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August 30, 1996

James Webb
Bureau of Radiation Protection
Ohio Department of Health
246 North High Street
Columbus, Ohio 43266-0188

Subject: Shieldalloy RI/FS
Radiological Data Quality Evaluation Issues
PTI Contract CA38-15-29

Dear Mr. Webb:

Please find enclosed our response to your August 8, 1996 and Ruth Vandegrift's August 23, 1996 letters to Jim Valenti and Pat Lee. Our response addresses the issues listed in the conclusions of *Evaluation of PTI's Response to Comments and Recommendations on Radiological Data Quality for the RI/FS of the Shieldalloy Metallurgical Corporation Site in Cambridge, Ohio,* which was attached to your August 8, 1996 letter and the *Addendum to Data Quality Evaluation of Remedial Investigation and Feasibility Study Radiological Data from the Shieldalloy Metallurgical Corporation Site in Cambridge, Ohio* attached to Ms. Vandegrift's August 23, 1996 letter.

We believe that your concerns regarding the validation, use, and reporting of the radiological data for the Cambridge site have been addressed and that this response resolves the outstanding issues regarding data validation. If you have any questions, please do not hesitate to call me at (206) 643-9803.

Cordially,

Walter J. Shields, Ph.D.
Principal

Enclosure

cc: Robert Karl, Ohio AG
John House, USNRC
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Ruth Vandegrift, ODH
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RESPONSE TO AUGUST 8 AND AUGUST 23, 1996 LETTERS

AUGUST 8 LETTER

As requested in the August 8, 1996 letter, this response is directed to the four recommendations identified in the *Conclusion* of the report entitled *Evaluation of PTI's Response to Comments and Recommendations on Radiological Data Quality for the RI/FS of the Shieldalloy Metallurgical Corporation Site in Cambridge, Ohio.* The recommendation is provided below in boldface text, followed by the response.

Recommendation #1: Use the entire valid data set of net results and uncertainties for the data analysis.

Tables have been generated that show the net results and uncertainties for all validated RI data. These tables were submitted electronically to the Ohio Department of Health on June 13, 1996 under separate cover. These data have been used in the determination of CoPCs (see response to Recommendation #3) and in the baseline risk assessment (see response to Recommendation #4). The data, the CoPC determination, and the baseline risk assessment results will be included in the final RI Report. Accordingly, Recommendation #1 is fully satisfied.

Recommendation #2: Remove data qualified as rejected from the data set and document this data set.

Volume II of the final RI report will include tabular summaries of all RI data including the radiological data. The data summary tables will include qualifiers assigned to the data during validation. Rejected data will be included in the data summary tables with an *R* qualifier identifying the result as rejected. Thus, Recommendation #2 is fully satisfied.

Recommendation #3: Fully document the parameters and results of the Wilcoxon Rank Sum Test and use these results to identify the radionuclides to include in the risk analysis.

The parameters and results of the Wilcoxon Rank Sum test (Conover 1980[1]) will be included in the final RI report. As discussed in the June 26, 1996 letter from W. J. Shields (PTI) to James Webb (Ohio Department of Health), two radionuclides were identified as

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[1] Conover, W.J. 1980. Practical nonparametric statistics. John Wiley & Sons, New York, NY.

potentially significant using this test - Actinium-227 and Radium-228. Also included in the June 26, 1996 letter were the results of risk assessment calculations that used as input the 95% upper confidence level of the mean for these two radionuclides, which showed that there were small but not significant differences between the RI report baseline risk assessment (which used Thorium-230 as the only CoPC) and this risk assessment. These results are compared in Table BK-1 (see also the response to Recommendation # 4). The risks from the two assessments had the same order of magnitude, so the conclusion of the baseline risk assessment remains the same. No significant impact to the risk assessment conclusions would result from the use of the Wilcoxon test. This fully satisfies Recommendation #3.

Recommendation #4: Include the Th-232 and U-235 (at least starting at Pa-231) decay chains in the risk assessment at the 95% upper confidence level of their mean concentration because of lack of sensitivity of detection at background levels. The pathway and exposure assumptions should be the same as those assumed in the final RI report.

