Hanford Single-Shell Tanks 241-T-203 and 241-T-204 Validation of Level Decrease Evaluation - 15343

Amie Feero *, John Schofield **, Jeremy Johnson ***
* Washington River Protection Solutions
** Columbia Engineering and Environmental Services
*** US DOE

ABSTRACT

Hanford single-shell tanks (SSTs) 241-T-203 (T-203) and 242-T-204 (T-204) were two tanks that showed decreasing waste surface level trends. All factors that could impact each tank's level change rate were evaluated with the conclusion being the level decreases could be explained by evaporation. The evaporation estimates contained several assumptions, so a test was performed to determine if the estimates could be supported by data. The breather filter valves on these two tanks were closed for one year in order to shut off the primary means of tank air exchange to the atmosphere. The results for tank T-203 showed the net level change for the year was zero which supported the evaporation rate estimate (and provided further information that the tank was not leaking). The data for tank T-204 were very erratic and prevented conclusive results, but the waste level showed a significant reduction in level decrease rate and supported the tank evaporation rate estimate [1].

INTRODUCTION

Tanks T-203 and T-204 are 6.1 m (20 ft.) diameter tanks that had shown small waste level decreases of 7.0×10^{-11} and 5.7×10^{-11} m/s (0.087 and 0.071 in./yr), respectively, for many years. This corresponds to an estimated volume decrease rates of 6.2×10^{-10} to 2.0×10^{-9} m^3/s (5.2 to 17 gal/yr) for tank T-203 and 7.3×10^{-10} to 1.7×10^{-9} m^3/s (6.1 to 14 gal/yr) for tank T-204 based on conservative assumptions [2]. Because of the decreasing level and volume, these tanks were evaluated to determine what was causing the decreases. First, estimating a volume change rate from level change data is only valid if the level instrument is sensing a liquid level. In-tank videos confirmed the level gauges were sensing liquid, so the measured level decreases are valid.

The original evaluation of the level decreases in T-203 and T-204 was completed by taking into account factors that could influence the waste level, including the following topics:

- Water intrusions
- Evaporation
- Leaks
- Waste subsidence
- Gas generation or release
- Conscious liquid additions (e.g., flushing the ENRAF plummet)

The evaluation concluded the major factors that would cause the level decrease rate were evaporation and/or leakage.

The evaporation rate was estimated from a variety of factors, including tank headspace temperatures, relative humidity, and breathing rates. Data and conservative assumptions were

used to estimate evaporation rates of 2.5 x 10^{-9} m^3/s (21 gal/yr) for tank T-203 and 2.6 x 10^{-9} m^3/s (22 gal/yr) for tank T-204.

Since the estimated evaporation rate exceeded the maximum estimated liquid loss rates for each tank it was concluded evaporation could explain the liquid loss rates. However, having data to support the estimated evaporation rate was desired to provide more support for the conclusion.

Closing the breather filter inlet valves reduces the tank headspace air exchange with the atmosphere and therefore the evaporation. In June 2013, the inlet valves on both Tank T-203 and Tank T-204 were closed. The valves remained closed for a full year, and during this year the liquid levels were monitored for changes.

While the breather valves were closed to the tank headspace, the flammable gas surveillance frequency was increased and more stringent requirements were set to verify that the flammable gas levels in the headspace were acceptable and safe.

METHODS

The methods involved in confirming whether evaporation could cause the decrease in liquid surface level were rather simple. Essentially, two things needed to happen:

1. Close the breather filter inlet valves for at least a year.
2. Monitor the liquid level changes during that year.

The breather filter inlet valves were closed by issuing a process memo to direct the work using existing procedures [3]. A drawing of a breather filter assembly is shown in Figure 1 below.

