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ANALYTICAL CHARACTERIZATION OF THE THORIUM NITRATE STOCKPILE

C. H. Mattus
W. H. Hermes
J. W. Terry

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ORNL/TM-2003/54

Nuclear Science and Technology Division
Environmental Sciences Division

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C. H. Mattus
W. H. Hermes
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ACRONYMS, ABBREVIATIONS, AND INITIALISMS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
Bq	becquerel
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm^3	cubic centimeters
CVAA	cold vapor atomic absorption
DLA	Defense Logistics Agency
DNSC	Defense National Stockpile Center
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
g	gram
HDPE	high-density polyethylene
ICP-AES	inductively coupled plasma–atomic emission spectroscopy
ICP-MS	inductively coupled plasma–mass spectroscopy
in.	inch
kg	kilogram
L	liter
LEL	lower explosive limit
m	meter
MDA	minimum detectable activity
mg	milligram
min	minute
mL	milliliter
mR/h	milliRoentgens per hour
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
sec	second
SOW	statement of work
SWRI	Southwest Research Institute
TCLP	toxicity characteristic leaching procedure
ThN	thorium nitrate
UN	United Nations
vol %	volume percent
wt %	weight percent
WAC	waste acceptance criteria

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ABSTRACT

For several years, Oak Ridge National Laboratory (ORNL) has been supporting the Defense Logistics Agency–Defense National Stockpile Center with stewardship of a thorium nitrate (ThN) stockpile. The effort for fiscal year 2002 was to prepare a sampling and analysis plan and to use the activities developed in the plan to characterize the ThN stockpile. The sampling was performed in June and July 2002 by RWE NUKEM with oversight by ORNL personnel. The analysis was performed by Southwest Research Institute of San Antonio, Texas, and data validation was performed by NFT, Inc., of Oak Ridge, Tennessee.

Of the ~ 21,000 drums in the stockpile, 99 were sampled and 53 were analyzed for total metals composition, radiological constituents (using alpha and gamma spectrometry), and oxidizing characteristics. Each lot at the Curtis Bay Depot was sampled. Several of the samples were also analyzed for density. The average density of the domestic ThN was found to be 1.89 ± 0.08 g/cm^3. The oxidizer test was performed following procedures issued by the United Nations in 1999. Test results indicated that none of the samples tested was a Division 5.1 oxidizer per Department of Transportation definition.

The samples were analyzed for total metals following the U.S. Environmental Protection Agency methods SW-846-6010B and 6020 (EPA 2003) using a combination of inductively coupled plasma–atomic emission spectroscopy and inductively coupled plasma–mass spectroscopy techniques. The results were used to compare the composition of the eight Resource Conservation and Recovery Act metals present in the sample (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) to regulatory limits. None of the samples was found to be hazardous for toxicity characteristics.

The radiological analyses confirmed, when possible, the results obtained by the inductively coupled plasma analyses. These results—combined with the historical process knowledge acquired on the material and the results of previous tests—classified the ThN as low-level radioactive waste for disposal purposes. This characterization was necessary to continue the efforts associated with disposition of the material at the Nevada Test Site, Mercury, Nevada.

With the current work presented in this report, the analytical characterization phase is completed for this source material stockpile.

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1. INTRODUCTION

The Defense Logistics Agency– Defense National Stockpile Center (DLA–DNSC) has stewardship of a stockpile of thorium nitrate (ThN) that has been in storage for decades, and Oak Ridge National Laboratory (ORNL) has been supporting the DLA in its effort to dispose of the stockpile. After the historical data gathered by the DLA were reviewed (see Sect. 2), it was apparent that the characterization of the material was insufficient to support a determination of acceptable disposal options. In addition, improvements in analytical chemistry methods and analyses could be used to produce more accurate data. Therefore, the main objective for fiscal year 2002 was to develop and implement a sampling and analysis plan for a more complete characterization of the material.

Although ThN is a radioactive material, it can be accepted for disposal at the Nevada Test Site (NTS) only if it is not classified as a mixed waste, meaning both radioactive and hazardous as defined by the U.S. Environmental Protection Agency (EPA). Under the guidelines of the Resource Conservation and Recovery Act (RCRA), the Land Disposal Restriction Program regulates the disposal of wastes to prevent the disposal of untreated wastes in or on the land if treatment or immobilization alternatives exist. EPA has established treatment standards to protect the human population and the environment when the treated waste is disposed of on land. These standards mandate the use of a specific treatment technology or require that the treated waste meet specified concentration limits for hazardous constituents.

To be regulated as a hazardous waste, a material must first be determined to be a solid waste. Section 261.2 of RCRA defines solid waste as "any discarded material that is not excluded by Section 261.4(a) or that is not excluded by variance granted under Sections 260.30 and 260.31." A solid waste is a hazardous waste if it is a listed waste or if it exhibits a hazardous waste characteristic. It is a listed waste if it is named in one of the four lists (F, K, P, and U) developed by EPA (*The Hazardous Waste Consultant* 1996). The ThN does not appear on any of these lists and, therefore, is not a listed waste. A solid waste is hazardous if it exhibits any of the four characteristics of hazardous waste established by EPA—ignitability (D001), corrosivity (D002), reactivity (D003), and toxicity (D004 to D043) — and is not excluded from regulation.

In 40 CFR 261.21(a), where the characteristic of ignitability for a solid waste is defined, the first three elements do not pertain to the ThN because it is a material already existing in an oxidized form. Only the fourth component of the definition could apply to the ThN, and it became the rationale for performing the UN oxidizer test (UN 1999) to determine if the material was a Division 5.1 oxidizer per definition by the U.S. Department of Transportation (DOT).

The ThN is not defined as D002 corrosive because it is not a liquid waste or "other corrosive" material [RCRA 261.22(a)(2)]. The ThN is not classified as D003 reactive because it does not contain reactive sulfides, unexploded ordnance and other explosive devices, explosives, or reactive cyanides; and it is not water reactive. In addition, based on the process knowledge of ThN manufacture (Hermes et al. 2002, Appendix D), organic compounds are not present in the stockpile material. Thus, the possibility of being classified as a D012 to D043 characteristic waste is eliminated. In 1994, during the first demonstration conducted to assess the possibility of transforming the ThN to thorium oxide, Allied Technology Group performed the analyses for organic constituents on three lots of ThN, one from each origin (Feizollahi and Cook 1996; Hermes et al. 1996). No organic constituents were detected, confirming the process knowledge.

The only remaining possibility for the ThN to be defined as a RCRA waste would be classification as a D004 to D011 waste—corresponding to the eight RCRA metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver, respectively. Even though the historical data showed that the ThN did not contain any of these metals at levels above the regulatory limits, the current analyses included these parameters.

To meet the NTS waste acceptance criteria (WAC), the material to be disposed of must be analyzed for the following characteristics (DOE 2002): density, moisture, organic content, nuclides content, and hazardous constituent composition.

Density measurements were performed as part of the sampling and analysis effort to fulfill the requirement of the WAC. The 99 drums that were opened did not show any liquid phase present in the upper part of the material, although droplets of condensation were found on the inner plastic in some drums. The percent moisture of the material was measured by the laboratory as well as the nuclides content and the hazardous constituent composition. In a second effort at the DLA depot in Curtis Bay that took place in April 2003, two drums were selected and emptied to verify that there was no liquid in the bottom of the drum.

During the sampling program, it was observed that at least two drums of the MD-1 configuration (domestic origin) at Curtis Bay had lost their lid or the lid was bulging because of a pressure buildup. An analysis of the gas in the headspace was performed, and CO_2 and NO_x compounds were found to be the primary constituents. An investigation of the potential sources of these gases concluded that they formed from the reaction of the slaked lime [$Ca(OH)_2$]—which had been added to the drums during repackaging operations—with the nitric acid (HNO_3) contained in the material (Hylton et al. 2003). To confirm the data obtained on the gas analysis, a second effort was conducted in April 2003 to sample and analyze ten more drums to verify the hypothesis of the gas formation and to assess the potential pressure of some drums. The results are presented in Sect. 9.

This report describes the gathering of analytical data on the ThN. Section 2 presents historical data on the composition of the thorium nitrate material. Section 3 describes the rationale used to determine the number of samples to test. Part of the statement of work (SOW) that was issued for the analytical contract is presented in Sect. 4, and Sect. 5 summarizes the visual observations made during the June/July 2002 effort. Section 6 presents the data received from the analytical laboratory, including the qualifiers affixed by the data validation process assessing the quality of the data generated by the laboratory. The data are statistically examined and compared with relevant regulatory limits in Section 7. The data quality objectives are evaluated in Sect. 8. Section 9 covers the effort deployed in April 2003 to assess the domestic (MD-1) drum pressurization. The original data forms received from the laboratory as well as the validation reports are presented in the appendices, as well as the qualification of the analytical laboratory.

2. HISTORICAL DATA ON THE COMPOSITION OF THORIUM NITRATE

The DLA kept numerous files regarding the ThN stockpile, and included among the documentation were analytical records. The historical data on the ThN composition have been compiled, and the additional information provided by these data is given in this section. Tables 1–3 present a statistical evaluation of the data and contain the average, the confidence, and the minimum and maximum values for each population, combining all lots for that population (i.e., 76 lots from Lindsay, 20 lots of French origin, and 14 lots of Indian origin).

The ThN from France and India had been analyzed by the originating country and by a U.S. laboratory to confirm those data. The data provided by the French administration were analyzed by the Commissariat a l'Energie Atomique (CEA). The Indian laboratory was Rare Earths Ltd.; however, the U.S. laboratory that confirmed these data was not identified. Additional analyses were performed by the New Brunswick laboratory for the material of Indian origin. The ThN from Lindsay has been analyzed only by the New Brunswick laboratory.

Some general comments can be made regarding the data produced by the laboratories:

1. The data provided by the foreign countries and the U.S. laboratory were very close to each other, while the data obtained by the New Brunswick laboratory appeared to be different. The methodology used for analysis by the foreign countries and the U.S. validator laboratory were not specified. The New Brunswick data were based on spectroscopic analyses, and many values in the tables were estimated; this may explain some of the discrepancies observed. For example, the aluminum concentration in the Indian ThN was found to be negligible by the Indian and U.S. laboratory, but the New Brunswick lab estimated the aluminum concentration at ~600 mg/kg.
2. For each country of origin, each lot had been sampled and analyzed. The data obtained are homogeneous, as seen in Tables 1–3. This information is important for the current effort of sampling and analyzing because it strongly supports the hypothesis that the populations are homogeneous within the material from each country of origin. This hypothesis was based on the fact that the process for the ThN fabrication was controlled to deliver a material of known quality. As a result, the sampling and analysis plan developed for the stockpile produced results that reflect the entire population and provide confirmatory data for the existing process knowledge.
3. The analyses focused on the compounds found in the purity specifications for the ThN. At the time, there were no RCRA laws and there are very few data on the metals of concern in that law. Only the New Brunswick laboratory provided estimates for some RCRA metals, but the numbers have to be considered suspect because of the way they were obtained.

The Lindsay's ThN appears to be less pure than the foreign materials; however, the only available analyses are from New Brunswick laboratory and are mostly estimated. From these results, the concentration of Fe+Ni+Cr (~61.7 ppm) was found to be above the specification level of 50 ppm. Also, the sum of alkalies, Na+K+Li (574 ppm) was above the maximum (500 ppm) allowed in the specification. Only two RCRA metals were analyzed for. The chromium concentration was ~3 mg/kg and lead was ~ 0.2 mg/kg.

Table 1. Historical data obtained for the ThN of domestic origin
[Units are mg/kg except where noted]

Analyte[a]	Average	Confidence	Minimum	Maximum	Specification
ThO_2 - NB (%)	46.085	0.000703	45.642	46.348	>46.0% ThO_2
^{230}Th - NB	0.35256	0.00046	0.1	0.49	
SO_3 - NB	145.455	0.69096	10	600	<250 ppm SO_3
U- NB	0.687	0.0048	0.2	4.7	
Al* - NB	39.605	0.4134	10	500	<50 ppm Al
B - NB	1.2822	0.0034	0.6	3	
Be* - NB	<1		<1	<1	
Bi* - NB	1		<1	1	
P - NB	20.187	0.128	1	150	<50 ppm P_2O_5
Na* - NB	547.37	1.237	100	1100	
K* - NB	26.125	0.13887	20	100	
Fe* - NB	50.1316	0.21404	20	150	
Ca* - NB	52.17	0.2384	10	170	
Mg* - NB	39.5395	0.18708	15	120	
Si* - NB	33.2237	0.21259	10	200	<50 ppm Si
Cd - NB	0.1	1.10E−11	0.1	0.1	
Co - NB	<1		<1	1	
Cr* - NB	2.9737	0.0171	1	10	
Cu* - NB	2.0139	0.0098	1	10	
Mn* - NB	2.0423	0.0064	1	4	
Ni* - NB	8.6579	0.042	2	30	
Pb* - NB	1.1892	0.005	1	5	<10 ppm Pb
Sn* - NB	3.5417	0.0699	1	50	
Zn* - NB	17.5	0.12715	10	120	
Li* - NB	0.53731	0.00095	0.5	1	
Gd - NB	5.9616	0.10609	0.7	120	
Dy - NB	4.62603	0.04993	0.7	48	
Sm - NB	1.8463	0.00931	0.8	6.2	
Eu - NB	<0.2		<0.2	<0.2	
Cl - NB	-				<10 ppm Cl
F - NB	-				<10 ppm F
Ti - NB	-				<50 ppm Ti
Fe+Ni+Cr - NB	61.7632				<50 ppm
Ba+Ca+Mg[b] - NB	91.7095				<500 ppm
Na+K+Li - NB	574.03231				<500 ppm

[a]Entries marked with an asterisk are estimated values. The "NB" indicates that the analyses were performed by the New Brunswick laboratory.

[b]No barium data available.

Table 2. Historical data obtained for the ThN of French origin
[Units are mg/kg except where noted]

Analyte[a]	Average	Confidence	Minimum	Maximum	Specification
Moisture-H_2O - CEA (%)	7.854	0.0332	5.97	12.41	
ThO_2 - CEA (%)	46.33	0.002	46.1	46.5	>46.0% ThO_2
ThO_2 - US (%)	46.47	0.003	46.09	46.82	>46.0% ThO_2
SO_3 - US	0.00313	0.0000042	0.0025	0.0035	<250 ppm SO_3
SO_3 - CEA	Traces		0	Traces	<250 ppm SO_3
Cl - US	0.00053	0.00000061	<0.0005	0.0006	<10 ppm Cl
Cl - CEA	0.00054	0.0000031	Traces	0.001	<10 ppm Cl
P_2O_5 - US	<0.001		<0.001	0.001	<50 ppm P_2O_5
P_2O_5 - CEA	0.002	0.000002	0.0015	0.002	<50 ppm P_2O_5
F - US	0.00072	0.0000033	0.0005	0.001	<10 ppm F
F - CEA	0.00063	0.0000024	Traces	0.0009	<10 ppm F
Na - US	0.029	0.00007	0.02	0.04	
Na - CEA	0.02468	0.00015	0.007	0.046	
K - US	0.004	0.000084	0.001	0.03	
Li - US	0.001	0.001	0.001	0.001	
Na+K+Li - US	0.034				<500 ppm Na+K+Li
Fe - US	0.0028	0.00001	0.002	0.004	
Ni - US	0.001		<0.001	0.001	
Cr - US	0.001		<0.001	0.001	
Fe+Ni+Cr - US	0.0048				<50 ppm Fe+Ni+Cr
Fe+Ni+Cr - CEA	0.00292	0.0000105	0.0018	0.0043	<50 ppm Fe+Ni+Cr
Ba - US	0.001		<0.001	0.001	
Ca - US	0.005		<0.005	0.005	
Mg - US	0.001		<0.001	0.001	
Ba+Ca+Mg - US	0.007				<500 ppm Ba+Ca+Mg
Ba+Ca+Mg - CEA	0.00632	0.000017	0.005	0.0075	<500 ppm Ba+Ca+Mg
Al - US	0.001		<0.001	0.001	<50 ppm Al
Al - CEA	0.001		0.001	0.001	<50 ppm Al
Si - US	0.00135	0.0000059	0.001	0.002	<50 ppm Si
Si - CEA	0.00165	0.000013	0.001	0.0032	<50 ppm Si
Ti - US	0.0019	0.000005	<0.001	0.002	<50 ppm Ti
Ti - CEA	0.003		0.003	0.003	<50 ppm Ti
Total ReO_2 - US	0.003275	0.0000148	0.0015	0.0045	<50 ppm ReO_2
Total ReO_2 - CEA	0.002537	0.000017	0.001	0.005	<50 ppm ReO_2
Pb - US	0.001		0.001	0.001	<10 ppm Pb
Pb - CEA	0.00039	0.0000024	0.0001	0.0007	<10 ppm Pb

[a]The material was analyzed by both the French laboratory of the Commissariat a l'Energie Atomique (indicated with "CEA") and the U.S. Government's laboratory ("US").

Table 3. Historical data obtained for the ThN of Indian origin
[Units are mg/kg except where noted]

Analyte[a]	Average	Confidence	Minimum	Maximum	Specification
ThO_2 - India (%)	48.049	0.0037	47.61	48.27	>46.0% ThO_2
ThO_2 - US (%)	48.032	0.0112	46.64	49.18	>46.0% ThO_2
ThO_2 - NB (%)	47.475	0.005805	46.996	48.567	>46.0% ThO_2
^{230}Th - NB	0.7331	0.0024	0.43	0.91	
SO_3 - US	0.05357	0.00097	0.01	0.2	<250 ppm SO_3
SO_3 - India	0.2231	0.00106	0.075	0.355	<250 ppm SO_3
Cl - US	0.02179	0.00016	0.01	0.037	<10 ppm Cl
Cl - India	Traces				<10 ppm Cl
P_2O_5 - US	0.00821	0.000096	0.001	0.015	<50 ppm P_2O_5
P_2O_5 - India	0.000607	0.0000025	0.0004	0.0009	<50 ppm P_2O_5
P* - NB	<10		<10	<10	<50 ppm P_2O_5
Na - US	0.00104	0.0000043	0.0007	0.0015	
Na* - NB	7.3636	0.04965	3	10	
K - US	0.0012	0.0000041	0.001	0.0015	
K* - NB	<5		<1	<10	
Li - US	0.0002	0	0.0002	0.0002	
Fe_2O_5 - US	0.00682	0.000072	0.001	0.01	
Fe_2O_5 - India	0.00066	0.0000055	0.0001	0.00098	
Fe* - NB	28.077	0.2218	10	50	
CaO - US	0.032714	0.00039	0.0015	0.05	
Ca* - NB	6.6667	0.0395	5	10	
MgO - US	0.03235	0.0004	0.0005	0.05	
Mg - NB	6.154	0.04547	2	10	
Al_2O_3 - US	0.005	1.0E−12	0.005	0.005	<50 ppm Al
Al_2O_3 - India	Traces				<50 ppm Al
Al* - NB	638.4615	2.506	500	800	<50 ppm Al
SiO_2 - US	0.04	0.00023	0.02	0.05	<50 ppm Si
Si* - NB	336.36	1.293	300	500	<50 ppm Si
TiO_2 - US	0.003929	0.000024	0.002	0.005	<50 ppm Ti
TiO_2 - Inida	0				<50 ppm Ti
Total RE - US	0.006929	0.000069	0.001	0.01	<50 ppm ReO_2
Total RE - India	0.01	3.9E−12	0.01	0.01	<50 ppm ReO_2
Alkali salts - US	0.01	1.95E−12	0.01	0.01	
Ce - India	Traces				
CaO+MgO+SiO_2+ alkali salts - India	0.10721	0.001837	0.054	0.5	
U - NB	0.6923	0.00787	0.2	2.2	
B - NB	7.4846	0.02039	4.3	9	
Be* - NB	<1		<1	<1	
Bi* - NB	<1		<1	1	
Cd - NB	<0.1		<0.1	<0.1	
Co - NB	<1		<1	<1	
Cr* - NB	1		<1	1	
Cu* - NB	19.231	0.0446	10	20	

[a]Entries marked with an asterisk are estimated values. The material was analyzed by the U.S. Government's laboratory ("US"), the New Brunswick laboratory ("NB"), and a laboratory in India ("India").

The Indian ThN is richer in Th than the domestic material. The analyses from New Brunswick laboratory are not consistent with the ones provided by two other laboratories, rendering the interpretation of the data difficult. The results from New Brunswick laboratory were not only estimated but also resulted from methods with very high detection limits. The data obtained from the two other laboratories show that the material is pure and passed the specification. From the New Brunswick laboratory, the estimated concentration for chromium is ~1 mg/kg and for lead is ~2.6 mg/kg.