To determine the sensitivity of including additional radionuclides in the baseline risk assessment, the risks at the Cambridge site were reanalyzed including all eleven radionuclides in the actinium decay series and all eleven radionuclides in the thorium decay series. The radionuclides were represented by the 95% upper confidence level of their mean concentrations. The results of this reanalysis are shown in Table BK-1, along with the results of the RI report's baseline risk assessment and the risk assessment calculations described in the response to Recommendation #3. The results including all radionuclides in both decay chains had the same order of magnitude as the risks from the two assessments described in the response to Recommendation # 3. Thus, no significant impact to the risk assessment conclusions would result from the use of all of the radionuclides in the actinium and the thorium decay chains. The results of all three risk assessments support the conclusion that the two slag piles do not pose a significant risk to the surrounding population. This fully satisfies Recommendation #4.

AUGUST 23 LETTER

The August 23, 1996 cover letter and attached *Addendum* report include three additional recommendations. The first two recommendations were included in the August 23, 1996 cover letter to the *Addendum*. The third recommendation was included in the conclusions of the *Addendum* report. The ODH recommendations are provided below in boldface text, followed by the response.

For each radionuclide present at the site (including both the slag piles and the surrounding media) we request that the companies provide the MDA value that PTI used during data analysis, and the equation used to determine the MDA value.

Volume II of the draft RI report includes data summary tables for all the radiological data generated for the RI. Section 1 of Volume II includes the data sorted by matrix. Section 2 of Volume II includes the data summary tables associated with each individual quality assurance review report. All of the data summary tables include the MDA value for data that were reported by the laboratory at or below the MDA. Because the Volume II data summary tables include the MDA values requested, no additional documentation is required. The equations used by the laboratory to determine the MDA values were requested from Quanterra's St. Louis laboratory. Table 2 summarizes the equations and/or software packages used by Quanterra's Earth City, Missouri Radiological Laboratory to calculate MDAs. This fully satisfies the state's recommendation.

The state recommends that a quality check be performed on the entire data set to ensure that the proper results have been entered in the database and the data tables.

As part of the finalization of the draft RI report, final proofing of the database was performed. In response to the state's request for a quality check specific to the radiological data, the changes made to the radiological data as a result of the final proofing were extracted and are summarized in Table 1, which is attached. Several types of errors were identified during the final proofing. The error types included missing concentration qualifiers (*U*, undetected) for samples, the inclusion of *U* qualifiers which should have been deleted as a result of validation, transcription errors when key-entering sample results or standard deviations, the reporting of preliminary results rather than final results for two groundwater samples (GW3001 and GW3007 [17 sample results]), and reporting of the SPLP samples for Bi-212 with the wrong units (pCi/g instead of pCi/L).

Because the source term document[2] was completed prior to receipt and completion of all isotope-specific laboratory data, data from less sensitive analyses (e.g., gamma spectroscopy) were used. The calculations included in the source term document were therefore reviewed to determine the impact, if any, to the inventory and leachate estimates from the revision of the data points described above. Table 2 summarizes the radioactivity concentrations for the East and the West Slag Piles reported in the Source Term Document and recalculated using final, revalidated data.

Very few of the slag concentrations changed significantly as a result of the recalculation. In particular, the primary contributors to the dose assessment model (Thorium-230,

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[2] IEM. 1995. Source term development: east and west slag piles, Shieldalloy Metallurgical Corporation, Cambridge, Ohio site. Submitted to U.S. Nuclear Regulatory Commission, Rockville, Maryland. Report No. 94014/G-101. Integrated Environmental Management, Inc. Knoxville, Tennessee. June 10.

Protoactinium-231, Actinium-227, Radium-226, and Radium-228) had essentially the same concentration, no matter which data set was used. A few of the concentrations (particularly Polonium-210 and Protactinium-234m) decreased significantly using isotope-specific data.

Table 3 summarizes the radioactivity concentrations for the East and West slag piles as reported in the source term document and recalculated using final validated data. Most of the concentrations that changed are lower using final data. The primary contributors to the dose assessment model, Th-230, Pa-231, Ac-227, Ra-226, and Ra-228 did not change significantly using final validated data.

The average Synthetic Precipitation Leaching Procedure (SPLP) extract concentrations were also recalculated for the two slag piles. The results of this calculation, along with the analogous results originally presented in the source term document, are shown in Table 4. As with the average slag concentrations, the SPLP values changed slightly due to the differences in the extract concentrations. These changes do not impact the conclusions of the RI report that migration of radioactivity to groundwater will not occur. Further, the extract concentrations for radionuclides that are of greatest concern to onsite and offsite receptors are virtually the same.

