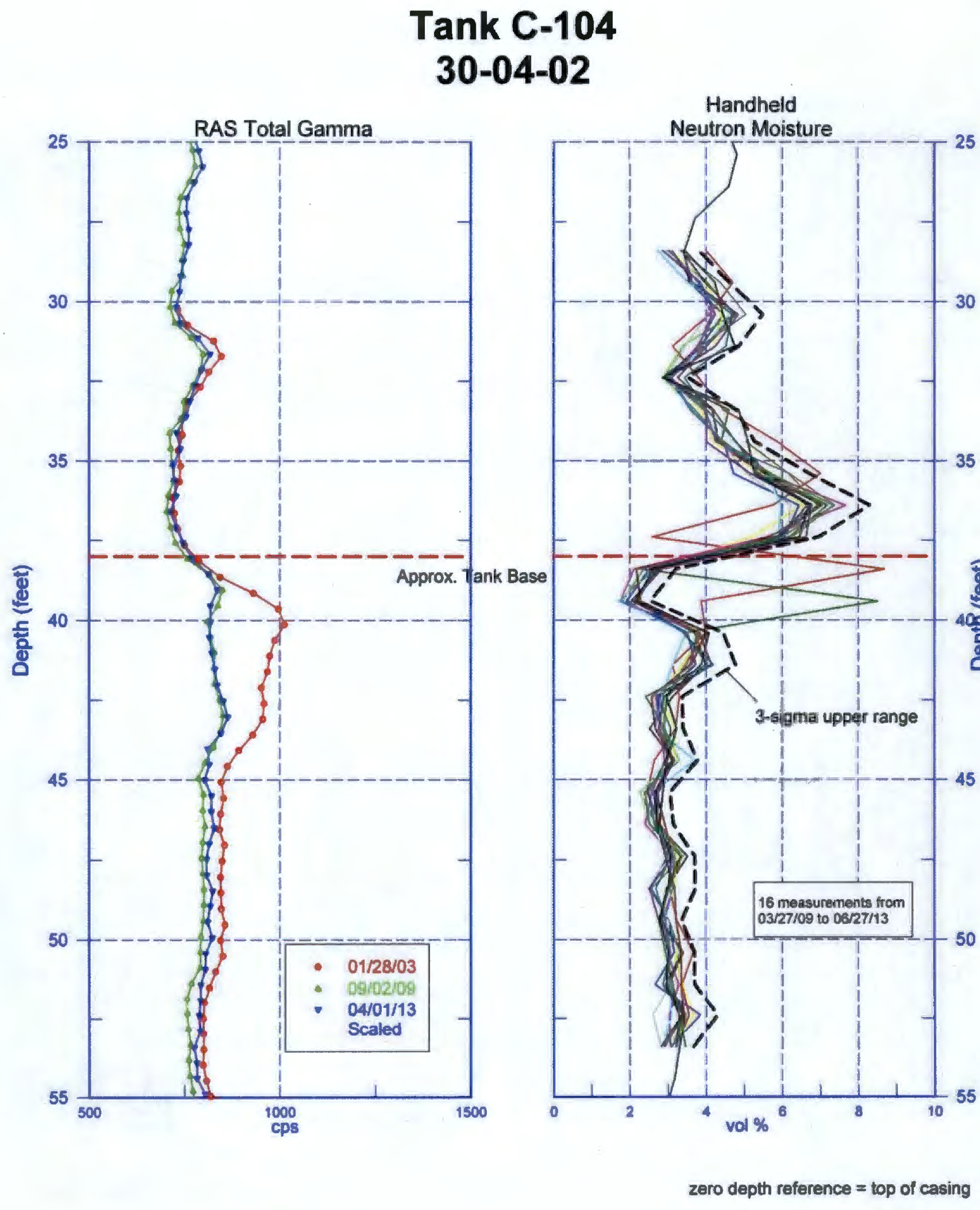


FIGURE 1-5A **TANK C-104 BOREHOLE 30-04-03**

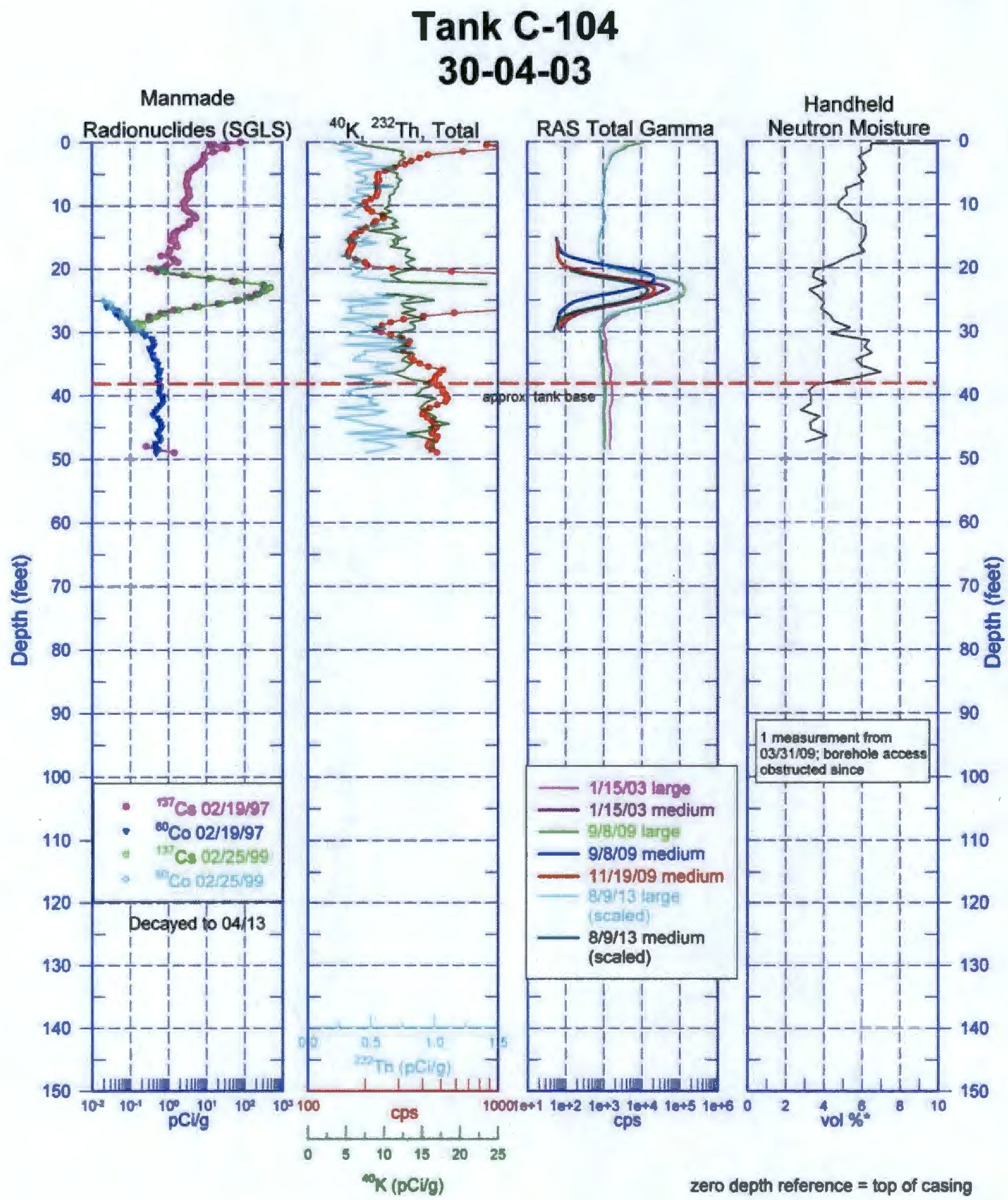