The French material is not as rich as the Indian, but richer than the domestic material for thorium. In addition, there were measurements provided by the CEA of the moisture content of the French material, a parameter that was not given by the other laboratories. Three of the RCRA metals were analyzed for and were found at almost negligible concentrations: 0.001 mg/kg for Cr, Ba and Pb. This material appeared to be very pure.

Except for ^{230}Th, no radiological data are presented. Thus, the radiological data were of significance in the 2002 analytical characterization effort.

Specifications regarding the thorium nitrate were found in "special instructions for thorium nitrate (SI-112)." This information was developed with the help of the U.S. Department of Agriculture to provide guidance to the then DNSC personnel having to process and handle the ThN material. The document contains a list of maximum concentrations allowed for four purities of ThN. This information is compiled in Table 4.

The data and information presented in this chapter support the fact that the ThN material is not a waste product but the result of a chemical process that resulted in a homogeneous product that was purchased and stored by the DNSC.

Table 4. Specifications for the purity of the ThN depending upon its use
[Units are mg/kg except where noted]

	Grade I Stockpile grade	Grade II Mantle lump	Grade III Alloys, missiles, crystal	Grade IV Atomic energy applications
ThO_2 min. (%)	46.00	46.00	46.00	46.00
ReO_2 max.	50	50	25	25
P_2O_5 max.	50	25	25	25
Cl max.	10	10	10	10
F max.	10	-	-	10
Si max.	50	-	-	50
SO_3 max.	250	0.5–1%	100	100
Pb max.	10	-	-	10
Fe+Ni+Cr max.	50	-	-	-
Ba+Ca+Mg max.	500	500	-	300
Na+Li+K max.	500	1000	-	500
Fe max.	-	50	50	30
SiO_2 max.	-	100	100	-
MgO max.	-	-	10	-
CaO max.	-	-	100	
Heavy metals max.	-	20	20	-
Al max.	50	-	50	50
Ti max.	50	-	50	50
U max.	-	-	-	2
B max.	-	-	-	1
Cd max.	-	-	-	2
Sm max.	-	-	-	1
Eu max.	-	-	-	1
Gd max.	-	-	-	1
Dy max.	-	-	-	1
^{230}Th max.	-	-	-	<1 ppm of the Th content
water solubility	soluble	soluble	soluble	soluble
Free H_2O max. (%)	2	2	2	2

3. RATIONALE USED FOR DETERMINING THE NUMBER OF SAMPLES TO TEST

In the previous chapter, it was confirmed that the ThN material was a homogeneous medium. Equation [8] in Chap. 9 of SW-846 (EPA 2003), which uses statistical data collected from previous analyses, was not applicable in this case because there is no threshold value for the thorium concentration. Similarly, there are no hazardous elements present in ThN for which threshold values exist. Therefore, since a large number of drums is involved, the common method of taking the cubic root of the total number of drums for determining how many to sample was used. This method is used by Bechtel Jacobs at ORNL for determining the number of samples to analyze prior to disposal of ORNL wastes at Envirocare or NTS (Bechtel Jacobs 2000a,b,c).

The number of drums to sample for material of each origin was calculated by applying the cubic-root method. The results are compiled in Table 5. Considering that the sampling could require extensive safety precautions and be costly, a second sampling could not be considered, even if an inadequate number of samples was taken. Therefore, a conservative approach would be to sample a sufficient number of drums to address the statistical needs as well as to provide a margin for error, and then keep the extra samples archived, using them only if needed. In summary, a conservative approach would be to sample 50% more drums than necessary.

Table 5. Number of drums to sample by country of origin

	U.S.	France	India
Total number of drums	18,924	1,901	760
Cubic root of total number	26.6	12.39	9.13
Number of drums to analyze	27	13	10
Number of drums to sample	40	20	15

In a first approach, a true random number of drums to sample was generated using atmospheric noise for the material each origin. The software required a total number of integers as well as the smallest and largest values possible. It then generated the list of random numbers. After reporting these random numbers in the layouts of the depots, it was found that accessing the randomly selected drums would require moving all the drums from their position to get the selected ones, thus requiring considerable labor and time for the workers inside the warehouses. The radiation field in the warehouses where the material is stored is as high as 80 mR/h and presents a risk for the workers in that environment. Radiation measurements collected in 1996 show surface radiation dose to be nominally 70–80 mR/h at the surface of the domestic drums and nominally 100 mR/h at the surface of the drums from France and India.

Therefore, based on the principles of ALARA (As Low As Reasonably Achievable) and to reduce radiation exposure to personnel (radiation exposure may be controlled by reducing time spent in the area, maximizing distance between the source and the individual, and by providing shielding), a second approach was chosen for selecting the drums to sample and analyze.

Because the material is homogeneous, any drum from one lot has the same chemical composition as the others in that lot. Therefore, choosing a specific drum is of lesser importance than protecting the workers. For the ThN from Curtis Bay, it was decided that one drum from each lot that would be easily accessible from the aisles inside the warehouse would be retrieved, opened and sampled. This process resulted in the collection of 63 samples of domestic origin, 14 samples of French origin, and 14 samples of Indian origin. Also, this approach resulted in more samples being collected than would have been collected using the statistical approach.

However, because of the homogeneity of the material, only the number of samples that was necessary for the statistical approach was sent for analysis. The intent was to statistically analyze the data obtained on the first set of samples sent to the laboratory and evaluate if there was a need for further analyses on the samples that were archived at the Curtis Bay Depot. The data proved that the material was as homogeneous as expected, and, therefore, the archived samples were not analyzed.

The average lot size at the Curtis Bay site is ~250-300 drums. Hammond has 50 lots with an average of 45 drums per lot. To avoid additional cost resulting from the smaller number of drums per lot, 6 lots were combined to form a lot equivalent to the ones at Curtis Bay. Therefore, the drums at Hammond would be equivalent to 8 lots from Curtis Bay for the number of drums contained in each lot. Additionally, to confirm that the material was in the form of a monolith, more drums were opened for observation but not sampled.

Finally, combining both depots, the plan called for the collection of 99 samples; and a statement of work and request for proposal were issued for the work to be done by a contractor.

4. ANALYTICAL STATEMENT OF WORK

This section presents the SOW provided to the analytical laboratory in May 2002.

4.1 INTRODUCTION AND BACKGROUND

The DNSC-DLA has custody of 3500 tons of ThN stored in ~21,000 drums at depots in Hammond, Indiana (in one building, 25 wt % of the stockpile), and Curtis Bay, Maryland (in three buildings, 75 wt %). The ThN stockpile managed by the DNSC has been declared surplus to the public needs. ORNL is assisting the DLA in providing the technical basis for decisions concerning its stewardship and disposition. Some of the drums require upgrades to meet DOT requirements. Long-term storage at the current locations is not compatible with the DLA strategic plan for excess material. One option being considered is disposal of the stockpile at NTS. Therefore, NTS WAC become drivers for the analyses that are described in the SOW.

4.2 DESCRIPTION OF SAMPLING EFFORT

4.2.1 Number of Samples for Analyses

In the DLA stockpile of ThN, the number of drums of domestic origin is 18,924; 1,901 drums are from France, and 760 are from India. The cubic-root method was applied to calculate the number of drums to sample (Table 6).

Table 6. Number of ThN storage drums to open, sample, and analyze by country of origin

	U.S.	France	India
Total number of drums	18,924	1,901	760
Number of lots at Curtis Bay	63	14	14
Number of lots at Hammond	50	0	0
Number of drums to open at Curtis Bay	63	14	14
Number of drums to open at Hammond	15	0	0
Number of drums to sample at Curtis Bay	63	14	14
Number of drums to sample at Hammond	8	0	0
Number of drums to analyze at Curtis Bay	23	13	10
Number of drums to analyze at Hammond	8	0	0

4.2.2 Samples to Be Sent to the Laboratory

At Hammond, samples from the following lots are to be sent to the laboratory: 7, 11, 23, 39, 30, 38, 47, and 48. At Curtis Bay, 23 samples from drums of domestic origin will be sent for analyses: lot numbers 2, 3, 9, 11, 12, 14, 15, 17, 18, 20, 22, 28, 29, 30, 36, 37, 44, 45, 48, 52, 58, 61, and 65. At Curtis Bay, samples from 13 drums of French origin will be sent for analyses: lot numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, and 14. At Curtis Bay, samples from 10 drums of Indian origin will be sent for analyses: lot numbers 3, 4, 5, 6, 7, 9, 11, 12, 13, and 14.

4.2.3 Sample Designation

A label will be affixed at the time of collection to each bottle to indicate

- site name (Curtis Bay or Hammond),
- drum identification,
- unique sample number,
- date and time of collection, and
- reference to the page number of the notebook where the entries for the sample were made.

The unique sample number will appear in the following format: *A–B–NN–DD–MM–Z*, where

A	=	site location—(C) for Curtis Bay and (H) for Hammond;
B	=	origin of the drum—(D) for domestic, (I) for India, and (F) for France;
NN	=	lot number;
DD	=	day of sampling;
MM	=	month of sampling;
Z	=	bottle number for the drum (1 to *x*).

4.3 DATA QUALITY OBJECTIVES

The sampling and analysis process is designed to generate objective data of known quality to support a decision regarding the regulatory status and management requirements of the ThN stockpile. The data quality objective (DQO) process is utilized to establish the quality and quantity of data required to satisfy decision-making needs. The data generated will be compared and validated by comparison with limits required by RCRA and by the NTS WAC. The DQO process addresses several quality indicators that support the generation of data of known quality.

4.3.1 Representativeness

Each lot from the stockpile will be sampled. The ThN is not a heterogeneous waste; it was manufactured to be within a precise range of purity. Within each lot, the process used to make the ThN was exactly the same; therefore, the material within each drum of each lot is representative of that lot.

4.3.2 Accuracy

Overall sampling accuracy refers to the closeness of sample results to the true value for the population being sampled. Sampling each lot increases the accuracy of the determination of the material composition. Analytical accuracy is measured in the laboratory by spiking samples with known concentrations of surrogates and comparing them with measured results. This method is one of the quality assurance/quality control (QA/QC) parameters checked during the review of analytical data.

4.3.3 Precision

Estimates of analytical precision are obtained by duplicate analyses of individual samples. Analytical precision is evaluated during the QA review of the data.

4.3.4 Completeness

Completeness is defined as the ratio of total useable points from the set of total data points collected, analyzed, and available. In this project, the completeness is expected to be at least 75%.

4.3.5 Comparability

Analytical data generated by the same analytical procedures are comparable, provided that relevant, specified QC elements (such as detection limits, initial and continuing calibration performance, accuracy, precision, and matrix interference acceptance criteria) are met or exceeded.

4.4 SAMPLE ANALYSES

4.4.1 Required Analyses

The analyses to be performed on the ThN material and the required analytical methods are compiled in Table 7. No deviation is allowed. The seller shall provide in its bid its standard turnaround time for receiving results.

4.4.2 Metals /Inorganic Test

The list of metals of first interest is as follows: Ag, As, Ba, Be, Cd, Cr, Ni, Pb, Sb, Se, Th, Tl, U, V and, Zn. In addition to that mandatory list, the project is also interested in the following elements: Al, B, Ca, Co, Cu, Fe, Mg, Mn, Mo, Na, Si, Sr and, Zr. Because of the expected matrix interferences, large dilutions are anticipated. However, the laboratory must report the RCRA elements (Ag, As, Ba, Cd, Cr, Pb, and Se) with a detection limit after dilution to allow a comparison with the RCRA limits. The detection limits after dilution should not exceed 50 mg/kg for Ag, As, Cr, or Pb; 10 mg/kg for Se or Cd; and 1000 mg/kg for Ba.

To confirm the detection limit achievable in the thorium matrix, the seller shall provide the results obtained with a surrogate containing a standard of thorium at the same concentration as that in the sample, spiked with all the other elements at the concentrations at which they are reported. This control is independent of all the regular QC associated with EPA Method SW-846-6020. Analyses shall follow EPA Method SW-846-6020. Any deviation from the standard method shall be reported and documented. The method for sample preparation shall be reported.

Moisture content as well as the pH of the sample shall be measured and reported. All the QA/QC requested in SW-846 shall be met. Data delivery shall include all documents: raw data, calculations, dilutions, and final forms. Data should be presented as a Contract Laboratory Program (CLP) package. Both an electronic and printed versions of the raw data are required.

Table 7. Requirements for ThN samples

Analytical parameter	Analytical method	Sample container[a]	Sample quantity[b]	Preservation	Holding time
Metals / inorganics	SW-846-6020, -7471	500-mL wide-mouth HDPE bottle	Fill sample jar completely or 1 core sample	None	Mercury 28 d, other metals 180 d
Oxidizer test	UN ST/SG/AC.10/11.Rev. 3	500-mL wide-mouth HDPE bottle	Fill sample jar completely or 8 core samples	None	Indefinitely
Radionuclides (thorium, uranium)	Gamma spectroscopy (method consistent with EPA 901.1 method)	500-mL wide-mouth HDPE bottle	Fill sample jar completely or 1 core sample	None	Indefinitely
Archived	Any test deemed necessary	500-mL wide-mouth HDPE bottle	Fill sample jar completely or 2 core samples	None	Indefinitely

[a]High-density polyethylene
[b]A core sample is defined as having a height of 2 in. and a diameter of 1.5 in.

The samples shall be analyzed for mercury according to EPA Method SW-846-7471 by using cold vapor atomic absorption analysis. As for the other metal analyses, all the QA/QC included in the method should be met. If a deviation occurs, it shall be reported and documented. The same data delivery package required for the other metals is required for mercury.

4.4.3 Oxidizer Test

This test is critical for the project, and the seller shall ensure that it is run according to all the directives provided in the "Classification Procedures, Test Methods and Criteria Relating to Oxidizing Substances of Division 5.1," issued by the UN and published in the *Recommendations on the Transport of Dangerous Goods—Manual of Tests and Criteria* (UN 1999).

The test has to be performed on the material "in the form in which it will be transported." For the monolithic samples, no grinding is to be performed. A chunk of material weighing about 15 or 24 g should be extracted from the monolith and used for the test (1:1 and 4:1 ratios). The test results will vary depending upon the moisture content of the sample and on the amount of humidity in the room in which the experiment will take place. Therefore, the sample shall be prepared just before testing. The elapsed time between the time it was removed from the container and the time it was tested shall be reported in the analysis report as well as the relative humidity and temperature in the room that day. The same approach shall be taken for the samples in the form of pellets or powder. Each time the sample container is opened, it shall remain open for a minimum amount of time and must be tightly closed afterward.

4.4.4 Radiological Characterization

The material analyzed is almost pure ThN; therefore, it is anticipated that ^{232}Th and its daughter products will be present. A gamma scan of the sample shall be performed and the radioactive elements present shall be identified and quantified. The procedure used shall be consistent with EPA Method 901.1. The sample preparation and the methods for counting the samples shall be documented. Raw data as well as calibration data shall be provided.

4.4.5 QA/QC Requirements

For the analytical methods conducted in accordance with EPA methods, all the QA/QC requirements included in each method shall be met, or documentation explaining the reasons for not meeting them shall be provided in the case narrative of the data package. The QA/QC parameters (blanks, spikes, duplicates, and serial dilution) shall be reported in the appropriate CLP forms.

For the UN oxidizer test (Sect. 4.4.3), it is required that five replicates of each sample/cellulose mixture be performed. The test report shall indicate both the mass of sample tested and the number of pieces in the 15 or 24 g tested. The measurements with the reference substance (potassium bromate) shall be performed for each batch of samples received. Because it is anticipated that the samples will be delivered in three batches, three complete tests with the reference shall be performed. It is also requested that every day when samples are run, one replicate of the three reference samples of potassium bromate and cellulose (ratios of 3:7, 2:3, and 3:2) be measured and compared with the initial tests done with five replicates. These data shall be reported in the analysis report.

4.4.6 Data Delivery

For the metals and mercury analyses, a full CLP-like package, including sample preparation, raw data, dilutions, calculations, QC parameters, and results forms, is required. Both paper and electronic versions are required.

For the radiological data, a listing of the peaks found and their concentrations shall be provided. The report shall list which radioelements were identified with their respective minimum detectable activities (MDAs), the window of energy selected for each radioelement, and the counting time. For the oxidizer test, the report shall include the requirements as set in Sect. 34.4.1.4 of the UN test method. A complete description of the experimental setup should be provided (e.g., wire characteristics, description of the cellulose used, and air stream velocity of the location used.) The burning times per sample for each of the five replicates shall be reported as well as any observation made during the test. The report shall also provide the results obtained for the reference material associated with each sample. The relative humidity and temperature of the room shall be recorded and reported for each test.

5. VISUAL OBSERVATIONS MADE WHILE OPENING THE DRUMS

One goal of the sampling effort in June 2002 was to verify the condition of the ThN material after being stored for about 40 years. This information was needed for the NTS requirements concerning the presence of free liquid and the particle size of the material. All the lots at Curtis Bay from the three countries of origin had been opened and visually inspected. At Hammond, a total of 15 drums were opened and visually inspected.

Three possible tasks were performed on the 106 drums that were opened: (1) opening the drum and observing the packaging and material condition—referred to as *VI* in the summary tables; (2) opening the drum, observing the packaging and material condition, and sampling for analysis—referred to as *ISA* in the tables; and (3) opening the drum, observing the packaging and material condition, and sampling for archive—referred to as *ISS* in the tables. In all cases, all the layers of internal packaging were opened to reach the material.

A full report describing the information gathered can be found in a companion report (Hylton et al. 2003). Table 8 summarizes the findings for the presence of moisture and pressure in the drums opened. It is important to clarify that the term "moisture" refers to droplets of condensation found on the inside of plastic bags; there was never enough liquid present to take a sample, and the only test possible was to wipe a pH paper strip and verify that the pH of the drops was acidic.

The measurements of three gases were done using a field instrument, "Miniwarn" from Draeger. It provided readings of the NO and NO_x contents—limited to 50 ppm—as well as the methane (CH_4) content, as a percent of the lower explosive limit (LEL). These data are semi-quantitative and are superceded by the quantitative data acquired in April 2003 based on GC and GC-MS techniques.

