ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

May 9, 2001

Louis Carson
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive
Region IV DNMS/FSDB
Suite 400
Arlington, TX 76011

SUBJECT: ANALYTICAL RESULTS FOR SOIL SAMPLES FROM KAISER ALUMINUM, TULSA, OKLAHOMA (DOCKET NUMBER 40-2377)[RFTA NO. 01-002]

Dear Mr. Carson:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) received a total of 46 soil samples collected at Kaiser Aluminum and arriving at ORISE on three different dates. The original RFTA requested alpha isotopic analysis for thorium on all soil samples. After reviewing the alpha isotopic data, ten percent of the samples were to be analyzed by gamma spectroscopy. It is ESSAP's practice to analyze all samples, when possible, by gamma spectroscopy. This process identifies gamma contamination that is not suspected of being present. In addition, the gamma spectroscopy data is used to determine the size of the aliquot needed for any alpha isotopic analyses. The gamma spectroscopy data and the alpha isotopic data for 39 of the 46 samples are reported in Tables 1 and 2, respectively. Data for the other seven samples are in Tables 3 and 4. Table 3 contains two sets of gamma spectroscopy data and alpha spectroscopy data for three samples where there was a discrepancy between the original gamma and alpha isotopic results. Table 4 contains two sets of gamma spectroscopy data and alpha spectroscopy data for four randomly selected samples to demonstrate that there was no need to reanalyze the remaining samples by alpha spectroscopy.

A case narrative is included to describe the laboratory work performed on this set of samples.

ESSAP's Quality Control (QC) procedures were followed for these analyses. The daily QC and detector background for the counting instrumentation used in the analyses were within acceptable limits. The QC files are available for your review upon request.

Please contact me at (865) 241-3242 or Wade Ivey at (865) 576-9184 with any questions or comments.

Sincerely,

Wade for P. Ivey

Dale Condra
Laboratory Manager
Environmental Survey and
Site Assessment Program

RDC/WPI/dkh

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CASE NARRATIVE

The original RFTA (01-002) requested that all samples be analyzed by alpha spectroscopy (alpha spec) for natural thorium. After reviewing the alpha spec data, ten percent of the samples were to be analyzed by gamma spectroscopy (gamma spec). Louis Carson was informed that it was standard operating procedure for ESSAP to perform gamma spec counts on all incoming samples, when possible. The two main purposes for performing gamma spec counts are: 1) to determine if any other identifiable photopeaks other than the ones requested are present in the samples, and, 2) to use the gamma spec data to determine the sample size needed for alpha spec to achieve adequate MDC's without contaminating the solid state surface barrier detectors used for alpha spec.

All samples were placed into 0.5 L Marinelli beakers and gamma counted. After the gamma spec data was reviewed, it was determined that a one gram aliquot was appropriate for all the samples for alpha isotopic analysis. Each one gram aliquot was then processed through the chemical separation procedure in preparation for alpha counting.

After the alpha isotopic analyses were completed, the data were compared to the gamma spec data. There were three samples (ESSAP IDs 782S024, 782S041, and 782S044) for which the alpha spec and gamma spec data did not statistically agree. This indicated a possible homogeneity problem for these samples. After inspecting these samples and determining that the percentage of large gravel particles was significantly more than in the other 43 samples, the decision was made to process these three samples through a 0.25 inch sieve. This decision supports the NRC's definition of "soil" as any material passing through a 0.25 inch sieve. This process provided information from which a correlation between the gravel content in the samples and the inconsistent data from the gamma spec and alpha spec analyses could be made. The sieved portion of these three samples was reanalyzed by both gamma spec and alpha spec. A comparison of the data for the non-sieved and sieved portions are presented in Table 3. An "S" at the end of ESSAP's ID indicates the sample was sieved. The data demonstrates that there can be a significant difference in the reported radionuclide concentrations, dependent upon the sample particle sizes used for the gamma spec count.

After the data for the above three samples were reviewed, it was decided that all samples would be processed through a 0.25 inch sieve. All the samples were gamma counted and four samples were randomly selected for additional alpha isotopic analysis to determine if there was a measurable difference. These four samples (ESSAP IDs 782S006, 782S012, 782S025, and 782S035) have two gamma spec data points and two alpha isotopic data points in Table 4. An "S" at the end of ESSAP's ID indicates the sample was sieved. The alpha spec and gamma spec data were compared for these four samples and there was agreement within the statistical deviation of the procedures. After reviewing the data comparisons with Mr. Carson, it was determined that it was not necessary to reanalyze the remaining samples by the alpha isotopic method as the rest of the samples did not have large particles in them.