FIGURE 1-5B **30-04-03: RETRIEVAL DATA**

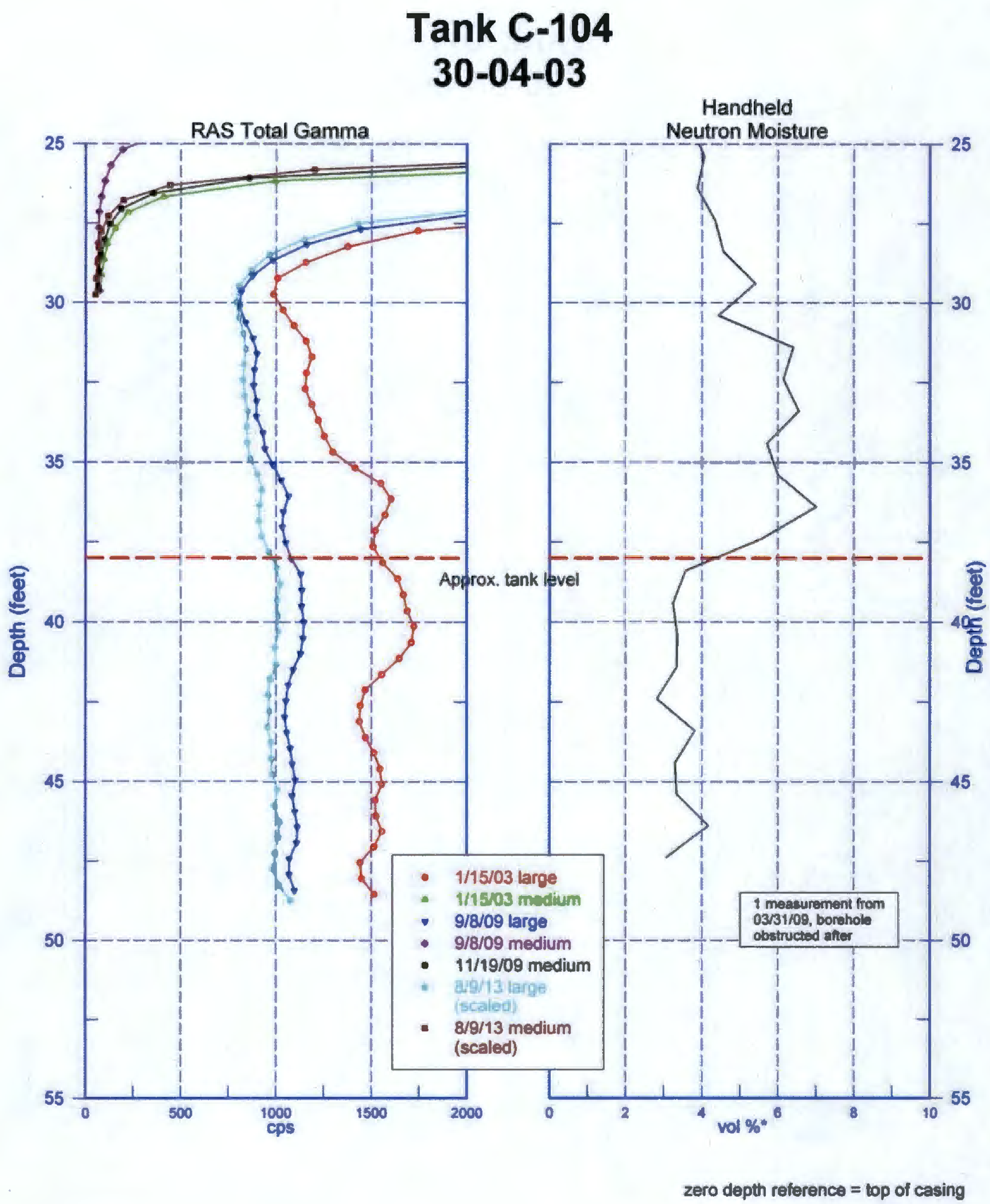


FIGURE 1-6A **TANK C-104 BOREHOLE 30-05-06**

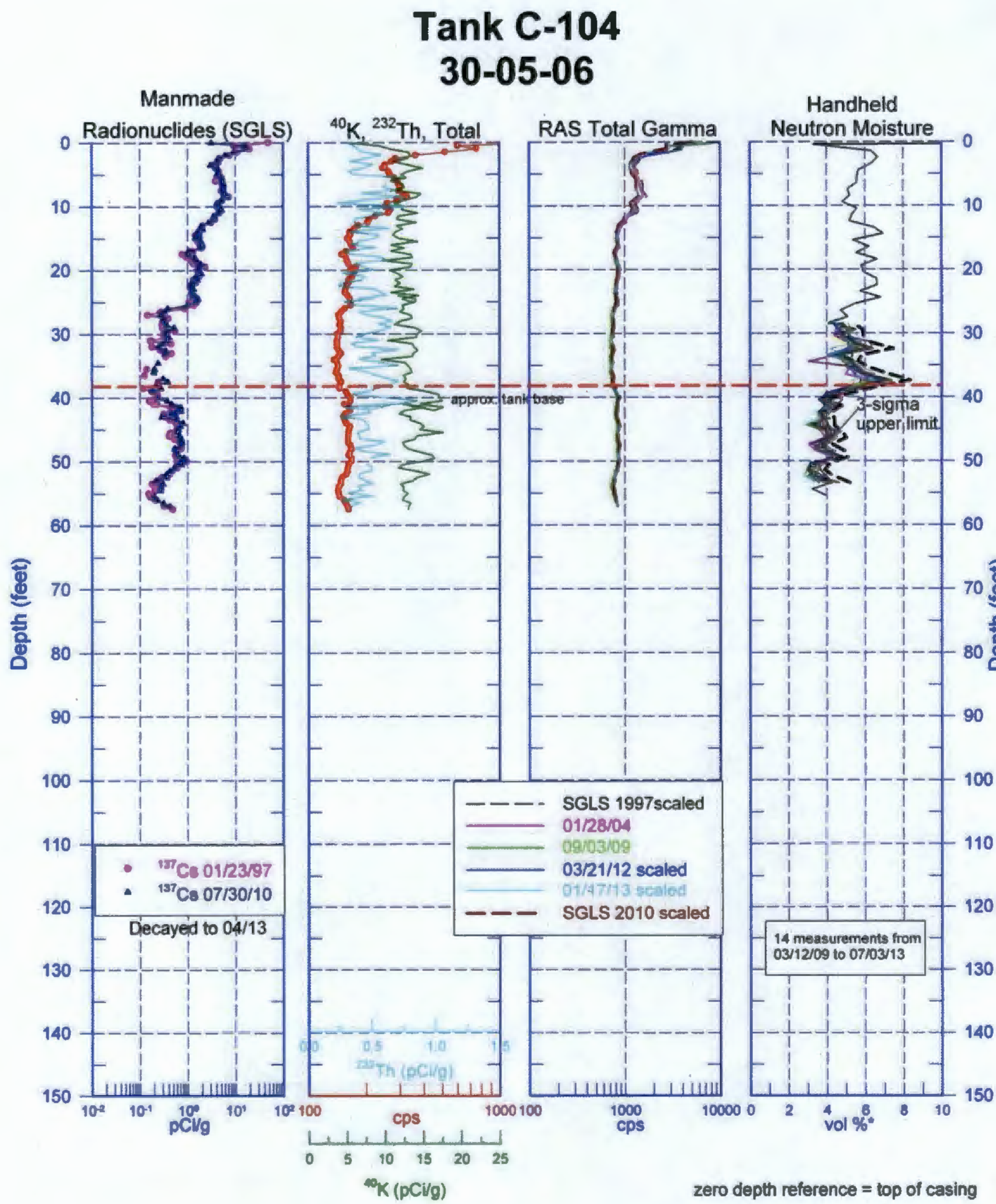