Table 8. Results of visual observations of the thorium nitrate stockpile

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
				ThN of French origin	
F1	52	dry powder	ISA	none	none
F2	49	dry powder	ISA	none	none
F3	95	dry powder	ISA	none	none
F4	29	dry powder	ISA	none	none
F6	100	dry powder	ISA	none	none
F9	51	dry powder	ISA	none	none
F10	94	dry powder	ISA	none	none
F11	42	dry powder	ISA	none	none
F13	137	dry powder	ISA	none	none
F14	78	dry powder	ISA	none	none
F16	57	dry powder	ISA	none	none
F17	6	dry powder	ISA	none	none
F18	55	dry powder	ISS	none	none
F19	58	dry powder	ISA	none	none

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
			ThN of Indian origin		
I1	14	very dry cubes / gravel	ISS	none	none
I2	99	very dry cubes / gravel	ISS	none	none
I3	149	very dry cubes / gravel	ISA	none	none
I4	206	very dry cubes / gravel	ISA	none	none
I5	251	very dry cubes / gravel	ISA	none	none
I6	300	very dry cubes / gravel	ISA	none	none
I7	358	very dry cubes / gravel	ISA	none	none
I8	371	very dry cubes / gravel	ISS	none	none
I9	780	very dry cubes / gravel	ISA	none	none
I10	484	very dry cubes / gravel	ISS	none	none
I11	537	very dry cubes / gravel	ISA	none	none
I12	589	very dry cubes / gravel	ISA	none	none
I13	637	very dry cubes / gravel	ISA	none	none
I14	714	very dry cubes / gravel	ISA	none	none

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
			ThN of domestic origin stored at Hammond		
2	49	very dry monolith	VI	none	none
8	18	very dry monolith	ISA	none	none
10	46	not so dry monolith	ISA	moisture in 2nd bag	none
20	39	very dry monolith	VI	moisture in 2nd bag	none; rust present on lid
23	42	very dry monolith	ISA	none	none
28	30	very dry monolith	VI	moisture in 2nd bag	headspace: 5.7% LEL; NO_x 7 ppm
29	4	very dry monolith	ISA	moisture in 2nd bag	none
30	6	very dry monolith	ISA	none	none
32	45	very dry monolith	VI	none	none; rust present on lid
38	25	very dry monolith	ISA	moisture in 2nd bag	none
43	44	very dry monolith	VI	none	none
45	22	very dry monolith	VI	moisture in 2nd bag	none; rust present on lid
47	16	damp monolith	ISA	moisture in 2nd bag	none
48	40	damp monolith	ISA	moisture in 2nd bag	none
49	2	very dry monolith	VI	moisture in 2nd bag	none; rust present on lid

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
			ThN of domestic origin stored at Curtis Bay		
1	111	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
2	78	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
3	57	very dry monolith	ISA	none	no pressure buildup
4	142	very dry monolith	ISS	none	no pressure buildup
5	111	very dry monolith	ISS	none	drum pressurized, inner bags not pressurized;
6	175	very dry monolith	ISS	none	no pressure buildup
7	59	very dry monolith	ISS	none	drum pressurized, inner bags not pressurized;
8	127	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 5.0%, NO, NO_x >50 ppm
9	24	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
10	135	very dry monolith	ISS	none	no pressure buildup
11	248	very dry monolith	ISA	none	no pressure buildup
12	136	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 6.0%, NO, NO_x >50 ppm
13	124	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd and 4th bag LEL 4.6%, NO, NO_x >50 ppm
14	123	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; LEL 3rd bag 6.1%, 4th bag 4.6%, NO, NO_x >50 ppm
15	239	very dry monolith	ISA	none	no pressure buildup
16	230	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd and 4th bag LEL 4.6%, NO, NO_x >50 ppm
17	108	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
		ThN of domestic origin stored at Curtis Bay (*continued*)			
18	212	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 3.2%, NO, NO_x >50 ppm
19	52	very dry monolith	ISS	none	no pressure buildup
20	11	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; LEL 3rd bag 5.2%,4th bag 4.6%, NO, NO_x >50 ppm;
21	83	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.1%, NO, NO_x >50 ppm
22	8	very dry monolith	ISA	none	drum had been pressurized
23	200	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
24	102	very dry monolith	ISS	none	no pressure buildup, 4th bag 4.6%LEL, NO, NO_x >50 ppm
25	25	very dry monolith	ISS	none	drum pressurized, inner bags pressurized
26	202	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 5.2%, NO, NO_x >50 ppm
27	159	very dry monolith	ISS	none	no pressure buildup
28	240	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag NO 7.2 ppm, NO_x 30.1 ppm
29	30	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
30	171	very dry monolith	ISA	none	no pressure buildup
31	00	very dry monolith	ISS	none	no pressure buildup
32	152	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm; fiber drum is damp
33	149	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.1%, NO, NO_x >50 ppm
34	80	very dry monolith	ISS	none	drum pressurized, inner bags pressurized

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
			ThN of domestic origin stored at Curtis Bay (*continued*)		
35	203	very dry monolith	ISS	none	drum pressurized, inner bags not pressurized; in fiber drum NO 3.4 ppm, NO_x 27.4 ppm
36	267	very dry monolith	ISA	none	no pressure buildup
37	19	very dry monolith	ISA	none	drum had been pressurized
38	75	very dry monolith	ISS	none	no pressure buildup
39	6	very dry monolith	ISS	none	drum pressurized, inner bags pressurized
40	35	very dry monolith	ISS	none	drum not pressurized, inner bags pressurized
41	142	very dry monolith	ISS	none	drum not pressurized, inner bags pressurized, NO 1.3 ppm, NO_x 22.1 ppm
42	154	very dry monolith	ISS	none	drum pressurized, NO 6.9 ppm, NO_x 31.5 ppm
43	179	very dry monolith	ISS	none	drum pressurized, inner bags pressurized
44	182	very dry monolith	ISA	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50ppm
45	105	very dry monolith	ISA	none	drum pressurized, inner bags pressurized
46	24	very dry monolith	ISS	none	no pressure buildup
47	204	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.6%, NO, NO_x >50 ppm
48	119	very dry monolith	ISA	none	drum pressurized, inner bags pressurized
50	3	very dry monolith	ISS	none	drum pressurized
51	155	very dry monolith	ISS	none	drum pressurized, inner bags pressurized
56	48	very dry monolith	ISS	none	drum pressurized
57	110	very dry monolith	ISS	none	no pressure buildup
59	241	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd and 4th bag LEL 6%, NO, NO_x >50 ppm

Table 8. (*continued*)

Lot number	Drum number	Description of ThN	Task[a]	Moisture	Pressure[b]
			ThN of domestic origin stored at Curtis Bay (*continued*)		
60	285	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; NO 8.7 ppm, NO_x 37.2 ppm
61	86	very dry monolith	ISA	none	no pressure buildup
62	159	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag LEL 4.2%, NO, NO_x >50 ppm
63	5	very dry monolith	ISS	none	no pressure buildup
64	00	very dry monolith	ISS	none	drum pressurized, inner bags pressurized
65	107	very dry monolith	ISA	none	drum had been pressurized
70	3	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd and 4th bag LEL 4.6%, NO, NO_x >50 ppm;
71	192	very dry monolith	ISS	none	drum pressurized, inner bags pressurized; 3rd bag very pressurized

[a]VI = opening the drum and observing the packaging and material condition; ISA = opening the drum, observing the packaging and material condition, and sampling for analysis; ISS = opening the drum, observing the packaging and material condition, and sampling for archive.

[b]LEL = lower explosive limit for methane gas.

6. ANALYTICAL RESULTS

Southwest Research Institute (SWRI) performed the analytical work. One criterion used for selecting the analytical laboratory was the accreditations and certifications that the laboratory had for working with samples for DOE or samples that would be sent for disposal at the NTS. SWRI is audited on a routine basis by the DOE Office of Environmental Management, National Analytical Management Program, Environmental Management Consolidated Audit Program. A copy of the Continuing Qualification Audit report from November 2001 is provided in Appendix A. The audit shows that there is no major problem with the laboratory's operations. SWRI provided two data packages, the first containing the data for the eight samples from Hammond and the second containing the data from Curtis Bay (see Appendix B). In addition to the analyses from the SOW, SWRI was asked to analyze some samples for uranium and thorium by alpha spectrometry and to measure the density of a few samples of domestic material from Curtis Bay. The data received were compiled in tables for easier comparison. The tables also include the validation qualifiers that were attributed by validators from NFT, Inc. in Oak Ridge. The validation reports are presented in Appendix C.

6.1 OXIDIZER TEST

According to the UN oxidizer test method,

> "The substance, in the form in which it will be transported, should be inspected for any particles less than 500 µm in diameter. If that powder constitutes more than 10% (mass) of the total, or if the substance is friable, then the whole of the test sample should be ground to a powder before testing to allow for a reduction in particle size during handling and transport."

This requirement is made to insure that the aliquot collected for the test is representative of the whole sample since the test is highly dependant on the particle size. If the sample contains more than 10%, the UN considers that the sample is not homogeneous and therefore requires it to be ground so the aliquots used for testing (24 g for the test using a 4:1 ratio of sample to cellulose and 15 g for the second one using a 1:1 ratio of sample to cellulose) will be representative.

The assistance of an ORNL specialist in regulation was sought to explain the definition of friable. His answer is provided in the memorandum reproduced below:

DATE: 24 June 2002
TO: Jim Terry
FROM: Harry Quarles
SUBJECT: Thorium Nitrate

QUESTION
What is the definition of "friable" as this word is used in paragraph 34.4.1.2.6 of the United Nations Manual of Tests and Criteria in the Recommendations on the Transport of Dangerous Goods?

BACKGROUND

You are interested in the definition of friable because it relates to being an oxidizer which relates to being a RCRA hazardous waste. I trace out these relations below.

As discussed in my memo to you of 11 June 2002, the RCRA definition of characteristic hazardous waste at issue for thorium nitrate uses a DOT definition of oxidizer. The controlling DOT regulation is located at 49 CFR § 173.127 (not 49 CFR 173.151 as is currently incorrectly referenced in RCRA; see my memos to you of 19 and 31 October 2000). The DOT regulation refers in turn to a UN Manual of Tests and Criteria.

The relevant part of the DOT regulation [49 CFR § 173.27(a)(1)] reads

> *. . . oxidizer (Division 5.1) means a material that may, generally by yielding oxygen, cause or enhance the combustion of other materials. (1) A solid material is classed as a Division 5.1 material if, when tested in accordance with the UN Manual of Tests and Criteria, its mean burning time is less than or equal to the burning time of a 3:7 potassium bromate/cellulose mixture.*

The UN Manual of Tests and Criteria referred to above [published in the United Nations Recommendations on the TRANSPORT OF DANGEROUS GOODS, 3rd revised edition, 1999] is number 34.4 Test methods for oxidizing substances. Use of the method requires grinding of a sample of the material to be tested keying on small particles. Whether grinding is required is controlled by paragraph 34.4.1.2.6 which states in its entirety:

> *The substance, in the form in which it will be transported, should be inspected for any particles less than 500 µm in diameter. If that powder constitutes more than 10% (mass) of the total, or if the substance is* ***friable****, then the whole of the test sample should be ground to a powder before testing to allow for a reduction in particle size during transport.*

The UN Manual does not, however, give a definition of friable.

DETERMINATION OF WORKING DEFINITION OF FRIABLE

The dictionary definition (Webster's Ninth New Collegiate Dictionary 1991) of friable is "easily crumbled or pulverized." Based on this definition, I formulated an interpretation of the meaning of paragraph 34.4.1.2.6, specifically of the first two clauses in the second sentence. The paragraph is addressing materials that will have lots of small particles during transport.

A material can get lots of small particles two different ways. It could start out with lots of small particles (>10% <500 µm in diameter) as stated the first clause of the second sentence of paragraph 34.4.1.2.6, or it could generate them during transport through friability [crumbling] caused by the hustle and bustle of forces acting on it during shipping, as I think is the intended meaning of the second clause of the second sentence of the paragraph. The number of small particles to be concerned with is >10% <500 µm in diameter; if there are less small particles than this then the first clause of the second sentence of the definition does not apply, and grinding of the material is not required. It follows reasonably, then, that if the material is friable only to the extent that <10% <500 µm in diameter particles would be created by forces during

transport, then grinding should also not be required. Similarly, if greater than this amount of particles is created during transport from crumbling and pulverization, then the material would require grinding by the first clause of the second sentence of paragraph 34.4.1.2.6, and therefore also should require grinding by action of the second clause of the second sentence of the paragraph.

Therefore, I concluded that paragraph 34.4.1.2.6 is requiring grinding if 1) the material has lots of fine particles, or 2) if it will form lots of fine particles during transport.

SEEKING A REGULATORY DEFINITION

On 13 June 2002, I telephoned Mr. Oliver Kervella who is the Head of Transport Division Dangerous Goods of the UN Economic Commission for Europe (telephone number 41.22.917.2456) to inquire about a definition of "friable" as used in the UN Manual. He told me that there was no published regulatory definition, and then read me a dictionary definition consistent with the one I reported above. He referred me to Mr. Charlie Ke at the US Department of Transportation whom he said was involved in the method's development.

I telephoned Mr. Ke (202-366-4545 ext 4495) and he returned my call on 17 June 2002. He confirmed that there was no published regulatory definition of friable, and told me that he been instrumental in development of the UN method. I told him of my interpretation, i.e., that paragraph 34.4.1.2.6 was concerned with existing small particles, or small particles that could be created in transit through crumbling or friability in transit. He agreed. I further stated that therefore I concluded that if <10% <500 µm in diameter particles would be created by forces received in typical transport then the material was not "friable" under paragraph 34.4.1.2.6; and that if >10% <500 µm in diameter particles would be created then it would be friable.

He agreed in principle and added the following qualification. He said that if less than 5% <500 µm in diameter particles would be created in transport then the material would clearly not be friable per paragraph 34.4.1.2.6; and if more than 10% <500 µm in diameter particles would be created then the material would clearly be friable per paragraph 34.4.1.2.6. He said that between 5% and 10% would be a gray area, and that perhaps the cutoff should be made closer to 5% than 10% "for safety concern."

ANSWER

Given that there is no formal regulatory definition of "friable" as this word is used in paragraph 34.4.1.2.6 of the United Nations Manual of Tests and Criteria, a reasonable definition is

A material is friable if >10% <500 µm in diameter particles would be created during typical transport; it is not friable if <5% <500 µm in diameter particles would be created during typical transport; and it is likely not friable if <10% <500 µm in diameter particles would be created during typical transport, but setting the limit closer to 5% provides a greater margin of safety.

For the domestic ThN, the issue would be the formation of fine particles during transportation. Initially, the laboratory tried to place the loose material from the plastic bags of domestic samples on a № 35 (0.5-mm) sieve to determine the percentage of powder. However, very little of the material passed through the sieve, indicating that the particle size of the material was larger than 0.5 mm.

In view of these results, and in accordance with the regulatory expert's advice, the following rationale was used for assessing the friability of the domestic material. In determinating the amount of fines that got generated during the transportation of the analytical samples from Curtis Bay, Maryland, to San Antonio, Texas, where the analytical laboratory is located, a miniature replication of how the sample could behaved during the real transportation from Curtis Bay to Mercury, Nevada, would be tested. It was also a worse case scenario since there was more than one chunk of material in the container that would create more friction than inside the drum containing a monolith of material.

The laboratory was asked to weigh both the material received intact and the material present as powder after transportation to the laboratory. This conservative approach considered the total weight of the loose material as the percentage of powder instead of the fraction that was less than 0.5 mm in diameter as called for in the UN method. This procedure prevented the need for sieving the material, which would have created additional risk of exposure to airborne particulates by laboratory personnel (ALARA principle), would have involved additional time and cost.

Using the total powder assumption, none of the domestic samples consisted of a fraction larger than 6.8 wt % powder. Therefore, none of the samples were friable according to the UN criterion. Data supporting this conclusion are presented in Table 9.

In view of these results, the samples were tested as they will be transported, meaning that the laboratory carved the chunk they received to one or two pieces that would be of the weight needed for the ratio of sample to cellulose.

The samples from India were found in the form of cubes or gravel having a size of 1–2 in. in diameter/larger dimension and were tested in the form they will be transported in. The laboratory used the same carving technique than for the domestic material to obtain the piece of sample of the correct weight for testing.

The samples from France were the only one in a powder form. A particle size analysis was performed on three lots and showed that the material is quite coarse, with 0 wt % being smaller than 38 µm, 2–7 wt % being in the range of 38 to 180 µm, and 93–98 wt % being larger than 180 µm. The material was homogeneous with no big chunks present; therefore, it was tested as received at the laboratory considering that in this case the size of 500 µm was not applicable because of the homogeneity of the material represented "the substance in the form in which it will be transported."

Fifty-three samples were sent for analysis: 8 domestic samples from Hammond and 22 domestic samples, 13 French samples, and 10 Indian samples from Curtis Bay. The laboratory tested them following the *Recommendations on the Transportation of Dangerous Goods—Manual of Tests and Criteria* (UN 1999).

The SOW requested that the laboratory perform one complete set of standards (five replicates) at the beginning, middle, and end of the sample testing and perform one set of standards (one replicate only) on each day a sample was tested. The laboratory complied with all the requirements of the SOW and provided information for each sample regarding temperature, humidity, and elapsed time during which the samples were exposed to air before testing.

Table 9. Justification for the qualification of nonfriability for the domestic ThN

Sample ID	RWE ThN (g)	SWRI Bulk weight (g)	SWRI Loose weight (g)	SWRI Total weight (g)	SWRI % powder
HD0807061-2002[a]	1,427	1,365.7	46.30	1,412.00	3.28
HD1010061-2002	1,749	1,600.58	86.52	1,687.10	5.13
HD2307061-2002	1,122	1,103.79	13.00	1,116.79	1.16
HD2907061-2002	1,147	1,001.55	50.39	1,051.94	4.79
HD3007061-2002[a]	1,040	969.69	59.37	1,029.06	5.77
HD3810061-2002	1,091	1,075.61	4.69	1,080.30	0.43
HD4710061-2002[a]	1,485	1,409.04	59.68	1,468.72	4.06
HD4810061-2002[a]	1,027	1,203.06	68.73	1,271.79	5.40
CD0212071-2002	1,149	1,135.65	18.65	1,154.30	1.62
CD0311071-2002	1,137	1,110.37	32.54	1,142.91	2.85
CD1111071-2002	1,003	955.15	55.50	1,010.65	5.49
CD1212071-2002	1,682	1,647.02	31.72	1,678.74	1.89
CD1412071-2002	1,220	1,177.03	34.85	1,211.88	2.88
CD1511071-2002	1,042	989.70	59.12	1,048.82	5.64
CD1710071-2002	1,199	1,142.20	0.75	1,142.95	0.07
CD1809071-2002	1,042	1,020.13	14.84	1,034.97	1.43
CD2010071-2002	1,224	1,189.05	32.84	1,221.89	2.69
CD2210071-2002	1,261	1,222.90	31.64	1,254.54	2.52
CD2801071-2002	1,234	1,194.86	30.60	1,225.46	2.50
CD2909071-2002	1,219	1,142.08	49.97	1,192.05	4.19
CD3028061-2002	1,392	1,401.29	0.00	1,401.29	0.00
CD3601071-2002	1,382	1,362.29	13.70	1,375.99	1.00
CD3710071-2002	1,173	1,132.89	28.96	1,161.85	2.49
CD4412071-2002	1,036	1,009.18	30.68	1,039.86	2.95
CD4528061-2002	1,359	1,340.42	6.46	1,346.88	0.48
CD4827061-2002	1,492	1,419.78	51.28	1,471.06	3.49
CD5210071-2002	1,354	1,322.26	35.20	1,357.46	2.59
CD5812071-2002	1,088	1,016.80	75.11	1,091.91	6.88
CD6109071-2002	1,129	1,116.26	14.26	1,130.52	1.26
CD6509071-2002	1,054	1,009.42	38.15	1,047.57	3.64

[a]These samples were broken manually to assess their friability.

The laboratory tested each ThN sample five times at 1:1 and 1:4 sample-to-cellulose ratios. As specified in the procedure, the power was to be applied to sample-cellulose mixtures for a maximum of 3 min, even if the "burning" had not ended. To be conservative, the laboratory chose to keep the power on for 4 min. The time at which each burn concluded was recorded for those samples that had burn times of less than 4 min. If any sample-cellulose mixture continued to burn longer than 4 min, the test was concluded and ">4 min" was recorded. Because of the lower amount of cellulose in the 1:4 samples (6g cellulose and 24 g sample), most had a burn time of >4 min. The mean burn time of each sample at each ratio was calculated and compared with the mean burn time of the three ratios of the potassium bromate and cellulose reference material to determine the classification. For the values that burned in more than 240 sec, the value of 240 was used for the statistical calculations. None of the ThN samples had a mean burn time less than that of the 3:7 reference mixture. All ThN samples were classified as "Not Division 5.1" by the laboratory. The following observations were recorded by the laboratory:

- **Domestic ThN:** Although the sample-cellulose mixtures burned, there were signs of an oxidizing reaction. The burns were slow and controlled, unlike the reference material. While the cellulose burned, the ThN became molten and evolved orange fumes.
- **Indian ThN:** Behaved very similarly to domestic ThN.
- **French ThN:** Unlike the other ThN samples, the French samples were all powder, unlike the solid pieces of the domestic and Indian origins. The French material exhibited flame retardant characteristics. At the 1:1 ratio, a typical burn started with a delayed onset of flame production; dense yellowish orange fumes evolved, and the flame luminosity was often low. In some cases, the piles consolidated, expanded, or split, or they simply lifted off the filament. The self-disorganizing behavior of these effects gave different burn rates. Although the burn times recorded were shorter than the domestic and Indian burn times, most exceeded 2 min, resulting in mean burn times that still exceeded that of the 3:7 reference burn. These outcomes occurred only with the 1:1 ratio. The French material in the 1:4 ratio gave results essentially identical to the results from the domestic and Indian samples (>4 min or >240 s).

Table 10 summarizes the results obtained for the standards that are mixtures of potassium bromate and cellulose at ratios of 3:7, 2:3, and 3:2 of potassium bromate to cellulose. Table 11 presents the oxidizer test results for the domestic Hammond samples, the domestic Curtis Bay samples, the French samples, and the Indian samples. The average, standard deviation, and error were calculated for each group of samples and are recorded in each table.

6.2 DENSITY MEASUREMENTS FOR THE DOMESTIC ThN FROM CURTIS BAY

Seven domestic samples from Curtis Bay were tested for density using a modified American Society for Testing and Materials (ASTM) D5057 method—modified because the solubility of the material in water made measuring the displacement of water impossible. The laboratory filled a container having a known volume with fine sand and weighed it (in triplicate) to measure the density of sand. A single piece of ThN having a mass ranging from 15 to 25 g was placed in the container, and the container was filled with sand to reach the same known volume. The volume of the piece of ThN was calculated from the density of the sand and the weight of sand displaced. The density results are compiled in Table 12.