There were no changes to the constituents of concern for the risk assessment or significant impacts to the source term calculations as a result of the final proofing of the radiological database. Tables 3 and 4 summarize the revised source term calculations. This response serves to document these minor changes for the radiological database used for the source term calculations and fully satisfies the state's recommendation.

Furthermore, in PTI's response to recommendations, it was noticed that in the tables the uncertainties were not correctly propagated when sample results were averaged. It is recommended that a QA check be performed on the entire data set to ensure that the proper results have been entered in the database and data tables.

A standard accepted method was used to propagate the uncertainties. Because there are different methods for propagating uncertainties, the method used, which involved the averaging of laboratory replicates and subsequent calculation of the standard deviation, is described here.

The method for reporting uncertainties for laboratory duplicate results was discussed in Section 3 of Volume II of the draft RI report. Averaging of laboratory replicates was performed as described below:

- If all results are detected (reported above the MDA), all results are averaged.
- If all results are undetected (reported to the MDA as undetected), the lowest detection limit is reported.

- If at least one result is detected and one result is undetected, then a) if all detected results are above the highest detection limit, then all results are averaged and reported as detected, or b) if at least one detection limit is higher than a detected value, only detected results are averaged.

Several of the data results that changed as a result of the final proofing of the data, as discussed above, were laboratory duplicates. Accordingly, after proofing and substitution of accurate data in the few instances where needed, the standard deviations also changed.

The standard deviation of each average of laboratory replicates is calculated using the fact that the variance of a sum is equal to the sum of the variances of the addends (Snedecor and Cochran 1967; Wang et al. 1975[3]). The procedure in detail is as follows:

1. The recorded standard deviation of each laboratory replicate (i.e., each activity) is squared, producing the variance of each replicate.
2. The variances of all laboratory replicates are summed, producing the variance of the sum of replicate activities.
3. The square root of the sum of variances is calculated, producing the standard deviation of the sum of activities.
4. The standard deviation of the sum of activities is divided by the sum of activities, producing the coefficient of variation of the sum of activities.
5. The coefficient of variation is multiplied by the average activity of all laboratory replicates, producing the standard deviation of the average activity.

An alternative method of calculating the standard deviation of the average activity is to calculate the standard deviation of the replicates and divide it by the square root of the number of replicates. This is the method used to estimate the standard deviation of a mean when the variance of individual observations (i.e., replicates) is unknown. Thus, this alternative method discards all information contained in the individual standard deviations. The method that is used by PTI takes advantage of all available information. Accordingly, it was the appropriate method to use here. Thus, this response fully satisfies the state's recommendation.

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[3] Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods, Sixth Edition. The Iowa State University Press, Ames Iowa. 593 pp.

Wang, C.H., D.L. Willis, and W.D. Loveland. 1975. Radiotracer methodology in the biological, environmental, and physical sciences. Prentice-Hall, Inc., New Jersey. 480 pp.

CONCLUSION

We appreciate the opportunity to respond to the state's recommendations and will incorporate the requested information into the RI/FS report. As demonstrated in these responses, as well as the response letter submitted on June 26, 1996, the conclusions of the draft RI remain unchanged.

Table BK-1. Comparison of Risk Assessments Using Different CoPCs (Cambridge Site)

Receptor	Age Group	Risk from Th-230 (RI Baseline) Table 107	Risk from Ra-228 + D & Ac-227 + D (6/26/96 Letter)	Risk from Actinium Series & Thorium Series (8/8/96 Letter)
Resident	Infant	3E-7	1E-6	2E-6
	Child	1E-7	2E-7	5E-7
	Teen	7E-7	1E-6	2E-6
	Adult	4E-7	1E-6	2E-6
Recreationist	Adult	6E-7	5E-7	6E-7
Worker	Adult	1E-5	1E-5	2E-5
Resident	TOTAL	2E-6	4E-6	6E-6
Worker	TOTAL	1E-5	1E-5	2E-5