A general conclusion can be made from evaluating all of the data. All samples should be processed through a 0.25 inch sieve prior to gamma spec. This procedure allows for a more representative sample if alpha spec is to be performed as well. From the data presented, the first three samples (782S024, 782S041, and 782S044) demonstrate this hypothesis well. The first gamma count in which the samples had not been sieved did not agree well with the alpha spec data. However, after sieving the samples, the data from the gamma spec and alpha spec analyses correlate much better. The analytical results for 782S041 indicate that even with sieving there can still be some problems producing a homogeneous sample. Finally, the data also indicate that for samples with more smaller particle sizes present, the better the correlation between gamma spec and alpha spec data.

TABLE 1

CONCENTRATION OF NATURAL THORIUM GAMMA EMITTING ISOTOPES IN SIEVED SOIL SAMPLES KAISER ALUMINUM TULSA, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentration (pCi/g)			
		Th-228 by Pb-212 @238.63	Th-230 @67.67 keV	Th-232 by Ac-228 @911.07 keV	Total Th by Gamma Spec[b]
782S001	001-BKHSA	0.8 ± 0.1[a]	0.4 ± 1.5	0.7 ± 0.1	1.5 ± 0.1
782S002	002-BKHSA	1.2 ± 0.1	-0.5 ± 2.1	1.2 ± 0.1	2.4 ± 0.1
782S003	024-FS-1A-166A2	4.0 ± 0.2	1.6 ± 2.5	3.9 ± 0.3	7.9 ± 0.4
782S004	017-FS-1A-58B2	2.0 ± 0.1	1.1 ± 3.6	1.9 ± 0.2	3.9 ± 0.2
782S005	22-FS-1A-60C1	1.2 ± 0.1	2.8 ± 2.0	1.2 ± 0.1	2.4 ± 0.1
782S007	005-FS-1B-54C1	1.7 ± 0.1	0.3 ± 2.5	1.8 ± 0.2	3.5 ± 0.2
782S008	1-2E-47A	1.1 ± 0.1	0.0 ± 2.9	1.1 ± 0.2	2.2 ± 0.2
782S009	1-2E-47D	1.1 ± 0.1	2.3 ± 2.9	1.2 ± 0.1	2.3 ± 0.1
