RPP-RPT-55264
Revision 0

Evaluation of Tanks 241-T-203 and 241-T-204 Level Data and In-Tank Video Inspections

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ACRONYMS

BBI	Best Basis Inventory
cfm	cubic feet per minute
DST	double-shell tank
HWS	Hanford Weather Station
HLAN	Hanford Local Area Network
HSIHD	Hanford Sitewide Industrial Hygiene Database
in.	inches
ILL	interstitial liquid level
IS	interim stabilization
kgal	thousand gallons
LOW	liquid observation well
RH	relative humidity
SL	surface level
SST	single-shell tank
TWINS	Tank Waste Information Network System
VOC	volatile organic compound
yr	year

1.0 Summary

This report documents level decrease evaluations for single-shell tanks (SST) 241-T-203 (T-203) and T-204. The evaluations show the liquid loss rate for both tanks can be explained by evaporation, there is no evidence indicating either of the tanks is actively leaking based upon the parameters used for estimating the liquid loss rate and evaporation rate.

These two SSTs with decreasing waste surface level (SL) data trends were recommended for level decrease evaluation in Letter, WRPS-1301005, *Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC Submittal of Single-Shell Tank Level Decrease Evaluation Plan to The U.S. Department of Energy, Office of River Protection,* March 18, 2013, C. A. Simpson, Washington River Protection Solutions LLC, to S. E. Bechtol, U.S. Department of Energy.

Surface level data alone are inadequate to determine if a tank is leaking unless the gauge plummet is resting on liquid. Tank T-203 has the plummet apparently sitting on liquid in a small depression adjacent to a large pool and tank T-204 has the plummet sitting in a large pool.

Both tanks are designated as Sound in HNF-EP-0182, *Waste Status Summary Report for Month Ending April 30, 2013,* Revision 301.

2.0 Introduction

During the summer of 2012 SL and interstitial liquid level (ILL) plots were prepared for all 149 single-shell tanks (SST). Linear trendlines were drawn through the SL and ILL data points for each tank to provide an estimate of the SL or ILL long term change rates. Linear trendlines are of the form y = mx +b, with m being the slope of the line. Positive values of m mean the level is increasing and negative values mean it is decreasing.

An evaluation plan for SSTs with increasing SLs or ILLs was issued September 13, 2012 as an attachment to WRPS-1203139 R1, *Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC Submittal of Single-Shell Tank Suspect Intrusion Evaluation Plan to The U.S. Department of Energy, Office of River Protection.* Concurrently with development and release of this plan, a second evaluation plan was drafted for SSTs with decreasing level data. This level decrease plan was issued on March 18, 2013 with WRPS-1301005.

Note: WRPS-1301005 has since been released as RPP-PLAN-55113, 2013, *March 2013 Single-Shell Tank Waste Level Decrease Evaluation Plan,* Revision 1, and is referred to by this number in the remainder of this document.

RPP-PLAN-55113, Rev 1, listed 83 SSTs with a decreasing ILL or SL. These tanks were screened down to a list of 20 recommended in RPP-PLAN-55113, Rev 1 for further level decrease evaluation.

The level decrease plan in RPP-PLAN-55113, Rev 1, committed to perform an initial evaluation for each of the 20 tanks that includes:

- Review of tank conditions.
- Evaporation estimates.
- Analysis of other conditions [e.g., long term response to interim stabilization (IS) or liquid observation well (LOW) installations, equipment calibrations or repairs] that could explain level decreases.

Following initial evaluation the 20 tanks were to be sorted into:

- Tanks for which the level decrease can be readily explained without further investigation, and,
- Tanks for which field investigations are needed to better understand the cause of the level decrease:
    - In-tank videos
    - Drywell logging
    - Other (as applicable)

The following results were to be documented:

- Initial evaluations
- Field investigations
- Determine if results warrant evaluation of any of the additional SSTs with negative SL or ILL trends not included in the list of 20

An announcement was made on February 15, 2013 that tank 241-T-111 (T-111) was leaking. On February 22, 2013 an additional five tanks with level decreases were announced. The level decreases for all six tanks were interpreted as leaks. As a result of the February 22, 2013 announcement the planned 20 tank evaluation was divided into 5 reports:

- T-111 (RPP-RPT-54964)
- T-203 and T-204 (RPP-RPT-55264) – this report
- B-203 and B-204 (RPP-RPT-55265)
- TY-105 (RPP-RPT-55263)
- Remaining 14 tanks (RPP-RPT-54981)

Each of the first four evaluations will include, for each tank:

- Review of tank conditions
- Evaporation estimates
- Analysis of other conditions
- Results of in-tank videos
- Conclusions

The fifth evaluation includes:

- Review of tank conditions for each tank
- Evaporation estimates for each tank
- Analysis of other conditions for each tank
- Conclusions for each tank
- An appendix providing evaporation rate vs. relative humidity plots and estimated headspace relative humidity for all 20 tanks
- An appendix providing the estimated heat generation rates for all 20 tanks

This report is the evaluation for tanks T-203 and T-204.

Table 1 provides the SL trendline decrease rates for tanks T-203 and T-204. Column 3 provides the decrease rates given in RPP-PLAN-55113, Rev. 1. These values were based upon SL plots with data current as of October-November 2012. Column 5 provides the updated SL decrease rates used in this document.

Table 1 Waste Surface Level Decrease Trends for Tanks T-203 and T-204

1	2	3	4	5
Tank	Values from RPP-PLAN-55113 Rev. 1		Updated Values for RPP-RPT-55264	
	ILL Change Rate (in./yr)	SL Change Rate (in./yr)	ILL Change Rate (in./yr)	SL Change Rate (in./yr)
T-203	No LOW	-0.089	No LOW	-0.087
T-204	No LOW	-0.071	No LOW	-0.071

3.0 Discussion

3.1 Selection of Tanks for Level Decrease Evaluation

Tanks were included on the list of 83 tanks in RPP-PLAN-55113, Rev 1 Appendix A, Table A-1, based upon their ILL and/or SL data change rate. All tanks with a change rate <0.001 in./yr were included. The basis for selection of tanks T-203 and T-204 for evaluation is described in that document, as well as the basis for the level change values in Column 3 of Table 1.

3.2 Updating of Tank Level Data Change Rates

The updated level data change rates in Column 5 of Table 1 are based upon linear trendlines drawn through the SL data points for each tank for as far back as a reasonable linear rate can be established.

The SL data change rates in Column 5 of Table 1 were estimated by:

- Downloading SL data from the Tank Waste Information Network System (TWINS - https://twins.labworks.org/twinsdata/Forms/About.aspx) database from January 1, 1990 to the present. The data back to 1980 is also included for some plots to show longer term trends.
- Plotting the results in Excel®. The following level data change plots were made for each tank:
  - A plot showing the SL raw data for the tank. The raw data is exactly as retrieved from TWINS with no adjustments for data correction. The y-axis is shown as approximately the same height as the full depth of the tank, to give the reader an indication of the relative rate of change for the tank SL.
  - A plot of the raw SL data, with the y-axis significantly expanded so that recent changes in the SL with time can be discerned.
- The expanded raw data plots were then reviewed for problems which could result in incorrect data interpretation. These include:
  - Repair or replacement of level gauge
  - Recalibration of level gauge resulting in different baseline depth value
  - Changing of zero value for tank reference level (i.e., changing from bottom of knuckle to tank centerline bottom)

For the purpose of data evaluation in this document a linear regression line provides an acceptable data change rate. The trendline formula is shown on the expanded y-axis plots, with the conversion factor to convert the trendline slope to a level data change rate in inches per year.

The final SL data change rates based upon the plot trendlines are given in Column 5 of Table 1. The plots for each tank are given in the tank evaluation section for the tank.

3.3 Volumetric Change Rates

The level change rates in Column 5 of Table 1 are converted to a volumetric change rate to assess the potential for a tank to be leaking. Estimation of a volumetric level change rate for any 200-series tank is based upon the following equation:

$$volumetric\ change\ rate = LCR\ in./yr \times 196\ \frac{gal}{in.} \times (FSL + (1 - FSL) \times \sigma)$$

where:

LCR = level change rate in inches/yr
FSL = fraction of waste surface that is liquid
σ = waste porosity

The fraction of waste surface that is liquid is calculated with a planimeter from sketches drawn after viewing the in-tank videos.

The porosity assumed in RPP-5556, 2000, *Updated Drainable Interstitial Liquid Volume Estimates for 119 Single-Shell Tanks Declared Stabilized*, Rev. 0, is used for consistency with past calculations.

A bounding maximum liquid loss rate is also estimated for tanks T-203 and T-204 assuming the surface is 100% liquid. The equation reduces to:

$$Bounding\ maximum\ liquid\ loss\ rate = LCR\ in./yr \times 196\ \frac{gal}{in.}$$

The bounding maximum liquid loss rate is unrealistic for tanks T-203 and T-204 since the videos show there is a lot of sludge on the surface, but the value is useful for comparing with the estimated tank evaporation rates.

3.4 Data Analysis

Changes in the SL data do not necessarily mean the SL is changing. Analysis of the data is necessary to interpret what is occurring. Factors that could cause changes in the surveillance data are listed in Table 2.

Table 2 Factors Causing Changes in Surface Level Data

	Factor
1	ILL increase and/or SL decrease due to consolidation/slumping of waste into pores.
2	Gas generation and entrapment within the waste causing level increase.
3	Release of retained gas entrapped within the waste causing a level decrease.
4	Conscious liquid additions to the tanks such as core sampling drill string flushes, core sampling head fluid additions, level gauges flushes, water lancing of equipment during installation, grab sample flushes.
5	Chemical changes within the waste.
6	ILL not at equilibrium following LOW installation or saltwell pumping (ILL only).
7	Level gauge plummet resting on uneven solid surface, (plummet rests on different spot when raised and lowered, or surface resistance changes), gauge maintenance or calibration problems, changing of tank reference location for zero level (SL only).
8	Water intrusion for level data increase.
9	Evaporation for level data decrease.
10	Tank leak for level data decrease.

The volumetric change rate is not necessarily a liquid volume change rate. The volumetric change rate is the sum of:

- Liquid addition to and/or removal from the tank
- Retained gas growth in and/or release from the tank
- Loss of gas due to porosity decrease
- Waste density change due to chemical changes

The tank volumetric change rate is equal to the net effect of intrusion, evaporation, leaks, and all other factors:

$$volumetric\ change\ rate = intrusion\ rate + evaporation\ rate + leak\ rate + \Sigma\ other$$

The intrusion rate, Factor 8, is positive or zero, the evaporation rate and leak rate, Factors 9 and 10, are negative or zero, and [Σ other] is equal to the net impact of Factors 1 through 5 in Table 2 and may be either positive or negative.

Factor 6 is irrelevant because there is no LOW in tanks T-203 or T-204.

Factor 7 is an assessment based upon review of the SL data plot trend and the data. If the plummet is resting on liquid or a reasonably flat solid surface, data changes can be assumed to represent changes in the waste surface. However, if the plummet is resting against debris in the tank or is perched on the edge of a crack or clump of waste such that data will be inconsistent, the data changes cannot be assumed to represent changes in the waste surface. In addition, some tanks had problems with the level gauge operation that resulted in misleading data trends, this became evident when the level gauge maintenance history was reviewed.

Rearranging the volumetric change rate equation:

$$leak\ rate = volumetric\ change\ rate - intrusion\ rate - evaporation\ rate - \Sigma\ other$$

or:

$$intrusion\ rate = volumetric\ change\ rate - leak\ rate - evaporation\ rate - \Sigma\ other$$

The volumetric change rate and the evaporation rate can be estimated from available data, and a value for [Σ other] assumed following a review of the available information. The net effect of the leak rate and intrusion rate can then be roughly estimated. It cannot be shown from SL data alone what a leak rate (or an intrusion rate) is for a tank without making assumptions as to the other variables in the equation. If the intrusion rate calculates to, e.g., (10 gal/yr + leak rate), this could mean there is a 10 gal/yr intrusion rate if the leak rate is zero, or a 30 gal/yr intrusion rate masking a -20 gal/yr leak rate, or any combination of intrusion plus leak rate that sums to a net 10 gal/yr. Data analysis cannot give separate values for a leak rate (or intrusion rate) but it can provide a degree of confidence as to what is probably occurring.

Data analysis is provided in the tank evaluation section for each tank.

4.0 Tank Evaluations

Each of the evaluations is divided up into the following subsections:

Tank Summary - Provides a short summary of the tank history and lists the Best Basis Inventory (BBI) tank waste volumes from a TWINS query on September 25, 2012.

Liquid Volume Change Rate – Converts the in./yr level change rates in Column 5 of Table 1 to gal/yr.

Data Analysis - Each tank data analysis uses the equation from Section 3.4:

$$volumetric\ change\ rate = intrusion\ rate + evaporation\ rate + leak\ rate + \Sigma\ other$$

where [Σ other] equals the net impact of:

- Waste subsidence
- Gas generation, entrapment, and release within the waste causing level increase or decrease
- Conscious liquid additions to the tanks such as core sampling drill string or grab sample bottle flushes, core sampling head fluid additions, level gauges flushes, water lancing of equipment during installation
- Chemical changes within the waste

Data analysis passes through the following steps for each tank:

- Estimation of a value for [Σ other]
- Estimation of a value for a potential intrusion rate
- Evaluation of whether changes in the SL data represent actual movement of the waste surface.