TABLE 1. FINAL CORRECTIONS TO THE DRAFT REMEDIAL INVESTIGATION RADIOLOGICAL DATABASE

Sample No.	Station	Radionuclide	Type	Reported in Draft RI Tables			Revised RI Results			ODH Tables (no MDAs)		
				Result	SD	Qual.	Result	SD	Qual.	Result [a]	SD	Qual.
Qualifiers Added or Removed, consequently Standard Deviations Changed												
Added												
COMP6	WPBO-CMP	TH-230	SPLP	0.77	0.17	J	0.77		UJ	0.77	0.17	J
SL011F	EPSL-10	RA-223	DRY	44.3	2.5	J	44.3		UJ	36.1	15.8	J
XRF031AF	WPSL-31A	PA-234	DRY	2.4	0.1		2.4		U	1.1	0.7	
Removed												
SL3012	WPBO-12	TL-208	DRY	0.45		U	0.45	0.11		0.45	0.11	
Qualifier Removed, no change in Standard Deviation												
SL009C	EPSL-08	U-235	SPLP	9.3	1.8	UJ	9.3	1.8	J	9.3	1.8	J
SO0196	FSRBOP2	RA-224	DRY	4.3		U	4.3 [b]			4.3	1.0	
Standard Deviations Only Changed												
GW3001	MW-9	RA-226	WHL	0.34	0.08	J	0.34 [b]		J	0.34	0.08	J
SD0001	CHRN-01	TH-232	DRY	1.3	0.3	J	1.3	0.2	J	1.3	0.2	J
SL3007	WPBO-11	PB-212	DRY	1.4	0.2		1.4	0.1		1.4	0.1	
SL3017	WPBO-14	PB-212	DRY	0.80	0.05		0.85	0.08		0.85	0.08	
SL3017	WPBO-14	TL-208	DRY	0.38	0.05		0.38	0.06		0.38	0.06	
SL3018	WPBO-14	TL-208	DRY	0.38	0.07		0.38	0.11		0.38	0.11	
SL5001	WPSL-3	RA-224	DRY	8.6	1.1	NJ	8.6	0.8	NJ	8.6	0.8	NJ
XRF007AF	WPSL-07A	U-235	DRY	1.1	0.1	J	1.1	0.2	J	1.1	0.2	J
Value, Qualifier, and Standard Deviation Changed												
COMP4	WPBO-CMP	AC-227	SPLP	52.0	1.9		46.2		U	-53.9	16.6	
COMP5	WPBO-CMP	TH-230	SPLP	1.3	0.2	J	0.82		UJ	1.3 [c]	0.2	J
GW3012	MW-9	BI-214	WHL	31.6		U	35.5	9.6		35.3 [d]	16.4	
SL5004	WPSL-8	RA-228	DRY	0.60		U	0.69	0.16		NR		
Values and Standard Deviations Changed												
COMP3	WPBO-CMP	BI-212	DRY	1.8	0.2		1.9 [b]			1.8	0.3	
COMP3	WPBO-CMP	PB-210	DRY	4.1	0.1	J	4.2	0.2	J	4.2	0.1	J
GW3001	MW-9	BI-214	WHL	40.5	11.0		33.7	10.0		33.7	10.0	
GW3001	MW-9	PB-214	WHL	46.8	11.0		42.0	12.5		42.0	12.5	
GW3012	MW-9	PB-214	WHL	47.1	6.4		49.3	6.8		49.3	6.8	
SD0006	UTEF-01	TH-230	DRY	3.9	7.6		4.3	0.5		4.3	0.5	
SL007F	EPSL-06	U-234	DRY	0.23 [b]			77.1	5.3		77.1	5.3	
SL3007	WPBO-11	RA-224	DRY	10.4 [b]		NJ	18.8	2.0	NJ	14.8 [e]	3.4	NJ
SL3007	WPBO-11	RA-228	DRY	1.1 [b]			1.7	0.3		--		
SL3010	WPBO-12	BI-214	DRY	83.0	2.4		1.6	0.3		1.6	0.3	
SL5012	WPSL-51	PB-214	DRY	0.61	0.13		0.90	0.08		0.90	0.08	
SO3003	WPBO-11	PB-210	DRY	2.7	0.2	J	1.2	0.3	J	1.2	0.2 [f]	J
Units Changed, consequently Values Changed												
COMP1	WPBO-CMP	BI-212	SPLP	87.0		U	87.0		U	24.0	23.4	