FIGURE 1-6B **30-05-06: RETRIEVAL DATA**

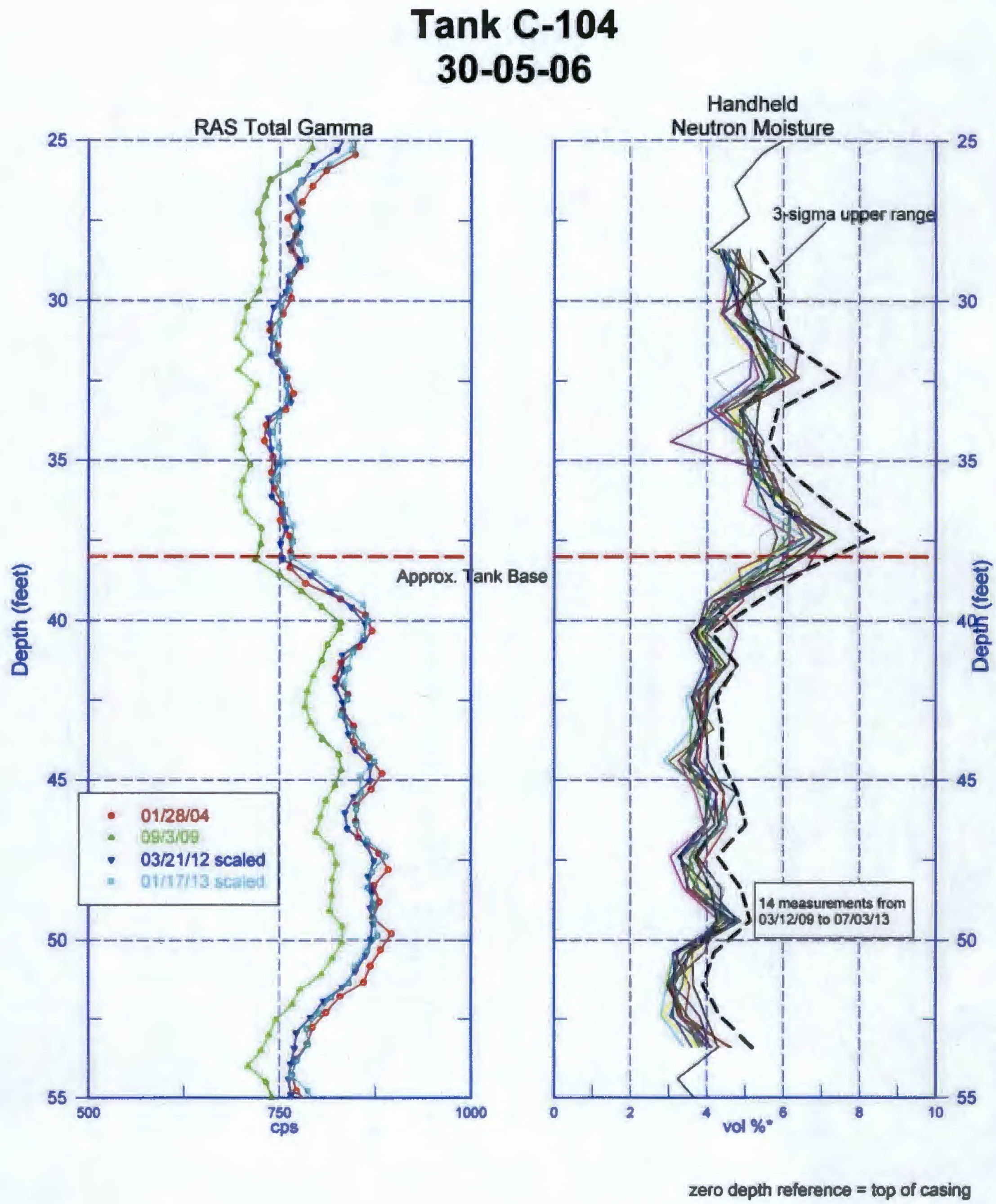


FIGURE 1-7A **TANK C-104 BOREHOLE 30-04-04**