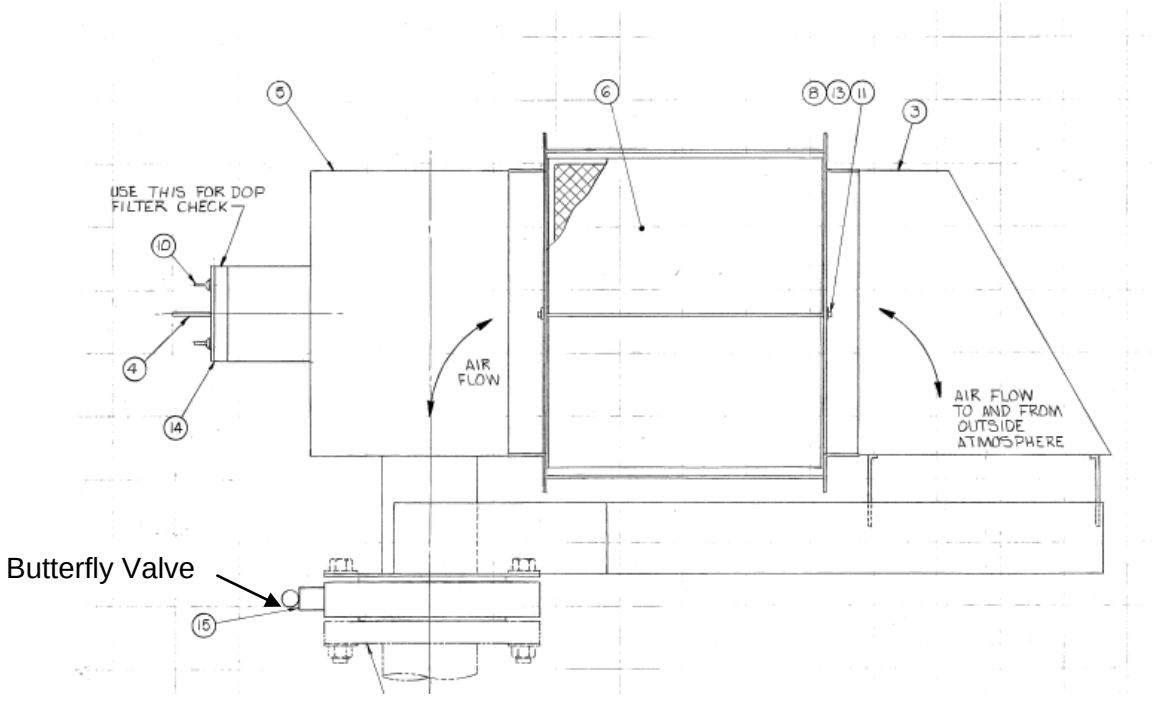

Fig. 1. Example of Breather Filter Assembly Showing Valve [4].

The liquid level changes were monitored using the ENRAF level gauge (±0.01 precision) with daily readings.

Because of the potential for buildup of flammable gases in a tank headspace after closing a breather filter valve, the flammable gas levels in the tank headspace were monitored every 30 days during the year the valves were shut. The standard headspace monitoring frequency is 182 days for T-203 and T-204 when the breather filters are open. The monitoring is to verify the flammable gas concentration is ≤25% of the lower flammability limit (LFL) [5]. In the current operating procedure, if the flammable gas reading is higher than 5% of the LFL but less than 25%, then the ventilation must be confirmed to be in the open position [6]. Therefore, the surveillance frequency was chosen to ensure that any tank headspace flammable gas concentration increase would be observed before the concentration reached 5% of the LFL. Because 25% of the LFL could be reached in 294 days [7], 5% of the LFL could be reached in 59 days. Therefore, flammable gas measurements were made every 30 days to ensure that the flammable gas levels were safe. Over the course of the breather filter valve closure, the flammable gas readings in both tanks never registered above 0% of the LFL.

RESULTS AND DISCUSSION

The results are discussed by tank in the subsequent sections.