The first part of [Σ other] is the effect of waste subsidence.

The second part of [Σ other] is the effect of retained gas on the level change. The volume of retained gas in a tank is unknown, but the relative volume can sometimes be inferred from combined plots of the liquid level and the inverse of atmospheric pressure vs. time. If retained gas is present an increase in the atmospheric pressure may result in a decrease in the liquid level as the gas bubbles are compressed, and a decrease in the pressure will result in an increase in the liquid level. Predominantly sludge tanks do not have a rigid waste matrix and show far less response to atmospheric pressure than saltcake tanks. Tank SL data plots also show far less response to atmospheric pressure than ILL data. Plots of liquid level vs. the inverse of the barometric pressure are not provided for tanks T-203 and T-204 since they provide no useful information.

Conscious liquid additions make up the third part of [Σ other].

The last portion of [Σ other] is chemical change which may be occurring in the tanks over time.

A value is provided for [Σ other] consisting of four entries: The first entry is either 0 or PCE (for porosity change effect), the second entry is either 0 or RGG (for retained gas growth), the third is a numerical value to account for annual liquid addition to a tank, and the last is either 0 or WCE (for waste change effect).

In-Tank Video Results – In-tank videos were obtained for tanks T-203 and T-204. A description is provided of the waste surface, how the Enraf plummet is sitting, and any visible evidence of intrusion into the tank.

Evaporation Estimate - Estimating a tank evaporation rate without having equipment on each tank to measure all the conditions requires knowledge or estimation of:

- the temperature and water vapor content of the air entering a tank
- the temperature and water vapor content of the air leaving the tank
- the effective flow rate of air through the tank, and,
- accounting for condensation of water vapor from exiting air that returns to the tank.

The evaporation estimate methodology is described in RPP-RPT-54981, Rev 0, Appendix A. A summary of the evaporation estimate results are provided in the Evaporation Estimate section of each evaluation.

Tank Heat Generation Rate - The energy to evaporate water from a tank comes from two sources:

- latent heat of the waste, surrounding soil, and air passing through the tank, and,
- heat generated within the waste by radioactive decay

An estimate of the heat generation rate for each tank is provided based upon the radionuclide content.

Tank Leak Potential This subsection summarizes the information from the previous subsections.

Each evaluation has a summary plot that provides evaporation, relative humidity, and liquid loss information to assess the potential for the tank to be leaking. Each of these plots contains:

- A blue line showing the estimated evaporation rate as a function of the relative humidity (RH) in the air leaving the tank headspace.
- A black vertical line for the estimated tank headspace RH for each tank. The basis for the estimate of the RH For tanks T-203 and T-204 is provided in RPP-RPT-54981, Rev 0, Appendix A, Section A.6.
- A black horizontal dashed line for the estimate of the liquid loss rate.

Where the black line crosses the blue line is the estimated evaporation rate for a tank, based upon the conditions assumed for the tank conditions.

If the liquid loss rate is below the estimated tank evaporation rate for the conditions assumed for a tank, there is no evidence the tank is leaking.

The evaporation rate, liquid change rate, and headspace relative humidity values presented for each tank are used together to provide a basis to determine the potential for a tank to be actively leaking.

Conclusion The final subsection summarizes the information in the previous subsections and gives a conclusion as to whether there is evidence the tank is leaking or not.

4.1 Tank T-203

4.1.1 Tank Summary

Tank T-203 was put into service in 1952 when it received 224 waste (plutonium purification cycle waste) from B-Plant. It was filled by the end of the year, with overflow liquid being sent to a crib. Most of the supernatant liquid was pumped out in 1976. Interim stabilization was documented as complete in 1981 (RPP-RPT-43173, *2009 Auto TCR for Tank 241-T-203,* Revision 0, HNF-EP-0182, Revision 301). Per a TWINS query on September 25, 2112 the tank contains 35.9 kgal sludge and zero supernatant liquid.

Figure 1 shows the raw SL data for tank T-203 from January 1, 1990. Figure 2 is a plot of the data used for calculation of the -0.075 in./yr trendline slope for the Enraf portion of the data used for RPP-PLAN-55113, Rev 1, with an expanded y-axis so the SL data changes can be seen. The SL shows a fairly constant decrease since the early 1980s. The SL data for Figure 1 and Figure 2 are from a TWINS tank surface level data download on February 15, 2013. Figure 3 is an updated plot showing the latest data included for this document. The slope of the decrease line is essentially the same at -0.087 in./yr. The SL data for Figure 3 are from a TWINS tank surface level data download on September 11, 2013.

There is no LOW in the tank.

Figure 4 is a plot from 1980 with the manual tape data (adjusted by having 6 inches added to it to account for the reference level change on April 2, 1996) and the ENRAF data combined. This plot indicates the decrease rate in tank T-203 has been fairly consistent since about 1990.

4.1.2 Liquid Change Rate Estimation

The liquid change rate estimate is based upon the -0.087 in./yr SL change.

Approximately 18% of the waste surface is liquid. This determination was made from sketching the liquid pool on tank drawing H-2-73068, 2007, *Piping Waste Tank Isolation 241-T-203*, Rev. 3, and using a planimeter to measure the area. Seven area measurements were taken and averaged for the reported liquid area of 55.6 ft^2. The sketch of the liquid pool is shown in Figure 5.

A sludge porosity of 0.15 is used for consistency with RPP-5556.

The estimated tank T-203 liquid change rate is:

$$Tank\ T-203\ estimated\ liquid\ change\ rate \\ = -0.087 \times 196 \times (0.18 + (1-0.18) \times 0.15)) = \mathbf{-5.2\ gal/yr}$$

The bounding maximum estimate of the tank T-203 liquid change rate assumes the level drop is equal all across the waste surface (i.e., it ignores any waste solids being present):

$$Tank\ T-203\ bounding\ maximum\ liquid\ change\ rate = -0.087 \times 196 = \mathbf{-17.1\ gal/yr}$$

4.1.3 Data Analysis

Estimation of [Σ other] – Since there is liquid right at or a few inches under the surface there is assumed to be negligible waste subsidence.

The BBI shows zero retained gas in tank T-203. Buildup and release of gases within the waste has been observed in double-shell tanks (DSTs) as evidenced by a slow increase in the waste level followed by a sudden decrease when the gas is released. Some SSTs may exhibit chronic release of gases at roughly the same rate gases are generated. A buildup of retained gas in the tank over a number of years followed by a steady release over >20 years is not expected based upon past experience. Additionally, monitoring for gases was performed prior to the in-tank video on April 23, 2013. Results recorded on industrial hygiene sample DRI-13-01427 showed 0.0 ppm flammable gas, 0.0 ppm ammonia and 45 ppb volatile organic compounds (VOC). It is assumed there is no retained gas impact on the level decrease even if there is retained gas in the tank.

No large items of equipment are known to have been lanced into the tank in the past 10 years and the TWINS database indicates no samples have been taken from the tank in that time. The water usage data sheets were not reviewed, but making the assumption that a level gauge is flushed with a nominal 10 gal of water every two years results in a nominal 5 gal/yr conscious liquid addition.

The last waste solids were put into the tank in ~1952. The assumption is made that any significant chemical changes that may occur within the waste would have already occurred so the potential for chemical reactions to be causing changes that would affect the level data is very small.

Therefore, the value [Σ other] for T-203 is assumed to be = 0 + 0 + 5 + 0 = 5 gal/yr.

Potential for Intrusion - Per Section 4.1.4, no evidence of intrusion was observed during the in-tank videos taken in tank T-203. Figure 4 does not show evidence of any intrusion since the late 1980s. The annual cycles for the liquid level in the tank are typical for most tanks with a moist or liquid surface.

From Section 3.4:

$$intrusion\ rate = volumetric\ change\ rate - leak\ rate - evaporation\ rate - \Sigma\ other$$

$$intrusion\ rate = -5.2\frac{gal}{yr} - leak\ rate - evaporation\ rate - 5\frac{gal}{yr}$$
$$= -10.2\frac{gal}{yr} - leak\ rate - evaporation\ rate$$

Since both evaporation rate and leak rate are negative values, the sum of the leak rate plus the evaporation rate would have to be <-10.2 gal/yr before an intrusion would be considered. As described below, evaporation is estimated to be -21 gal/yr so a small intrusion is theoretically possible if the evaporation rate and volumetric change rate are accurate.

Evaluation of ILL or SL Validity – There is no LOW in the tank, the volumetric change rate is based upon SL data.

The Enraf plummet can be seen in Figure 6. It appears to be sitting on solids, but the plummet is in a small depression a few inches away from the edge of the pool in the tank. Looking at the flatness of the waste surface it appears that the interstitial liquid is present at the bottom of the depression. There is minimal concern for data impact from debris or a rough surface. Observation of the plot in Figure 3 shows the plummet is responding to the annual temperature cycles seen in tanks with a moist or liquid surface.

Table 3 lists all tank T-203 Enraf work packages for the 2006 to 2013 time period. The last two columns list the as-found and as-left data from the work packages. There is negligible change between calibrations, there is no calibration impact change affecting the level decrease rate.

Table 3 Tank T-203 Enraf Gauge Work Packages Since January 1, 2006

Work Package No.	Title	Date	As Found (in.)	As Left (in.)
CLO-WO-06-000619	241-T, 203 ENRAF INSPECTION	5/30/2006	187.26	187.26
CLO-WO-07-0268	241-T, 203 ENRAF INSPECTION	3/7/2007	187.20	187.13
CLO-WO-07-2020	241-T, 203 ENRAF INSPECTION	2/28/2008	186.98	186.98
TFC-WO-08-2216	241-T, 203 ENRAF CAL	12/18/2008	187.00	187.17
TFC-WO-09-3001	241-T, 203 ENRAF CAL	9/10/2009	187.20	187.03
TFC-WO-10-2139	241-T, 203 ENRAF CAL	10/7/2010	187.00	187.03
TFC-WO-11-3313	241-T, 203 ENRAF CAL	1/3/2012	186.87	186.86
TFC-WO-12-5375	241-T, 203 ENRAF CAL	12/11/2012	186.84	186.84

The SL reference was changed from the bottom of the knuckle to the tank centerline bottom in April of 1996 when the manual tape was still in place. The level change rate is based upon Enraf data from 2002.

The SL data are assumed valid.

4.1.4 In-Tank Video Results

An in-tank video was obtained in tank T-203 on April 23, 2013. The following discussion is limited to results of the in-tank video information as it relates to evaluation of the tank for level change; i.e., the waste surface, the Enraf plummet, and evidence of intrusion.

Figure 7 is a composite of screen images from the May 20, 2013 video. The fraction of liquid on the surface of 18% is greater than it appears in Figure 7 due to the distortion with the camera from one side of the tank to the other. The sketch in Figure 5 must be used to observe the approximate pool outline.

No drips were noted and no evidence of past intrusion was observed.

4.1.5 Evaporation Estimate

Figure 8 provides the evaporation estimate results for tank T-203. Derivation of the evaporation rate for tank T-203 is described in RPP-RPT-54981, Revision 0, Appendix A. See Appendix A, Section A.5 for calculation estimate details.

The blue line Figure 8 shows the estimated evaporation rate from tank T-203 as a function of the RH in the tank vapor space. The evaporation rate plot is of limited use without knowing the approximate RH in the tank. No past vapor sample RH data are available for tank T-203 but RPP-RPT-54981, Revision 0, Appendix A, Section A.6 derives a RH value for the tank based upon past vapor sample data for a similar tank (tank B-202) with similar tank conditions. The estimated average RH value for tank T-203 is indicated by the vertical black line.

Where the vertical black RH line crosses the blue evaporation line in Figure 8 is the best estimate for evaporation from tank T-203, assuming the parameters used in RPP-RPT-54981, Revision 0, Appendix A are valid. Figure 8 indicates the tank T-203 evaporation rate is -21 gal/yr.

RPP-RPT-54981, Revision 0, Appendix A describes the variables involved with the evaporation rate estimate and provides a basis for the value selected. The ambient air conditions and tank headspace temperatures are obtained from recorded data. The primary variables in Appendix A that will impact the tank T-203 evaporation rate are the assumed breathing rate and the assumed tank headspace relative humidity.

The breathing rate used for 20 ft. diameter tank T-203, 1.03 cfm, is about half that used for most 75 ft. diameter tanks in RPP-RPT-54981, Revision 0. The tank breathing rates derived in RPP-RPT-54981, Revision 0, Appendix A are based on tracer gas tests performed in the 1996 to 1998 time period. No tracer gas tests were performed in 200-series tanks. The breathing rate derivations provided in RPP-RPT-54981, Revision 0, Appendix A are comprised of a variable rate and a fixed rate. The variable rate is dependent upon the tank headspace volume and the fixed rate is an average of the fixed rates calculated for the tanks in which tracer gas tests were performed. The fixed rate should be proportional to the number of tank connections to the atmosphere and the cross-sectional area of those openings. The 200-series tanks have a similar number of penetrations and openings as the 75 ft. diameter tanks in B, C, T, U, and BX farms, but for conservatism the fixed rate portion of the breathing rate for 200-series tanks was assumed only half of that for a 75 ft. diameter tank. This results in the T-203 breathing rate to be a little less than half of the breathing rates for 75 ft. diameter tanks because the variable portion of the breathing rate for 200-series tanks is assumed very low due to the small headspace volume compared to that in 75 ft. diameter tanks.