Table 10. Results of the oxidizer test for the standards
[Burn times are given in seconds]

Date	Test no.	3:7 $KBrO_3$/ cellulose	2:3 $KBrO_3$/ cellulose	3:2 $KBrO_3$/ cellulose
7/14/2002	1	102.93	77.35	21.53
7/14/2002	2	89.22	51.65	9.75
7/14/2002	3	117.37	85.59	10.32
7/14/2002	4	106.63	60.03	10.22
7/14/2002	5	117.59	78.40	22.31
7/15/2002	6	109.19	71.93	8.90
7/17/2002	7	136.81	63.62	17.34
7/18/2002	8	104.03	111.06	9.50
7/30/2002	9	143.91	129.22	15.75
7/31/2002	10	143.91	73.44	14.28
8/1/2002	11	130.78	78.78	16.07
8/6/2002	12	108.25	67.47	13.32
8/7/2002	13	154.75	87.03	15.38
8/8/2002	14	99.44	65.78	12.04
8/13/2002	15	107.16	48.91	11.69
8/15/2002	16	118.81	47.44	9.68
8/16/2002	17	91.54	44.91	10.25
8/19/2002	18	91.60	63.20	13.5
8/20/2002	19	120.93	56.29	3.87
8/22/2002	20	109.50	61.90	14.15
8/23/2002	21	117.65	50.68	14.85
8/27/2002	22	108.41	70.66	17.5
8/28/2002	23	85.90	44.62	7.15
8/28/2002	24	82.94	41.65	11.41
8/28/2002	25	70.72	42.16	6.84
8/28/2002	26	116.16	41.72	10.59
8/28/2002	27	97.53	43.29	9.78
9/3/2002	28	114.41	55.63	11.41
9/5/2002	29	91.34	33.91	8.82
9/10/2002	30	137.25	38.91	10.6
9/11/2002	31	88.78	39.21	8.15
9/12/2002	32	111.47	35.63	10.94
9/18/2002	33	89.25	43.91	9.65
9/18/2002	34	110.28	33.56	9.32
9/18/2002	35	109.03	45.03	10.06
9/18/2002	36	101.44	48.54	10.72
9/18/2002	37	86.75	36.72	14.5
	Average (seconds)	108.74	58.64	11.95
	Standard deviation	18.80	21.39	3.84
	Error (±)	6.25	7.11	1.26

Table 11. Results of the oxidizer tests for the ThN samples
[Burn times are given in seconds]

Sample name	Readings for sample to cellulose ratio 4:1						Readings for sample to cellulose ratio 1:1					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Domestic samples from Hammond												
HD0807061-2002	180	180	180	180	180	180	478	293	287	369	233	332
HD1010061-2002	160	180	204	158	193	179	365	306	344	225	298	308
HD2307061-2002	136	180	205	191	206	184	>240	>240	>240	>240	>240	>240
HD2907061-2002	167	171	194	236	194	192	>240	>240	>240	>240	>240	>240
HD3007061-2002	204	208	189	202	274	216	>240	>240	>240	>240	>240	>240
HD3810061-2002	194	190	222	206	194	201	>240	>240	>240	>240	>240	>240
HD4710061-2002	184	218	217	194	192	201	>240	>240	>240	>240	>240	>240
HD4810061-2002	239	181	212	187	188	201	>240	>240	>240	>240	>240	>240
Average (seconds)						194.3						260.0
Standard deviation						23.8						49.8
Error (±)						21.3						NA

Table 11. (*continued*)
[Burn times are given in seconds]

Sample name	Readings for sample to cellulose ratio 4:1						Readings for sample to cellulose ratio 1:1					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Domestic samples from Curtis Bay												
CD0212071	190.84	186.50	181.37	197.25	205.47	192.29	>240	>240	>240	>240	>240	>240
CD0311071	204.03	205.41	193.40	219.03	209.04	206.18	>240	>240	>240	>240	>240	>240
CD1111071	188.90	197.06	192.08	212.01	189.63	195.94	>240	>240	>240	>240	>240	>240
CD1212071	200.72	228.22	189.25	225.09	195.37	207.73	>240	>240	>240	>240	>240	>240
CD1412071	186.50	216.84	210.90	187.97	199.07	200.26	>240	>240	>240	>240	>240	>240
CD1511071	189.22	195.03	209.78	>240	225.66	211.94	>240	>240	>240	>240	>240	>240
CD1710071	190.91	210.56	193.66	193.16	190.07	195.68	>240	>240	>240	>240	>240	>240
CD1809071	202.40	207.37	237.88	201.78	186.35	207.16	>240	>240	>240	>240	>240	>240
CD2010071	191.07	190.41	204.28	216.87	209.37	202.40	>240	>240	>240	>240	>240	>240
CD2210071	221.35	221.16	183.72	200.37	197.47	204.81	>240	>240	>240	>240	>240	>240
CD2801071	208.13	184.03	186.59	185.03	194.31	191.62	>240	>240	>240	>240	>240	>240
CD2904071	192.25	210.81	160.75	216.66	208.78	197.85	>240	>240	>240	>240	>240	>240
CD3028061	197.53	205.13	227.19	196.13	193.25	203.85	>240	>240	>240	>240	>240	>240
CD3601071	154.62	213.94	205.25	188.03	189.50	190.27	>240	>240	>240	>240	>240	>240
CD3710071	197.47	>240	188.68	198.22	196.37	204.15	>240	>240	>240	>240	>240	>240
CD4412071	199.22	203.93	194.97	190.10	209.84	199.61	>240	>240	>240	>240	>240	>240
CD4527061	204.10	196.40	190.12	192.68	200.53	196.77	>240	>240	>240	>240	>240	>240
CD4827061	188.50	210.91	186.68	200.09	193.50	195.94	>240	>240	>240	>240	>240	>240
CD5210071	190.10	190.06	222.40	214.56	202.31	203.89	>240	>240	>240	>240	>240	>240
CD5812071	207.19	200.39	197.51	186.06	185.13	195.26	>240	>240	>240	>240	>240	>240
CD6109071	193.28	187.84	189.50	189.37	220.03	196.00	>240	>240	>240	>240	>240	>240
CD6509071	200.75	199.78	>240	190.28	185.22	203.21	>240	>240	>240	>240	>240	>240
Average (seconds)						200.1						>240
Standard deviation						14.58						NA
Error (±)						6.5						NA

Table 11. (*continued*)
[Burn times are given in seconds]

Sample name	Readings for sample to cellulose ratio 4:1						Readings for sample to cellulose ratio 1:1					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
French samples from Curtis Bay												
CF108071	137.40	180.50	157.09	189.10	171.78	167.17	>240	>240	>240	>240	>240	>240
CF208071	184.25	182.65	180.87	181.59	170.38	179.95	>240	>240	>240	>240	>240	>240
CF308071	182.56	180.32	210.41	172.06	176.87	184.44	>240	>240	>240	>240	>240	>240
CF408071	196.68	186.59	172.66	168.03	136.85	172.16	>240	>240	>240	>240	>240	>240
CF608071	152.53	172.57	157.28	153.66	223.88	171.98	>240	>240	>240	>240	>240	>240
CF908071	165.06	190.22	186.53	210.07	187.44	187.86	>240	>240	>240	>240	>240	>240
CF1002071	185.53	181.50	184.44	183.71	178.81	182.80	>240	>240	>240	>240	>240	>240
CF1102071	217.34	197.40	186.44	220.61	179.72	200.30	>240	>240	>240	>240	>240	>240
CF1308071	226.03	185.22	190.88	216.79	187.03	201.19	>240	>240	>240	>240	>240	>240
CF1403071	150.28	159.63	144.62	122.05	153.22	145.96	>240	199	>240	216	>240	227
CF1608071	183.72	182.65	190.41	186.13	182.84	185.15	>240	>240	>240	>240	>240	>240
CF1708071	181.05	18055	143.06	183.63	184.65	174.59	>240	>240	>240	>240	>240	>240
CF1908071	180.00	172.12	189.44	182.41	187.22	182.24	>240	>240	>240	>240	>240	>240
Average (seconds)						179.7						>240
Standard deviation						20.46						NA
Error (±)						12.4						NA

Table 11. (*continued*)
[Burn times are given in seconds]

Sample name	Readings for sample to cellulose ratio 4:1						Readings for sample to cellulose ratio 1:1					
	R1	R2	R3	R4	R5	Mean	R1	R2	R3	R4	R5	Mean
Indian samples from Curtis Bay												
CI307071	227.35	231.96	192.09	232.60	223.68	221.54	>240	>240	>240	>240	>240	>240
CI403071	176.93	203.59	186.16	208.50	159.03	186.84	>240	>240	>240	>240	>240	>240
CI503071	226.97	196.12	198.80	186.96	203.12	202.39	>240	>240	>240	>240	>240	>240
CI603071	>240	194.44	187.34	201.36	195.16	203.66	>240	>240	>240	>240	>240	>240
CI703071	195.28	203.97	192.47	190.72	189.85	194.46	>240	>240	>240	>240	>240	>240
CI903071	205.84	227.25	186.50	234.97	202.09	211.33	>240	>240	>240	>240	>240	>240
CI1102071	224.56	196.50	184.66	207.41	205.53	203.73	>240	>240	>240	>240	>240	>240
CI1202071	190.25	229.94	183.22	200.03	>240	208.69	>240	>240	>240	>240	>240	>240
CI1302071	202.44	202.03	189.33	196.41	158.40	189.72	>240	>240	>240	>240	>240	>240
CI1403071	192.87	>240	191.66	187.13	186.78	199.69	>240	>240	>240	>240	>240	>240
Average (seconds)						199.8						>240
Standard deviation						17.5						NA
Error (±)						12.5						NA

Table 12. Density measurements of domestic ThN

Sample	Density (g/cm^3)
CD201007	1.931
CD111107	1.870
CD151107	1.876
CD021207	1.929
CD221007	1.869
CD290407	1.787
CD482706	2.014
CD371007	1.695
CD610907	2.013
Average	1.89
Error (±)	0.08

6.3 METAL ANALYSES

Fifty-three ThN samples were analyzed for mercury using EPA Method SW-846-7471A. The samples were diluted in 4 vol % nitric acid for assays of the remaining metals. The samples were analyzed for Al, As, Cu, Pb, Mg, Se, Ag, and U by inductively coupled plasma–mass spectroscopy (ICP-MS) (EPA Method SW-846-6020) and for the remaining metals by inductively coupled plasma–atomic emission spectroscopy (ICP-AES) (SW-846-6010B). Results are reported on a dry-weight basis. Several ICP-AES runs were performed, each with its own calibration and QC controls. Thorium was run separately; Ca, Fe, Na, and V were run together; and the remaining elements (Sb, Ba, Be, B, Cd, Cr, Co, Mn, Mo, Ni, Si, Sr, Tl, Zn, and Zr) were run as a group. Mercury was run using cold vapor atomic absorption (CVAA). Because of the elevated thorium concentration in the samples, some elements had to be manually calculated to correct for thorium interference: Cd, Cr, Mn, Sb, Si, Tl, Ca, Fe, and V. The data were validated according to EPA guidance, and data qualifiers (Q) for metals validations were applied as follows:

U The analyte was not detected above the reported detection limit.
J The analyte was identified; the associated numerical value is approximated.
UJ The analyte was not detected above the reported detection limit, and the associated detection limit is approximated because of quality deficiency.
= Data that, as a result of the validation process, have been determined to meet QA/QC requirements and are considered to be a valid result greater than the reporting limit are presented with an equal sign, indicating that no qualifier is necessary.

Results of the metal analyses for the ThN samples are presented in Table 13. For the domestic samples from Hammond, almost all the analytes were found to be below the detection limit. However, in two samples, small amounts of sodium were detected: 2440 mg/kg in sample HD1010061-2002 and 2480 mg/kg in sample HD3810061-2002. In two other samples, trace amounts of lead were detected: 0.72 mg/kg in sample HD2907061-2002 and 1.5 mg/kg in sample HD4710061-2002. The results for thorium vary from 42.0 to 43.4 wt %.

Table 13. Total composition for the ThN samples
[Units are mg/kg]

	Sample ID and % solids[a]															
	HD0807061, 92.4		HD1010061, 92.2		HD2307061, 92.6		HD2907061, 91.0		HD3007061, 92.4		HD3810061, 90.3		HD4710061, 92.2		HD4810061, 91.2	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Domestic ThN from Hammond																
Aluminum	22.7	U	23.0	U	23.5	U	23.1	U	23.1	U	23.7	U	22.0	U	24.9	U
Antimony	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Arsenic	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Barium	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Beryllium	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Boron	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Cadmium	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Calcium	45.5	U	46.0	U	47.0	U	46.2	U	46.3	U	47.3	U	44.1	U	49.8	U
Chromium	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Cobalt	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Copper	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Iron	45.5	U	46.0	U	47.0	U	46.2	U	46.3	U	47.3	U	44.1	U	49.8	U
Lead	0.45	U	0.46	U	0.47	U	0.72	=	0.46	U	0.47	U	1.5	=	0.5	U
Magnesium	22.7	U	23.0	U	23.5	U	23.1	U	23.1	U	23.7	U	22.0	U	24.9	U
Manganese	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Mercury	0.02	U	0.03	U	0.05	U	0.04	U	0.05	U	0.05	U	0.04	U	0.05	U
Molybdenum	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Nickel	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Selenium	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Silicon	22.7	U	23.0	U	23.5	U	23.1	U	23.1	U	23.7	U	22.0	U	24.9	U
Silver	0.45	U	0.46	U	0.47	U	0.46	U	0.46	U	0.47	U	0.44	U	0.50	U
Sodium	90.9	U	2440	=	93.9	U	92.3	U	92.5	U	2480	=	88.2	U	99.7	U
Strontium	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Thallium	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Thorium	428000	=	420000	=	425000	=	430000	=	434000	=	433000	=	431000	=	432000	=
Uranium	0.46	U	0.46	U	0.47	U	0.46	U	0.46	U	0.47	U	0.44	U	0.50	U
Vanadium	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U
Zinc	4.5	U	4.6	U	4.7	U	4.6	U	4.6	U	4.7	U	4.4	U	5.0	U
Zirconium	9.1	U	9.2	U	9.4	U	9.2	U	9.3	U	9.5	U	8.8	U	10.0	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]															
	CD021207, 90.6		CD031107, 93.1		CD111107, 92.2		CD121207, 90.1		CD141207, 89.6		CD151107, 93.6		CD171007, 84.1		CD180907, 93.3	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Domestic ThN from Curtis Bay																
Aluminum	53.6	UJ	49.3	UJ	48.9	UJ	48.3	UJ	49.8	UJ	49.0	UJ	58.3	UJ	43.2	UJ
Antimony	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Arsenic	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Barium	5.4	U	45.6	=	4.9	U	4.8	U	5.0	U	647	=	5.8	U	4.3	U
Beryllium	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Boron	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Cadmium	5.4	UJ	4.9	UJ	4.9	UJ	4.8	UJ	5.0	UJ	4.9	UJ	5.8	UJ	4.3	UJ
Calcium	53.6	U	49.3	U	48.9	U	48.3	U	49.8	U	49.0	U	58.3	U	43.2	U
Chromium	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Cobalt	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Copper	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Iron	53.6	UJ	49.3	UJ	48.9	UJ	48.3	UJ	49.8	UJ	49.0	UJ	58.3	UJ	43.2	UJ
Lead	1.10	U	0.99	U	0.98	U	0.97	U	1.00	U	0.98	U	1.20	U	0.86	U
Magnesium	53.6	UJ	49.3	UJ	48.9	UJ	48.3	UJ	49.8	UJ	49.0	UJ	58.3	UJ	43.2	UJ
Manganese	10.7	U	9.9	U	11.6	J	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Mercury	0.06	U	0.06	U	0.03	U	0.06	U	0.04	U	0.07	U	0.06	U	0.05	U
Molybdenum	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Nickel	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Selenium	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Silicon	26.8	U	24.6	U	24.4	U	24.1	U	24.9	U	24.5	U	29.1	U	21.6	U
Silver	1.10	UJ	0.99	UJ	0.98	UJ	0.97	UJ	1.00	UJ	0.98	UJ	1.20	UJ	0.86	UJ
Sodium	107.0	U	98.5	U	97.7	U	96.5	U	99.6	U	98.0	U	117.0	U	86.4	U
Strontium	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Thallium	11.4	=	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U
Thorium	474000	=	459000	=	462000	=	482000	=	506000	=	467000	=	518000	=	468000	=
Uranium	1.10	UJ	0.99	UJ	0.98	UJ	0.97	UJ	1.00	UJ	0.98	UJ	1.20	UJ	0.86	UJ
Vanadium	10.7	UJ	9.9	UJ	9.8	UJ	9.7	UJ	10.0	UJ	9.8	UJ	11.7	UJ	8.6	UJ
Zinc	5.4	U	4.9	U	4.9	U	4.8	U	5.0	U	4.9	U	5.8	U	4.3	U
Zirconium	10.7	U	9.9	U	9.8	U	9.7	U	10.0	U	9.8	U	11.7	U	8.6	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]															
	CD201007 91.5		CD221007 88.9		CD280107 92.4		CD290407 92.4		CD302806 93.3		CD360107 94.1		CD371007 92.2		CD441207 92.0	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Domestic ThN from Curtis Bay *(continued)*																
Aluminum	49.2	UJ	43.9	UJ	47.9	UJ	46.3	UJ	42.9	UJ	40.9	UJ	52.7	UJ	44.9	UJ
Antimony	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Arsenic	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Barium	295	=	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Beryllium	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Boron	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Cadmium	4.9	UJ	4.4	UJ	4.8	UJ	4.6	UJ	4.3	UJ	4.1	UJ	5.3	UJ	4.5	UJ
Calcium	49.2	U	43.9	U	47.9	U	46.3	U	42.9	U	40.9	U	52.7	U	44.9	U
Chromium	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Cobalt	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Copper	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Iron	49.2	UJ	43.9	UJ	47.9	UJ	46.3	UJ	42.9	UJ	40.9	UJ	52.7	UJ	44.9	UJ
Lead	0.98	U	0.88	U	0.96	U	0.93	U	0.86	U	0.82	U	1.10	U	0.90	U
Magnesium	49.2	UJ	43.9	UJ	47.9	UJ	46.3	UJ	42.9	UJ	40.9	UJ	52.7	UJ	44.9	UJ
Manganese	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Mercury	0.04	U	0.06	U	0.03	U	0.07	U	0.04	U	0.05	U	0.06	U	0.05	U
Molybdenum	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Nickel	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Selenium	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Silicon	24.6	U	22.0	U	23.9	U	23.1	U	21.4	U	20.4	U	26.3	U	38.1	=
Silver	0.98	UJ	0.88	UJ	0.96	UJ	0.93	UJ	0.86	UJ	0.82	UJ	1.10	UJ	0.90	UJ
Sodium	98.5	U	87.9	U	95.8	U	156	=	85.7	U	81.7	U	105.0	U	89.8	U
Strontium	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Thallium	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U
Thorium	468000	=	485000	=	466000	=	467000	=	462000	=	451000	=	462000	=	468000	=
Uranium	0.98	UJ	0.88	UJ	0.96	UJ	0.93	UJ	0.86	UJ	0.82	UJ	1.10	UJ	0.90	UJ
Vanadium	9.8	UJ	8.8	UJ	9.6	UJ	9.3	UJ	8.6	UJ	8.2	UJ	10.5	UJ	9.0	UJ
Zinc	4.9	U	4.4	U	4.8	U	4.6	U	4.3	U	4.1	U	5.3	U	4.5	U
Zirconium	9.8	U	8.8	U	9.6	U	9.3	U	8.6	U	8.2	U	10.5	U	9.0	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]											
	CD452706 93.4		CD482706 94.8		CD521007 90.6		CD581207 97.4		CD610907 90.7		CD650907 88.5	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Domestic ThN from Curtis Bay *(continued)*												
Aluminum	48.2	UJ	50.2	UJ	48.4	UJ	45.0	UJ	52.0	UJ	46.3	UJ
Antimony	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Arsenic	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Barium	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Beryllium	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Boron	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Cadmium	4.8	UJ	5.0	UJ	4.8	UJ	4.5	UJ	5.2	UJ	4.6	UJ
Calcium	48.2	U	50.2	U	48.4	U	45.0	U	52.0	U	46.3	U
Chromium	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Cobalt	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Copper	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Iron	48.2	UJ	50.2	UJ	48.4	UJ	45.0	UJ	52.0	UJ	46.3	UJ
Lead	0.96	U	1.00	U	0.97	U	0.90	U	1.00	U	0.93	U
Magnesium	48.2	UJ	50.2	UJ	48.4	UJ	45.0	UJ	52.0	UJ	46.3	UJ
Manganese	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Mercury	0.04	U	0.04	U	0.04	U	0.04	U	0.05	U	0.06	U
Molybdenum	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Nickel	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Selenium	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Silicon	24.1	U	25.4	U	24.2	U	22.5	U	26.0	U	23.2	U
Silver	0.96	UJ	1.00	UJ	0.97	UJ	0.90	UJ	1.00	UJ	0.93	UJ
Sodium	96.5	U	100.0	U	96.8	U	90.1	U	104.0	U	92.6	U
Strontium	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Thallium	9.6	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U
Thorium	463000	=	425000	=	479000	=	428000	=	476000	=	509000	=
Uranium	0.96	UJ	1.00	UJ	0.97	UJ	0.90	UJ	1.00	UJ	0.93	UJ
Vanadium	9.6	UJ	10.0	UJ	9.7	UJ	9.0	UJ	10.4	UJ	9.3	UJ
Zinc	4.8	U	5.0	U	4.8	U	4.5	U	5.2	U	4.6	U
Zirconium	9.65	U	10.0	U	9.7	U	9.0	U	10.4	U	9.3	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]													
	CF010807, 94.8		CF020807, 86.8		CF030807, 80.7		CF040807, 80.4		CF060807, 83.3		CF090807, 93.1		CF100207, 81.9	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
French ThN from Curtis Bay														
Aluminum	43.2	UJ	48.4	UJ	53.4	UJ	54.1	UJ	51.7	UJ	49.3	UJ	50.5	UJ
Antimony	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Arsenic	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Barium	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Beryllium	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Boron	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Cadmium	4.3	UJ	4.8	UJ	5.3	UJ	5.4	UJ	5.2	UJ	4.9	UJ	5.0	UJ
Calcium	43.2	U	48.4	U	53.4	U	54.1	U	51.7	U	49.3	U	50.5	U
Chromium	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	10.6	U	10.1	U
Cobalt	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Copper	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Iron	43.2	UJ	48.4	UJ	53.4	UJ	54.1	UJ	51.7	UJ	49.3	UJ	50.5	UJ
Lead	0.86	U	11.9	=	4.3	=	7.7	=	2.2	=	5.8	=	9.3	=
Magnesium	43.2	UJ	48.4	UJ	53.4	UJ	54.1	UJ	51.7	UJ	49.3	UJ	50.5	UJ
Manganese	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Mercury	0.05	U	0.05	U	0.04	U	0.04	U	0.05	U	0.04	U	0.06	U
Molybdenum	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Nickel	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	5.7	=	6.0	=
Selenium	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Silicon	21.6	U	24.2	U	26.7	U	27.0	U	25.9	U	24.6	U	25.2	U
Silver	0.86	UJ	0.97	UJ	1.10	UJ	1.10	UJ	1.00	UJ	0.99	UJ	1.00	UJ
Sodium	422	=	232	=	356	=	236	=	597	=	213	=	472	=
Strontium	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Thallium	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U
Thorium	434000	=	495000	=	517000	=	529000	=	511000	=	466000	=	522000	=
Uranium	13.5	J	22.7	J	18.9	J	35.9	J	11.4	J	46.3	J	35.4	J
Vanadium	8.6	UJ	9.7	UJ	10.7	UJ	10.8	UJ	10.3	UJ	9.9	UJ	10.1	UJ
Zinc	4.3	U	4.8	U	5.3	U	5.4	U	5.2	U	4.9	U	5.0	U
Zirconium	8.6	U	9.7	U	10.7	U	10.8	U	10.3	U	9.9	U	10.1	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]											
	CF110207, 92.7		CF130807, 92.8		CF140307, 91.6		CF160807, 83.6		CF170807, 92.1		CF190807, 89.1	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
French ThN from Curtis Bay (*continued*)												
Aluminum	45.7	UJ	48.1	UJ	44.0	UJ	51.6	UJ	42.4	UJ	52.0	UJ
Antimony	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Arsenic	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	1.4	U
Barium	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Beryllium	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Boron	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Cadmium	4.6	UJ	4.8	UJ	4.4	UJ	5.2	UJ	4.2	UJ	5.2	UJ
Calcium	45.7	U	48.1	U	44.0	U	51.6	U	42.4	U	52.0	U
Chromium	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	16.3	J
Cobalt	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Copper	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Iron	45.7	UJ	48.1	UJ	44.0	UJ	51.6	UJ	42.4	UJ	52.0	UJ
Lead	2.5	=	6.0	=	15.0	=	1.0	U	2.5	=	7.5	=
Magnesium	45.7	UJ	48.1	UJ	44.0	UJ	51.6	UJ	52.4	UJ	52.0	UJ
Manganese	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Mercury	0.05	U	0.04	U	0.05	U	0.06	U	0.05	U	0.04	U
Molybdenum	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Nickel	4.6	U	4.8	U	6.2	=	5.2	U	4.2	U	9.4	=
Selenium	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Silicon	22.9	U	24.1	U	22.0	U	25.8	U	21.2	U	26.0	U
Silver	0.91	UJ	0.96	UJ	0.88	UJ	1.00	UJ	0.85	UJ	1.00	UJ
Sodium	176	=	273	=	819	=	171	=	530	=	250	=
Strontium	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Thallium	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	10.4	U
Thorium	460000	=	488000	=	456000	=	516000	=	471000	=	460000	=
Uranium	17.5	J	34.6	J	24.8	J	7.8	J	28.8	J	24.3	J
Vanadium	9.1	UJ	9.6	UJ	8.8	UJ	10.3	UJ	8.5	UJ	10.5	UJ
Zinc	4.6	U	4.8	U	4.4	U	5.2	U	4.2	U	5.2	U
Zirconium	9.1	U	9.6	U	8.8	U	10.3	U	8.5	U	12.1	U