Tank 241-T-203

The tank T-203 breather valve was shut in June 2013. Over the course of 12 months (starting on June 13), the level data were collected and plotted. For reference, a 10-year period of level data is shown in Figure 2. The annual liquid level fluctuations are expected for a tank where the level gauge is reading a liquid surface and are due to the annual temperature-caused density changes in the waste. The surface level before the breather filter was shut off (vertical red line), showed a decreasing trend—which is what prompted the original level evaluation. The jumps in data were in the 2008-2009 timeframe were due to instrument problems.

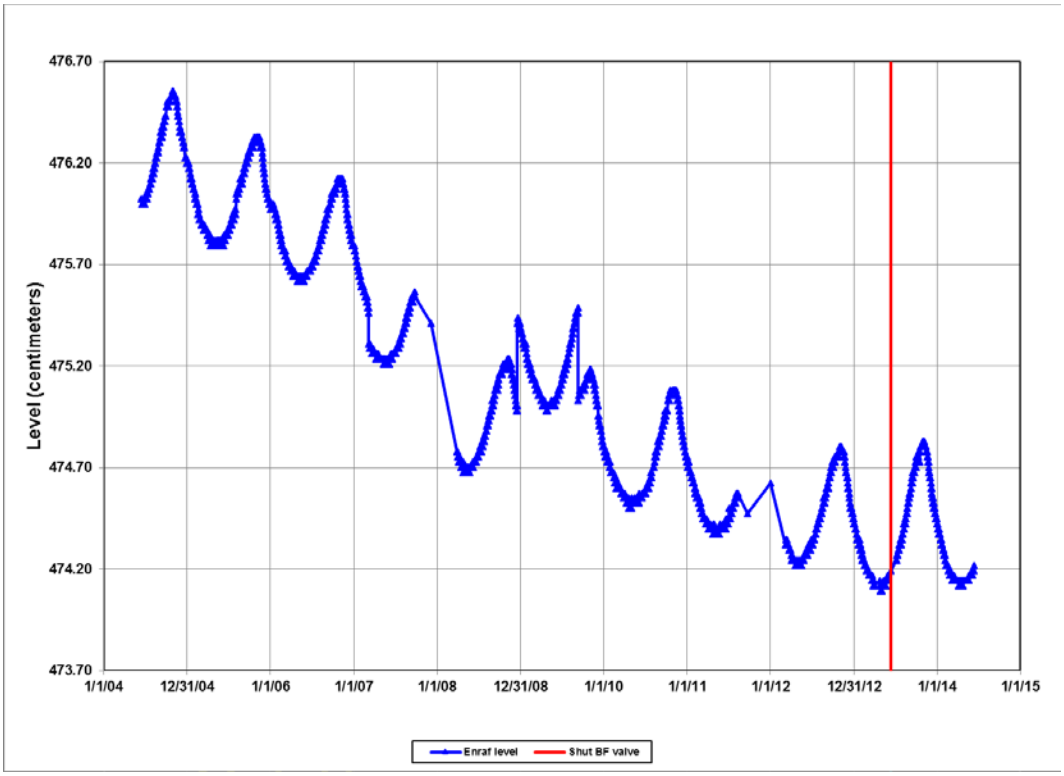

Fig. 2. Tank T-203 Level Data 2004 to 2014.

To more accurately compare the data before and after shutting the valve, a comparison chart was prepared showing the daily difference between the surface level reading and the June 13th reading for each one-year June 13 to June 13 period and is shown in Figure 3. This was done for each of the one-year June 13 to June 13 periods from June 13, 2004 to June 13, 2014. The data for 2008-2009 were adjusted to account for the data spiked recorded by the ENRAF gauge. The red line is the period from June 13, 2013 to June 13, 2014. The difference between the June 13, 2013 and June 13, 2014 surface level reading was 0.0 m (0.0 inches). In comparison, the annual change for most of the other periods was in the -7.6 x 10^{-4} m to -2.8 x 10^{-3} m (-0.03 to -0.11 in.) range. The -5.3 x 10^{-3} m (-0.21 in.) change for the 2007-2008 data was due to instrument problems.