TABLE 1. FINAL CORRECTIONS TO THE DRAFT REMEDIAL INVESTIGATION RADIOLOGICAL DATABASE

				Reported in Draft RI Tables			Revised RI Results			ODH Tables (no MDAs)		
Sample No.	Station	Radionuclide	Type	Result	SD	Qual.	Result	SD	Qual.	Result [a]	SD	Qual.
COMP3	WPBO-CMP	BI-212	SPLP	0.094		U	93.7		U	38.7	24.8	
COMP4	WPBO-CMP	BI-212	SPLP	0.078		U	77.7		U	-41.8	20.9	
SL007C	EPSL-06	BI-212	SPLP	0.078		U	78.3		U	-13.4	23.9	
XRF001C	WPSL-01	BI-212	SPLP	0.083		U	83.4		U	12.1	25.6	
Values Changed												
Detected												
SL5001	WPSL-3	RA-228	DRY	0.54 [b]			0.66 [b]			NR		
XRF001C	WPSL-01	U-234	SPLP	0.10 [b]			0.25 [b]			0.22	0.08	
XRF001F	WPSL-01	TL-208	DRY	0.24 [b]			0.28 [b]			0.25	0.05	
XRF020F	WPSL-20	PB-210	DRY	0.099	0.099	J	0.80	0.10	J	0.80	0.10	J
Undetected												
GW0033	MW-13	BI-212	WHL	93.3		U	92.3		U	5.3	28.9	
GW3001	MW-9	AC-227	WHL	67.6		U	68.5		U	-0.51	19.65	
GW3001	MW-9	BI-212	WHL	80.7		U	88.5		U	16.1	23.6	
GW3001	MW-9	PA-231	WHL	350		U	325		U	4.6	92.8	
GW3001	MW-9	PA-234	WHL	32.6		U	37.6		U	14.4	10.6	
GW3001	MW-9	RA-223	WHL	371		U	322		U	-130	98	
GW3001	MW-9	RA-224	WHL	227		U	240		U	223	63	
GW3001	MW-9	TL-208	WHL	12.5		U	11.1		U	-0.44	3.09	
GW3007	MW-23	AC-227	WHL	44.4		U	46.1		U	-71.7	17.6	
GW3007	MW-23	BI-212	WHL	78.7		U	88.6		U	7.3	23.7	
GW3007	MW-23	BI-214	WHL	24.9		U	27.2		U	1.9	9.9	
GW3007	MW-23	PA-231	WHL	244		U	262		U	8.1	72.5	
GW3007	MW-23	PA-234	WHL	19.2		U	20.3		U	-1.8	5.9	
GW3007	MW-23	PB-212	WHL	12.2		U	15.7		U	7.4	4.4	
GW3007	MW-23	PB-214	WHL	22.1		U	26.1		U	24.4	9.7	
GW3007	MW-23	RA-223	WHL	254		U	302		U	-94.1	89.6	
GW3007	MW-23	RA-224	WHL	150		U	147		U	-197	54	
GW3007	MW-23	TL-208	WHL	8.5		U	9.3		U	-2.2	2.8	
GW3012	MW-9	RA-228	WHL	1.3		U	1.2		U	0.12	0.35	
SL3010	WPBO-12	BI-212	DRY	1.1	0.3		1.2	0.3		1.2	0.3	
SL3011	WPBO-12	BI-212	DRY	1.2		U	1.9		U	1.2	0.5	
SL3018	WPBO-14	RA-223	DRY	10.0		U	11.1		U	1.3	3.1	
SL3027	WPBO-12	RA-223	DRY	4.4		U	7.9		U	6.5	0.9	
S00196	FSRBOP2	TH-232	DRY	0.11		U	0.13 [b]			0.08	0.03	
XRF001C	WPSL-01	TH-232	SPLP	0.21		U	0.17		U	-0.0050	0.0050	
XRF014C	WPSL-14	U-234	SPLP	0.27		U	0.24		U	0.083	0.065	
XRF014F	WPSL-14	RA-223	DRY	0.84		U	4.8		U	0.31	1.40	

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				Reported in Draft RI Tables			Revised RI Results			ODH Tables (no MDAs)		
Sample No.	Station	Radionuclide	Type	Result	SD	Qual.	Result	SD	Qual.	Result [a]	SD	Qual.