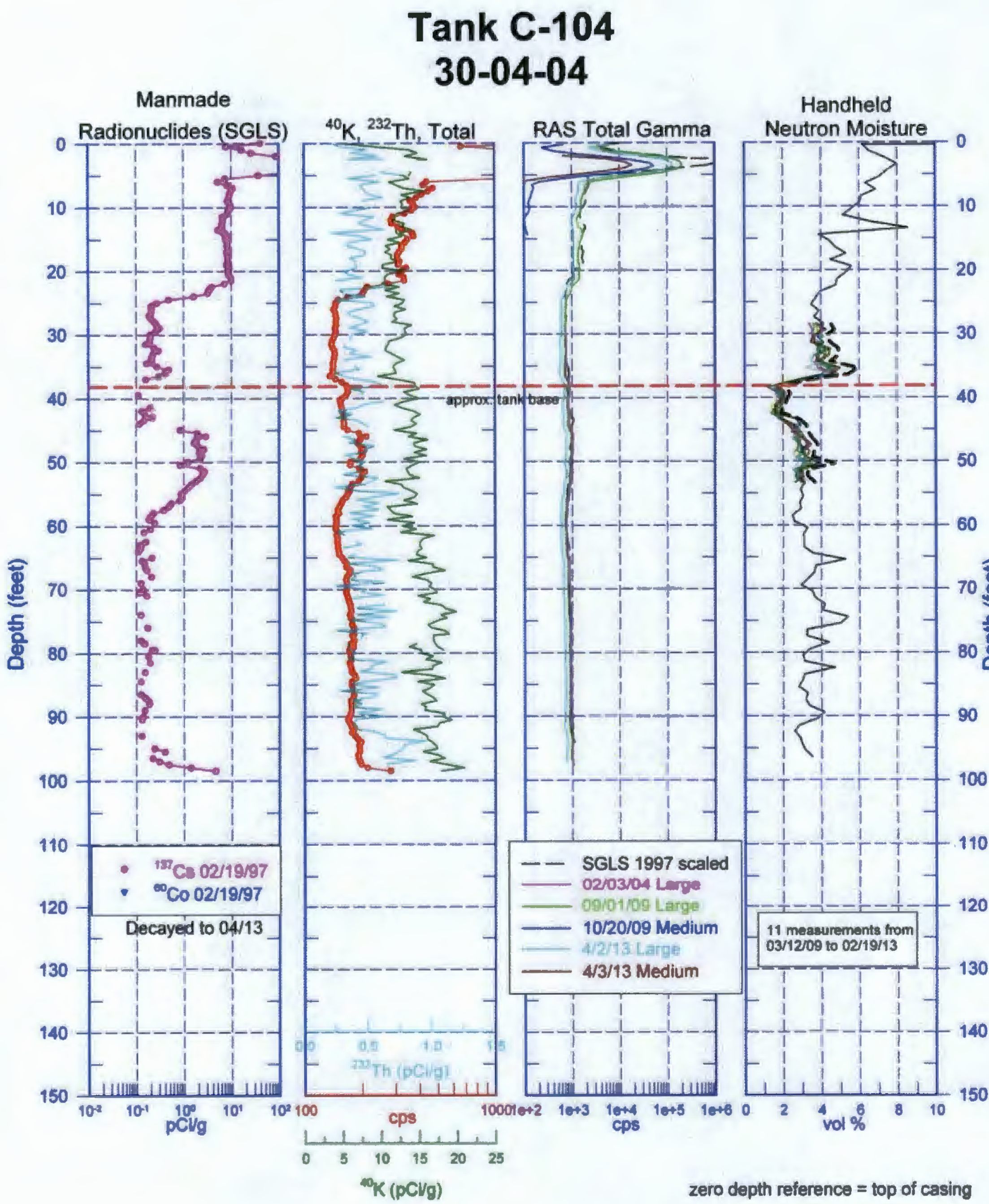


FIGURE 1-7B 30-04-04: RETRIEVAL DATA

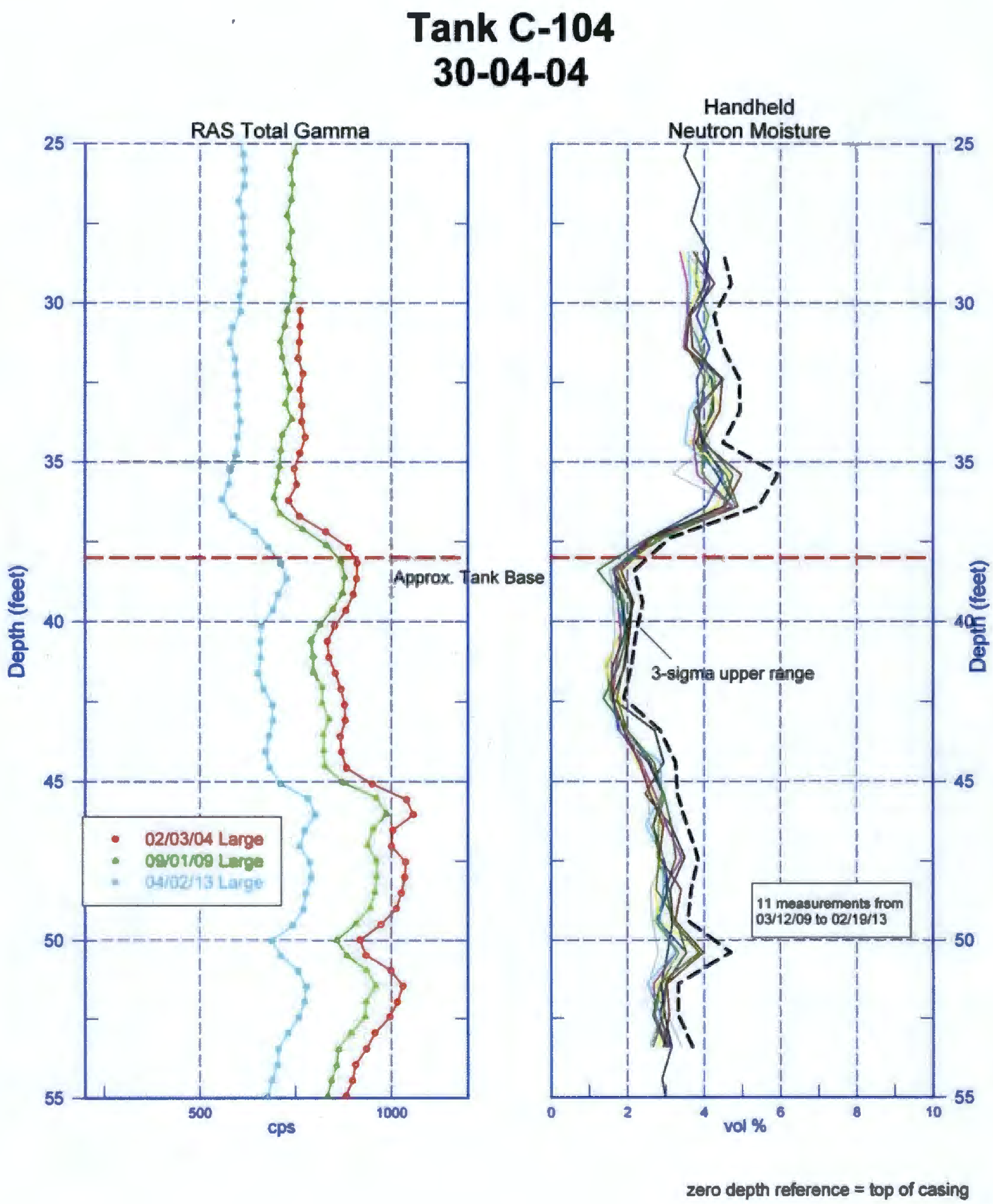


FIGURE 1-8A **TANK C-104 BOREHOLE 30-04-05**