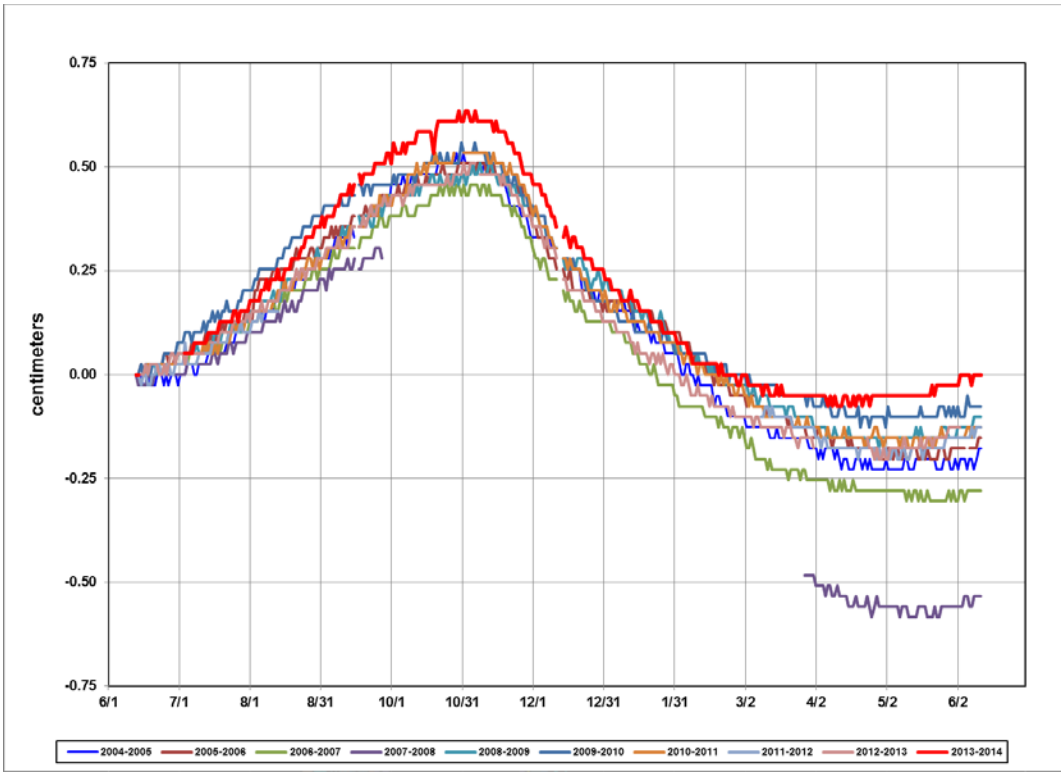

Fig. 3. Tank T-203 Annual Surface Level Change 2004 to 2014.

In summary, closing the breather filter valve in tank T-203 for a year resulted in a net surface level change of 0.0 m (0.0 in.) and supported the conclusion that the decreasing liquid level in the tank was due to evaporation.

Tank 241-T-204

The tank T-204 breather valve was also shut in June 2013, and, similar to tank T-203, the level data was collected and analyzed over the course of the ensuing 12 months. The 10-year period of level data for tank T-204 is shown in Figure 4. It was very erratic due to instrument problems, so the spikes in Figure 4 data were not actual level changes. This made it more difficult to analyze and interpret the data.