The complete basis for the breathing rate assumed for tank T-203 is provided in RPP-RPT-54981, Revision 0, Appendix A and is the best estimate available when considering the information, but the actual rate could be higher or lower than assumed. Changing the breathing rate would result in a proportional change in the evaporation rate.

The assumed tank T-203 headspace RH of 85% is based upon the 1996 vapor space sample in tank B-202 showing water vapor present at 91.7%. The tank B-202 sample was obtained when the headspace temperature was 61°F. When sampled, tank B-202 had a waste surface level of 146.25 in. Tank T-203 has more waste in it than tank B-202 and about the same temperature. Tank B-202 may have a higher fraction of the waste surface that is liquid, since it appears to have an intrusion. An RH of 85% appears reasonable for tank T-203.

In conclusion, an evaporation rate of ~-21 gal/yr for tank T-203 appears reasonable.

4.1.6 Tank Heat Generation Rate Impact

RPP-54981, Revision 0, Appendix B describes the process used to estimate a heat generation rate for the waste in a tank. Table 4 in this document lists the nuclides contributing >0.01 percent to the tank T-203 heat generation rate, which is about 7.5 BTU/hr. This is based upon a radionuclide decay date of January 1, 2008, so the heat generation rate as of July 1, 2013 is slightly less. The heat generation rate is negligible, the energy for evaporation from the tank has to come from the latent heat of the incoming air, surrounding waste, and soil.

Table 4 Radionuclides Contributing Greater Than 0.01% to the Tank T-203 Waste Heat Generation Rate

Radionuclide	Ci[1]	Heat Generation Rate (watts/Ci)[2]	Heat Generation Rate (watts)
90Sr	3.34E-01	6.70E-03	2.24E-03
90Y	3.34E-01	0.00E+00 (with parent)	0.00E+00
137Cs	1.01E+00	4.82E-03	4.86E-03
137mBa	9.50E-01	0.00E+00 (with parent)	0.00E+00
151Sm	9.44E-01	1.17E-04	1.10E-04
238Pu	3.10E-01	3.32E-02	1.03E-02
239Pu	3.71E+01	3.11E-02	3.94E+00
240Pu	4.67E+00	3.12E-02	4.97E-01
241Am	6.23E+00	3.34E-02	7.11E-01
241Pu	7.35E+00	3.18E-05	7.97E-04
Sum			1.5 (5.2 BTU/hr)

[1] From TWINS download March 19, 2013, radionuclide decay date January 1, 2008
[2] From HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, Rev 14 (reissue), August 11, 2008

4.1.7 Tank T-203 Leak Potential

Based upon Figure 8 the tank T-203 estimated evaporation rate can account for the observed liquid loss rate.

Using the equation from Section 3.4:

$$leak\ rate = volumetric\ change\ rate - intrusion\ rate - evaporation\ rate - \Sigma\ other$$

$$leak\ rate = -5.2\frac{gal}{yr} - intrusion\ rate - (-21\frac{gal}{yr}) - \left(5\ \frac{gal}{yr}\right)$$
$$= 10.8\frac{gal}{yr} - intrusion\ rate$$

If the evaporation rate for tank T-203 is -21 gal/yr, the intrusion rate would have to exceed 10.8 gal/yr, for a leak to exist. The estimated evaporation rate from the tank also exceeds the bounding maximum estimated liquid loss rate. Based upon Figure 8 the tank T-203 liquid loss rate can be explained by evaporation.

4.1.8 Tank T-203 Conclusion

There is no basis to assume a leak from tank T-203.