782S010	074-FS-2F-42-D2	1.1 ± 0.1	1.3 ± 1.7	1.1 ± 0.1	2.2 ± 0.1
782S011	054-FS-2F-40-A2	1.2 ± 0.1	1.8 ± 1.7	1.2 ± 0.1	2.4 ± 0.1
782S013	063-FS-2F-41-B2	1.4 ± 0.1	4.2 ± 2.5	1.4 ± 0.2	2.8 ± 0.2
782S014	065-FS-2F-41-D2	1.4 ± 0.1	1.0 ± 2.5	1.5 ± 0.2	2.9 ± 0.2
782S015	031-FS-2A-37-C-2	1.5 ± 0.1	1.1 ± 2.2	1.4 ± 0.2	2.9 ± 0.2
782S016	81A	1.1 ± 0.1	-1.4 ± 1.8	1.3 ± 0.1	2.4 ± 0.1
782S017	80A	1.4 ± 0.1	-0.6 ± 2.1	1.4 ± 0.1	2.8 ± 0.1
782S018	78B	1.4 ± 0.1	0.7 ± 2.0	1.4 ± 0.1	2.8± 0.1
782S019	78C	1.6 ± 0.1	0.3 ± 2.5	1.6 ± 0.2	3.2 ± 0.2
782S020	77B	1.6 ± 0.1	4.1 ± 3.7	1.7 ± 0.2	3.3 ± 0.2
782S021	79B	1.4 ± 0.1	1.4 ± 2.1	1.3 ± 0.2	2.7 ± 0.2
782S022	162D	0.7 ± 0.0	0.4 ± 1.6	0.7 ± 0.1	1.4 ± 0.1
782S023	71C	1.4 ± 0.1	1.9 ± 3.5	1.5 ± 0.2	2.9 ± 0.2
782S026	73B	4.3 ± 0.2	5.3 ± 3.1	4.3 ± 0.4	8.6 ± 0.4
782S027	29D	1.5 ± 0.1	1.2 ± 3.9	1.5 ± 0.2	3.0 ± 0.2
782S028	72B	1.3 ± 0.1	0.8 ± 2.0	1.3 ± 0.1	1.6 ± 0.1
782S029	26C	1.9 ± 0.1	1.7 ± 3.3	2.0 ± 0.2	3.9 ± 0.2
782S030	161A	1.1 ± 0.1	0.8 ± 1.7	1.1 ± 0.1	2.2 ± 0.1
782S031	76A	1.8 ± 0.1	1.8 ± 2.2	1.8 ± 0.2	3.6 ± 0.2
782S032	28C	1.5 ± 0.1	1.3 ± 2.1	1.5± 0.2	3.0 ± 0.2
782S033	27A	1.5 ± 0.1	0.3 ± 3.7	1.6 ± 0.2	3.1 ± 0.2
782S034	82B	0.7 ± 0.1	0.2 ± 2.9	0.9 ± 0.1	1.6 ± 0.1
782S036	143	1.2 ± 0.1	4.2 ± 2.5	1.2 ± 0.1	2.4 ± 0.1
782S037	120A	1.5 ± 0.1	0.4 ± 2.3	1.4 ± 0.2	2.9 ± 0.2
782S038	142	1.3 ± 0.1	-0.7 ± 3.6	1.3 ± 0.2	2.6 ± 0.2
782S039	122C	1.4 ± 0.1	1.8 ± 1.9	1.4 ± 0.1	2.8 ± 0.1
782S040	84D	1.2 ± 0.1	0.5 ± 2.0	1.2 ± 0.3	2.4 ± 0.3
782S042	152C	0.6 ± 0.0	1.4 ± 1.5	0.6 ± 0.1	1.2 ± 0.1
782S043	121A	1.3 ± 0.1	0.7 ± 2.0	1.2 ± 0.1	1.5 ± 0.1
782S045	144	1.3 ± 0.1	1.4 ± 3.3	1.3 ± 0.1	2.6 ± 0.1
782S046	119A	1.6 ± 0.1	1.7 ± 2.1	1.7 ± 0.2	1.3 ± 0.2