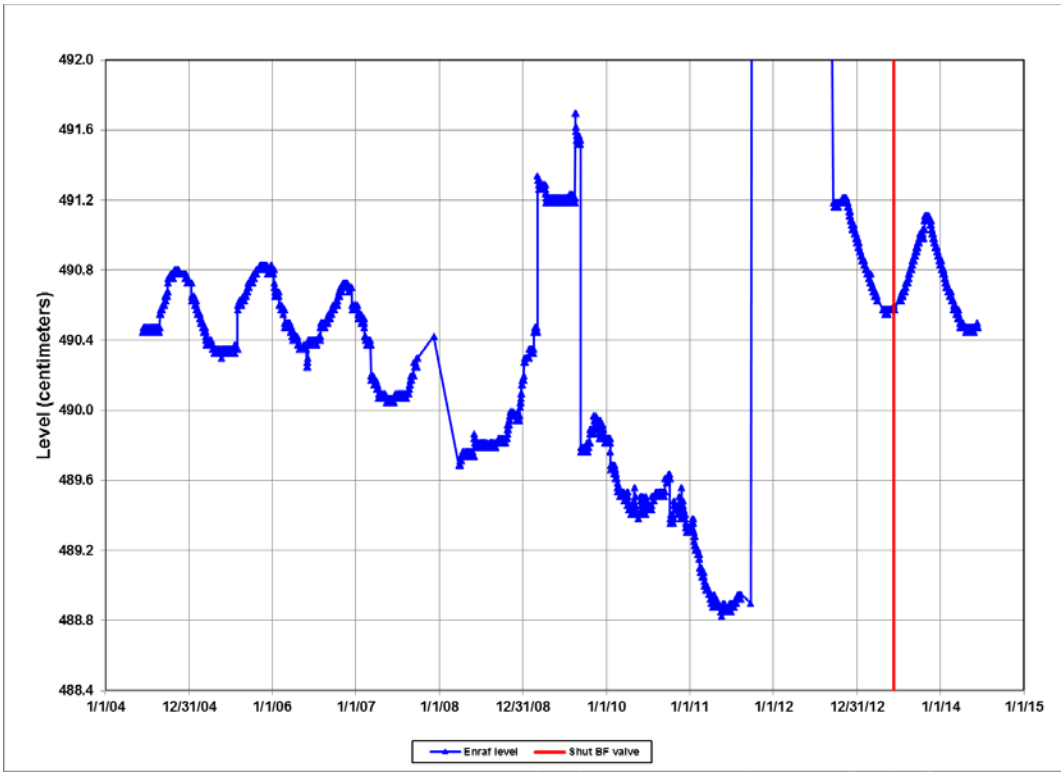

Fig. 4. Tank T-204 Level Data 2004 to 2014.

Once again, a comparison chart was prepared to display the daily differences in level data compared to the June 13 starting value for a one year period. This chart is shown in Figure 5, and the red line is the period between June 13, 2013 and June 13, 2014. The change in surface level for this period was about -1.3×10^{-3} m (-0.05 in.) and less than the change for all other periods with stable data. The change for the majority of the other relatively stable June to June annual periods was approximately -1.3×10^{-3} m to -5.8×10^{-3} m (-0.05 to -0.23 in.).