Figure 1 Tank T-203 Full Depth Raw Data Plot

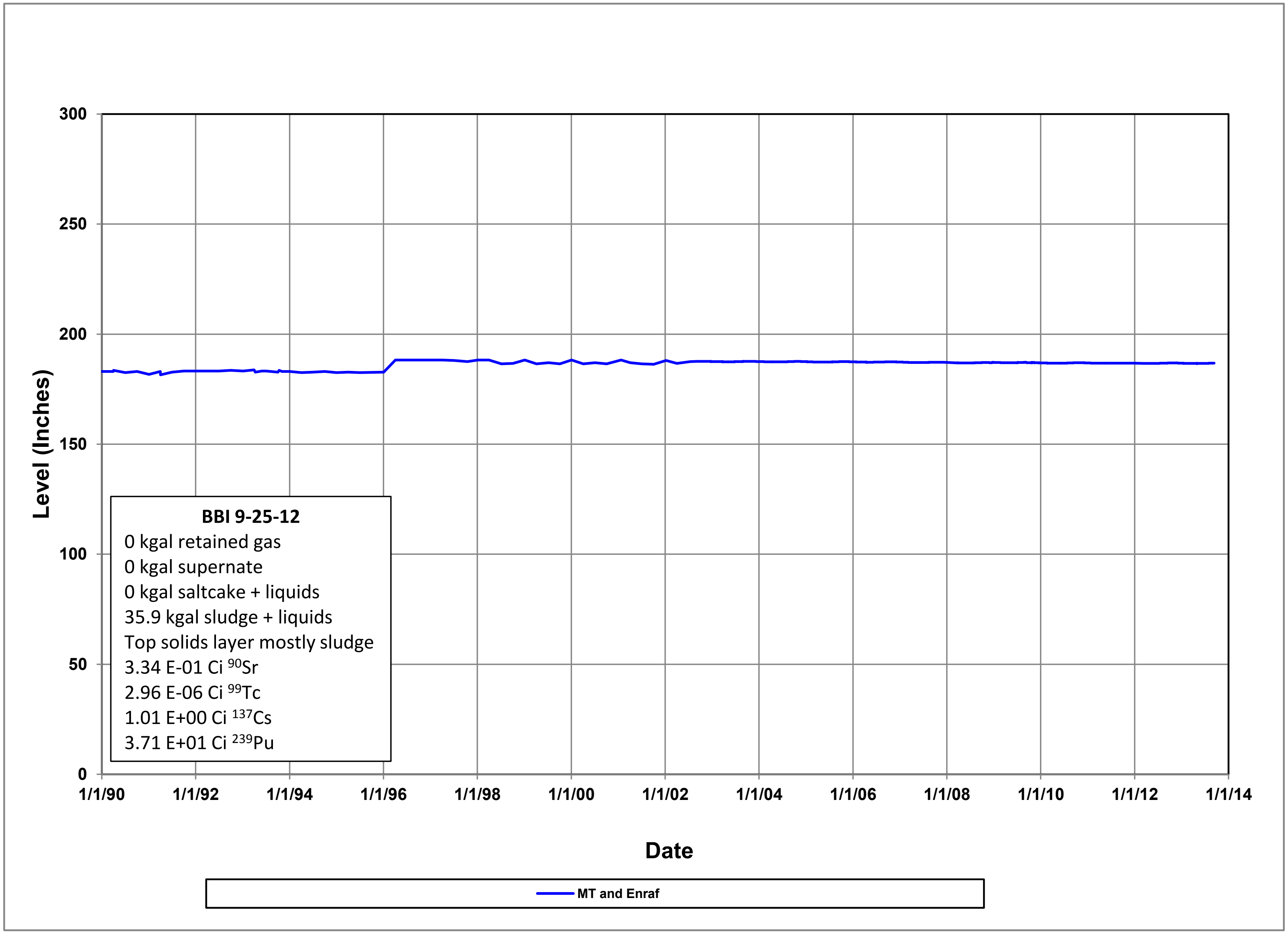


Figure 2 T-203 Expanded SL Data Plot Used for RPP-PLAN-55113, Rev. 1

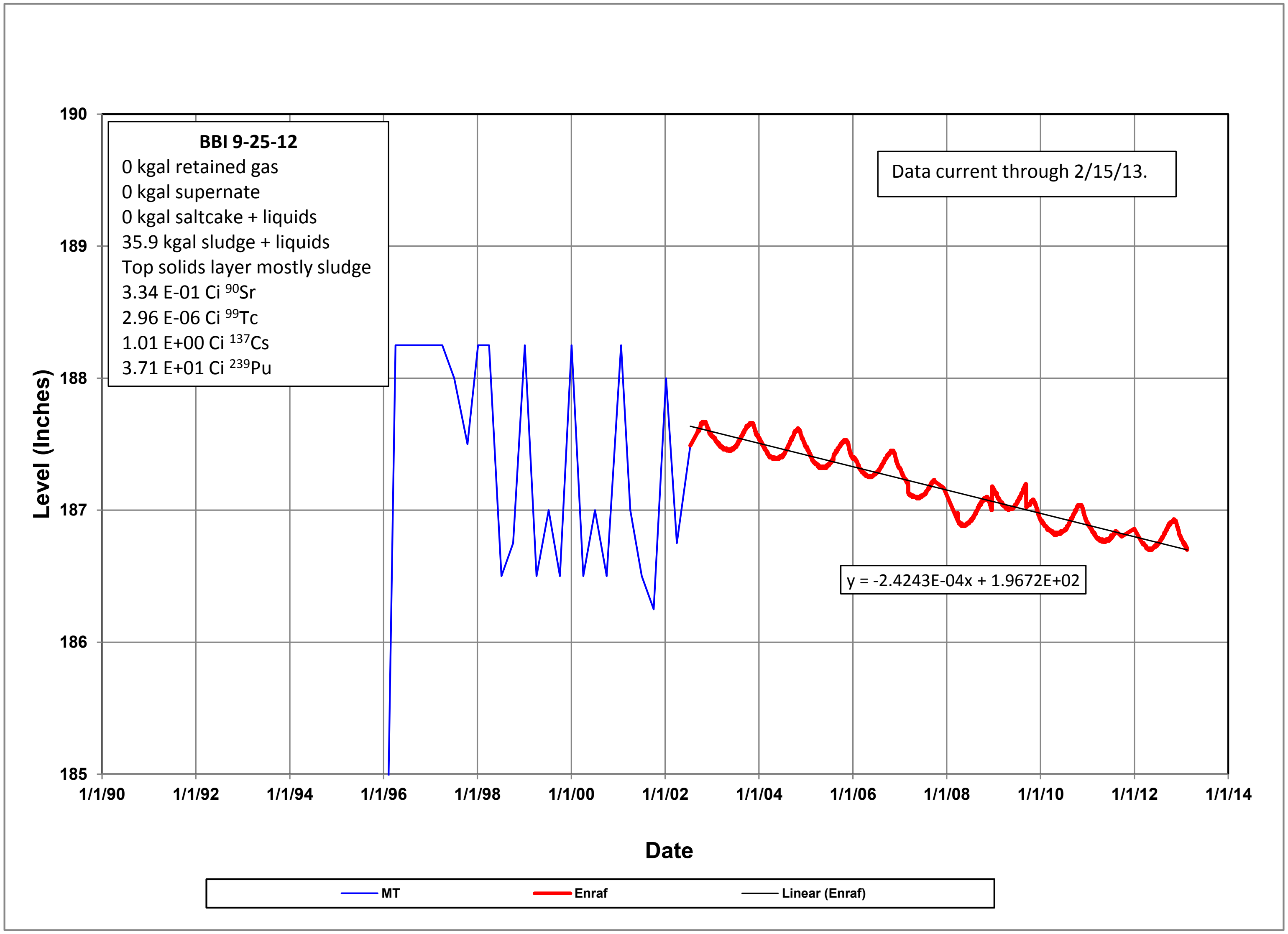


Figure 3 Tank T-203 Expanded SL Data Plot Used for RPP-RPT-55264

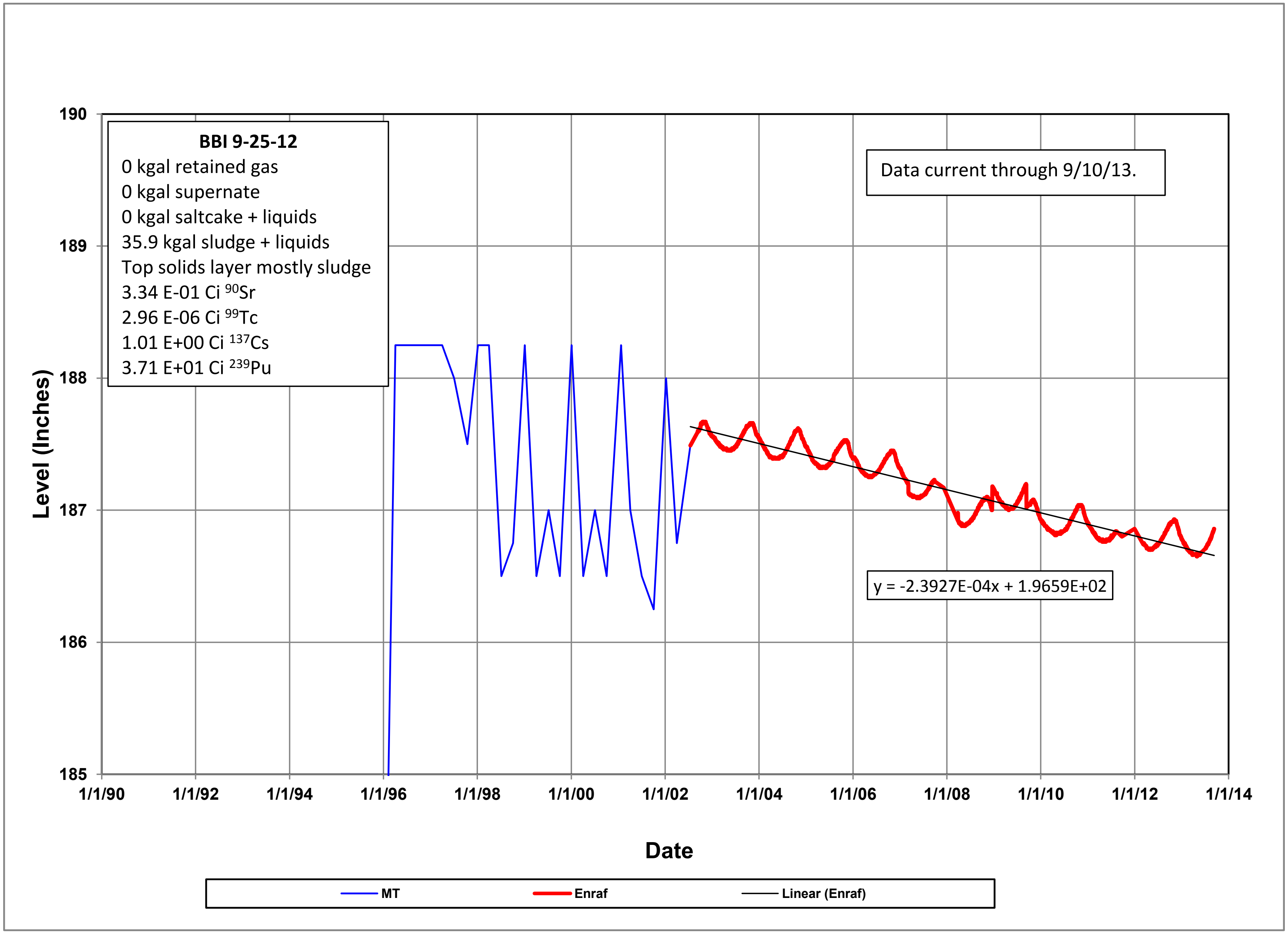


Figure 4 Tank T-203 Expanded and Adjusted SL Data Plot from 1980

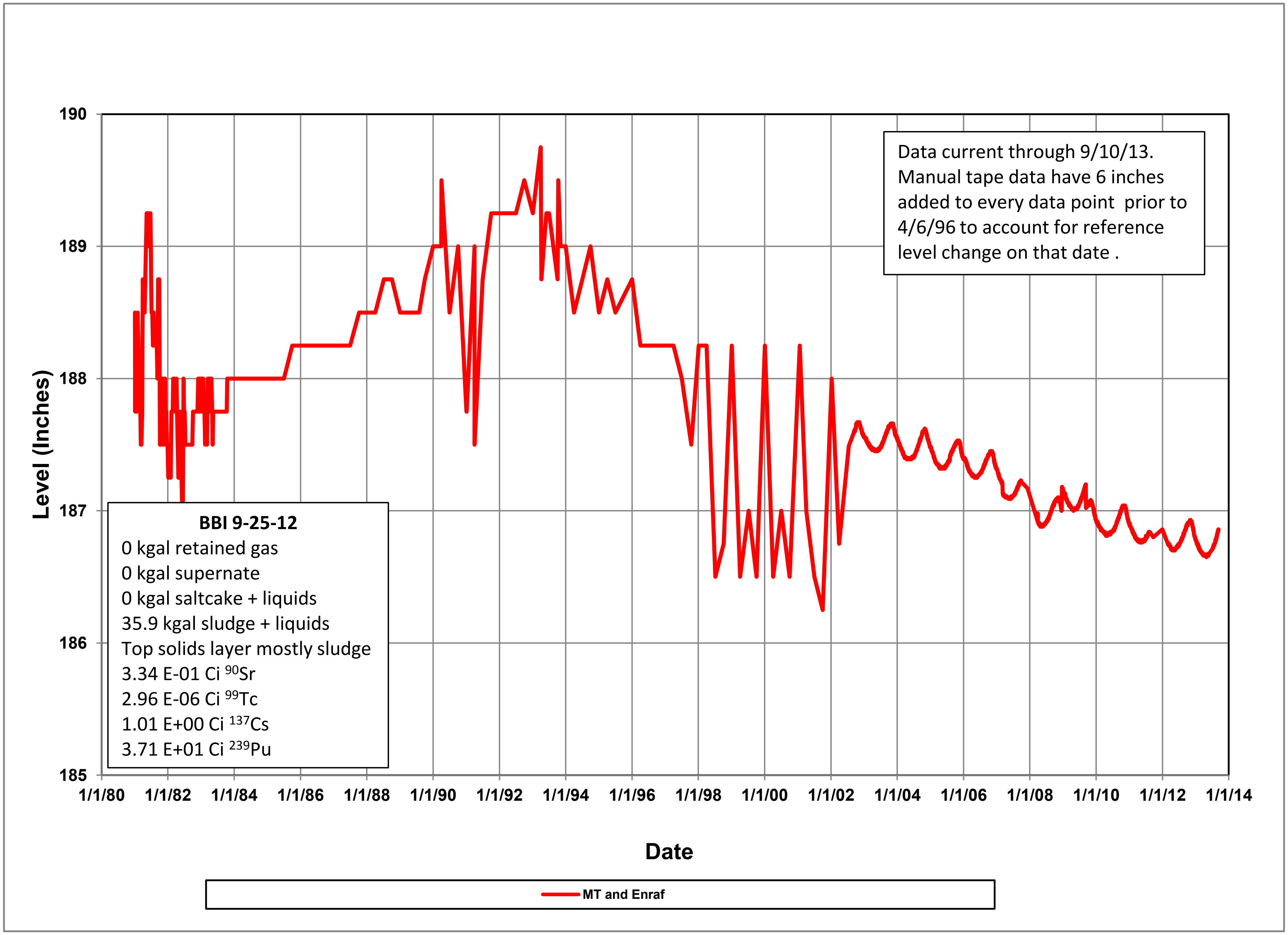


Figure 5 Tank T-203 Estimated Liquid Pool Outline

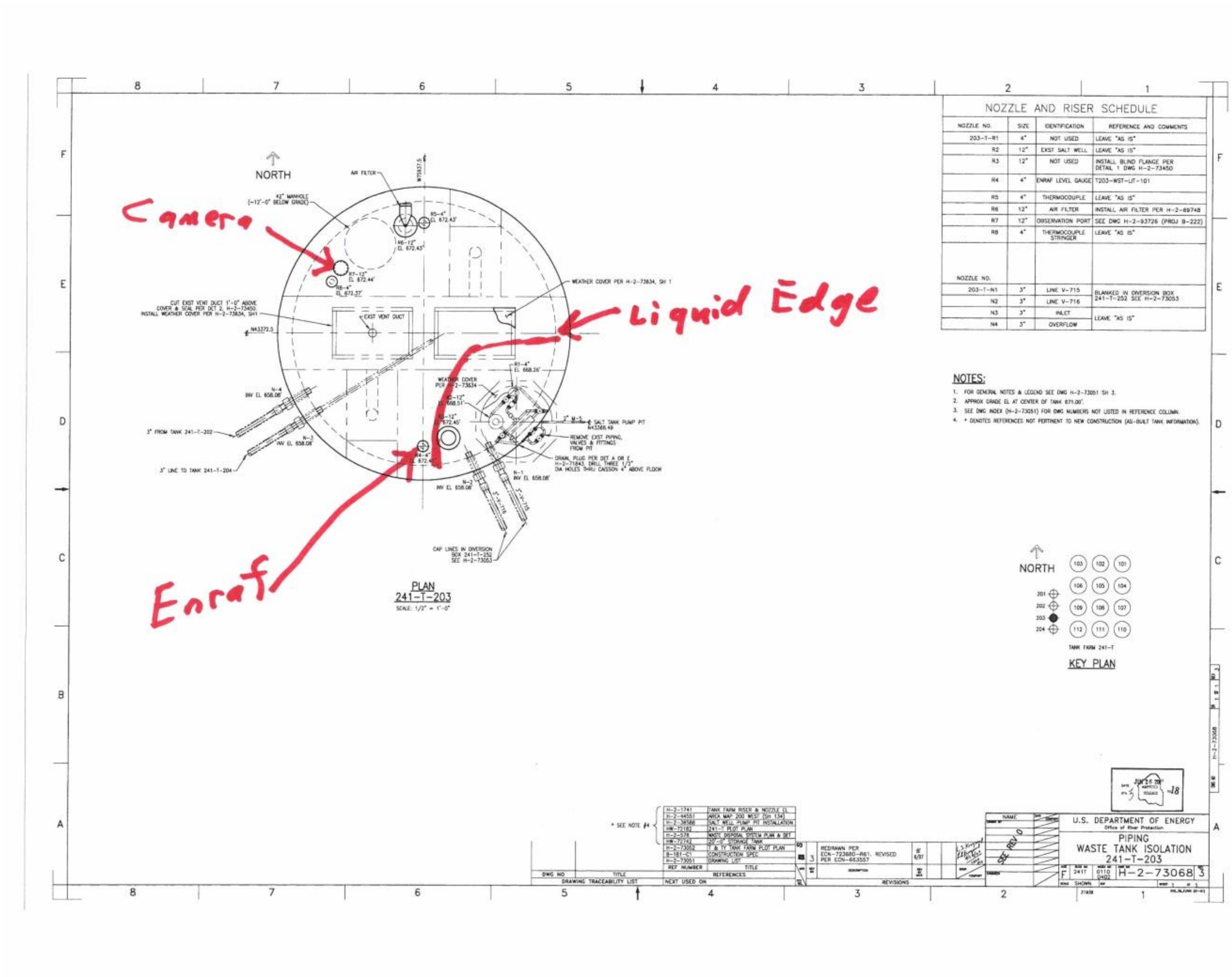


Figure 6 Close-Up of Tank T-203 Enraf Plummet in Small Depression Adjacent to Liquid Pool

Figure 7 Screen Image Composite of Tank T-203 Waste Surface from April 23, 2013 In-Tank Video