[a]Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

[b]Total Th is the sum of Th-228 and Th-232.

TABLE 2

CONCENTRATION OF THORIUM ALPHA EMITTING ISOTOPES IN SOIL SAMPLES KAISER ALUMINUM TULSA, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentrations (pCi/g)			
		Th-228	Th-230	Th-232	Total Th[b]
782S001	001-BKHSA	0.86 ± 0.12[a]	0.92 ± 0.12	0.77 ± 0.11	1.63 ± 0.16
782S002	002-BKHSA	1.12 ± 0.13	1.26 ± 0.14	1.14 ± 0.13	2.26 ± 0.18
782S003	024-FS-1A-166A2	4.07 ± 0.35	2.04 ± 0.20	3.94 ± 0.34	8.01 ± 0.49
782S004	017-FS-1A-58B2	1.94 ± 0.20	1.87 ± 0.19	1.92 ± 0.20	3.86 ± 0.28
782S005	22-FS-1A-60C1	1.30 ± 0.14	1.32 ± 0.14	1.05 ± 0.12	2.35 ± 0.18
782S007	005-FS-1B-54C1	1.61 ± 0.18	1.35 ± 0.15	1.44 ± 0.16	3.05 ± 0.24
782S008	1-2E-47A	1.32 ± 0.15	1.74 ± 0.18	1.26 ± 0.14	2.58 ± 0.21
782S009	1-2E-47D	1.37 ± 0.15	1.84 ± 0.18	1.36 ± 0.14	2.73 ± 0.21
782S010	074-FS-2F-42-D2	1.07 ± 0.12	1.10 ± 0.12	1.01 ± 0.12	2.08 ± 0.17
782S011	054-FS-2F-40-A2	1.16 ± 0.14	0.99 ± 0.13	1.04 ± 0.13	2.20 ± 0.19
782S013	063-FS-2F-41-B2	1.28 ± 0.15	1.41 ± 0.16	1.00 ± 0.12	2.28 ± 0.19
782S014	065-FS-2F-41-D2	1.48 ± 0.17	1.47 ± 0.17	1.26 ± 0.15	2.74 ± 0.23
782S015	031-FS-2A-37-C-2	1.48 ± 0.17	1.56 ± 0.18	1.35 ± 0.16	2.83 ± 0.23
782S016	81A	1.29 ± 0.14	1.32 ± 0.14	1.17 ± 0.13	2.46 ± 0.19
782S017	80A	1.44 ± 0.15	1.36 ± 0.15	1.26 ± 0.14	2.70 ± 0.21
782S018	78B	1.38 ± 0.15	1.56 ± 0.16	1.34 ± 0.14	2.72 ± 0.21
782S019	78C	1.59 ± 0.16	1.53 ± 0.15	1.50 ± 0.15	3.09 ± 0.22
782S020	77B	1.72 ± 0.18	1.49 ± 0.16	1.60 ± 0.17	3.32 ± 0.25
782S021	79B	1.36 ± 0.15	1.83 ± 0.18	1.33 ± 0.14	2.69 ± 0.21
782S022	162D	0.74 ± 0.09	0.89 ± 0.10	0.70 ± 0.09	1.44 ± 0.13
782S023	71C	1.36 ± 0.14	1.32 ± 0.14	1.36 ± 0.14	2.72 ± 0.20
782S026	73B	7.69 ± 0.63	7.71 ± 0.63	7.53 ± 0.62	15.22 ± 0.88
782S027	29D	1.44 ± 0.17	2.06 ± 0.22	1.44 ± 0.17	2.88 ± 0.24
782S028	72B	1.48 ± 0.18	1.55 ± 0.18	1.41 ± 0.17	2.89 ± 0.25
782S029	26C	2.28 ± 0.23	4.79 ± 0.43	2.44 ± 0.24	4.72 ± 0.33
782S030	161A	1.08 ± 0.13	1.24 ± 0.14	1.12 ± 0.13	2.20 ± 0.18
782S031	76A	1.97 ± 0.21	1.89 ± 0.20	1.91 ± 0.20	3.88 ± 0.29
782S032	28C	1.53 ± 0.16	2.04 ± 0.20	1.58 ± 0.16	3.11 ± 0.23
782S033	27A	1.30 ± 0.14	1.57 ± 0.16	1.13 ± 0.13	2.43 ± 0.19
782S034	82B	0.90 ± 0.11	0.84 ± 0.11	0.88 ± 0.11	1.78 ± 0.16
782S036	143	1.14 ± 0.13	1.69 ± 0.17	1.14 ± 0.13	2.28 ± 0.18
782S037	120A	1.31 ± 0.15	1.54 ± 0.17	1.36 ± 0.16	2.67 ± 0.22
782S038	142	1.46 ± 0.18	1.83 ± 0.21	1.31 ± 0.16	2.77 ± 0.24
782S039	122C	1.48 ± 0.16	1.65 ± 0.17	1.40 ± 0.15	2.88 ± 0.22
782S040	84D	1.29 ± 0.15	1.23 ± 0.14	1.26 ± 0.14	2.55 ± 0.21
782S042	152C	1.47 ± 0.16	3.08 ± 0.28	1.60 ± 0.16	3.07 ± 0.23
782S043	121A	1.47 ± 0.16	1.44 ± 0.15	1.21 ± 0.13	2.68 ± 0.21
782S045	144	1.38 ± 0.15	1.54 ± 0.17	1.21 ± 0.14	2.59 ± 0.21
782S046	119A	1.77 ± 0.20	3.47 ± 0.34	1.67 ± 0.18	3.44 ± 0.27