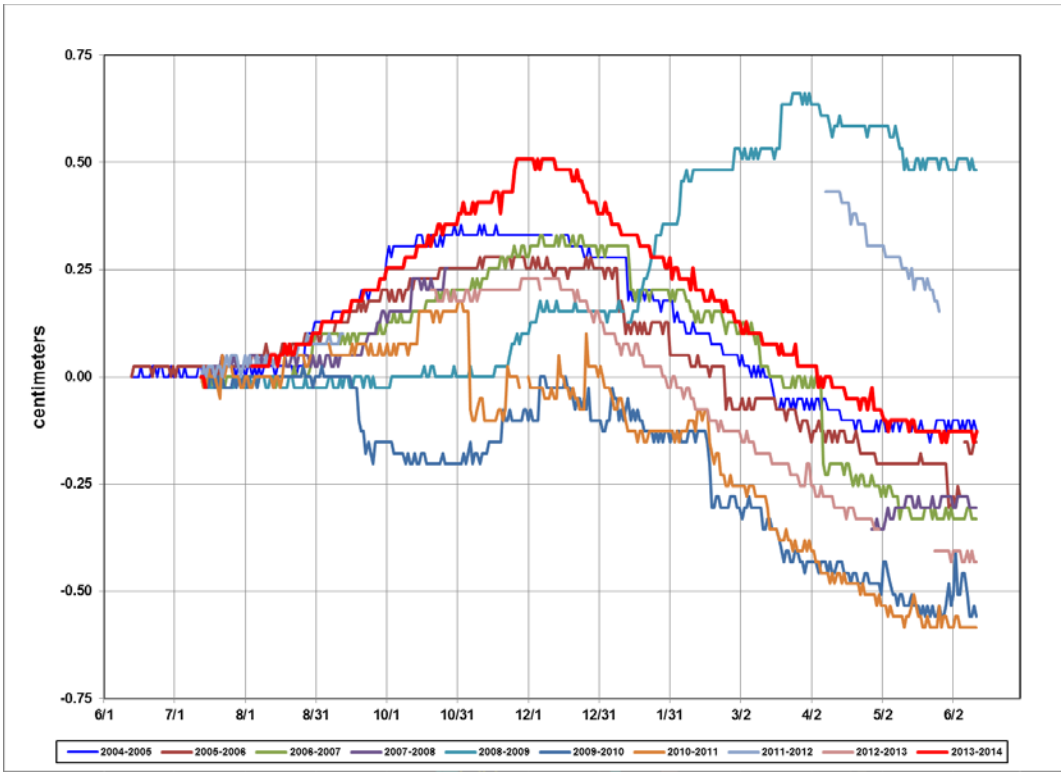

Fig. 5. Tank T-204 Annual Surface Level Change.

In summary, closing the breather filter valve in tank T-204 for one year resulted in a significantly smaller annual level change compared to years with the valve open, but because of the erratic data, no other conclusions could be drawn. It still supports the claim that the evaporation estimates are reasonable.

CONCLUSIONS

Closing the breather filter inlet valves proved to be a useful way to confirm that evaporation estimates were reasonable for the 6.1 m (20 ft.) diameter tanks evaluated. A better understanding of the contribution of evaporation to level change in the tanks will be useful in evaluations of other tanks with decreasing level trends.

REFERENCES

1. J. S. SCHOFIELD and A. J. Feero, RPP-RPT-57960, “Results of June 2013 to June 2014 Breather Filter Inlet Valve Closure Test for Tanks 241-T-203 and 241-T-204,” Revision 0, Washington River Protection Solutions LLC, Richland, Washington (2014).
2. J. S. SCHOFIELD, RPP-RPT-55264, “Evaluation of Tanks 241-T-203 and 241-T-204 Level Data and In-Tank Video Inspections,” Revision 0, Washington River Protection Solutions LLC, Richland, Washington (2013).
3. TANK AND PIPELINE INTEGRITY, PM-13-004, “Closing Breather Filter Inlet Valves on 241-T-203 and 241-T-204,” Washington River Protection Solutions LLC, Richland, Washington (2013).
4. H-2-69748, “Air Filter for Waste Tank Atmospheric Breathing,” Sheet 1, Revision 4, Washington River Protection Solutions LLC, Richland, Washington (1981).

5. L. J. KRIPPS, HNF-SD-WM-TSR-006, “Tank Farms Technical Safety Requirements,” Revision 7-P, Washington River Protection Solutions LLC, Richland, Washington (2013).
6. TF-AOP-005, “Response to Unexpected Tank Temperature, Level or Flammable Gas Increase,” Revision E-0, Washington River Protection Solutions LLC, Richland, Washington (2013).
7. R. J. YARBROUGH, RPP-5926, “Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste,” Revision 13, Washington River Protection Solutions LLC, Richland, Washington (2013).