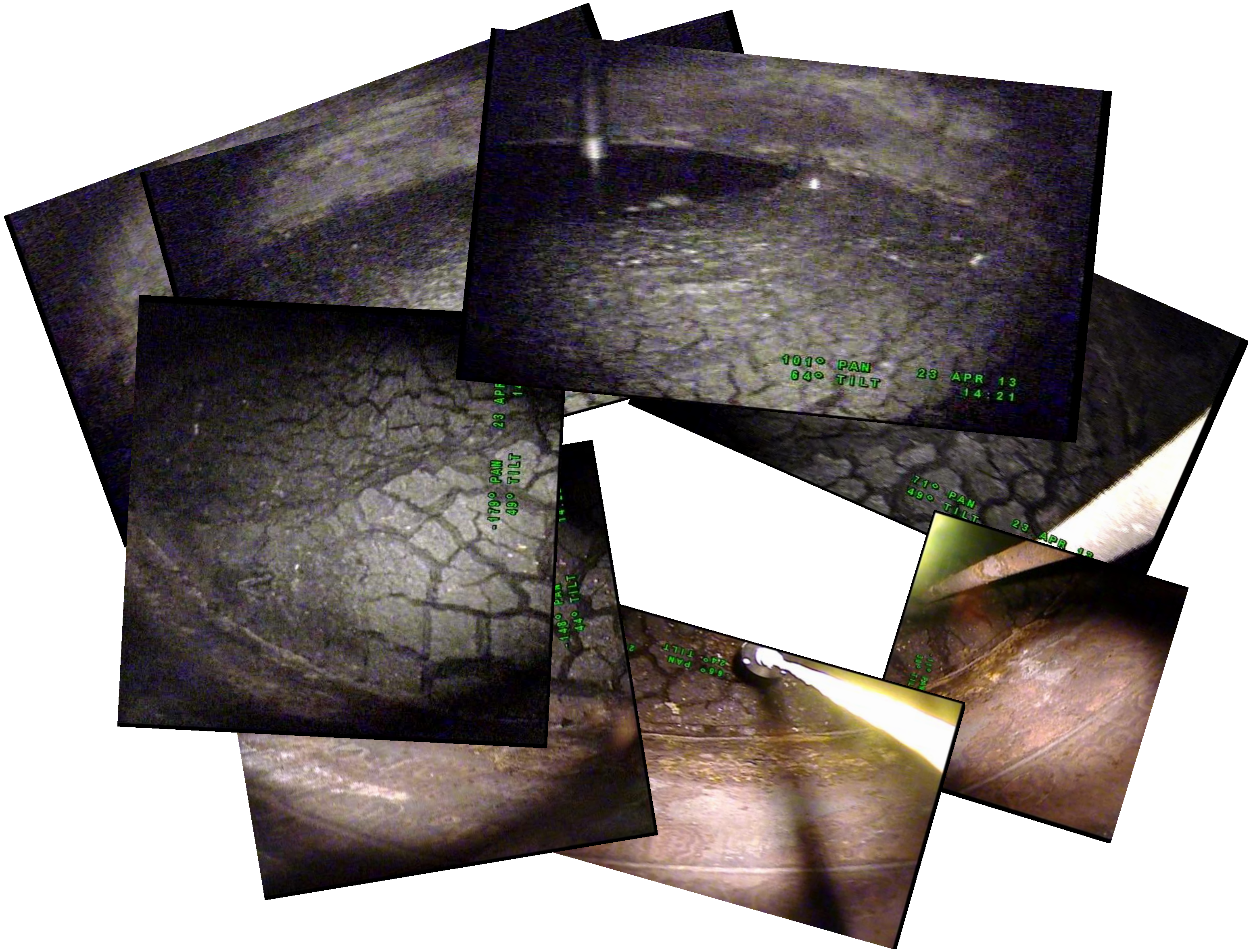
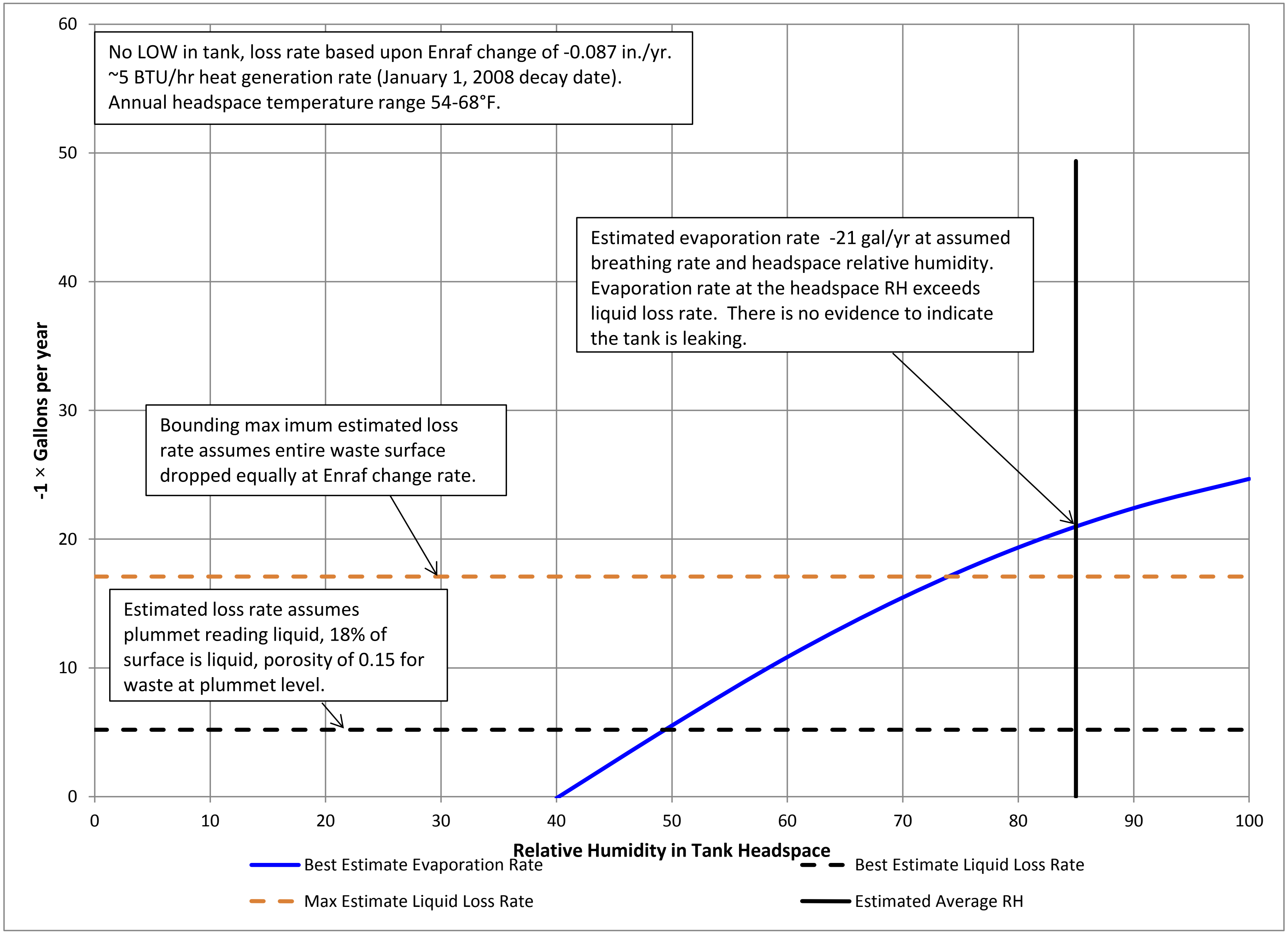


Figure 8 T-203 Estimated Evaporation Loss Rate and Observed Liquid Loss Rate



4.2 Tank T-204

4.2.1 Tank Summary

Tank T-204 was put into service in 1952 when it received 224 waste (plutonium purification cycle waste) from B-Plant. It was filled by the end of 1952 with liquid overflow to another tank. Most of the supernate was transferred out to an SST in 1976. Interim stabilization was documented as complete in 1981 (RPP-RPT-43174, *2009 Auto TCR for Tank 241-T-204*, Revision 0, WHC-MR-0132, 1990, *A History of The Hanford 200 Area Tank Farms*, Revision 0, HNF-EP-0182, Revision 299, HNF-SD-WM-TI-178, 1007, *Single-Shell Tank Interim Stabilization Record*, Rev 9a). Per a TWINS query on September 25, 2112 the tank contains 35.9 kgal sludge and zero supernatant liquid.

Figure 9 shows the raw SL data for tank T-204 from January 1, 1990. Figure 10 is a plot of the data used for calculation of the -0.071 in./yr trendline slope for the Enraf portion of the data used for RPP-RPT-55113, Rev 1, with an expanded y-axis so the SL data changes can be seen. The slope of the decrease line is not changed for this document because there are insufficient valid data to obtain a revised trendline since the Enraf gauge was repaired in September 2012. The SL data for Figure 9 and Figure 10 are from a TWINS tank surface level data download on September 11, 2013.

There is no LOW in the tank.

Figure 11 is a plot from 1980 with the manual tape data (adjusted by having 6 inches added to it to account for the reference level change on April 2, 1996) and the ENRAF data combined. This plot indicates the decrease rate in tank T-203 has been fairly consistent since about 1990.

4.2.2 Liquid Change Rate Estimation

The liquid change rate estimate is based upon the -0.071 in./yr SL change.

Approximately 34% of the waste surface is liquid. This determination was made from sketching the liquid pool on tank drawing H-2-73069, 2007, *Piping Waste Tank Isolation 241-T-204*, Rev. 3, and using a planimeter to measure the area. Seven area measurements were taken and averaged for the reported liquid area of 106 ft^2. The sketch of the liquid pool is shown in Figure 12.

A sludge porosity of 0.15 is used for consistency with RPP-5556.

The estimated tank T-204 liquid change rate is:

$$Tank\ T-204\ estimated\ liquid\ change\ rate = -0.071 \times 196 \times (0.34 + (1-0.34) \times 0.15)) = \mathbf{-6.1\ gal/yr}$$

The bounding maximum estimate of the tank T-204 liquid change rate assumes the level drop is equal all across the waste surface (i.e., it ignores any waste solids being present):

$$Tank\ T-204\ bounding\ maximum\ liquid\ change\ rate = -0.071 \times 196 = \mathbf{-13.9\ gal/yr}$$

4.2.3 Data Analysis

<u>Estimation of [Σ other]</u> – Since there is liquid right at or a few inches under the surface there is assumed to be negligible waste subsidence.

The BBI shows zero retained gas in tank T-204. Buildup and release of gases within the waste has been observed in double-shell tanks (DSTs) as evidenced by a slow increase in the waste level followed by a sudden decrease when the gas is released. Some SSTs may exhibit chronic release of gases at roughly the same rate gases are generated. A buildup of retained gas in the tank over a number of years followed by a steady release over >20 years is not expected based upon past experience. Additionally, monitoring for gases was performed on April 23, 2013 and prior to the in-tank video on April 25, 2013. Results from April 23, 2013 recorded on industrial hygiene sample DRI-13-01427 showed 0.0 ppm flammable gas, 0.0 ppm ammonia and 204 ppb VOCs. Results from April 25, 2013 recorded on industrial hygiene sample DRI-13-01453 showed 0.0 ppm ammonia and 7 ppb VOCs. It is assumed there is no retained gas impact on the level decrease even if there is retained gas in the tank.

No large items of equipment are known to have been lanced into the tank in the past 10 years and the TWINS database indicates no samples have been taken from the tank in that time. The water usage data sheets were not reviewed, but making the assumption that a level gauge is flushed with a nominal 10 gal of water every two years results in a nominal 5 gal/yr conscious liquid addition.

The last waste solids were put into the tank in ~1952. The assumption is made that any significant chemical changes that may occur within the waste would have already occurred so the potential for chemical reactions to be causing changes that would affect the level data is very small.

Therefore, the value [Σ other] for T-204 is assumed to be = 0 + 0 + 5 + 0 = 5 gal/yr.

<u>Potential for Intrusion</u> - Per Section 4.1.4, no evidence of intrusion was observed during the in-tank videos taken in tank T-204. Figure 11 does not show evidence of any intrusion since about 1990. The annual cycles for the liquid level in the tank are typical for most tanks with a moist or liquid surface.

From Section 3.4:

$$intrusion\ rate = volumetric\ change\ rate - leak\ rate - evaporation\ rate - \Sigma\ other$$

$$intrusion\ rate = -6.1\frac{gal}{yr} - leak\ rate - evaporation\ rate - 5\frac{gal}{yr}$$
$$= -11.1\frac{gal}{yr} - leak\ rate - evaporation\ rate$$

Since both evaporation rate and leak rate are negative values, the sum of the leak rate plus the evaporation rate would have to be <-11.1 gal/yr before an intrusion would be considered. As described below, evaporation is estimated to be -21.7 gal/yr so a small intrusion is theoretically possible if the evaporation rate and volumetric change rate are accurate.

<u>Evaluation of ILL or SL Validity</u> – There is no LOW in the tank, the volumetric change rate is based upon SL data.

The Enraf plummet can be seen in Figure 13. It is sitting in liquid.

Table 5 lists all tank T-204 Enraf work packages for the 2006 to 2013 time period. The last two columns list the as-found and as-left data from the work packages. Most of the calibration changes were small, but the one in 2009 was significant and in 2012 the unit obviously needed repair, which took about 9 months. The trendline used is only based upon data through September 2011 since there is not enough data since the repair in September 2012 to see if there is any real change.

Table 5 Tank T-204 Enraf Gauge Work Packages Since January 1, 2006

Work Package No.	Title	Date	As Found (in.)	As Left (in.)
CLO-WO-06-000620	241-T, 204 ENRAF INSPECTION	5/30/2006	193.05	192.97
CLO-WO-07-0267	241-T, 204 ENRAF INSPECTION	3/7/2007	193.06	192.98
CLO-WO-07-2021	241-T, 204 ENRAF INSPECTION	2/28/2008	200.71	200.71
TFC-WO-08-2215	241-T, 204 ENRAF CAL	12/18/2008	192.90	192.92
TFC-WO-09-3000	241-T, 204 ENRAF CAL	9/10/2009	193.51	192.85
TFC-WO-10-2152	241-T, 204 ENRAF CAL	10/6/2010	192.77	192.78
TFC-WO-11-3314	241-T, 204 ENRAF CAL	1/3/2012	215.56	none
TFC-WO-12-1142	241-T, 204 ENRAF CAL	3/15/2012	229.54	none
TFC-WO-12-2234	241-T, 204, replace drum and/or bearing	9/12/2012	repair	
TFC-WO-12-2765	241-T, 204 ENRAF CAL	9/13/2012	NA	193.43

The SL reference was changed from the bottom of the knuckle to the tank centerline bottom in April of 1996 when the manual tape was still in place. The level change rate is based upon Enraf data from 2002.

The SL data are assumed valid for the period used to estimate a level change.

4.2.4 In-Tank Video Results

An in-tank videos was obtained in tank T-204 on April 25, 2013. The following discussion is limited to results of the in-tank video information as it relates to evaluation of the tank for level change; i.e., the waste surface, the Enraf plummet, and evidence of intrusion.

Figure 14 is a composite of screen images from the May 20, 2013 video. The fraction of liquid on the surface is greater than it appears due to the distortion with the camera from one side of the tank to the other. The sketch in Figure 12 must be used to observe the approximate pool outline.

The Enraf plummet was lowered to the top of the sludge below the liquid, the resulting depth was 5.75 in. If this is an accurate representation of the average liquid depth in the tank, the tank has about 380 gal of supernatant liquid, assuming the surface is 34% liquid.

No drips were noted and no evidence of past intrusion was observed.

4.2.5 Evaporation Estimate

Figure 15 provides the evaporation estimate results for tank T-204. Derivation of the evaporation rate for tank T-204 is described in RPP-RPT-54981, Revision 0, Appendix A. See Appendix A, Section A.5 for calculation estimate details.

The blue line in Figure 15 shows the estimated evaporation rate from tank T-204 as a function of the RH in the tank vapor space. The evaporation rate plot is of limited use without knowing the approximate RH in the tank. No past vapor sample RH data are available for tank T-204 but RPP-RPT-54981, Revision 0, Appendix A, Section A.6 derives a RH value for the tank based upon past vapor sample data for a similar tank (tank B-202) with similar tank conditions. The estimated average RH value for tank T-204 is indicated by the vertical black line.