[a]Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

TABLE 3

COMPARISON OF NON-SIEVED AND SIEVED DATA FOR THREE SAMPLES WITH HIGH PERCENTAGE OF GRAVEL KAISER ALUMINUM TULSA, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentration (pCi/g)							
		Th-228 by Alpha Spec	Th-228 by Pb-212 @238.63 keV	Th-230 by Alpha Spec	Th-230 @67.67 keV	Th-232 by Alpha Spec	Th-232 by Ac-228 @911.07 keV	Total Th[d] by Alpha Spec	Total Th[d] by Gamma Spec
782S024[a]	74D	23.3 ± 2.1[c]	9.4 ± 0.5	9.71 ± 0.91	6.9 ± 4.7	25.6 ± 2.3	9.3 ± 0.8	48.9 ± 3.1	18.7 ± 0.9
782S024S[b]	74D	10.8 ± 1.0	10.4 ± 0.6	4.39 ± 0.51	9.0 ± 5.1	10.6 ± 1.0	10.1 ± 0.8	21.4 ± 1.4	20.5 ± 1.0
782S041	123A	25.3 ± 2.0	6.1 ± 0.3	33.5 ± 2.6	9.7 ± 4.9	28.9 ± 2.3	6.1 ± 0.5	54.2 ± 3.0	12.2 ± 0.6
782S041S	123A	17.1 ± 1.5	8.9 ± 0.5	18.9 ± 1.7	11.3 ± 4.8	19.0 ± 1.7	8.7 ± 0.7	36.1 ± 2.3	17.6 ± 0.9
782S044	83C	7.19 ± 0.59	1.4 ± 0.1	6.70 ± 0.55	1.7 ± 1.8	6.57 ± 0.54	1.4 ± 0.1	13.76 ± 0.80	2.8 ± 0.1
782S044S	83C	2.97 ± 0.28	2.1 ± 0.1	2.38 ± 0.23	1.3 ± 1.7	2.14 ± 0.21	2.2 ± 0.2	5.11 ± 0.35	4.3 ± 0.2

[a]Samples without an extension on the ID were not processed through 0.25" sieve.

[b]Samples with an "S" extension on the ID were processed through 0.25" sieve.

[c]Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

[d]Total Th is the sum of Th-228 and Th-232.

TABLE 4

COMPARISON OF NON-SIEVED AND SIEVED DATA FOR FOUR SAMPLES WITH LOW PERCENTAGE OF GRAVEL KAISER ALUMINUM TULSA, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentration (pCi/g)							
		Th-228 by Alpha Spec	Th-228 by Pb-212 @238.63 keV	Th-230 by Alpha Spec	Th-230 @67.67 keV	Th-232 by Alpha Spec	Th-232 by Ac-228 @911.07 keV	Total Th[d] by Alpha Spec	Total Th[d] by Gamma Spec
782S006[a]	014-FS-A1-57A1	1.23 ± 0.14[c]	1.4 ± 0.1	1.20 ± 0.14	1.2 ± 1.2	1.19 ± 0.14	1.4 ± 0.1	2.42 ± 0.20	2.8 ± 0.1
782S006S[b]	014-FS-A1-57A1	1.41 ± 0.16	1.2 ± 0.1	1.40 ± 0.16	-0.6 ± 2.1	1.37 ± 0.16	1.1 ± 0.1	2.78 ± 0.23	2.3 ± 0.1
782S012	042-FS-2D-124-2-B	2.22 ± 0.22	2.3 ± 0.1	2.71 ± 0.26	3.0 ± 1.8	2.43 ± 0.24	2.2 ± 0.2	4.65 ± 0.33	5.5 ± 0.2
782S012S	042-FS-2D-124-2-B	2.55 ± 0.26	2.3 ± 0.1	3.36 ± 0.32	2.5 ± 1.7	2.60 ± 0.26	2.2 ± 0.2	5.15 ± 0.37	4.5 ± 0.2
782S025	75A	1.59 ± 0.18	1.4 ± 0.1	2.80 ± 0.28	0.7 ± 2.0	1.33 ± 0.16	1.4 ± 0.1	2.59 ± 0.24	2.8 ± 0.1
782S025S	75A	1.98 ± 0.21	1.6 ± 0.1	3.10 ± 0.30	4.6 ± 3.2	1.79 ± 0.20	1.5 ± 0.2	3.77 ± 0.29	3.1 ± 0.2
782S035	25B	3.46 ± 0.31	2.4 ± 0.1	10.52 ± 0.84	7.4 ± 3.5	4.12 ± 0.36	2.6 ± 0.2	7.58 ± 0.48	5.0 ± 0.2
782S035S	25B	3.55 ± 0.44	3.5 ± 0.2	9.20 ± 0.87	12.2 ± 4.6	3.76 ± 0.45	3.4 ± 0.3	7.31 ± 0.63	6.9 ± 0.4

[a]Samples without an extension on the ID were not processed through 0.25" sieve.

[b]Samples with an "S" extension on the ID were processed through 0.25" sieve.

[c]Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

[d]Total Th is the sum of Th-228 and Th-232.