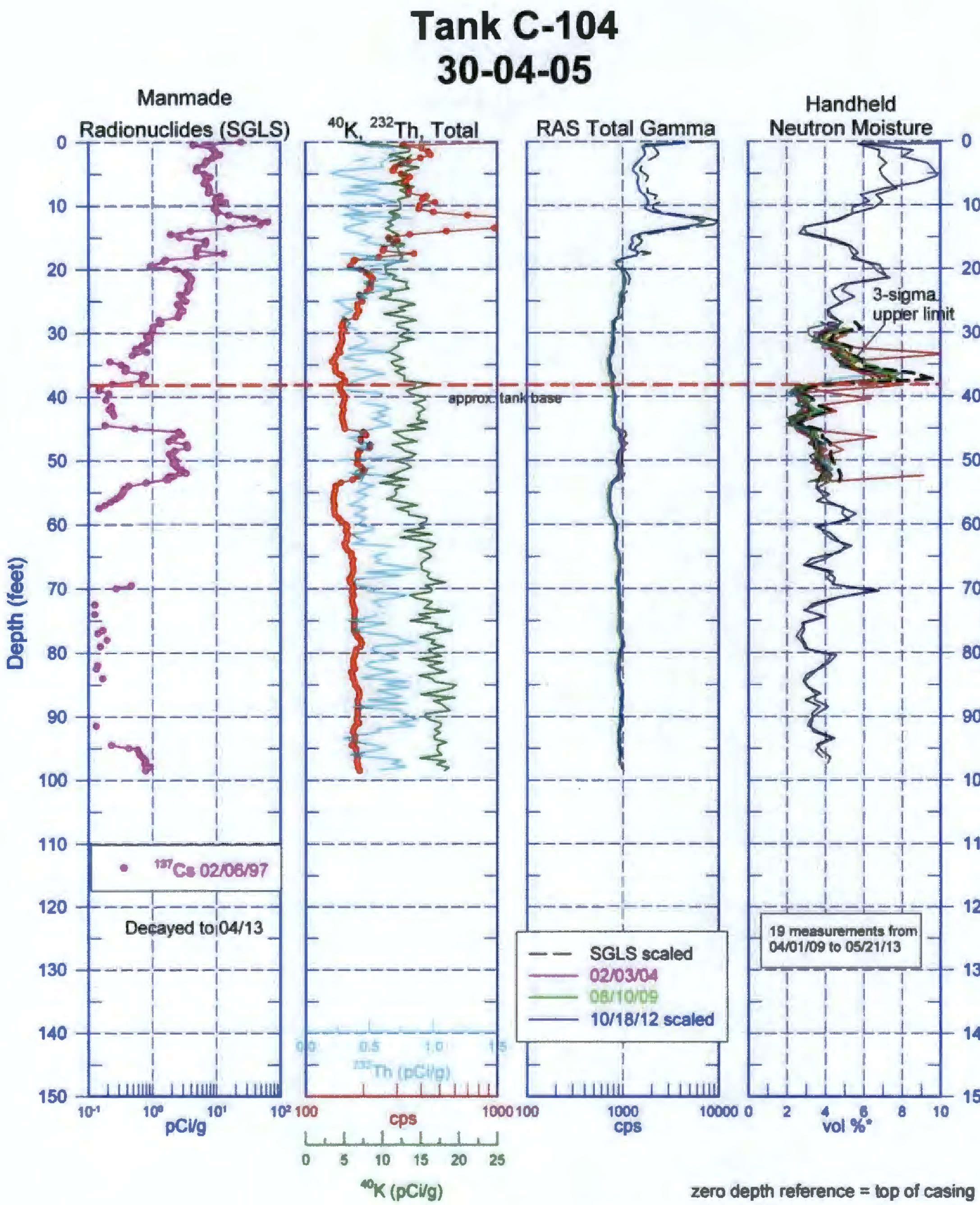


FIGURE 1-8B 30-04-05: RETRIEVAL DATA

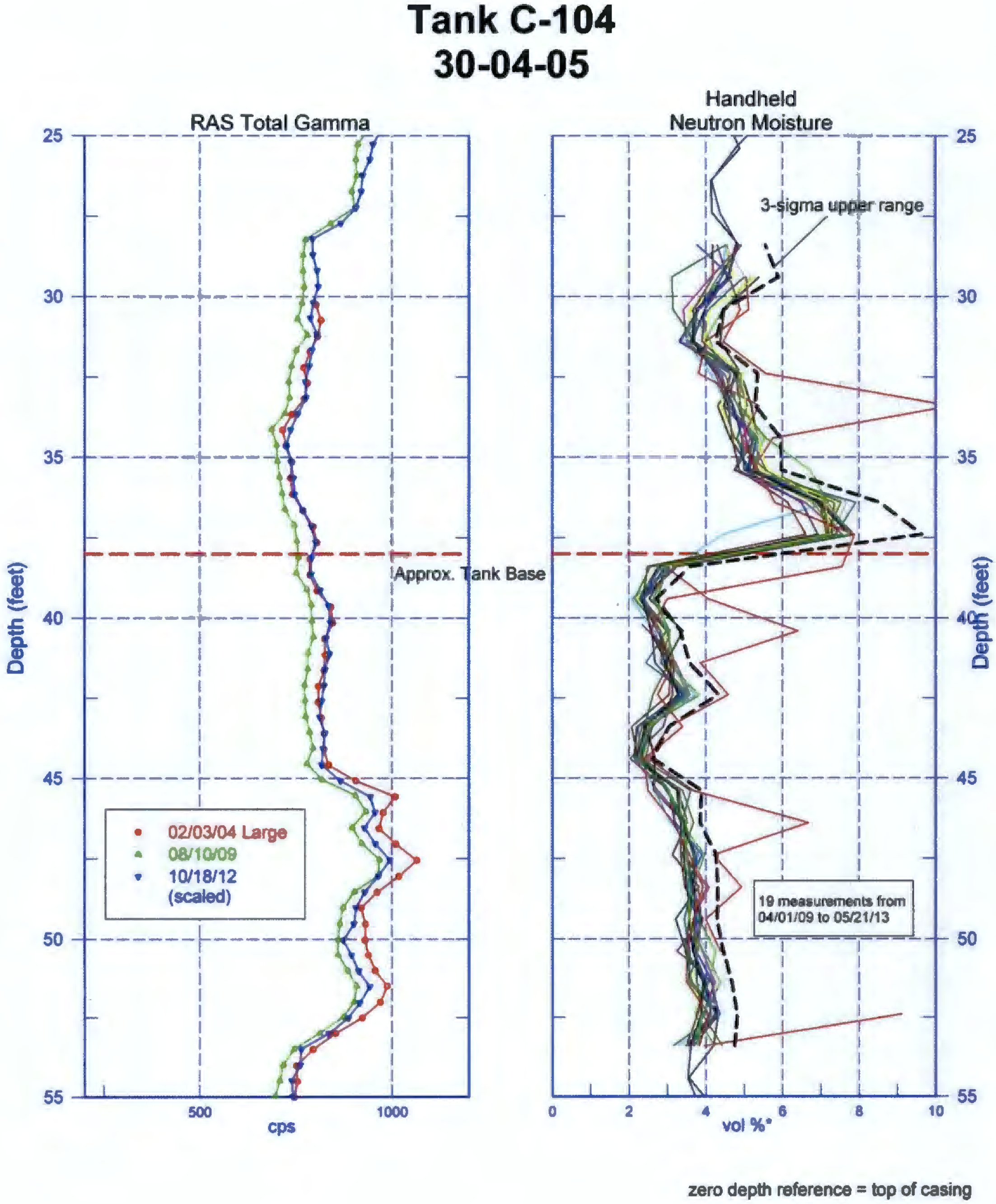