Where the vertical black RH line crosses the blue evaporation line in Figure 15 is the best estimate for evaporation from tank T-204, assuming the parameters used in RPP-RPT-54981, Revision 0, Appendix A are valid. Figure 15 indicates the tank T-204 evaporation rate is -21.7 gal/yr.

RPP-RPT-54981, Revision 0, Appendix A describes the variables involved with the evaporation rate estimate and provides a basis for the value selected. The ambient air conditions and tank headspace temperatures are obtained from recorded data. The primary variables in Appendix A that will impact the tank T-204 evaporation rate are the assumed breathing rate and the assumed tank headspace relative humidity.

The breathing rate used for 20 ft. diameter tank T-204, 1.03 cfm, is about half that used for most 75 ft. diameter tanks in RPP-RPT-54981, Revision 0. The tank breathing rates derived in RPP-RPT-54981, Revision 0, Appendix A are based on tracer gas tests performed in the 1996 to 1998 time period. No tracer gas tests were performed in 200-series tanks. The breathing rate derivations provided in RPP-RPT-54981, Revision 0, Appendix A are comprised of a variable rate and a fixed rate. The variable rate is dependent upon the tank headspace volume and the fixed rate is an average of the fixed rates calculated for the tanks in which tracer gas tests were performed. The fixed rate should be proportional to the number of tank connections to the atmosphere and the cross-sectional area of those openings. The 200-series tanks have a similar number of penetrations and openings as the 75 ft. diameter tanks in B, C, T, U, and BX farms, but for conservatism the fixed rate portion of the breathing rate for 200-series tanks was assumed only half of that for a 75 ft. diameter tank. This results in the T-204 breathing rate to be a little less than half of the breathing rates for 75 ft. diameter tanks because the variable portion of the breathing rate for 200-series tanks is assumed very low due to the small headspace volume compared to that in 75 ft. diameter tanks.

The complete basis for the breathing rate assumed for tank T-204 is provided in RPP-RPT-54981, Revision 0, Appendix A and is the best estimate available when considering the information, but the actual rate could be higher or lower than assumed. Changing the breathing rate would result in a proportional change in the evaporation rate.

The assumed tank T-204 headspace RH of 85% is based upon the 1996 vapor space sample in tank B-202 showing water vapor present at 91.7%. The tank B-202 sample was obtained when the headspace temperature was 61°F. When sampled, tank B-202 had a waste surface level of 146.25 in. Tank T-204 has more waste in it than tank B-202 and about the same temperature. Tank B-202 may have a higher fraction of the waste surface that is liquid, since it appears to have an intrusion. An RH of 85% appears reasonable for tank T-204.

In conclusion, an evaporation rate of -21.7 gal/yr for tank T-204 appears reasonable.

4.2.6 Tank Heat Generation Rate Impact

RPP-54981, Revision 0, Appendix B describes the process used to estimate a heat generation rate for the waste in a tank. Table 6 in this document lists the nuclides contributing >0.01 percent to the tank T-204 heat generation rate, which is about 4.1 BTU/hr. This is based upon a radionuclide decay date of January 1, 2008, so the heat generation rate as of July 1, 2013 is slightly less. The heat generation rate is negligible, the energy for evaporation from the tank has to come from the latent heat of the incoming air and the surrounding waste.

Table 6 Radionuclides Contributing Greater Than 0.01% to the Tank T-204 Waste Heat Generation Rate

Radionuclide	Ci[1]	Heat Generation Rate (watts/Ci)[2]	Heat Generation Rate (watts)
90Sr	5.88E-01	6.70E-03	3.94E-03
90Y	5.88E-01	0.00E+00 (with parent)	0.00E+00
137Cs	1.00E+00	4.82E-03	4.82E-03
137mBa	9.46E-01	0.00E+00 (with parent)	0.00E+00
151Sm	9.59E-01	1.17E-04	1.12E-04
238Pu	2.55E-01	3.32E-02	8.45E-03
239Pu	3.04E+01	3.11E-02	9.45E-01
240Pu	3.84E+00	3.12E-02	1.20E-01
241Am	3.66E+00	3.34E-02	1.22E-01
241Pu	6.04E+00	3.18E-05	1.92E-04
Sum			1.2 (4.1 BTU/hr)

[1] From TWINS download March 19, 2013, radionuclide decay date January 1, 2008
[2] From HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, Rev 14 (reissue), August 11, 2008

4.2.7 Tank T-204 Leak Potential

Based upon Figure 15 the tank T-204 estimated evaporation rate can account for the observed liquid loss rate.

Using the equation from Section 3.4:

$$leak\ rate = volumetric\ change\ rate - intrusion\ rate - evaporation\ rate - \Sigma\ other$$

$$leak\ rate = -6.1\frac{gal}{yr} - intrusion\ rate - (-21.7\frac{gal}{yr}) - \left(5\ \frac{gal}{yr}\right)$$
$$= 10.6\frac{gal}{yr} - intrusion\ rate$$

If the evaporation rate for tank T-204 is -21.7 gal/yr, the intrusion rate would have to exceed 10.6 gal/yr, for a leak to exist. The estimated evaporation rate from the tank also exceeds the bounding maximum estimated liquid loss rate. Based upon Figure 15 the tank T-204 liquid loss rate can be explained by evaporation.

4.2.8 Tank T-204 Conclusion

There is no basis to assume a leak from tank T-204.

Figure 9 Tank T-204 Full Depth Raw Data Plot

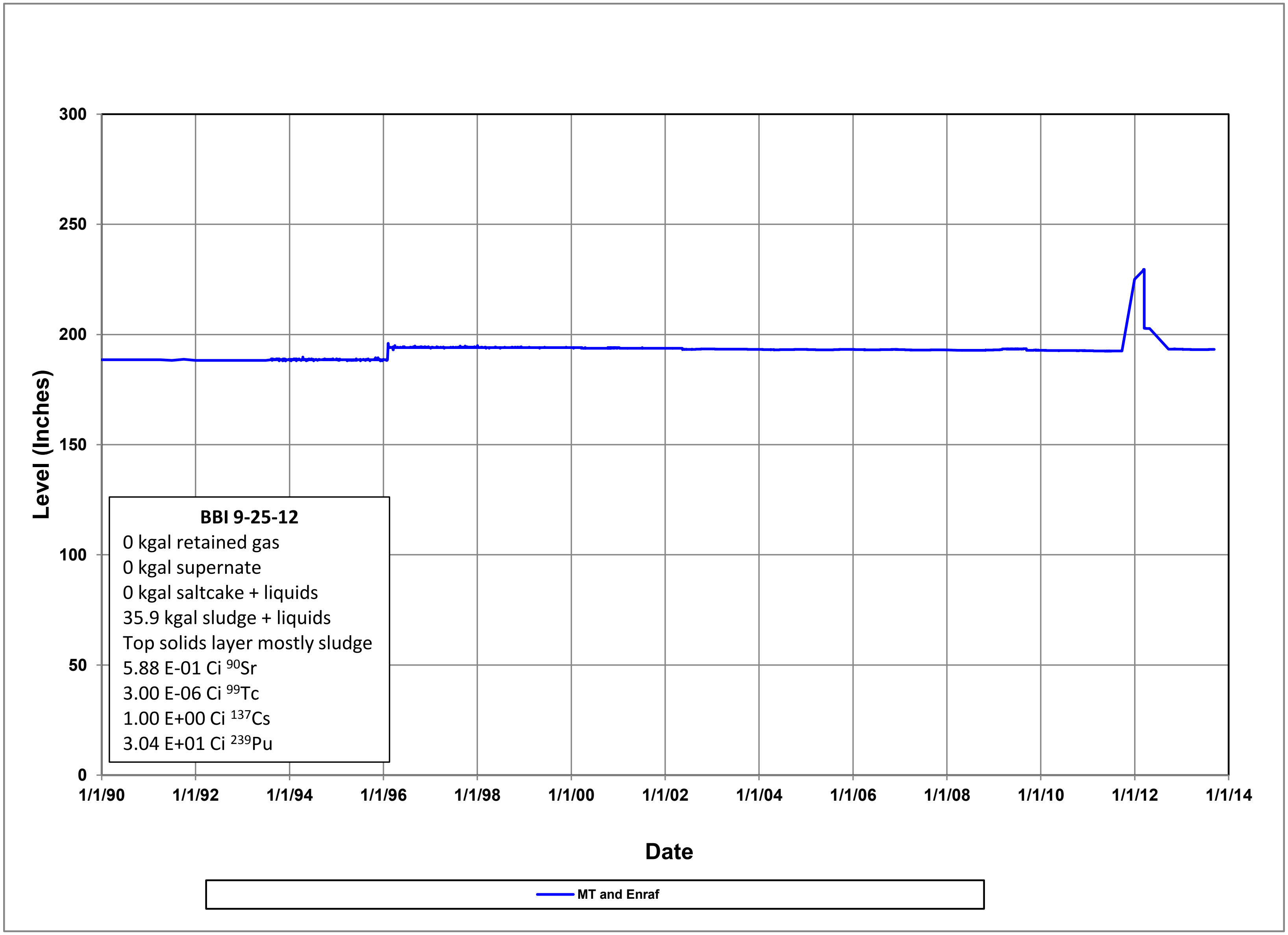


Figure 10 T-204 Expanded SL Data Plot Used for RPP-RPT-55113 Rev 1 and RPP-RPT-55264