Table 13. (*continued*)
[Units are mg/kg]

Element	Sample ID and % solids[a]									
	CI030707, 85.4		CI040307, 87.9		CI050307, 93.7		CI060307, 93.2		CI070307, 93.8	
	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Indian ThN from Curtis Bay										
Aluminum	86.7	J	72.8	J	467	J	91.6	J	187	J
Antimony	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Arsenic	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Barium	5.7	=	4.5	U	4.6	U	5.1	U	14.3	=
Beryllium	5.6	U	4.5	U	4.6	U	5.1	U	5.1	U
Boron	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Cadmium	5.6	UJ	4.5	UJ	4.6	UJ	5.1	UJ	5.1	UJ
Calcium	55.8	U	44.8	U	45.6	U	50.6	U	51.3	U
Chromium	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Cobalt	5.6	U	4.5	U	4.6	U	5.1	U	5.1	U
Copper	8.4	=	6.1	=	9.6	=	12.1	=	5.1	U
Iron	55.8	UJ	44.8	UJ	45.6	UJ	50.6	UJ	51.3	UJ
Lead	1.10	U	0.90	U	0.91	U	1.00	U	1.00	U
Magnesium	55.8	UJ	44.8	UJ	45.6	UJ	50.6	UJ	51.3	UJ
Manganese	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Mercury	0.05	U	0.04	U	0.05	U	0.05	U	0.03	U
Molybdenum	5.6	U	4.5	U	4.6	U	5.1	U	5.1	U
Nickel	5.6	U	4.5	U	4.6	U	5.1	U	5.1	U
Selenium	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Silicon	108.0	=	37.1	=	81.9	=	88.6	=	120.0	=
Silver	1.10	UJ	0.90	UJ	0.91	UJ	1.00	UJ	1.00	UJ
Sodium	112.0	U	89.6	U	91.2	U	101.0	U	119.0	=
Strontium	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Thallium	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U
Thorium	524000	=	533000	=	496000	=	478000	=	450000	=
Uranium	1.10	UJ	0.90	U	0.91	UJ	1.00	UJ	1.00	UJ
Vanadium	11.2	UJ	9.0	UJ	9.1	UJ	10.1	UJ	10.3	UJ
Zinc	5.6	U	4.5	U	4.6	U	5.1	U	5.1	U
Zirconium	11.2	U	9.0	U	9.1	U	10.1	U	10.3	U

Table 13. (*continued*)
[Units are mg/kg]

	Sample ID and % solids[a]									
	CI090307, 93.1		CI110207, 95.5		CI120207, 94.8		CI130207, 85.3		CI140207, 92.8	
Element	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q	Conc.	Q
Indian ThN from Curtis Bay (*continued*)										
Aluminum	178	J	47.6	UJ	72.7	J	193.0	J	131.0	J
Antimony	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Arsenic	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Barium	4.8	U	4.8	U	19.6	=	5.7	U	5.5	=
Beryllium	4.8	U	4.8	U	4.9	U	5.7	U	5.0	U
Boron	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Cadmium	4.8	UJ	4.8	UJ	4.9	UJ	5.7	UJ	5.0	UJ
Calcium	48.0	U	47.6	U	48.8	U	56.9	U	50.4	U
Chromium	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Cobalt	4.8	U	4.8	U	4.9	U	5.7	U	5.0	U
Copper	9.2	=	14.1	=	7.6	=	8.7	=	9.7	0
Iron	48.0	UJ	47.6	UJ	48.8	UJ	56.9	UJ	50.4	UJ
Lead	0.96	U	5.00	=	0.98	U	1.10	U	1.00	U
Magnesium	48.0	UJ	47.6	UJ	48.8	UJ	56.9	UJ	50.4	U
Manganese	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Mercury	0.04	U	0.02	U	0.05	U	0.06	U	0.04	U
Molybdenum	4.8	U	4.8	U	4.9	U	5.7	U	5.0	U
Nickel	4.8	U	4.8	U	4.9	U	5.7	U	5.0	U
Selenium	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Silicon	117.0	=	35.5	=	24.4	U	80.2	=	38.2	=
Silver	0.96	UJ	0.95	UJ	0.98	UJ	1.10	UJ	1.00	UJ
Sodium	95.9	U	95.2	U	97.7	U	114.0	U	101.0	U
Strontium	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Thallium	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U
Thorium	475000	=	472000	=	468000	=	520000	=	482000	=
Uranium	0.96	UJ	0.95	UJ	0.98	UJ	1.10	UJ	1.00	UJ
Vanadium	9.6	UJ	9.5	UJ	9.8	UJ	11.4	UJ	10.1	UJ
Zinc	4.8	U	4.8	U	4.9	U	5.7	U	5.0	U
Zirconium	9.6	U	9.5	U	9.8	U	11.4	U	10.1	U

[a]Data qualifiers (*Q*) — *U*, the analyte was not detected above the reported detection limit; *J*, the analyte was identified; the associated numerical value is approximated; *UJ*, the analyte was not detected above the reported detection limit, and the associated detection limit is approximated because of quality deficiency; = data that, as a result of the validation process, have been determined to meet QA/QC requirements and are considered to be a valid result greater than the reporting limit.

The results of the domestic samples from Curtis Bay showed barium in 3 of the 22 samples at a maximum concentration of 647 mg/kg. Manganese was found in one sample at a concentration of 11.6 mg/kg. Silicon was found in one sample at the concentration of 38 mg/kg. Thallium was found in one sample at the concentration of 11.4 mg/kg, and sodium was found in one sample at the concentration of 156 mg/kg. The concentration of thorium was within the range of 42.8 to 51.8 wt %.

The French ThN product is less pure than the products from the two other countries of origin. Two of the 13 samples contained chromium at the maximum of 16.3 mg/kg. Lead was present in 11 of the 13 samples with concentrations up to 15 mg/kg, and nickel was found in four samples at a maximum concentration of 9.4 mg/kg. Sodium and uranium were present in all samples, with sodium concentrations ranging from 171 to 819 mg/kg and uranium concentrations ranging from 7.8 to 46.3 mg/kg. The thorium concentration ranged between 43.4 and 52.9 wt %.

For the Indian ThN samples, aluminum was found at the maximum concentration of 467 mg/kg in nine of the ten samples analyzed. Barium was found in four samples at the maximum of 19.6 mg/kg. Copper was found in nine samples at a maximum concentration of 14.1 mg/kg. Lead was found in only one sample at the concentration of 5 mg/kg. Silicon was present in nine samples at a maximum concentration of 120 mg/kg. Sodium was detected in one sample at the concentration of 119 mg/kg. The thorium concentration was between 45.0 and 53.3 wt %.

6.4 RCRA METALS

The toxicity characteristic leaching procedure (TCLP) extraction was not requested in the SOW. In slightly acidic solutions (as the TCLP extraction solutions are), the extraction would have resulted in a dissolution almost identical to the one performed for the sample preparation for the metals analyses. Also, if a TCLP extraction were requested, the laboratory would provide only the eight RCRA elements for a cost higher than a total analysis. Therefore, instead of obtaining data for the TCLP extraction, ORNL used the results of the total analysis and divided them by 20 to reproduce the dilution performed in the TCLP test, where 100 g of material are extracted in 2 L of extraction fluid. The calculated concentrations of the RCRA metals are found in Tables 14–17. None of the samples from any origin was found to contain RCRA metals at levels above the regulatory limits.

6.5 RADIOLOGICAL ANALYSES: ALPHA SPECTROMETRY

The SOW requested a gamma spectrometry analysis for each sample. Because NTS has strict action limits for ^{230}Th, alpha spectrometry analyses were also requested on 18 of the 53 samples. The results are provided on an “as received” basis. The data were validated following EPA guidelines, and data qualifiers (Q) were assigned as follows:

U The analyte was not detected above the reported detection limit.
J The analyte was identified; the associated numerical value is approximated.
UJ The analyte was not detected above the reported detection limit, and the associated detection limit is approximated due to quality deficiency.
NJ The analyte was presumably present at an estimated quantity.
= Data, that, as a result of the validation process, have been determined to meet the QA/QC requirements and are considered to be a valid result greater than the reporting limit are represented with an equal sign (“=”), indicating that no qualifier is necessary.

Table 14. Calculated concentration of the RCRA metals for the domestic ThN from Hammond
[Units are mg/L]

Sample		Element (and RCRA concentration limit)							
		Arsenic (5)	Barium (100)	Cadmium (1)	Chromium (5)	Lead (5)	Mercury (0.2)	Selenium (1)	Silver (5)
HD0807061	Conc.	0.225	0.225	0.225	0.455	0.0225	0.001	0.225	0.0225
	Q	U	U	UJ	U	U	U	U	UJ
HD1010061	Conc.	0.23	0.23	0.23	0.46	0.023	0.0015	0.23	0.023
	Q	U	U	UJ	U	U	U	U	UJ
HD2307061	Conc.	0.235	0.235	0.235	0.47	0.0235	0.0025	0.235	0.0235
	Q	U	U	UJ	U	U	U	U	UJ
HD2907061	Conc.	0.23	0.23	0.23	0.46	0.036	0.002	0.23	0.023
	Q	U	U	UJ	U	=	U	U	UJ
HD3007061	Conc.	0.23	0.23	0.23	0.465	0.023	0.0025	0.23	0.023
	Q	U	U	UJ	U	U	U	U	UJ
HD3810061	Conc.	0.235	0.235	0.235	0.475	0.0235	0.0025	0.235	0.0235
	Q	U	U	UJ	U	U	U	U	UJ
HD4710061	Conc.	0.22	0.22	0.22	0.44	0.075	0.002	0.22	0.022
	Q	U	U	UJ	U	=	U	U	UJ
HD4810061	Conc.	0.25	0.25	0.25	0.5	0.025	0.0025	0.25	0.025
	Q	U	U	UJ	U	U	U	U	UJ

For the domestic ThN from Hammond (Table 18) the collected data show a good comparison between the thorium results from the alpha spectrometry (44.6, 40.3, and 40.5 wt %) and the ICP-AES (39.5, 40.1, and 39.4 wt %, respectively). However, the correlation is not as good for the uranium content, mainly because the concentrations are very low and the error at these levels is high. The ICP-AES data for uranium indicate that the analyte was not detected at about 0.5 mg/kg. The alpha spectrometry results indicate that in one sample it was undetected at a level of 1.83 mg/kg, and it was detected in two samples but at levels too low to be quantified reliably (5.72 mg/kg and 2.48 mg/kg). The results for the domestic ThN from Curtis Bay are compiled in Table 19, for the French ThN in Table 20, and for the Indian ThN in Table 21.

6.6 RADIOLOGICAL ANALYSES: GAMMA SPECTROMETRY

The results for these analyses are compiled in Tables 22–25. The EPA qualifiers are the same as those used for the alpha spectrometry analyses. Because of the age of the material, the spectra obtained were very complex and had numerous peaks. These abundant peaks created interference and made the interpretation of the spectra difficult.

Table 15. Calculated concentration of the RCRA metals for the domestic ThN from Curtis Bay
[Units are mg/L]

		Element (and RCRA concentration limit)							
Sample		Arsenic (5)	Barium (100)	Cadmium (1)	Chromium (5)	Lead (5)	Mercury (0.2)	Selenium (1)	Silver (5)
CD021207	Conc.	0.535	0.27	0.27	0.535	0.055	0.003	0.535	0.055
	Q	U	U	UJ	U	U	U	U	UJ
CD031107	Conc.	0.495	2.28	0.245	0.495	0.0495	0.003	0.495	0.0495
	Q	U	=	UJ	U	U	U	U	UJ
CD111107	Conc.	0.49	0.245	0.245	0.49	0.049	0.0015	0.49	0.049
	Q	U	U	UJ	U	U	U	U	UJ
CD121207	Conc.	0.485	0.24	0.24	0.485	0.049	0.003	0.485	0.049
	Q	U	U	UJ	U	U	U	U	UJ
CD141207	Conc.	0.5	0.25	0.25	0.5	0.05	0.002	0.5	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CD151107	Conc.	0.49	32.35	0.245	0.49	0.049	0.004	0.49	0.049
	Q	U	=	UJ	U	U	U	U	UJ
CD171007	Conc.	0.585	0.29	0.29	0.585	0.06	0.003	0.585	0.06
	Q	U	U	UJ	U	U	U	U	UJ
CD180907	Conc.	0.43	0.215	0.215	0.43	0.043	0.0025	0.43	0.043
	Q	U	U	UJ	U	U	U	U	UJ
CD201007	Conc.	0.49	14.75	0.245	0.49	0.049	0.002	0.49	0.049
	Q	U	=	UJ	U	U	U	U	UJ
CD221007	Conc.	0.44	0.22	0.22	0.44	0.044	0.003	0.44	0.044
	Q	U	U	UJ	U	U	U	U	UJ
CD280107	Conc.	0.48	0.24	0.24	0.48	0.048	0.0015	0.48	0.048
	Q	U	U	UJ	U	U	U	U	UJ
CD290407	Conc.	0.465	0.23	0.23	0.465	0.0465	0.0035	0.465	0.0465
	Q	U	U	UJ	U	U	U	U	UJ
CD302806	Conc.	0.43	0.215	0.215	0.43	0.043	0.002	0.43	0.043
	Q	U	U	UJ	U	U	U	U	UJ
CD360107	Conc.	0.41	0.205	0.205	0.41	0.041	0.0025	0.41	0.041
	Q	U	U	UJ	U	U	U	U	UJ
CD371007	Conc.	0.525	0.265	0.265	0.525	0.055	0.003	0.525	0.055
	Q	U	U	UJ	U	U	U	U	UJ
CD441207	Conc.	0.45	0.225	0.225	0.45	0.045	0.0025	0.45	0.045
	Q	U	U	UJ	U	U	U	U	UJ
CD452706	Conc.	0.48	0.24	0.24	0.48	0.048	0.002	0.48	0.048
	Q	U	U	UJ	U	U	U	U	UJ
CD482706	Conc.	0.5	0.25	0.25	0.5	0.05	0.002	0.5	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CD521007	Conc.	0.485	0.24	0.24	0.485	0.0485	0.002	0.485	0.0485
	Q	U	U	UJ	U	U	U	U	UJ
CD581207	Conc.	0.45	0.225	0.225	0.45	0.045	0.002	0.45	0.045
	Q	U	U	UJ	U	U	U	U	UJ
CD610907	Conc.	0.52	0.26	0.26	0.52	0.05	0.0025	0.52	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CD650907	Conc.	0.465	0.23	0.23	0.465	0.0465	0.003	0.465	0.0465
	Q	U	U	UJ	U	U	U	U	UJ

Table 16. Calculated concentration of the RCRA metals for the French ThN from Curtis Bay
[Units are mg/L]

		Element (and RCRA concentration limit)							
Sample		Arsenic (5)	Barium (100)	Cadmium (1)	Chromium (5)	Lead (5)	Mercury (0.2)	Selenium (1)	Silver (5)
CF010807	Conc.	0.43	0.215	0.215	0.43	0.043	0.0025	0.43	0.043
	Q	U	U	UJ	U	U	U	U	UJ
CF020807	Conc.	0.485	0.24	0.24	0.485	0.595	0.0025	0.485	0.0485
	Q	U	U	UJ	U	=	U	U	UJ
CF030807	Conc.	0.535	0.265	0.265	0.535	0.215	0.002	0.535	0.055
	Q	U	U	UJ	U	=	U	U	UJ
CF040807	Conc.	0.54	0.27	0.27	0.54	0.385	0.002	0.54	0.055
	Q	U	U	UJ	U	=	U	U	UJ
CF060807	Conc.	0.515	0.26	0.26	0.515	0.11	0.0025	0.515	0.05
	Q	U	U	UJ	U	=	U	U	UJ
CF100207	Conc.	0.505	0.25	0.25	0.505	0.465	0.003	0.505	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CF110207	Conc.	0.455	0.23	0.23	0.455	0.125	0.0025	0.455	0.0455
	Q	U	U	UJ	U	=	U	U	UJ
CF130807	Conc.	0.48	0.24	0.24	0.48	0.3	0.002	0.48	0.048
	Q	U	U	UJ	U	=	U	U	UJ
CF140307	Conc.	0.44	0.22	0.22	0.44	0.75	0.0025	0.44	0.044
	Q	U	U	UJ	U	=	U	U	UJ
CF160807	Conc.	0.515	0.26	0.26	0.515	0.05	0.003	0.515	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CF170807	Conc.	0.425	0.21	0.21	0.425	0.125	0.0025	0.425	0.0425
	Q	U	U	UJ	U	=	U	U	UJ
CF190807	Conc.	0.52	0.26	0.26	0.815	0.375	0.002	0.52	0.05
	Q	U	U	UJ	=	=	U	U	UJ