Note:

The convention used for the reporting of laboratory duplicate results in the draft remedial investigation is as follows: If all laboratory duplicate results were detected then the average of all duplicates was reported. If all duplicate results were undetected then the lowest detection limit was reported. If at least one duplicate was undetected and one detected and the concentration of the detected result was above the MDA for the undetected result, then all results were averaged. If at least one duplicate was undetected and one detected and the concentration of the detected result was below the MDA for the undetected result, then only the detected results were averaged.

SPLP - SPLP extract sample, units are pCi/L.

WHL - Whole water sample, units are pCi/L.

DRY - Dry solid sample, units are pCi/g.

NR - Not reported in the draft remedial investigation

SD - Standard deviation, rounded to the same number of decimal places as the result.

J - Estimated

NJ - Tentatively identified/ estimated

U - Undetected

-- Ra-226 and Ra-228 were analyzed by gamma spectroscopy and gas proportional counting for Phases 1 and 2. For Phase 3, the West Slag Pile Boring samples were analyzed by gamma spectroscopy only. When the data were exported to the ODH, the Ra-226 and Ra-228 results reported by gas proportional counting were included in the export, and therefore, the Phase 3 gamma spectroscopy results were not reported.

[a] Results were rounded to match the number of significant figures reported in the draft remedial investigation and the revised RI results.

[b] Standard deviations were not reported in the case when one laboratory duplicate result was detected and one was undetected.

[c] Result reported to ODH should have been 0.82, the lower of the laboratory duplicate results because both were undetected.

[d] Result reported to ODH should have been 35.4, the average of the laboratory duplicate results of 35.3u and 35.5, the measured activities. The revised RI result is 35.5 because the first duplicate result is changed to the MDA, 38.5u. Because 38.5u is higher than 35.5, only the detected result is reported.

[e] Result reported to ODH should have been 18.8, the average of the laboratory duplicate results, 22.8 and 14.8. Using the convention for reporting laboratory duplicate results, PTI previosuly reported the concentration as 14.8 because the first duplicate result was incorrectly qualified as undetected. After the removal of the u qualifier, the duplicate results were averaged as required by the convention for reporting laboratory duplicate results.

[f] The result and standard deviation were entered into the database twice. Therefore, the standard deviation calculated for the mean was smaller, 0.2. When the multiple result was removed, the standard deviation was correctly reported as 0.3.

TABLE 2. LABORATORY MDA CALCULATIONS

Method Type	Radionuclides	Equation/Software Package Used to Generate MDAs
Gamma spectroscopy	Ac-227, Bi-212, Bi-214, Pa-231, Pa-234, Pb-212, Pb-214, Ra-223, Ra-224, Th-229, Th-234, Tl-208	Canberra's Procount with Error Propagation
Alpha spectroscopy	Po-210, Ra-223, Ra-224, Ra-226, Ra-228, Th-228, Th-230, Th-232, total thorium, U-234, U-235, U-238	Canberra's Alpha Management system with Error Propagation
Gas proportional counting	Pb-210, Ra-228, alpha radioactivity, beta radioactivity	Excel® spreadsheet[a]
Kinetic phosphorescence	Total uranium	Reporting limit established by laboratory is 1 pCi/L

Note: MDA - minimum detectable activity

[a] MDA calculation from data packages.

$$MDA = \frac{(4.65 * \sqrt{BCPM * SCT} + 2.71)}{CF * Eff * ALIQ * PbCY * BiCY * I * D * TF * SCT}$$

where

ALIQ = aliquot
BCPM = background counts per minute
CF = correction factor
CY = chemical yield
D = decay
Eff = efficiency
I = ingrowth
SCT = sample count time
TF = transmission factor