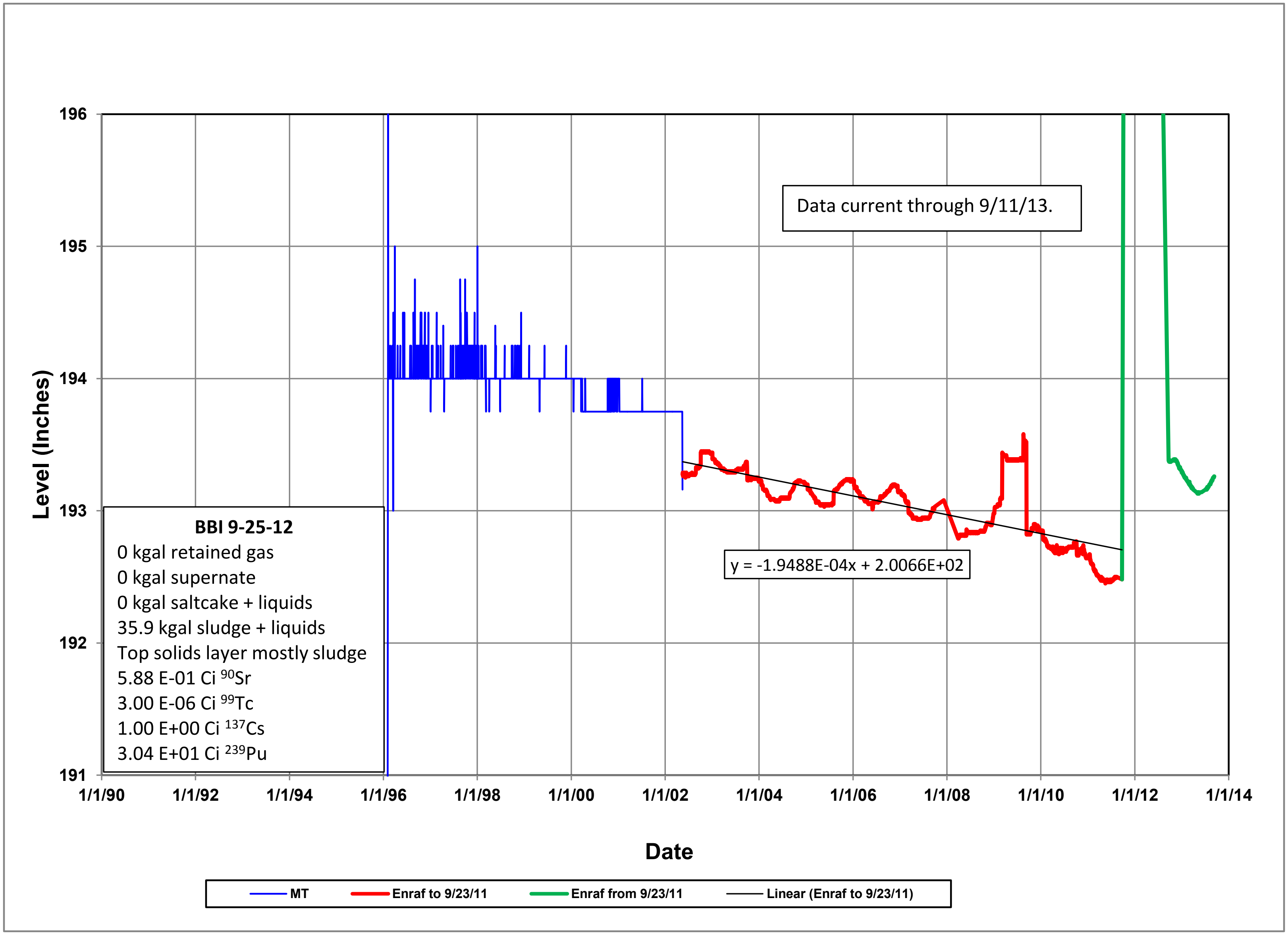


Figure 11 Tank T-204 Expanded and Adjusted SL Data Plot from 1980

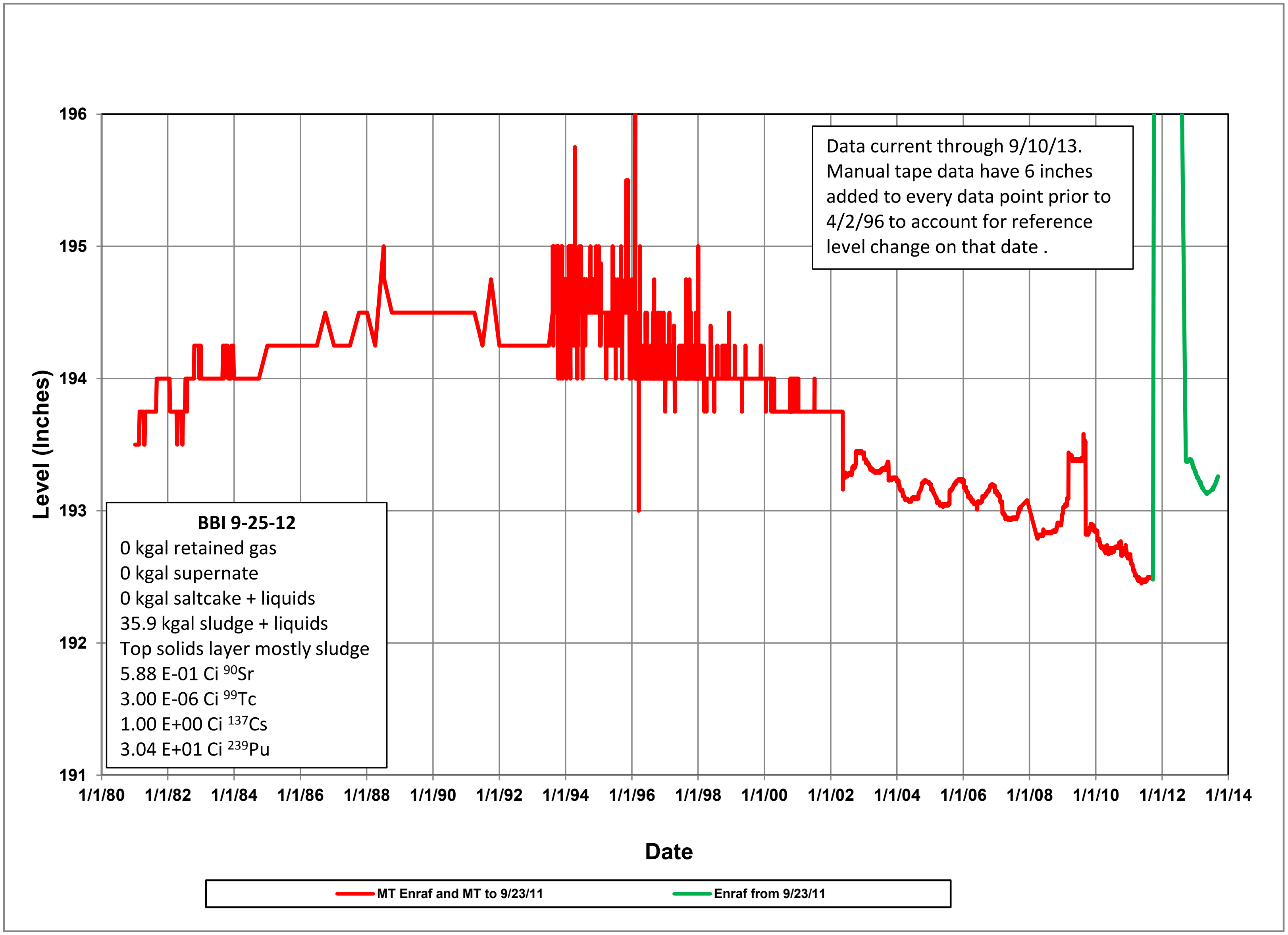


Figure 12 Tank T-204 Estimated Liquid Pool Outline

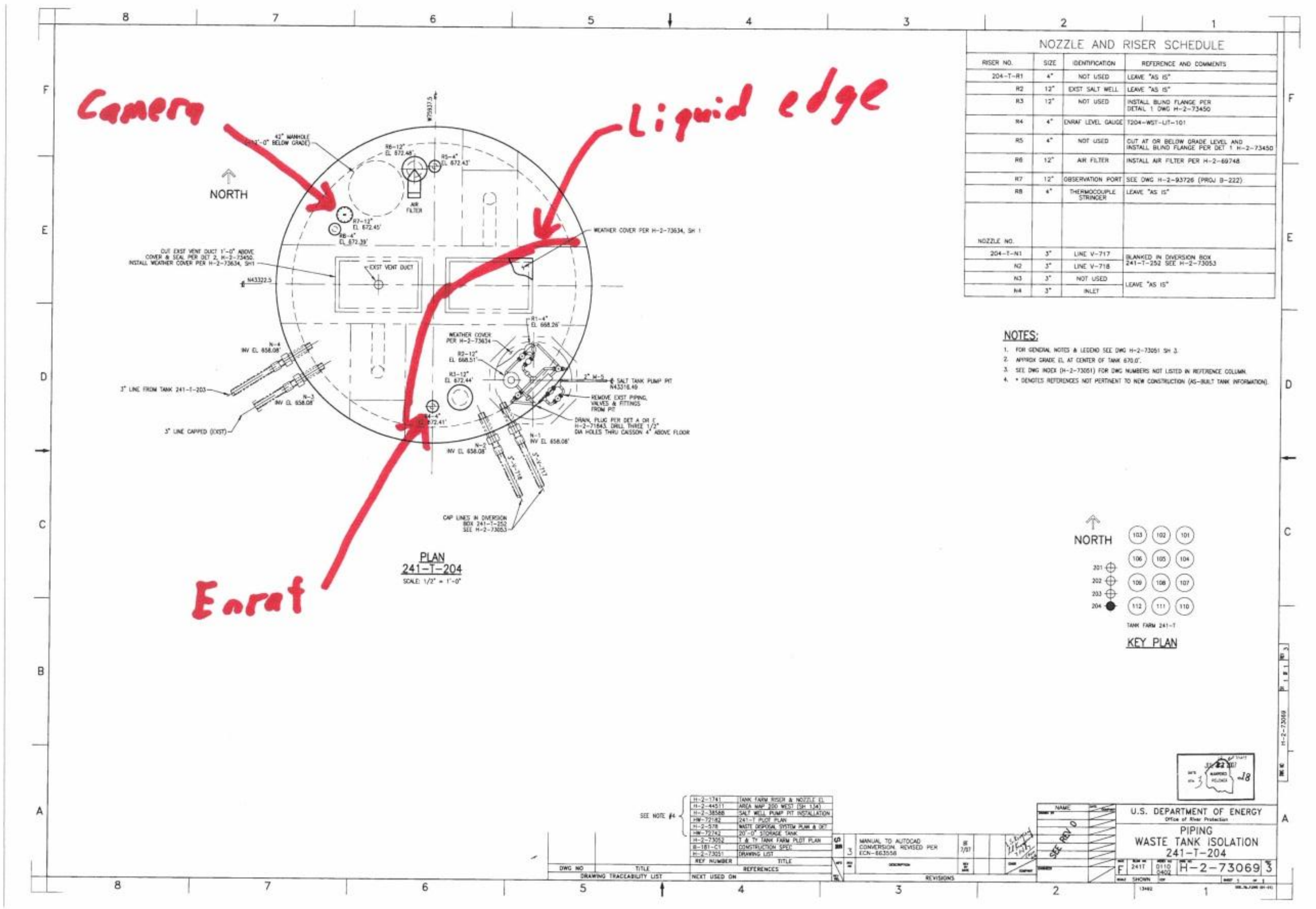


Figure 13 Tank T-204 Enraf Plummet in Liquid Pool

Figure 14 Screen Image Composite of Tank T-204 Waste Surface from May 23, 2013 In-Tank Video

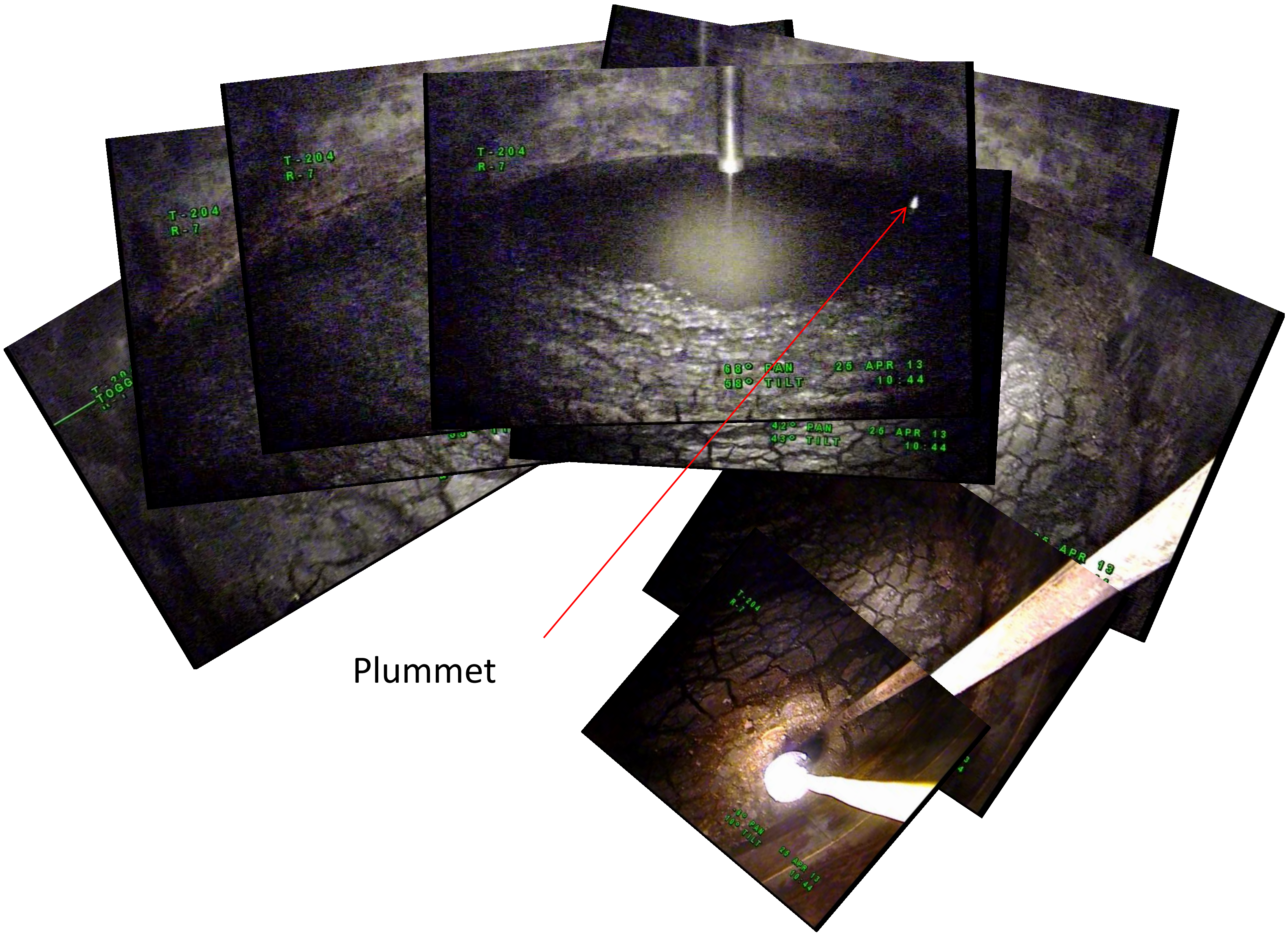
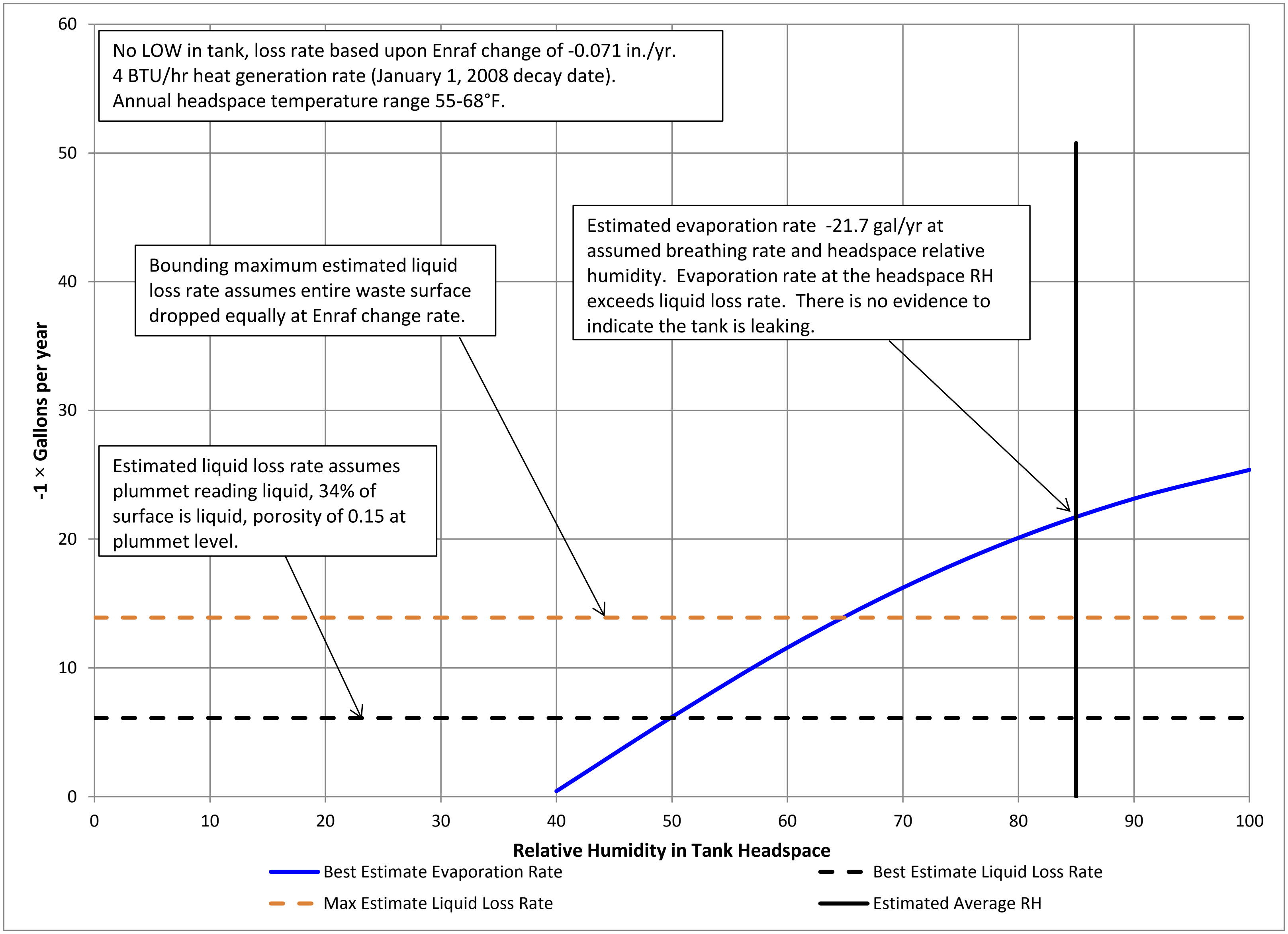