Table 17. Calculated concentration of the RCRA metals for the Indian ThN from Curtis Bay
[Units are mg/L]

Sample		Element (and RCRA concentration limit)							
		Arsenic (5)	Barium (100)	Cadmium (1)	Chromium (5)	Lead (5)	Mercury (0.2)	Selenium (1)	Silver (5)
CI030707	Conc.	0.56	0.285	0.28	0.56	0.055	0.0025	0.56	0.055
	Q	U	=	UJ	U	U	U	U	UJ
CI040307	Conc.	0.45	0.225	0.225	0.45	0.045	0.002	0.45	0.045
	Q	U	U	UJ	U	U	U	U	UJ
CI050307	Conc.	0.455	0.23	0.23	0.455	0.0455	0.0025	0.455	0.0455
	Q	U	U	UJ	U	U	U	U	UJ
CI060307	Conc.	0.505	0.255	0.255	0.505	0.05	0.0025	0.505	0.05
	Q	U	U	UJ	U	U	U	U	UJ
CI070307	Conc.	0.515	0.715	0.255	0.515	0.05	0.0015	0.515	0.05
	Q	U	=	UJ	U	U	U	U	UJ
CI090307	Conc.	0.48	0.24	0.24	0.48	0.048	0.002	0.48	0.048
	Q	U	U	UJ	U	U	U	U	UJ
CI110207	Conc.	0.475	0.24	0.24	0.475	0.25	0.001	0.475	0.0475
	Q	U	U	UJ	U	=	U	U	UJ
CI120207	Conc.	0.49	0.98	0.245	0.49	0.049	0.0025	0.49	0.049
	Q	U	U	UJ	U	U	U	U	UJ
CI130207	Conc.	0.57	0.285	0.285	0.57	0.055	0.003	0.57	0.055
	Q	U	U	UJ	U	U	U	U	UJ
CI140207	Conc.	0.505	0.275	0.25	0.505	0.05	0.002	0.505	0.05
	Q	U	=	UJ	U	U	U	U	UJ

Table 18. Alpha spectrometry results for the domestic samples from Hammond
[Units are pCi/g except where noted]

Nuclide/element	HD0807061		HD4810061		HD3007061	
	Activity	Q	Activity	Q	Activity	Q
^{234}U	1.86	J	0.505	UJ	1.32	J
^{235}U	0.0769	UJ	0.311	UJ	0	UJ
^{236}U	0.133	UJ	0.568	UJ	0.835	UJ
^{238}U	1.91	UJ	0.568	UJ	0.835	UJ
Total U	3.98		1.38		2.09	
Total U (mg/kg)	5.72		1.83		2.48	
^{228}Th	54600	=	46800	=	49200	=
^{230}Th	4470	=	3550	=	3570	=
^{232}Th	49000	=	44200	=	44500	=
Total Th	108070		94550		97270	
Total Th (wt %)	44.6		40.3		40.5	

Table 19. Alpha spectrometry results for the domestic samples from Curtis Bay
[Units are pCi/g except where noted]]

Nuclide/ element	Sample ID[a]																	
	CD111107		CD151107		CD201007		CD221007		CD280107		CD290407		CD371007		CD482706		CD610907	
	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{234}U	1.21	U	0.86	U	0.82	U	0.3	U	1.31	U	0.71	U	0.77	U	0.78	U	0.78	U
^{235}U	1.22	=	0.4	=	0	U	0.11	U	0.28	U	0.37	=	0.04	U	0.28	U	0	U
^{236}U	1.22	J	0	UJ	0.11	UJ	0.3	J	0.45	J	0.25	UJ	0.12	UJ	0.62	J	0.25	UJ
^{238}U	0.22	UJ	0.32	J	0.33	UJ	0	UJ	0.53	UJ	0.2	UJ	0.22	UJ	0.45	J	0.33	J
Total U	3.87		1.58		1.27		0.71		2.58		1.53		1.15		2.12		1.37	
Total U, mg/kg	1.24		1.14		1		0.06		1.72		0.77		0.67		1.46		1	
^{228}Th	44040	=	46190	=	46500	=	50810	=	45900	=	45910	=	45410	=	45740	=	45460	=
^{230}Th	4058	=	4436	=	4579	=	4984	=	3652	=	4524	=	4099	=	4156	=	4121	=
^{232}Th	43510	=	44290	=	46670	=	49810	=	45690	=	45600	=	46460	=	46150	=	44180	=
Total Th	91608		94916		97749		105604		95242		96034		95969		96046		93761	
Total Th, wt %	39.6		40.3		42.5		45.4		41.6		41.6		42.3		42		40.2	

[a] Data qualifiers (*Q*) — *U*, the analyte was not detected above the reported detection limit; *J*, the analyte was identified; the associated numerical value is approximated; *UJ*, the analyte was not detected above the reported detection limit, and the associated detection limit is approximated due to quality deficiency; *NJ*, the analyte was presumably present at an estimated quantity; =, data that, as a result of the validation process, have been determined to meet the QA/QC requirements and are considered to be a valid result greater than the reporting limit.

Table 20. Alpha spectrometry results for the French samples from Curtis Bay
[Units are pCi/g unless indicated]

	Blank	CF020807		CF100207		CF190807	
Nuclide/element	Activity	Activity	Q	Activity	Q	Activity	Q
^{234}U	0.94	7.83	=	4.07	=	14.48	=
^{235}U	0.14	0.73	=	0.12	U	1.42	=
^{236}U	0.3	0.33	J	0.52	J	0.46	J
^{238}U	0.35	8.65	J	2.45	J	14.23	J
Total U	1.73	17.54		7.16		30.6	
Total U, mg/kg	1.12	26.09		7.35		43.02	
^{228}Th	124	43080	=	44580	=	46530	=
^{230}Th	174	300700	=	49950	=	38740	=
^{232}Th	61	41220	=	43530	=	45440	=
Total Th	359	114370		138060		130710	
Total Th, wt %	0.0559	37.5		39.6		41.4	

Table 21. Alpha spectrometry results for the Indian samples from Curtis Bay
[Units are pCi/g unless indicated]

	Blank	CI030707		CI040307		CI090307	
Nuclide/element	Activity	Activity	Q	Activity	Q	Activity	Q
^{234}U	0.94	0.66	U	0.35	U	0.51	U
^{235}U	0.14	0	U	0.03	U	0.13	=
^{236}U	0.3	0.37	J	0.1	UJ	0.03	UJ
^{238}U	0.35	0.22	UJ	0.02	UJ	0.1	UJ
Total U	1.73	1.25		0.51		0.77	
Total U, mg/kg	1.12	0.66		0.09		0.36	
^{228}Th	124	47330	=	48180	=	49880	=
^{230}Th	174	7532	=	7632	=	7450	=
^{232}Th	61	44770	=	44580	=	48530	=
Total Th	359	99632		100392		105860	
Total Th, wt %	0.0559	40.8		40.6		44.2	

Table 22. Gamma spectrometry results for the domestic samples from Hammond[a]

[Units are pCi/g]]

	Nuclide	HD0807061		HD1010061		HD2307061		HD2907061		HD3007061		HD3810061		HD4710061		HD4810061	
		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	11370	J	10370	J	9530	J	11460	J	10730	J	10420	J	9997	J	11030	J
	^{212}Bi	33130	J	32370	J	29410	J	33910	J	32340	J	4157	J	32550	J	35910	J
	^{212}Pb	21190	U	9079	J	11590	J	17620	U	14950	U	8651	J	7608	J	9843	J
	^{224}Ra	458000	NJ	434500	NJ	368900	J	467400	J	435200	J	424100	J	399800	J	463100	J
	^{228}Ac	33840	J	31750	J	29680	J	33640	J	32870	J	19500	J	30010	J	32550	J
	^{228}Th	40400	J	38510	J	32600	J	41430	J	38400	J	39890	J	34800	J	38580	J
^{235}U series	^{211}Bi	126	NJ	ND		ND		ND		113	NJ	ND		57.6	U	112	U
	^{219}Rn	10620	NJ	10070	NJ	8766	NJ	10780	NJ	10130	NJ	10020	NJ	9631	NJ	10790	NJ
	^{231}Pa	466	U	824	NJ	790	NJ	667	NJ	635	NJ	613	NJ	802	NJ	79750	NJ
	^{231}Th	ND		ND		ND		180300	NJ	ND		164400	NJ	ND		179800	NJ
	^{233}Ra	85940	NJ	1394	NJ	68600	NJ	87290	NJ	77600	NJ	1555	NJ	1512	NJ	1646	NJ
	^{235}U	38.4	NJ	30.5	NJ	23.7	NJ	24	NJ	12.2	U	ND		ND		ND	
^{237} series	^{229}Th	586	NJ	454	NJ	479	NJ	645	NJ	455	NJ	623	NJ	638	NJ	652	NJ
	^{233}Pa	ND		ND		ND		ND		25.9	U	ND		ND		ND	
	^{237}Np	ND		ND		ND		ND		ND		1847	NJ	1660	NJ	1723	NJ
^{238}U series	^{226}Ra	ND		ND		ND		ND		ND		401	NJ	500	NJ	565	NJ
	^{234m}Pa	6681	NJ	7289	NJ	7205	NJ	8776	NJ	7028	NJ	ND		ND		ND	
	^{234}Th	272	J	282	J	210	J	324	J	254	J	203	J	208	J	294	J
Other series	^{40}K	2712	NJ	2550	NJ	2207	NJ	2779	NJ	2678	NJ	2652	NJ	2662	NJ	2769	NJ
	^{94m}Nb	ND		ND		ND		22.8	NJ	18.9	NJ	ND		ND		ND	
	^{146}Pm	3186	NJ	3148	NJ	2668	NJ	3032	NJ	3125	NJ	2889	NJ	2853	NJ	3340	NJ
	^{155}Eu	59540	NJ	54300	NJ	31600	NJ	65450	NJ	43890	NJ	150700	NJ	150600	NJ	163900	NJ

[a]ND = not detected.

Table 23. Gamma spectrometry results for the domestic samples from Curtis Bay[a]

[Units are pCi/g]]

		CD021207		CD031107		CD111107		CD121207		CD141207		CD151107		CD171007		CD180907	
Nuclide		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	11600	J	11910	J	11420	J	11090	J	11670	J	11070	J	11620	J	11360	J
	^{212}Bi	12340	J	10350	J	9941	J	35250	J	34150	J	32970	J	33700	J	33490	J
	^{212}Pb	9627	J	9588	J	9315	J	13370	J	21390	J	15820	J	26130	J	26900	J
	^{224}Ra	472800	NJ	491400	NJ	464100	NJ	446100	NJ	473800	NJ	439100	NJ	473000	NJ	460100	NJ
	^{228}Ac	33330	J	25340	J	32850	J	33710	J	34750	J	33100	J	34140	J	33640	J
	^{228}Th	44210	J	39870	J	39390	J	38750	J	42000	J	38690	J	39350	J	41380	J
^{235}U series	^{211}Pb	ND		ND		ND		432	NJ	ND		ND		ND		ND	
	^{211}Bi	ND		ND		100	U	ND		136	NJ	194	NJ	ND		ND	
	^{219}Rn	11130	NJ	11340	NJ	10820	NJ	ND		11000	NJ	10320	NJ	19940	NJ	10530	NJ
	^{231}Pa	1238	NJ	569	U	963	NJ	1185	NJ	ND		758	NJ	ND		ND	
	^{231}Th	184300	NJ	ND		179500	NJ	ND		184300	NJ	ND		180300	NJ	178000	NJ
	^{233}Ra	1578	NJ	1589	NJ	1470	NJ	1543	NJ	1452	NJ	1710	NJ	1642	NJ	79250	NJ
	^{235}U	ND		ND		40.3	NJ	35.9	NJ	ND		33.6	NJ	ND		ND	
^{237} series	^{229}Th	881	NJ	749	NJ	641	NJ	376	NJ	669	NJ	517	NJ	651	NJ	564	NJ
	^{233}Pa	ND		ND		ND		ND		ND		ND		ND		ND	
	^{237}Np	ND		ND		1598	NJ	ND		ND		ND		ND		2002	NJ
^{238}U series	^{214}Pb	ND		ND		ND		41.9	J	ND		ND		ND		ND	
	^{226}Ra	552	NJ	518	NJ	ND		ND		410	NJ	ND		489	NJ	ND	
	^{234m}Pa	9033	NJ	7553	NJ	7027	NJ	7168	NJ	6055	NJ	6606	NJ	7261	NJ	5797	NJ
	^{234}Th	266	NJ	271	NJ	293	NJ	279	NJ	307	NJ	222	NJ	310	NJ	274	NJ
Other series	^{40}K	2733	NJ	2843	NJ	2754	NJ	2711	NJ	2815	NJ	2592	NJ	2797	NJ	ND	
	^{94m}Nb	ND		ND		ND		ND		ND		20.3	NJ	ND		ND	
	^{137}Cs	ND		28.1	U	ND		ND		ND		ND		ND		ND	
	^{146}Pm	3254	NJ	327	U	3068	NJ	3196	NJ	3260	NJ	3263	NJ	3268	NJ	3246	NJ
	^{155}Eu	53390	NJ	68300	NJ	163400	NJ	59400	NJ	60480	NJ	59720	NJ	163300	NJ	164700	NJ

Table 23. (*continued*)[a]
[Units are pCi/g]]

	Nuclide	CD201007		CD221007		CD280107		CD290407		CD302806		CD360107		CD371007		CD441207	
		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	12520	J	11420	J	11450	J	11140	J	11220	J	10590	J	11600	J	11000	J
	^{212}Bi	37710	J	34860	J	34730	J	33830	J	34310	J	31990	J	34190	J	32670	J
	^{212}Pb	17050	J	16330	J	27910	J	15970	J	9538	J	9302	J	19500	J	9388	J
	^{224}Ra	534400	NJ	477400	NJ	483200	NJ	456200	NJ	465000	NJ	428500	NJ	467100	NJ	453000	NJ
	^{228}Ac	37780	J	35080	J	34780	J	34500	J	34140	J	31610	J	34200	J	33360	J
	^{228}Th	48150	J	41850	J	40520	J	45260	J	41180	J	36940	J	40420	J	39780	J
^{235}U series	^{211}Pb	ND		ND		ND		ND		ND		ND		ND		ND	
	^{211}Bi	ND		ND		139	NJ	123	NJ	77.7	U	ND		ND		ND	
	^{219}Rn	10530	NJ	14810	NJ	11100	NJ	10670	NJ	10980	NJ	9955	NJ	10870	NJ	10490	NJ
	^{231}Pa	ND		696	NJ	ND		889	NJ	374	U	45190	NJ	485	U	48370	NJ
	^{231}Th	178000	NJ	188700	NJ	188800	NJ	175500	NJ	183200	NJ	164000	NJ	183800	NJ	173800	NJ
	^{233}Ra	79250	NJ	1848	NJ	1814	NJ	1687	NJ	1717	NJ	1438	NJ	1937	NJ	1662	NJ
	^{235}U	ND		ND		32.6	NJ	30.3	NJ	ND		ND		ND		ND	
^{237} series	^{229}Th	564	NJ	567	NJ	693	NJ	608	NJ	787	NJ	578	NJ	480	NJ	ND	
	^{233}Pa	ND		ND		48.2	NJ	ND		ND		ND		ND		ND	
	^{237}Np	2002	NJ	ND		ND		1836	NJ	2061	NJ	ND		1834	NJ	ND	
^{238}U series	^{214}Pb	ND		ND		ND		ND		ND		ND		ND		ND	
	^{226}Ra	ND		432	NJ	ND		ND		511	NJ	395	NJ	556	NJ	584	NJ
	^{234m}Pa	5797	NJ	8170	NJ	6281	NJ	5484	NJ	7366	NJ	9424	NJ	6904	NJ	7842	NJ
	^{234}Th	274	NJ	254	NJ	259	NJ	313	NJ	267	NJ	261	NJ	284	NJ	296	NJ
Other series	^{40}K	ND		2772	NJ	2768	NJ	2824	NJ	2783	NJ	2624	NJ	2830	NJ	2624	NJ
	^{94m}Nb	ND		ND		ND		ND		ND		ND		ND		ND	
	^{137}Cs	ND		ND		ND		ND		ND		ND		ND		ND	
	^{146}Pm	3246	NJ	3431	NJ	3431	NJ	3340	NJ	3254	NJ	2948	NJ	3422	NJ	3192	NJ
	^{155}Eu	164700	NJ	48650	NJ	48650	NJ	159900	NJ	169800	NJ	47780	NJ	168900	NJ	59580	NJ

Table 23. (*continued*)[a]
[Units are pCi/g]]

	Nuclide	CD452706		CD482706		CD521007		CD581207		CD610907		CD650907	
		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	11740	J	11850	J	11840	J	12610	J	12500	J	12140	J
	^{212}Bi	35900	J	34120	J	35820	J	37170	J	36310	J	36370	J
	^{212}Pb	10440	J	9789	J	13000	J	12020	J	17430	J	14930	J
	^{224}Ra	499400	NJ	467800	NJ	501400	NJ	537900	NJ	518100	NJ	508200	NJ
	^{228}Ac	34820	J	34770	J	36200	J	37620	J	364300	J	36470	J
	^{228}Th	45450	J	42940	J	47310	J	50780	J	46870	J	43310	J
^{235}U series	^{211}Pb	ND		ND		ND		ND		ND		ND	
	^{211}Bi	ND		ND		119	U	ND		136	NJ	110	U
	^{219}Rn	11210	NJ	10930	NJ	11520	NJ	12180	NJ	11800	NJ	14280	NJ
	^{231}Pa	51800	NJ	49110	NJ	532	U	55510	NJ	891	NJ	890	NJ
	^{231}Th	191300	NJ	ND		195400	NJ	204000	NJ	201400	NJ	199700	NJ
	^{233}Ra	1436	NJ	185	NJ	1473	NJ	1778	NJ	1813	NJ	1648	NJ
	^{235}U	ND		ND		ND		39.6	NJ	ND		ND	
^{237} series	^{229}Th	705	NJ	707	NJ	868	NJ	651	NJ	ND		838	NJ
	^{233}Pa	ND		ND		ND		ND		ND		ND	
	^{237}Np	1075	NJ	ND		2091	NJ	ND		2132	NJ	2058	NJ
^{238}U series	^{214}Pb	ND		ND		ND		ND		ND		ND	
	^{226}Ra	481	NJ	466	NJ	564	NJ	ND		871	NJ	490	NJ
	^{234m}Pa	6732	NJ	7043	NJ	7572	NJ	7397	NJ	7727	NJ	7241	NJ
	^{234}Th	301	NJ	308	NJ	343	NJ	404	NJ	301	NJ	334	NJ
Other series	^{40}K	2665	NJ	2797	NJ	2716	NJ	2937	NJ	2819	NJ	2983	NJ
	^{94m}Nb	ND		ND		ND		ND		26.7	NJ	ND	
	^{137}Cs	ND		ND		ND		ND		ND		ND	
	^{146}Pm	3311	NJ	2024	NJ	3465	NJ	3733	NJ	3589	NJ	3590	NJ
	^{155}Eu	174000	NJ	64220	NJ	176300	NJ	79670	NJ	180900	NJ	180800	NJ

[a]ND = not detected.