TABLE 3. COMPARISON OF RADIOACTIVITY IN SLAG PILES

	East Pile Slag Data		West Pile Slag Data	
Radionuclide	Source Term Document (pCi/g)	Using Validated RI Data Values (pCi/g)	Source Term Document (pCi/g)	Using Validated RI Data Values (pCi/g)
U-238	40.4	41.7	4.04	4.4
Th-234	26.2	26.0	3.89	3.35
Pa-234m	41.1	1.62	4.38	0.774
U-234	41.3	42.6	4.20	4.56
Th-230	980	997	285	291
Ra-226	38.5	38.5	6.39	6.39
Rn-222	38.5	38.5	6.39	6.39
Po-218	38.5	38.5	6.39	6.39
Pb-214	39.1	38.7	6.70	6.54
Bi-214	38.5	38.1	6.39	6.23
Po-214	38.5	38.1	6.39	6.23
Pb-210	32.4	12.9	90.4	7.34
Bi-210	12.4	15.0	7.61	5.63
Po-210	9.87	8.96	3.75	3.57
U-235	4.68	5.08	0.92	0.483
Th-231	4.68	3.97	0.92	0.526
Pa-231	39.0	39.5	10.3	10.4
Ac-227	26.1	25.9	5.48	5.36
Th-227	26.1	25.9	5.48	5.36
Ra-223	32.5	31.3	12.4	11.3
Rn-219	32.5	31.4	12.4	11.5
Po-215	32.5	31.4	12.4	11.5
Pb-211	32.5	31.4	12.4	11.5
Bi-211	32.5	31.4	12.4	11.5
Tl-207	32.5	31.4	12.4	11.5

TABLE 3. (Cont.)

	East Pile Slag Data		West Pile Slag Data	
Radionuclide	Source Term Document (pCi/g)	Using Validated RI Data Values (pCi/g)	Source Term Document (pCi/g)	Using Validated RI Data Values (pCi/g)
Th-232	21.3	21.3	3.74	3.62
Ra-228	21.6	21.6	2.08	2.08
Ac-228	21.6	21.6	2.08	2.08
Th-228	15.6	15.3	2.02	1.75
Ra-224	99.8	98.2	19.8	18.8
Rn-220	99.8	98.2	19.8	18.8
Po-216	99.8	98.2	19.8	18.8
Pb-212	23.7	23.5	2.06	2.01
Bi-212	15.9	15.5	1.67	1.59
Po-212	10.2	10.2	1.07	1.09
Tl-208	7.55	7.49	0.684	0.645

TABLE 4. COMPARISON OF RADIOACTIVITY IN SLAG PILES

	East Pile SPLP Data		West Pile SPLP Data	
Radionuclide	Source Term Document (pCi/L)	Using Validated RI Data Values (pCi/L)	Source Term Document (pCi/L)	Using Validated RI Data Values (pCi/L)
U-238	0.43	0.41	0.21	0.2
Th-234	0.43	0.41	0.21	0.2
Pa-234m	2.46	4.42	4.61	8.78
U-234	3.45	3.41	0.49	0.47
Th-230	3.59	3.36	1.11	0.93
Ra-226	189.28	190.98	42.34	36.56
Rn-222	189.28	190.98	42.34	36.56
Po-218	189.28	190.98	42.34	36.56
Pb-214	131.03	131.72	24.5	27.42
Bi-214	137.92	139.44	26.66	30.31
Po-214	137.92	137.94	26.66	26.56
Pb-210	137.92	139.44	26.66	30.31
Bi-210	9.63	0.63	2.43	0.43
Po-210	9.58	0.38	2.42	0.33
U-235	1.09	1.30	0.19	0.33
Th-231	0.93	0.98	29.34	0.12
Pa-231	101.48	49.91	60.75	113.68
Ac-227	20.0	9.46	46.02	19.87
Th-227	20.0	9.46	46.02	19.87
Ra-223	232.48	114.87	121.42	165.81
Rn-219	232.48	114.87	121.42	165.81
Po-215	232.48	114.87	121.42	165.81
Pb-211	232.48	114.87	121.42	165.81
Bi-211	232.48	114.87	121.42	165.81
Tl-207	232.48	114.87	121.42	165.81

TABLE 4. (Cont.)

	East Pile SPLP Data		West Pile SPLP Data	
Radionuclide	Source Term Document (pCi/L)	Using Validated RI Data Values (pCi/L)	Source Term Document (pCi/L)	Using Validated RI Data Values (pCi/L)
Th-232	0.24	0.24	0.12	0.20
Ra-228	1.58	5.00	0.71	0.71
Ac-228	1.70	5.11	0.79	0.78
Th-228	0.3	0.32	0.15	0.17
Ra-224	289.1	196.9	86.48	86.71
Rn-220	289.1	196.9	86.48	86.71
Po-216	289.1	196.9	86.48	86.71
Pb-212	6.57	4.81	5.07	6.79
Bi-212	6.57	11.58	5.07	29.56
Po-212	4.02	7.56	2.52	19.02
Tl-208	4.2	3.19	3.41	4.88