Figure 15 T-204 Estimated Evaporation Loss Rate and Observed Liquid Loss Rate



5.0 Discussion of Results

The evaluations for tanks T-203 and T-204 are dependent upon the validity of three separate estimates: evaporation rate, volumetric change rate, and tank headspace relative humidity. The possible variation in these is addressed in the following subsections.

5.1 Evaporation Rate Variation

The tank evaporation rate depends upon the following variables:

- Ambient temperature, pressure, and relative humidity
- Tank headspace air temperature
- Tank headspace relative humidity
- Tank breathing rate
- How a tank breathing rate differs from a once-through active ventilation process with its effect on water vapor condensing out of headspace air before the air reaches the atmosphere.

Ambient conditions are assumed the same as measured at the Hanford Weather Station (HWS). While local conditions at each tank can vary slightly from at the HWS, and the HWS data used is hourly not continuous, any errors in using the HWS are assumed to be minor and should cancel each other out over three years' worth of data.

The tank headspace air temperature is based upon a regression line formula for each tank, which is in turn dependent upon the accuracy of the tank thermocouple used and the degree of variation of the data over the years used for the regression line. The tank thermocouples themselves cannot be calibrated since they are located inside pipes inserted into the waste, but it is assumed that the tank thermocouple data is reasonably accurate as the data points read about as expected and show the same nominal 60 to 70°F temperature range for tanks with low heat generation rate. It is also assumed that variations in the headspace temperature in comparison to the regression line formula will cancel out over the period of evaporation calculations.

RPP-RPT-54981, Rev 0, Appendix A, Section A.4 explains the derivation of breathing rate estimates. The breathing rate estimates are based upon extrapolation of results from 13 tracer gas tests made in the 1990s. No breathing rate tests were performed in 20 ft. diameter tanks. Information presented in Appendix A indicates atmospheric pressure variation may not have a major impact on tank breathing rate. See RPP-RPT-54981, Rev 0, Appendix A, for discussion of the assumed breathing rates and extrapolation of the breathing rate test results to 200-series SSTs.

How condensation during a tank breathing process differs from a once-through active ventilation system was estimated conservatively. In an active ventilation system there should be minimal condensation until the ventilated air leaves the tank and is above ground. For a breathing tank it is conservatively assumed that the air leaving the tank headspace and entering the bottom of the breather filter (in the process of leaving the tank), and the ambient air entering the top of the breather filter (in the process of entering the tank) are mixed, and any water vapor remaining at 100% relative humidity for the air mixture is returned to the tank. This assumption should overestimate the quantity of water returned to the tank at higher tank headspace relative humidities, resulting in an underestimation of the tank evaporation rate.

5.2 Liquid Change Rate Variation

The tank liquid loss rate depends upon the following variables:

- Accuracy of ILL or SL data used
- Assumed fraction of a tank surface that is liquid
- Assumed tank waste porosity

The tank ILL and SL data are assumed accurate since the instruments used are routinely calibrated. The most important data attribute is repeatability so that trends can be observed. Sections 4.1.3 and 4.2.3 show the data are acceptable for this purpose.

The fraction of tank surface that is liquid is believed reasonable for both T-203 and T-204. Figure 5 and Figure 12 were sketched using the Enraf plummet and pump locations as a basis. The measured fraction of tank surface that is liquid appears larger than would seem reasonable from Figure 7 and Figure 14, but the difference is due to the camera perspective. If the surface area fractions are overestimated this errs on the side of conservatism because the liquid change rate will be overestimated.

The waste porosity of 0.15 assumed for tanks T-203 and T-204 is the value used for each tank in RPP-5556. The porosities in the tanks are unknown, but 0.15 may be high for the type of waste in the tank (primarily $BiPO_4$ plutonium purification waste) since a value of 0.105 was estimated for tank T-111 based upon saltwell pumping, and overestimation of the waste porosity again errs on the side of conservatism because it will result in overestimation of the liquid change rate.

The liquid change rate estimate is assumed reasonable.

5.3 Headspace Relative Humidity Variation

The assumed current tank headspace relative humidities for tanks T-203 and T-204 are based upon water vapor data from a tank B-202 headspace sample taken in 1996. Since tanks T-203 and T-204 are believed to have similar conditions as tank B-202 when sampled the assumed relative humidities should be reasonable. Since both T-203 and T-204 have supernatant present and are fairly full, the RH in the headspace should be the same as or near to the 1996 B-202 RH.

6.0 Conclusions

The conclusions from this document are:

1. Based upon Figure 8 the liquid loss rate for tank T-203 can be explained by evaporation.
2. Based upon Figure 15 the liquid loss rate for tank T-204 can be explained by evaporation.

Tanks B-203, B-204, T-203 and T-204 all show similar level decrease rates, are between 2/3 full and full, and have partial or all liquid surfaces. It is apparent that similar conditions in these tanks are resulting in similar loss rates. The volume change rates and evaporation rates in the tanks are similar, and observing the small distance between the top of the liquid and the vent to the atmosphere it is apparent that evaporation is the cause of the decrease in tanks T-203 and T-204.

7.0 References

CLO-WO-06-000619, 241-T, 203 ENRAF INSPECTION, completed 5/30/2006, CH2M Hill Hanford Group, Inc., Richland, Washington.

CLO-WO-06-000620, 241-T, 204 ENRAF INSPECTION, completed 5/30/2006, CH2M Hill Hanford Group, Inc., Richland, Washington.

CLO-WO-07-0267, 241-T, 204 ENRAF INSPECTION, completed 3/7/2007, CH2M Hill Hanford Group, Inc., Richland, Washington.

CLO-WO-07-0268, 241-T, 203 ENRAF INSPECTION, completed 3/7/2007, CH2M Hill Hanford Group, Inc., Richland, Washington.

CLO-WO-07-2020, 241-T, 203 ENRAF INSPECTION, completed 2/28/2008, CH2M Hill Hanford Group, Inc., Richland, Washington.

CLO-WO-07-2021, 241-T, 204 ENRAF INSPECTION, completed 2/28/2008, CH2M Hill Hanford Group, Inc., Richland, Washington.

DRI-10-01427, Survey Results for Tank T-203 Video Inspection and T-204 Top Hat Installation on April 23, 2013, available from Hanford Sitewide Industrial Hygiene Database (HSIHD), restricted access through Industrial Safety and Health, Washington River Protection Solutions, Richland, Washington.

DRI-10-01453, Survey Results for Tank T-204 Video Inspection on April 25, 2013, available from HSIHD, restricted access through Industrial Safety and Health, Washington River Protection Solutions, Richland, Washington.

H-2-73068, 2007, *Piping Waste Tank Isolation 241-T-203*, Rev. 3, CH2M Hill Hanford Group, Inc., Richland, Washington.

H-2-73069, 2007, *Piping Waste Tank Isolation 241-T-204*, Rev. 3, CH2M Hill Hanford Group, Inc., Richland, Washington.

HNF-EP-0182, *Waste Status Summary for Month Ending April 30, 2013*, Rev 301, 2013, Washington River Protection Solutions, Richland, Washington.

HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record,* Rev 9(a), 2007, CH2M Hill Hanford Group, Inc., Richland, Washington.

OSD-T-151-00031, 2012, *Operating Specifications for Tank Farm Leak Detection and Single-Shell Tank Intrusion Detection*, Revision 1, Washington River Protection Solutions, Richland, Washington.

RPP-5556, 2000, *Updated Drainable Interstitial Liquid Volume Estimates for 119 Single-Shell Tanks Declared Stabilized*, Rev 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-RPT-43173, 2009, *2009 Auto TCR for Tank 241-T-203*, Revision 0, Washington River Protection Solutions, Richland, Washington.

RPP-RPT-43174, 2009, *2009 Auto TCR for Tank 241-T-204*, Revision 0, Washington River Protection Solutions, Richland, Washington.

RPP-RPT-54981, 2013, *Evaluation of Fourteen Tanks with Decreasing Baselines Selected for Review in RPP-PLAN-55113, Revision 1*, Revision 0, Washington River Protection Solutions, Richland, Washington.

TFC-WO-08-2215, 241-T, 204 ENRAF CAL, completed 12/18/2008, CH2M Hill Hanford Group, Inc., Richland, Washington.

TFC-WO-08-2216, 241-T, 203 ENRAF CAL, completed 12/18/2008, CH2M Hill Hanford Group, Inc., Richland, Washington.

TFC-WO-09-3000, 241-T, 204 ENRAF CAL, completed 9/10/2009, Washington River Protection Solutions, Richland, Washington.

TFC-WO-09-3001, 241-T, 203 ENRAF CAL, completed 9/10/2009, Washington River Protection Solutions, Richland, Washington.

TFC-WO-10-2139, 241-T, 203 ENRAF CAL, completed 10/7/2010, Washington River Protection Solutions, Richland, Washington.

TFC-WO-10-2152, 241-T, 204 ENRAF CAL, completed 10/6/2010, Washington River Protection Solutions, Richland, Washington.

TFC-WO-11-3313, 241-T, 203 ENRAF CAL, completed 1/3/2012, Washington River Protection Solutions, Richland, Washington.

TFC-WO-11-3314, 241-T, 204 ENRAF CAL, completed 1/3/2012, Washington River Protection Solutions, Richland, Washington.

TFC-WO-12-1142, 241-T, 204 ENRAF CAL, completed 3/15/2012, Washington River Protection Solutions, Richland, Washington.

TFC-WO-12-2234, 241-T, 204, replace drum and/or bearing, completed 9/12/2012, Washington River Protection Solutions, Richland, Washington.

TFC-WO-12-2765, 241-T, 204 ENRAF CAL, completed 9/13/2012, Washington River Protection Solutions, Richland, Washington.

TFC-WO-12-5375, 241-T, 203 ENRAF CAL, completed 12/11/2012, Washington River Protection Solutions, Richland, Washington.

TWINS, *Tank Waste Information Network System*, database available on the Hanford Local Area Network (HLAN) at https://twins.labworks.org/twinsdata/Forms/About.aspx

WHC-MR-0132, 1990, *A History of The Hanford 200 Area Tank Farms*, Revision 0, Westinghouse Hanford Company, Inc., Richland, Washington.

WRPS-1203139R1, *Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC Submittal of Single-Shell Tank Suspect Intrusion Evaluation Plan to The U.S. Department of Energy, Office of River Protection*, Letter, C.A. Simpson, WRPS to S.E. Bechtol, US Department of Energy, Washington River Protection Solutions, Richland, Washington, dated September 13, 2012.

WRPS-1301005, *Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC Submittal of Single-Shell Tank Level Decrease Evaluation Plan to The U.S. Department of Energy, Office of River Protection*, Letter, C.A. Simpson, WRPS to S.E. Bechtol, US Department of Energy, Washington River Protection Solutions, Richland, Washington, dated March 18, 2013.