Table 24. Gamma spectrometry results for the French samples from Curtis Bay[a]

[Units are pCi/g]]

Nuclide		CF010807		CF020807		CF030807		CF040807		CF060807		CF090807		CF100207	
		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	11630	J	12010	J	12730	J	12580	J	10790	J	11400	J	12360	J
	^{212}Bi	36050	J	37150	J	39100	J	38580	J	33350	J	34550	J	37720	J
	^{212}Pb	12770	J	10410	J	11720	J	10810	J	8914	J	8011	J	10960	J
	^{224}Ra	471600	NJ	479600	NJ	519600	NJ	503500	NJ	412700	NJ	446300	NJ	500800	NJ
	^{228}Ac	35100	J	34890	J	36920	J	36030	J	31910	J	33450	J	35480	J
	^{228}Th	44500	J	44980	J	48780	J	45110	J	34910	J	37180	J	45270	J
^{235}U series	^{211}Pb	2014	NJ	ND		ND		1510	NJ	ND		ND		1246	NJ
	^{211}Bi	11150	NJ	11130	NJ	11890	NJ	11710	NJ	9727	NJ	10450	NJ	11700	NJ
	^{219}Rn	50520	NJ	1081	NJ	1180	NJ	52030	NJ	44310	NJ	627	NJ	1215	NJ
	^{231}Pa	190600	NJ	ND		204200	NJ	ND		ND		ND		193700	NJ
	^{231}Th	1645	NJ	1702	NJ	1496	NJ	1648	NJ	1511	NJ	1418	NJ	1519	NJ
	^{233}Ra	ND		ND		50.2	NJ	ND		ND		ND		ND	
	^{235}U	ND		753	NJ	737	NJ	904	NJ	ND		ND		647	NJ
^{237} series	^{229}Th	ND		ND		ND		ND		ND		ND		ND	
	^{233}Pa	ND		ND		ND		ND		ND		ND		ND	
	^{237}Np	655	J	316	J	610	J	ND		693	J	578	J	ND	
^{238}U series	^{214}Pb	676	J	465	J	583	J	507	J	578	J	546	J	408	J
	^{226}Ra	1252	J	502	J	ND		729	J	797	J	713	J	492	J
	^{234m}Pa	9237	NJ	7830	NJ	8952	NJ	7285	NJ	6825	NJ	6612	NJ	6462	NJ
	^{234}Th	286	NJ	288	NJ	358	NJ	338	NJ	196	N	257	NJ	314	NJ
Other series	^{40}K	2852	NJ	2826	NJ	2939	NJ	3029	NJ	2612	NJ	2642	NJ	2801	NJ
	^{94m}Nb	ND		ND		ND		ND		ND		ND		23.4	NJ
	^{137}Cs	ND		ND		ND		36.2	U	ND		ND		44.4	J
	^{146}Pm	3234	NJ	3254	NJ	3528	NJ	3713	NJ	2922	NJ	2989	NJ	3513	NJ
	^{155}Eu	61340	NJ	61280	NJ	62500	NJ	64680	NJ	48700	NJ	56120	NJ	74150	NJ

Table 24. (*continued*)[a]
[Units are pCi/g]]

	Nuclide	CF110207		CF130807		CF140307		CF160807		CF170807		CF190807	
		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th series	^{208}Tl	13330	J	11450	J	11010	J	11200	J	11620	J	11310	J
	^{212}Bi	39820	J	34350	J	33130	J	34410	J	35670	J	34350	J
	^{212}Pb	11670	J	8135	J	8633	J	8009	J	8697	J	8465	J
	^{224}Ra	550600	NJ	448800	NJ	431000	NJ	442000	NJ	456200	NJ	437400	NJ
	^{228}Ac	38330	J	33350	J	32860	J	33410	J	34670	J	32770	J
	^{228}Th	50330	J	42330	J	37640	J	39730	J	41270	J	36340	J
^{235}U series	^{211}Pb	ND		1283	NJ	1358	NJ	1759	NJ	ND		ND	
	^{211}Bi	19930	NJ	12410	NJ	9982	NJ	10330	NJ	10710	NJ	10200	NJ
	^{219}Rn	1137	NJ	991	NJ	45410	NJ	46750	NJ	48010	NJ	703	NJ
	^{231}Pa	213400	NJ	176700	NJ	ND		175800	NJ	ND		ND	
	^{231}Th	1825	NJ	1446	NJ	1402	NJ	1399	NJ	1656	NJ	1650	NJ
	^{233}Ra	ND		ND		ND		ND		ND		ND	
	^{235}U	835	NJ	474	NJ	569	NJ	666	NJ	ND		574	NJ
^{237} series	^{229}Th	ND		ND		ND		ND		ND		ND	
	^{233}Pa	ND		ND		ND		ND		1544	NJ	1733	NJ
	^{237}Np	445	J	390	J	394	J	570	J	699	J	244	J
^{238}U series	^{214}Pb	516	J	409	J	443	J	566	J	564	J	488	J
	^{226}Ra	1377	J	403	J	606	J	751	J	610	J	604	J
	^{234m}Pa	8949	NJ	7394	NJ	9784	NJ	7279	NJ	7780	NJ	6500	NJ
	^{234}Th	391	NJ	217	NJ	255	NJ	255	NJ	267	NJ	243	NJ
Other series	^{40}K	3121	NJ	2614	NJ	2474	NJ	2815	NJ	2717	NJ	2736	NJ
	^{94m}Nb	ND		ND		ND		ND		ND		ND	
	^{137}Cs	34	U	ND		ND		ND		ND		ND	
	^{146}Pm	3531	NJ	3166	NJ	3108	NJ	3125	NJ	3253	NJ	3058	NJ
	^{155}Eu	66150	NJ	52610	NJ	33960	NJ	50170	NJ	168400	NJ	161600	NJ

[a]ND = not detected.

Table 25. Gamma spectrometry results for the Indian samples from Curtis Bay[a]
[Units are pCi/g]

		CI030707		CI040307		CI050307		CI060307		CI070307	
Nuclide		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th Series	^{208}Tl	13220	J	13130	J	13140	J	11880	J	11580	J
	^{212}Bi	39170	J	39390	J	38780	J	37000	J	36920	J
	^{212}Pb	15830	J	13780	J	14180	J	10980	J	30150	J
	^{224}Ra	553500	NJ	558900	NJ	561000	NJ	473600	NJ	480100	NJ
	^{228}Ac	40240	J	38880	J	38380	J	36160	J	36030	J
	^{228}Th	47650	J	48480	J	51300	J	42160	J	43920	J
^{235}U series	^{211}Bi	217	NJ	257	NJ	243	NJ	206	NJ	321	NJ
	^{219}Rn	12740	NJ	15700	NJ	16870	NJ	11020	NJ	11250	NJ
	^{231}Pa	945	NJ	58400	NJ	775	NJ	1001	NJ	ND	
	^{227}Th	ND		ND		ND		ND		ND	
	^{231}Th	216700	NJ	221500	NJ	218400	NJ	189900	NJ	190900	NJ
	^{233}Ra	1952	NJ	1773	NJ	1725	NJ	1691	NJ	1554	NJ
	^{235}U	41.7	NJ	ND		ND		ND		ND	
^{237} Series	^{229}Th	ND		575	NJ	665	NJ	501	NJ	633	NJ
	^{233}Pa	ND		ND		ND		ND		ND	
	^{237}Np	2441	NJ	ND		3386	NJ	1796	NJ	ND	
^{238}U series	^{214}Pb	ND		ND		ND		51.3	J	94	J
	^{226}Ra	ND		850	NJ	427	U	685	NJ	316	U
	^{234m}Pa	8262	NJ	10650	NJ	10440	NJ	8045	NJ	7928	NJ
	^{234}Th	331	NJ	334	NJ	396	NJ	283	NJ	311	NJ
Other Series	^{40}K	3046	NJ	3466	NJ	3147	NJ	2771	NJ	3130	NJ
	^{94m}Nb	ND		ND		ND		ND		ND	
	^{137}Cs	ND		ND		ND		ND		ND	
	^{146}Pm	3782	NJ	3979	NJ	3848	NJ	3468	NJ	3348	NJ
	^{155}Eu	195500	NJ	68930	NJ	195900	NJ	179500	NJ	55330	NJ

Table 25. (*continued*)[a]
[Units are pCi/g]

		CI090307		CI110207		CI120207		CI130207		CI140207	
Nuclide		Activity	Q	Activity	Q	Activity	Q	Activity	Q	Activity	Q
^{232}Th Series	^{208}Tl	12190	J	13750	J	12740	J	13140	J	12760	J
	^{212}Bi	36800	J	39710	J	40610	J	40360	J	38880	J
	^{212}Pb	14280	J	12060	J	17200	J	12260	J	14020	J
	^{224}Ra	505000	NJ	567800	NJ	536700	NJ	554300	NJ	521500	NJ
	^{228}Ac	37070	J	39700	J	38450	J	38340	J	38380	J
	^{228}Th	45200	J	50500	J	48980	J	47770	J	49670	J
^{235}U series	^{211}Bi	245	NJ	188	NJ	ND[a]		ND[a]		382	NJ
	^{219}Rn	15560	NJ	12860	NJ	14710	NJ	16490	NJ	15810	NJ
	^{231}Pa	ND[a]		58150	NJ	983	NJ	930	NJ	968	NJ
	^{227}Th	205	NJ	ND[a]		ND[a]		ND[a]		ND[a]	
	^{231}Th	201900	NJ	ND[a]		213300	NJ	217500	NJ	207800	NJ
	^{233}Ra	1864	NJ	1785	NJ	1749	NJ	2015	NJ	1519	NJ
	^{235}U	ND[a]		ND[a]		ND[a]		51.6	NJ	ND[a]	
^{237} Series	^{229}Th	831	NJ	1098	NJ	959	NJ	721	NJ	961	NJ
	^{233}Pa	ND[a]		ND[a]		ND[a]		ND[a]		ND[a]	
	^{237}Np	ND[a]		ND[a]		1867	NJ	ND[a]		ND[a]	
^{238}U series	^{214}Pb	ND[a]		ND[a]		249	J	71	J	91.9	J
	^{226}Ra	156	U	617	J	347	J	ND[a]		339	U
	^{234m}Pa	7792	NJ	7948	NJ	8865	NJ	8723	NJ	5949	NJ
	^{234}Th	286	NJ	348	NJ	308	NJ	383	NJ	340	NJ
Other Series	^{40}K	3157	NJ	3231	NJ	3120	NJ	2966	NJ	2929	NJ
	^{94m}Nb	ND[a]		ND[a]		ND[a]		ND[a]		ND[a]	
	^{137}Cs	ND[a]		51.9	J	ND[a]		ND[a]		ND[a]	
	^{146}Pm	3372	NJ	3896	NJ	3831	NJ	3791	NJ	3574	NJ
	^{155}Eu	60110	NJ	78130	NJ	195200	NJ	81100	NJ	60510	NJ

[a]ND = not detected

The laboratory flagged the peaks that appeared to be interference instead of real hits with the qualifier "I" (for interference). This flag indicated that SWRI believed that either the isotope was not present or that the activity of the isotope was overestimated due to an overlap of another isotope line. Normally, these results would have been left out of the report, but the laboratory wished to be very conservative in its reporting. Therefore, SWRI reported that the software found the lines and that the lines were deemed to be interference. The laboratory outlined the following specifics as to the rejection of the isotopes:

- **^{40}K** — The laboratory does not believe that any ^{40}K was in the samples, although a photo peak at the only energy for ^{40}K (1460 keV) was identified in the gamma spectra. No potassium was found by the ICP analysis of the sample, so ^{40}K is probably not present. The line found in the spectrum is actually from ^{228}Ac at 1459 keV, but because there is only one

^{40}K line, it is impossible to quantify the actual ^{40}K present; hence the laboratory flagged the data on the forms with an "I," basing its judgement on the reliable data obtained by ICP.

- **^{146}Pm** — The laboratory does not believe that any ^{146}Pm was in the samples. This nuclide has the following peaks, in KeV, and abundances (%): 146 (0.22), 454 (66), 590 (0.43), 633 (1.12), 736 (22.8), and 747 (17.7). In most spectra, peaks were identified at 146, 454, and 590 keV. Because the 454-keV peak has the highest abundance and no interference, the software identified ^{146}Pm as being present. The laboratory rejected this finding because the 146-keV line has an interfering peak for ^{228}Ac and because the higher abundance peaks at 736 keV and 747 keV were not found.

- **^{155}Eu**: SWRI does not believe that ^{155}Eu was in the samples. This nuclide has the following usable peaks, in keV, and abundances (%): 27.5 (0.32), 45 (1.32), 60 (1.13), 86 (30.7) and 105 (21.2). The 60-, 86-, and 105-keV lines were identified in the spectra. The 86-keV line has interference from ^{228}Th at 84 keV. SWRI rejected this isotope because the 45-keV line was not detected.

In general, no unusual isotopes were detected in the background spectra, and for those that were identified, their activities were subtracted from the sample results. The nuclide ^{40}K was present in the background spectra at about 126 pCi/sample in 15-h count. Based on a nominal sample size of 30 g, this would have added (if the background correction was not performed) about 4.2 pCi/g.

During the data validation process, the data validator changed the "I" flag from the laboratory to "NJ," which means "presumably present at an estimated quantity." The rationale for this qualifier is that EPA does not have another qualifier that would better describe the situation for these samples.

7. STATISTICAL EVALUATION OF THE COLLECTED DATA

7.1 OXIDIZER TEST

Standard deviation (σ) is the parameter that fixes the width of the normal distribution of results and includes a fixed fraction of the values making up the curve. In a population having a normal distribution, 95% of the values are within ± 2σ, and 99% are within ± 3σ. Figure 1 depicts the individual results for the standard 3:7 $KBrO_3$:cellulose reference sample compared with the individual results for the ThN samples at the mixing ratio of 4:1 ThN:cellulose. In Fig. 1, the confidence limits of average ± 2 standard deviations ("$-2S_x$","$+2S_x$") are warning limits and average ± 3 standard deviations ("$-3S_x$""$+3S_x$") are control limits. As seen in Fig. 1, all the results obtained for ThN are above the control limit line, except for one French sample. These results indicate that the ThN should not be classified as a DOT Division 5.1 oxidizer.

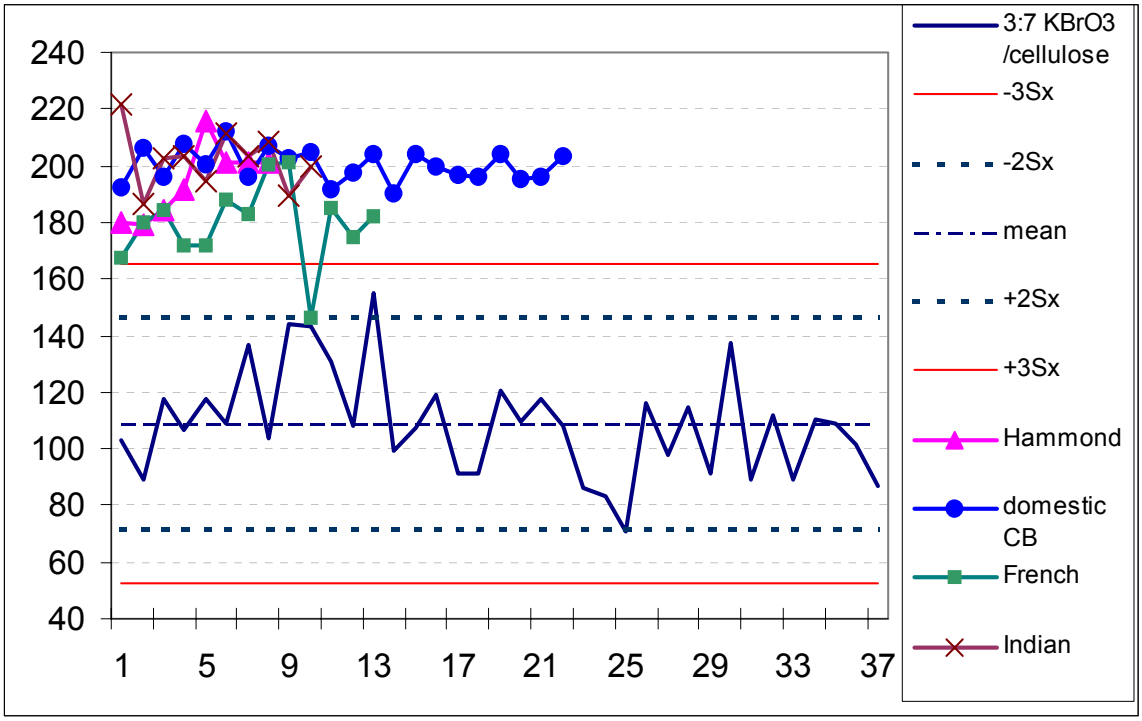

Fig. 1. Graphic representation of the oxidizer test results.

In Table 26, the average results obtained for each category—domestic Hammond, domestic Curtis Bay, French, and Indian—are shown with the error associated with the average. The data are represented graphically in Fig. 2.

Table 26. Summary of the results obtained for the oxidizer test

Sample tested	Average burn time (sec)
3:7 $KBrO_3$ /cellulose	109 ± 6
2:3 $KBrO_3$/cellulose	59 ± 7
3:2 $KBrO_3$/cellulose	12.0 ± 1.3
4:1 domestic Hammond/cellulose	194 ± 21
1:1 domestic Hammond/cellulose	>240
4:1 domestic Curtis Bay/cellulose	200 ± 7
1:1 domestic Curtis Bay/cellulose	>240
4:1 French/cellulose	180 ± 12
1:1 French/cellulose	>240
4:1 Indian/cellulose	200 ± 13
1:1 Indian/cellulose	>240

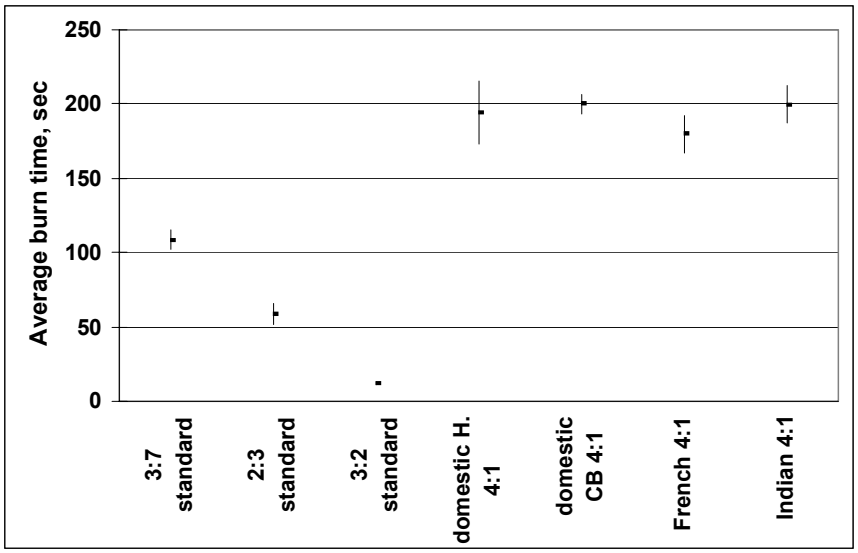

Fig. 2. Comparison of the average burn times obtained for the standards and the samples at a 4:1 sample/cellulose ratio.

7.2 RCRA METALS

The validated data were used to compare the chemical composition of the ThN with the RCRA regulatory threshold at a 90% confidence limit (as requested in NTS WAC Appendix B). For this comparison, the "less than" results were transformed to a value equal to half the detection limit in the calculation of the statistical parameters. Duplicate analyses were also included in the statistical treatment. Four statistical parameters (average, standard deviation, error, and coefficient of variance) were generated for the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.)

The coefficient of variance is the standard deviation divided by the average. When its value is calculated to be <1.25, the data may be assumed to be approximately normally distributed. This condition is necessary for the formation of the 90% confidence limit. As seen in Table 27, the coefficients of variance for the four categories satisfy this condition except in the results for barium in the domestic samples at Curtis Bay. Barium was detected in some samples, although it was undetected in most cases. This finding suggests that an alternate distribution profile may exist for barium. Because the measured concentrations were far below the regulatory limit, a data transformation followed by a statistical evaluation was not deemed necessary.

The average concentration for each RCRA metal and its associated error are also compiled in Table 27. To ease the representation of the values found in comparison with the RCRA limits, the data were compiled in eight graphics (Figs. 3–10) representing each of the RCRA metals. In Figs. 3–10, the averages with error bars and regulatory limits for the RCRA metals are presented for each of the four categories — domestic Hammond, domestic Curtis Bay, French, and Indian. An error bar is visible on the chart for barium at Curtis Bay (Fig. 4); the other bars are not visible because they are too small to show on the graph. The results shown in the charts indicate that the stockpile of ThN is not characteristically hazardous when compared to the RCRA standard.

7.3 TOTAL COMPOSITION

The average concentration for each metal and its associated error are shown in Table 28. As for the RCRA metals, the "less than" results were transformed to a value equal to half the detection limit in the calculation of the statistical parameters. These results are on a dry basis (i.e., they were calculated for the material dried at 105°C until constant weight is achieved).

7.4 ALPHA SPECTROMETRY

The average activities for uranium and thorium isotopic analyses and the error for the averages are given in Table 29. Figure 11 indicates that the results for uranium are often not significantly different from zero. The analytical precision is usually poor when sample concentrations are near the minimum detectable concentration or activity. Because of the high activity measured for thorium, the statistical parameters are meaningful and can be compared. Figure 12 shows that average isotopic activities for thorium from the four categories (domestic Hammond, domestic Curtis Bay, French, and Indian) do not differ from each other significantly.