FIGURE 1-9A TANK C-104 BOREHOLE 30-04-08

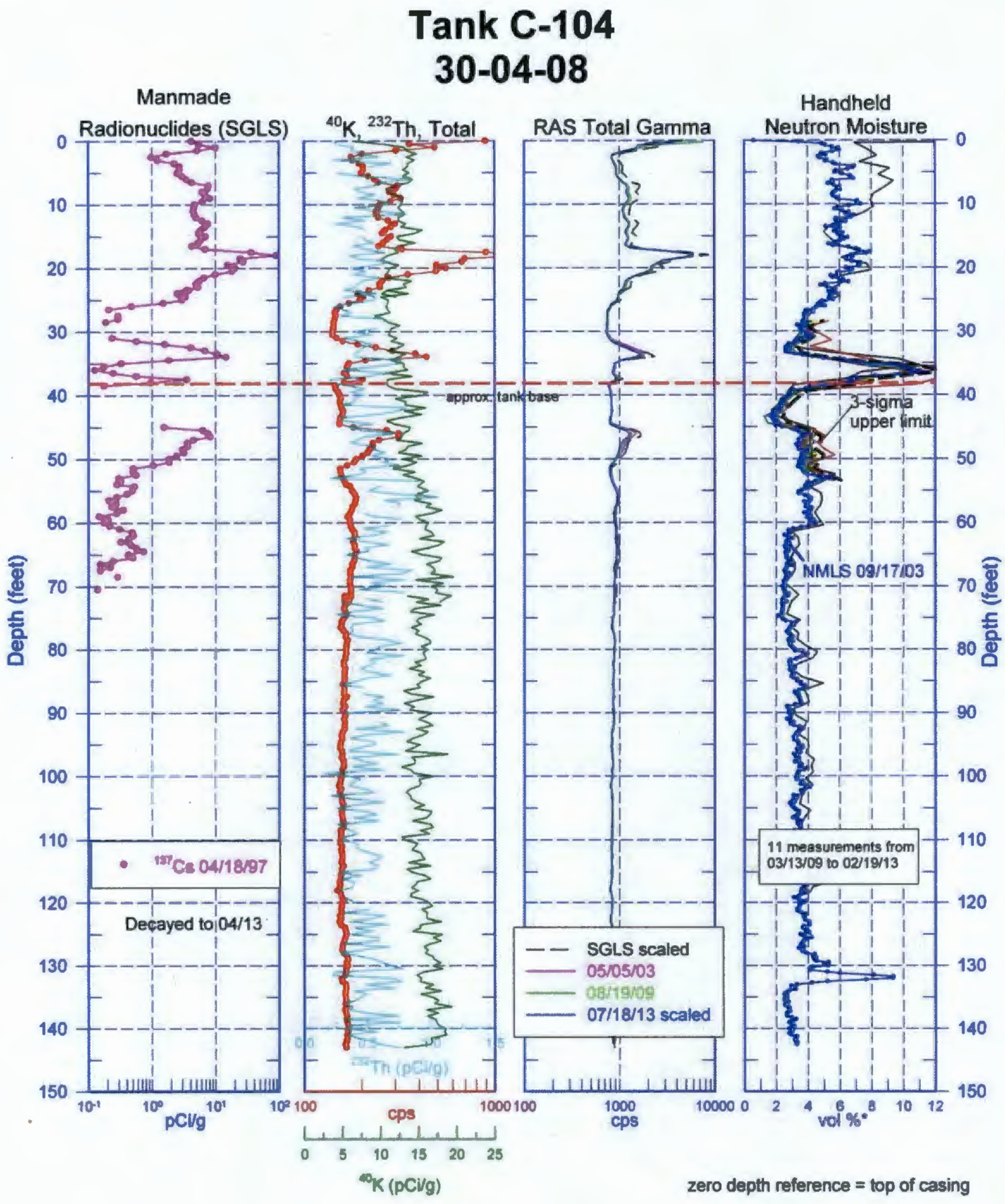


FIGURE 1-9B 30-04-08: RETRIEVAL DATA

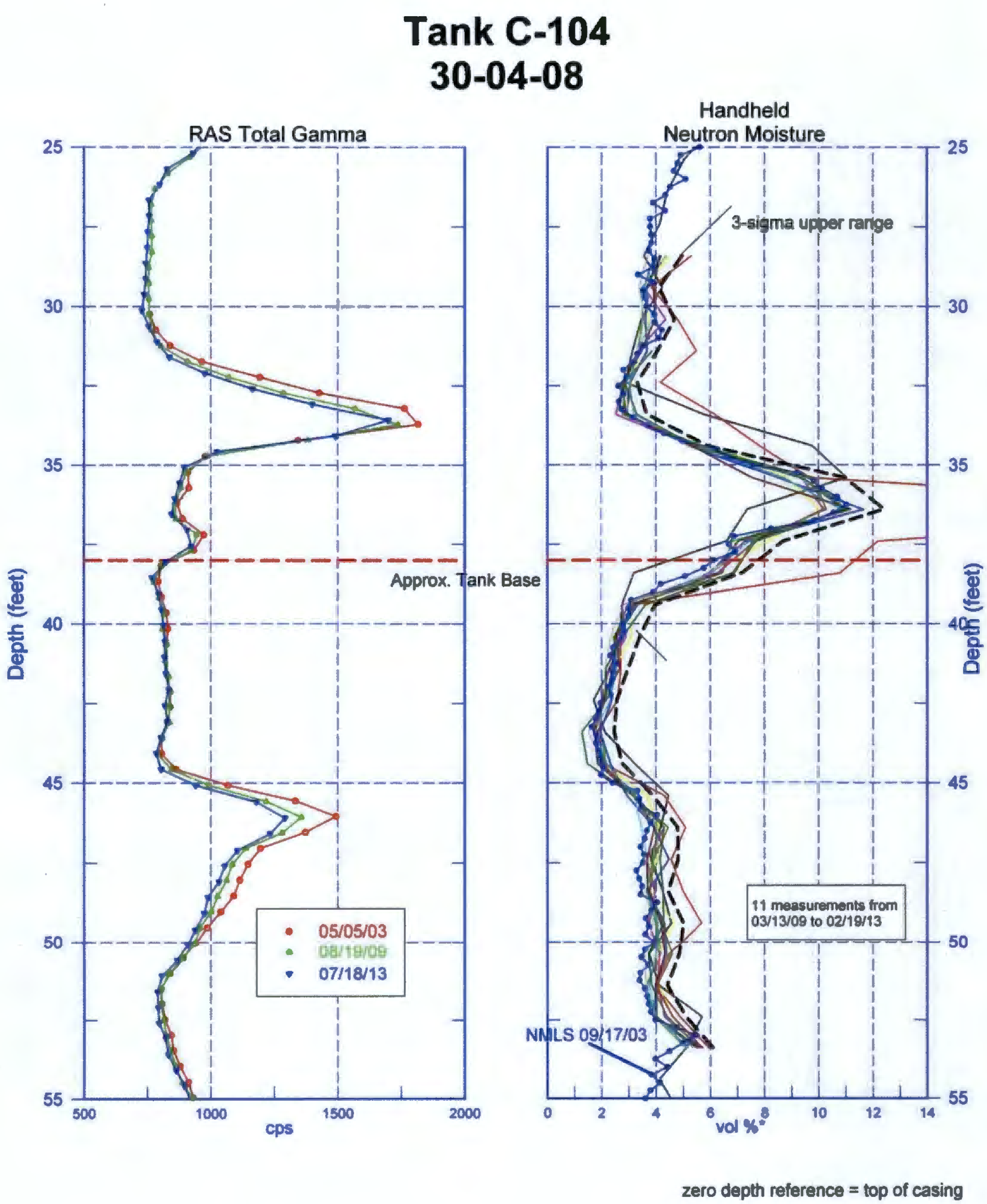


