Appendix G

Sampling Error and Correction Efforts For Mass Balance Study

Mass Balance Sampling Error

The initial sample results from the drum debris samples reported by the laboratory were much higher than the results used in the mass balance equation in Chapter 5. These higher concentrations were scrutinized by the team and upon further discussion with the laboratory, an error in the analytical method for the drum debris bulk samples was discovered. Table 1 presents the results from the initial analysis that was used in the original mass balance equation.

Table 1: Initial Drum Debris Bulk Sample Analytical Results

Device	Sample #	Result	Average Concentration
MFG A	R/B-2/27-16	160 µg/g	123.3µg/g
MFG A	R/B-2/27-17	100 µg/g	
MFG A	R/B-2/27-18	110 µg/g	
MFG B	D/B-2/28-35	140 µg/g	180.0 µg/g
MFG B	D/B-2/28-36	130 µg/g	
MFG B	D/B-2/28-37	270 µg/g	
MFG C	A/B-2/26-07	150 µg/g	145.3 µg/g
MFG C	A/B-2/26-08	200 µg/g	
MFG C	A/B-2/26-09	86 µg/g	

The quantity of mercury in the drum debris was calculated by multiplying the average of the drum debris results by the weight of the debris in the drum. The weight of the drum debris for the Mfg C device was 436 pounds that converts to 197766.3 grams. The weight of the drum debris for the Mfg A device was 466 pounds that converts to 211374 grams. The weight of the drum debris of the Mfg B device was 331 pounds that converts to 150139.1 grams. Based on the drum debris analytical results and debris weight the quantity of mercury in the debris for each device is:

- Mfg C 28,735.4 mg
- Mfg A 26,062.4 mg
- Mfg B 27,025.0 mg

When these quantities are added into the table presenting all the mass balance quantities, a large difference between the quantity of mercury processed Hg_T and the quantity of mercury in the drum debris is notable. Table 2 presents the results of the mass balance equation using the values presented for Hg_T, Hg_U, and Hg_R. Refer to Chapter 5 of the report for a description of how the other quantities were derived.

Table 2: Mass Balance Results

Device	Hg_T	Hg_U				Hg_R
		Drum Debris	Pre-filter	HEPA filter	Carbon filter	
MFG A	2675.4 mg	26,062.4 mg	NA	2.659 mg	1015.5 mg	0.38 mg
MFG B	2307.6 mg	27,025.0mg	12.45 mg	NA	7.3 mg	0.41 mg
MFG C	2934.5 mg	28,735.4 mg	47.35 mg	0.029 mg	57.9 mg	0.39 mg

Upon reviewing results in Table 3 below, the amount of mercury recovered is significantly greater than the calculated quantity of mercury processed in the study.

Table 3: Percentage of Mercury Recovery

Device	Hg Processed (HgT)	Hg Recovered (HgU+HgR)	% Recovery
MFG A	2675.4 mg	27080.8 mg	1012.2 %
MFG B	2307.6 mg	27045.0 mg	1172.0 %
MFG C	2934.5 mg	28841.0 mg	982.8 %

Due to significant error in the results of the Mass Balance Analysis, the study team re-evaluated the entire original mass balance study including the laboratory results to identify discrepancies in the study to account for the errors when balancing the equation. Upon further discussion with the laboratory it was discovered that the when preparing the drum debris sample for analysis, only the "fines" were removed from the bulk sample for analysis. The "fines" consisted of the fine phosphor powder and possibly the very small pieces of glass. However, the content of the drum debris samples also consisted of larger glass pieces and metal end caps, which could also contain some of the unaccounted mercury and contributed mass to the calculation of the total mercury concentration. In an effort to obtain more accurate bulk sample results and account for mercury post crushing, the remainder of the original drum debris bulk samples were analyzed and the results were combined with the results from the first analysis.

The second analysis of the drum debris involved weighing the entire remaining content of the samples and digesting the entire sample. The results from the original analysis and the second analysis were combined mathematically and presented as µg/sample. The weights in grams from the original analysis and the second analysis were added together to get the total weight of the drum debris bulk samples. The final reported results shown below in Table 4, in µg/g, are a combination of the analytical results and the weights from the original and second analyses. The following table presents the drum debris bulk sample results from the second analysis and shows a comparison to the original analysis.

Table 4: Drum Debris Bulk Sample Results (2nd Analysis)

Sample #	Device	Combined Wt. [1]	Corrected Result	Original Result	% Difference
A/B-2/26-07	MFG C	74.8 g	6.07 µg/g	150 µg/g	- 95.9 %
A/B-2/26-08	MFG C	56.6 g	5.58 µg/g	200 µg/g	- 97.2 %
A/B-2/26-09	MFG C	95.2 g	2.43 µg/g	86 µg/g	- 97.2 %
R/B-2/27-16	MFG A	72.9 g	5.84 µg/g	160 µg/g	- 96.4 %
R/B-2/27-17	MFG A	79.2 g	2.70 µg/g	100 µg/g	- 97.3 %
R/B-2/27-18	MFG A	86.4 g	2.57 µg/g	110 µg/g	- 97.7 %
D/B-2/28-35	MFG B	67.7 g	5.17 µg/g	140 µg/g	- 96.3 %
D/B-2/28-36	MFG B	85.2 g	4.59 µg/g	130 µg/g	- 96.5 %
D/B-2/28-37	MFG B	79.0 g	5.56 µg/g	270 µg/g	- 97.9 %

1. The combined weight presented in the table was reported in the final analytical report as measured by the laboratory.

Analyzing the results between the original analysis and the corrected analysis has identified an approximate 96 % difference in the concentration of mercury in the drum debris bulk samples. This significant change in values is due to the significant increase in sample weight when the larger pieces of debris are included in the analysis. When the analysis included only the "fines", where mercury is expected to be concentrated, it resulted in biased results and increased the concentration.

Table 5 presents the recalculated quantity of mercury in the drums compared to the original quantity:

Table 5: Re-calculated Mercury Amounts

Device	Total Weight Crushed Material and Drum Weight (Net)	Total Mass of Hg Corrected	Total Mass of Hg Original
MFG C	197,765 g	927.5 mg	28,735.3 mg
MFG A	211,373 g	782.1 mg	26,062.3 mg
MFG B	150,138 g	767.2 mg	27,024.8 mg

The new drum debris results above are inputted into the mass balance table to replace the original results. Refer to Chapter 5 of the report presents the mass balance study using the correct drum debris bulk sample results.