FIGURE 1-10A TANK C-104 BOREHOLE 30-04-12

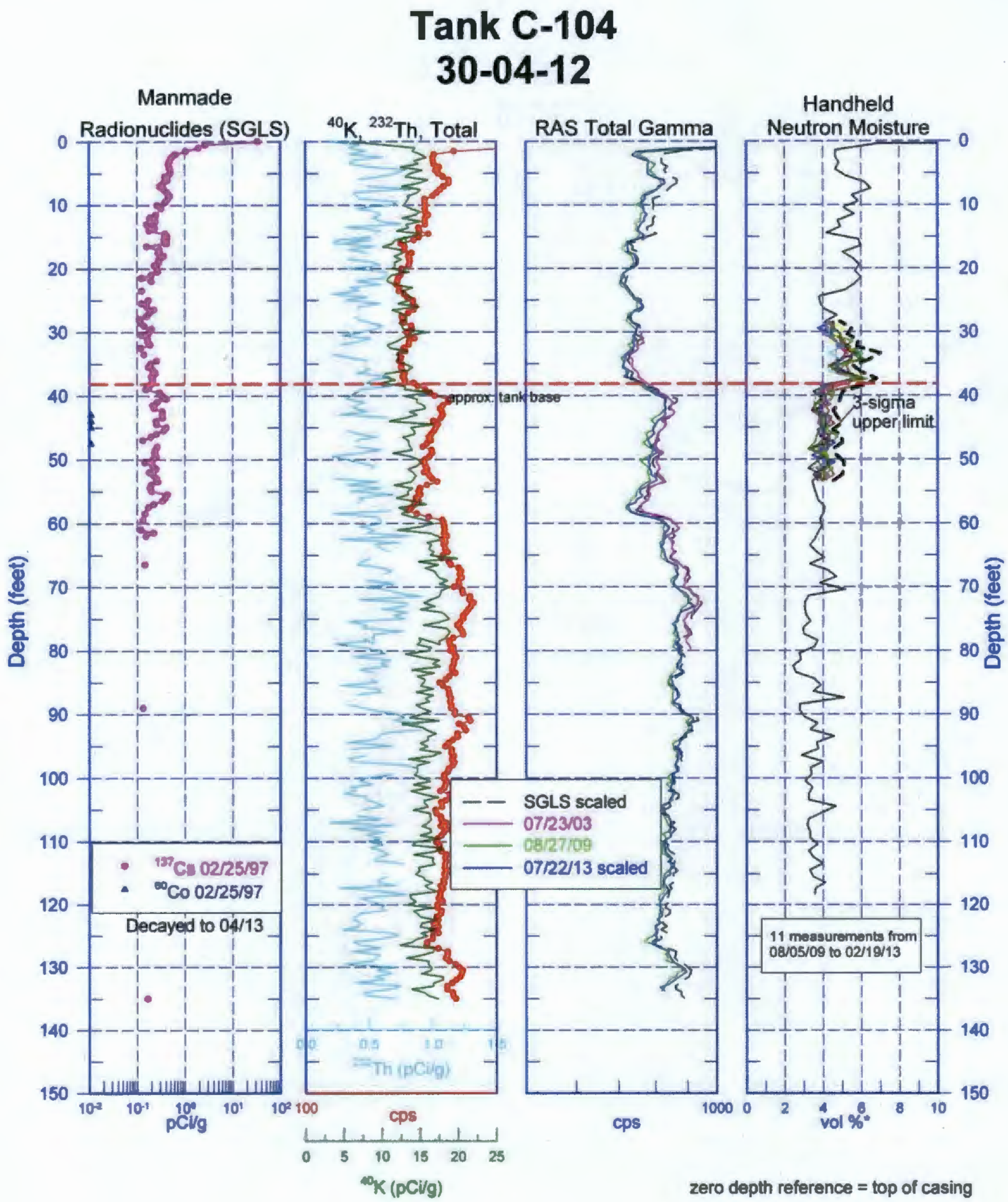
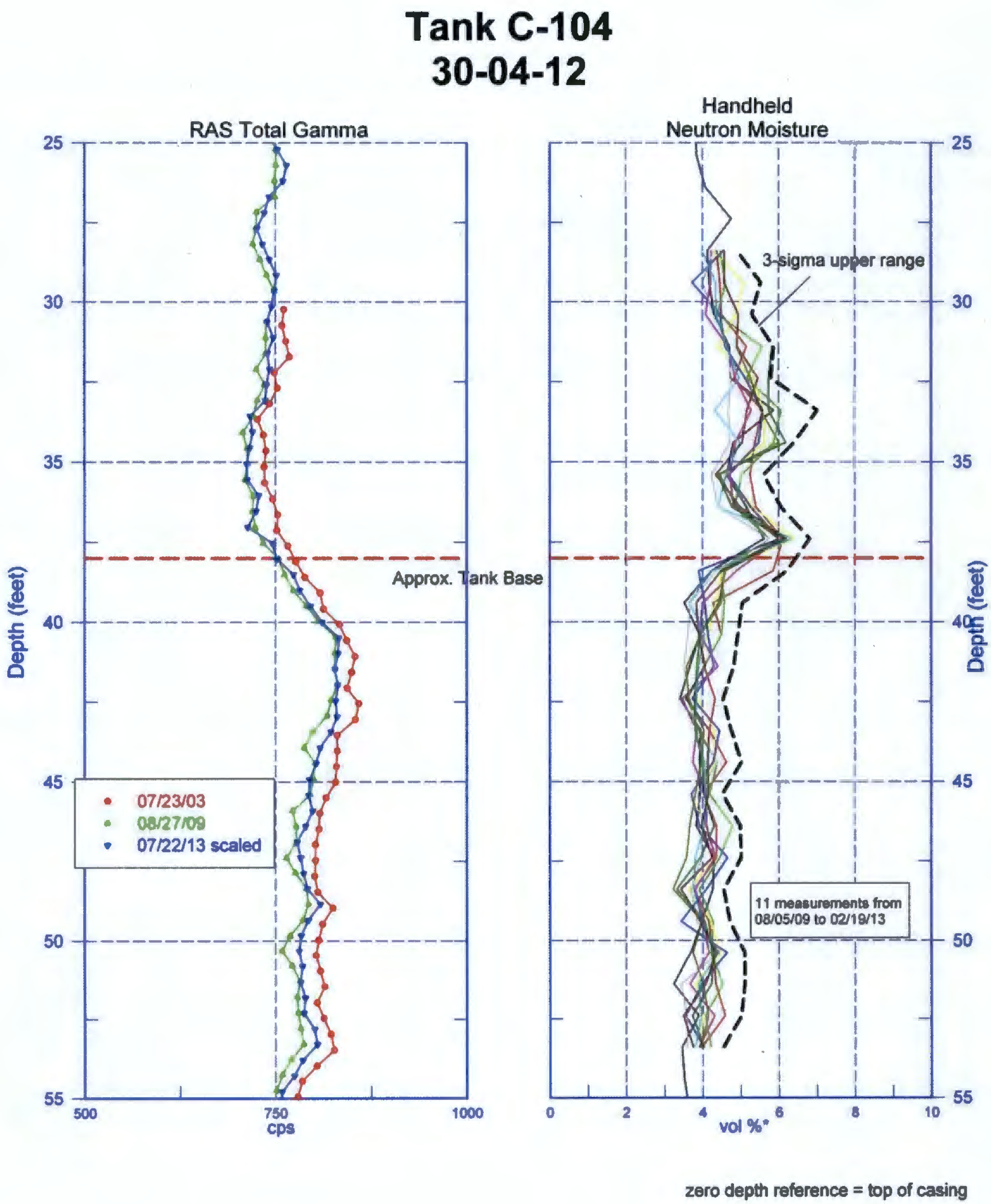


FIGURE 1-10B 30-04-12: RETRIEVAL DATA



2.0 Previous Geophysical Log Data

Gross gamma logs were routinely collected in C Tank Farm drywells until 1994. These data are available in electronic format from 1975 to 1994 and have been evaluated by Randall and Price (2001).

A baseline of subsurface contamination conditions in the vicinity of Tank C-104 was established in 1997 and reported in the *Vadose Zone Characterization Project at the Hanford Tank Farms, Tank Summary Data Report for Tank C-104* (DOE 1997). A discussion of subsurface contamination conditions and visualizations of subsurface contaminant plumes were published in the *Hanford Tank Farms Vadose Zone, C Tank Farm Report* (DOE 1998) and updated in 2000 (DOE 2000).

Some RAS and SGLS logging was conducted during the Hanford Tank Farms Vadose Zone Monitoring Project from 2002 through 2004. The program was effectively terminated around the end of 2004, as resources were increasingly diverted to single-shell tank retrieval operations. Results from the monitoring project were presented in quarterly and annual reports drafted by Stoller, issued by DOE-GJO, and presented to DOE-ORP. At the time, Stoller was a prime contractor to DOE-GJO. The last annual report for the program was issued in January 2005, summarizing routine monitoring efforts for fiscal year 2004 (DOE 2005a).

3.0 Recent Geophysical Log Data

Baseline RAS measurements were acquired during in drywells 30-04-01, 30-04-02, 30-04-03, 30-05-06, 30-04-04, 30-04-05, 30-04-08, and 30-04-12 between August and October 2009. Table 3-1 summarizes gamma logs collected during and after retrieval operations. The –L and –M designations after the acronym RAS indicate either the Large or Medium detector was used.

HHNM baseline measurements were collected in March 2009. Table 3-2 below summarizes the number of logging/monitoring events occurring in support of retrieval operations with each system for each drywell (Figure 1-1).

Figure 1-3a through 1-10a present a graphical summary of these data, as well as any RAS or SGLS data acquired prior to retrieval of C-104. These data include observed manmade radionuclide (Cs-137 and Co-60) concentrations, K-40, U-238, Th-232 concentrations, and gross gamma collected with the SGLS and RAS, as well as HHNM measurements. Most SGLS gross-gamma data as well as post-2009 RAS data have been scaled to facilitate direct comparisons. The scaling is linear and the scaling factors are empirically derived by averaging count rate ratios over an interval of 10 ft or more in "clean" or "nearly clean" regions of the drywells, as determined from the most recent SGLS logs. RAS and SGLS gross-gamma data are not corrected for decay. Pre- and post-retrieval RAS data were acquired over the entire depth of the drywells. Moisture measurements were typically acquired from about 28 ft to about 53 ft.

Figure 1-3b through Figure 1-9b exhibit only pre-retrieval through post-retrieval RAS and SGLS gross-gamma data from the drywells alongside plots of the HHNM data.

TABLE 3-1 TANK C-104 SUMMARY OF AVAILABLE DRYWELL GAMMA LOGS

August 2009 to Present

	DRYWELL							
DATE	**30-04-01**	**30-04-02**	**30-04-03**	**30-05-06**	**30-04-04**	**30-04-05**	**30-04-08**	**30-04-12**
Aug 2009	RAS-L					RAS-L	RAS-L	RAS-L
Sep 2009		RAS-L	RAS-L/M	RAS-L	RAS-L			
Oct 2009					RAS-M			
Nov 2009			RAS-M					
Jul 2010				SGLS				
Aug 2010	SGLS							
Mar 2012				RAS-L				
Oct 2012						RAS-L		
Jan 2013				RAS-L				
Apr 2013	RAS-L	RAS-L			RAS-L/M			
Jul 2013							RAS-L	RAS-L
Aug 2013	RAS-L/M		RAS-L/M					

TABLE 3-2 LOGGING/MONITORING MEASUREMENTS FOR C-104 RETRIEVAL OPERATIONS

DRYWELL	SGLS	RAS	HHNM	GAMMA CHANGE DURING RETRIEVAL
30-04-01	1	3	11	None
30-04-02	0	2	16	None
30-04-03	0	3	11	None
30-05-06	1	3	14	None
30-04-04	0	3	11	None
30-04-05	0	2	19	None
30-04-08	0	2	11	None
30-04-12	0	2	11	None

4.0 Observations and Findings

Historical gross-gamma data (1975 to 1994) were not examined during this investigation. Instead, the 1997 SGLS manmade and gross-gamma data were used as a baseline against which to compare RAS gross-gamma data.

Available log data for drywells associated with C-104 (30-04-01, 30-04-02, 30-04-03, 30-05-06, 30-04-04, 30-04-05, 30-04-08, and 30-04-12) show no evidence of any significant changes in either moisture content or gamma activity during and after retrieval operations.

5.0 Conclusions and Discussion

None of the drywells around C-104 show evidence of significant changes in either gamma activity or subsurface moisture content. Available data from these drywells provide no evidence of any leak or contaminant movement that might be attributed to tank retrieval operations.

Experience with the handheld moisture data suggests that it is not the most effective drywell monitoring method. This is due in equal measure to the physical basis of the measurement and the way in which it is performed. The handheld moisture gage measures the extent to which "fast" neutrons are scattered and moderated to "thermal" levels in the immediate vicinity of the drywell. It responds primarily to the presence of water. While water would be a major component of any tank leak, increases in soil moisture can also occur from heavy precipitation or a raw (uncontaminated) water leak. Current procedures require that the moisture gage be manually lowered into the drywell, and measurements are made at specific points where "stops" are installed on the cable. For each measurement, the total counts for the specified interval are displayed on the readout unit. The operator copies this number onto a data sheet alongside the depth. This sheet is then faxed or emailed to Stoller and the data are manually typed into an Excel®spreadsheet for analysis. Opportunities for error abound in such a system. Moreover, any anomaly requires gamma activity measurements to confirm that the observed moisture increase may actually indicate the possibility of a tank leak.

6.0 References

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