Table 27. Statistical calculations of the RCRA metals[a]
[Concentrations given in mg/L]

Sample	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Domestic samples from Hammond								
HD0807061	0.113	0.113	0.113	0.228	0.011	0.001	0.113	0.011
HD0807061Dup	0.112	0.112	0.112	0.224	0.011	0.001	0.112	0.011
HD1010061	0.115	0.115	0.115	0.230	0.012	0.001	0.115	0.012
HD2307061	0.118	0.118	0.118	0.235	0.012	0.001	0.118	0.012
HD2907061	0.115	0.115	0.115	0.230	0.036	0.001	0.115	0.012
HD3007061	0.115	0.115	0.115	0.233	0.012	0.001	0.115	0.012
HD3810061	0.118	0.118	0.118	0.238	0.012	0.001	0.118	0.012
HD4710061	0.110	0.110	0.110	0.220	0.075	0.001	0.110	0.011
HD4810061	0.125	0.125	0.125	0.250	0.013	0.001	0.125	0.013
Average	0.115	0.115	0.115	0.232	0.021	0.001	0.115	0.012
Standard deviation	0.004	0.004	0.004	0.009	0.022	0.000	0.004	0.000
Error	0.003	0.003	0.003	0.005	0.013	0.000	0.003	0.000
Coefficient of variance	0.038	0.038	0.038	0.038	1.013	0.254	0.038	0.038

Table 27. (*continued*)[a]
[Concentrations given in mg/L]

Sample	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Domestic samples from Curtis Bay								
CD021207	0.268	0.135	0.135	0.268	0.028	0.002	0.268	0.028
CD031107	0.248	2.280	0.123	0.248	0.025	0.002	0.248	0.025
CD111107	0.245	0.123	0.123	0.245	0.025	0.001	0.245	0.025
CD121207	0.243	0.120	0.120	0.243	0.024	0.002	0.243	0.024
CD141207	0.250	0.125	0.125	0.250	0.025	0.001	0.250	0.025
CD141207Dup	0.245	0.122	0.122	0.245	0.025	NA	0.245	0.025
CD151107	0.245	32.350	0.123	0.245	0.025	0.002	0.245	0.025
CD171007	0.293	0.145	0.145	0.293	0.030	0.002	0.293	0.030
CD221007	0.220	0.110	0.110	0.220	0.022	0.002	0.220	0.022
CD180907	0.215	0.108	0.108	0.215	0.022	0.001	0.215	0.022
CD201007	0.245	14.750	0.123	0.245	0.025	0.001	0.245	0.025
CD280107	0.240	0.120	0.120	0.240	0.024	0.001	0.240	0.024
CD280107Dup	NA	NA	NA	NA	NA	0.001	NA	NA
CD290407	0.233	0.115	0.115	0.233	0.023	0.002	0.233	0.023
CD302806	0.215	0.108	0.108	0.215	0.022	0.001	0.215	0.022
CD360107	0.205	0.103	0.103	0.205	0.021	0.001	0.205	0.021
CD371007	0.263	0.133	0.133	0.263	0.028	0.002	0.263	0.028
CD441207	0.225	0.113	0.113	0.225	0.023	0.001	0.225	0.023
CD452706	0.240	0.120	0.120	0.240	0.024	0.001	0.240	0.024
CD482706	0.250	0.125	0.125	0.250	0.025	0.001	0.250	0.025
CD521007	0.243	0.120	0.120	0.243	0.024	0.001	0.243	0.024
CD581207	0.225	0.113	0.113	0.225	0.023	0.001	0.225	0.023
CD610907	0.260	0.130	0.130	0.260	0.025	0.001	0.260	0.025
CD650907	0.233	0.115	0.115	0.233	0.023	0.002	0.233	0.023
CD650907Dup	0.224	0.112	0.112	0.224	0.022	NA	0.224	0.022
Average	0.240	2.162	0.120	0.240	0.024	0.001	0.240	0.024
Standard deviation	0.019	7.094	0.010	0.019	0.002	0.000	0.019	0.002
Error	0.007	2.482	0.003	0.007	0.001	0.000	0.007	0.001
Coefficient of variance	0.080	3.281	0.080	0.080	0.087	0.234	0.080	0.087

Table 27. (*continued*)[a]
[Concentrations given in mg/L]

Sample	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
French samples from Curtis Bay								
CF010807	0.215	0.108	0.108	0.215	0.022	0.001	0.215	0.022
CF020807	0.243	0.120	0.120	0.243	0.298	0.001	0.243	0.024
CF030807	0.268	0.133	0.133	0.268	0.108	0.001	0.268	0.028
CF040807	0.270	0.135	0.135	0.270	0.193	0.001	0.270	0.028
CF060807	0.258	0.130	0.130	0.258	0.055	0.001	0.258	0.025
CF090807	0.248	0.123	0.123	0.265	0.145	0.000	0.248	0.025
CF110207	0.228	0.115	0.115	0.228	0.063	0.001	0.228	0.023
CF130807	0.240	0.120	0.120	0.240	0.150	0.001	0.240	0.024
CF140307	0.220	0.110	0.110	0.220	0.375	0.001	0.220	0.022
CF170807	0.213	0.105	0.105	0.213	0.063	0.001	0.213	0.021
CF190807	0.260	0.130	0.130	0.408	0.188	0.001	0.260	0.025
Average	0.244	0.122	0.122	0.257	0.147	0.001	0.244	0.024
Standard deviation	0.020	0.010	0.010	0.050	0.108	0.000	0.020	0.002
Error	0.010	0.005	0.005	0.025	0.053	0.000	0.010	0.001
Coefficient of variance	0.081	0.081	0.081	0.193	0.735	0.338	0.081	0.082

Table 27. (*continued*)[a]
[Concentrations given in mg/L]

Sample	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
				Indian samples from Curtis Bay				
CI030707	0.280	0.285	0.140	0.280	0.028	0.0013	0.280	0.028
CI040307	0.225	0.113	0.113	0.225	0.022	0.0010	0.225	0.023
CI050307	0.228	0.115	0.115	0.228	0.023	0.0013	0.228	0.023
CI060307	0.253	0.128	0.128	0.253	0.025	0.0012	0.253	0.025
CI070307	0.258	0.715	0.128	0.258	0.025	0.0008	0.258	0.025
CI090307	0.240	0.120	0.120	0.240	0.024	0.0010	0.240	0.024
CI100207	0.238	0.120	0.120	0.238	0.250	0.0005	0.238	0.024
CI120207	0.245	0.490	0.123	0.245	0.024	0.0012	0.245	0.025
CI130207	0.285	0.143	0.143	0.285	0.028	0.0015	0.285	0.028
CI140207	0.253	0.275	0.125	0.253	0.025	0.0010	0.253	0.025
Average	0.250	0.187	0.125	0.250	0.035	0.0011	0.250	0.025
Standard deviation	0.020	0.129	0010	0.020	0.032	0.0003	0.020	0.002
Error	0.012	0.075	0.006	0.012	0.018	0.0002	0.012	0.001
Coefficient of variance	0.080	0.693	0.078	0.080	0.909	0.270	0.080	0.069

[a]NA = not analyzed for.

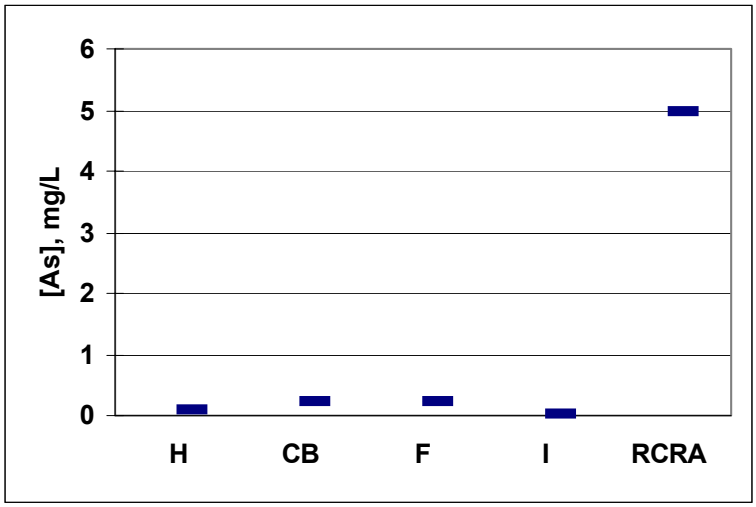

Fig. 3. Calculated average concentration of arsenic in TCLP.

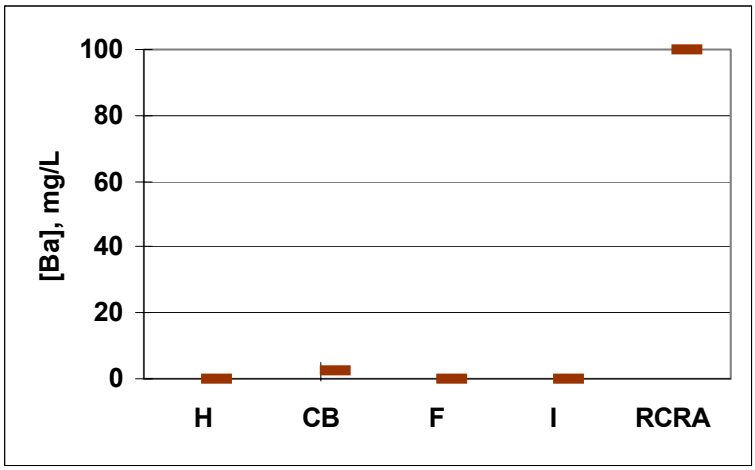

Fig. 4. Calculated average concentration of barium in TCLP.

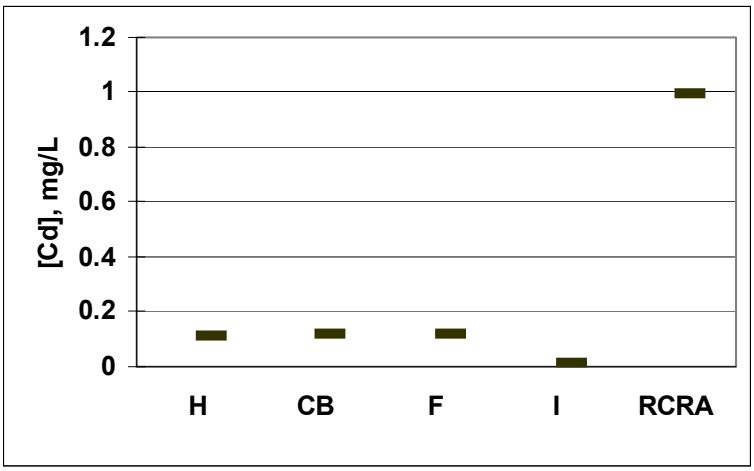

Fig. 5. Calculated average concentration of cadmium in TCLP.

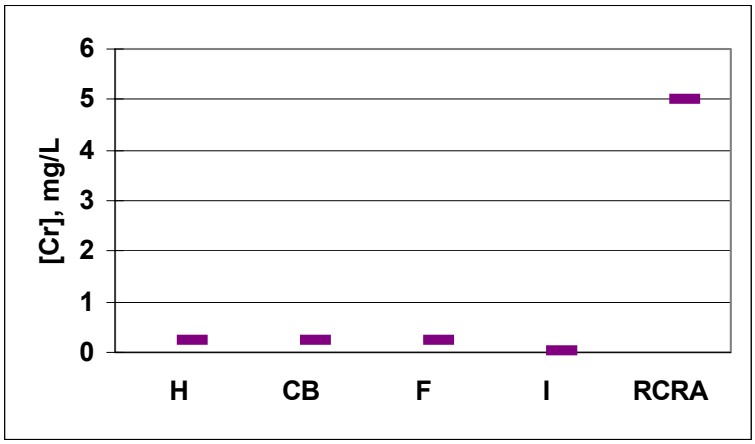

Fig. 6. Calculated average concentration of chromium in TCLP.

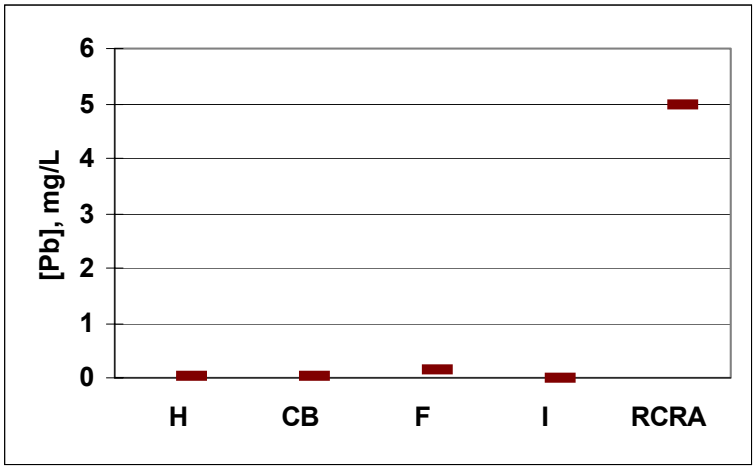

Fig. 7. Calculated average concentration of lead in TCLP.

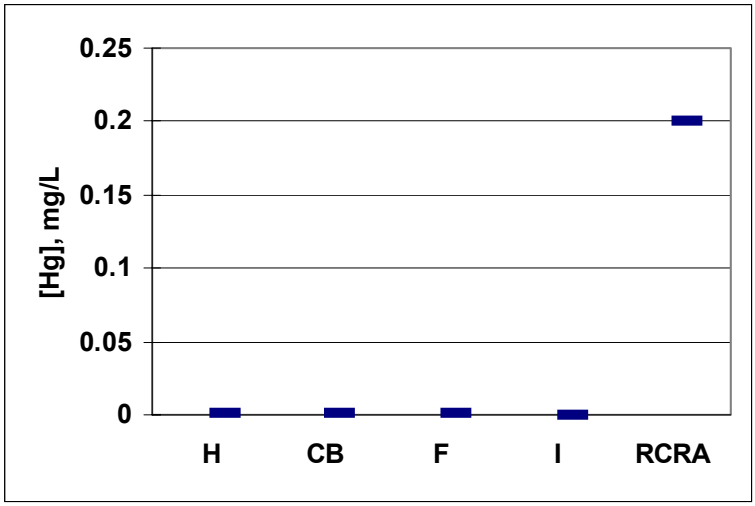

Fig. 8. Calculated average concentration of mercury in TCLP.

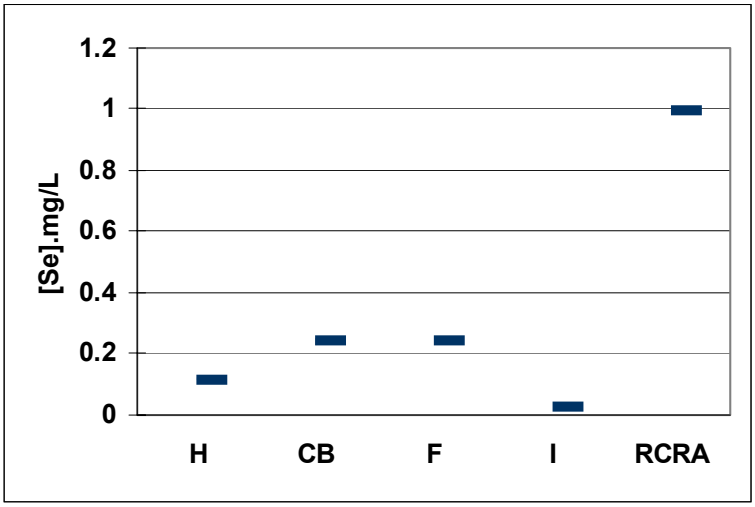

Fig. 9. Calculated average concentration of selenium in TCLP.

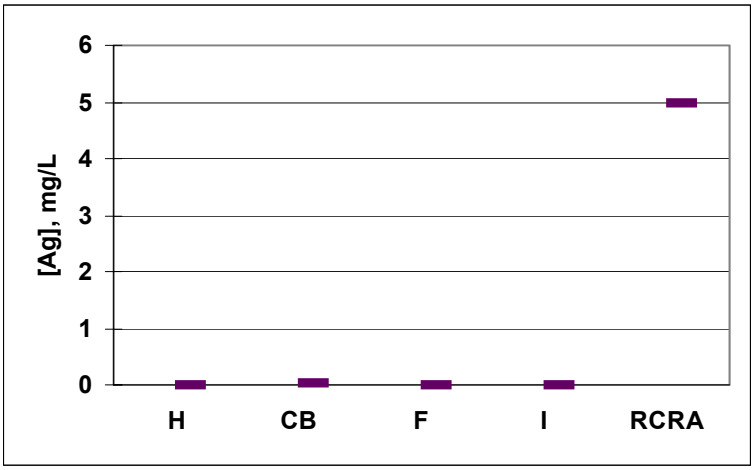

Fig. 10. Calculated average concentration of silver in TCLP.

Table 28. Average total composition of the ThN material
[Units are mg/kg]

Element	Origin: Domestic Hammond			Domestic Curtis Bay			French			Indian		
Aluminum	11.6	±	0.3	24.1	±	0.7	24.4	±	1.0	144	±	74
Antimony	4.7	±	0.1	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Arsenic	2.32	±	0.06	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Barium	2.32	±	0.06	47	±	56	2.4	±	0.1	5.0	±	2.4
Beryllium	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	2.5	±	0.1
Boron	4.7	±	0.1	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Cadmium	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	2.5	±	0.1
Calcium	23.3	±	0.6	24.1	±	0.7	24	±	1	25	±	1
Chromium	4.7	±	0.1	4.8	±	0.1	6.2	±	1.7	5.0	±	0.2
Cobalt	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	2.5	±	0.1
Copper	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	9.1	±	1.5
Iron	23.3	±	0.6	24.1	±	0.7	24.4	±	1.0	25.0	±	1.1
Lead	0.5	±	0.3	0.48	±	0.02	5.8	±	2.2	1.0	±	0.8
Magnesium	11.6	±	0.3	24.1	±	0.7	24.4	±	1.0	25.0	±	1.1
Manganese	4.7	±	0.1	5.1	±	0.6	4.9	±	0.2	5.0	±	0.2
Mercury	0.021	±	0.004	0.025	±	0.002	0.022	±	0.004	0.022	±	0.003
Molybdenum	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	2.5	±	0.1
Nickel	2.32	±	0.06	2.40	±	0.07	3.6	±	1.1	2.5	±	0.1
Selenium	2.32	±	0.06	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Silicon	11.6	±	0.3	13	±	2	12.2	±	0.5	72	±	22
Silver	0.23	±	0.01	0.48	±	0.02	0.49	±	0.02	0.50	±	0.02
Sodium	650	±	749	53	±	9	365	±	96	61	±	14
Strontium	4.7	±	0.1	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Thallium	4.7	±	0.1	5.1	±	0.5	4.9	±	0.2	5.0	±	0.2
Thorium	429125	±	3131	470227	±	8269	486538	±	15162	489800	±	15911
Uranium	0.23	±	0.01	0.48	±	0.02	25	±	6	0.50	±	0.02
Vanadium	4.7	±	0.1	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2
Zinc	2.32	±	0.06	2.40	±	0.07	2.4	±	0.1	2.5	±	0.1
Zirconium	4.7	±	0.1	4.8	±	0.1	4.9	±	0.2	5.0	±	0.2

Table 29. Average activities obtained by alpha spectrometry
[Units are pCi/g unless indicated]

Nuclide/element	Origin: Domestic Hammond			Domestic Curtis Bay			French			Indian		
^{234}U	1.23	±	1.15	0.84	±	0.18	8.79	±	8.89	0.51	±	0.26
^{235}U	0.13	±	0.27	0.30	±	0.23	0.76	±	1.10	0.05	±	0.11
^{236}U	0.02	±	0.17	0.37	±	0.23	0.44	±	0.16	0.17	±	0.30
^{238}U	1.10	±	1.20	0.29	±	0.10	8.44	±	9.93	0.11	±	0.17
Total U	2.48	±	2.27	1.80	±	0.59	18.43	±	19.80	0.84	±	0.63
Total U, mg/kg	3.34	±	3.51	1.01	±	0.30	25.49	±	30.08	0.37	±	0.48
^{228}Th	50200	±	6735	46218	±	1151	44730	±	2916	48463	±	2189
^{230}Th	3863	±	886	4290	±	239	39587	±	16803	7538	±	154
^{232}Th	45900	±	4533	45818	±	1151	43397	±	3562	45960	±	3756
Total Th	99963	±	12056	96325	±	2405	127713	±	20443	101961	±	5728
Total Th, wt %	41.8	±	4.1	41.7	±	1.1	39.5	±	3.3	41.9	±	3.4

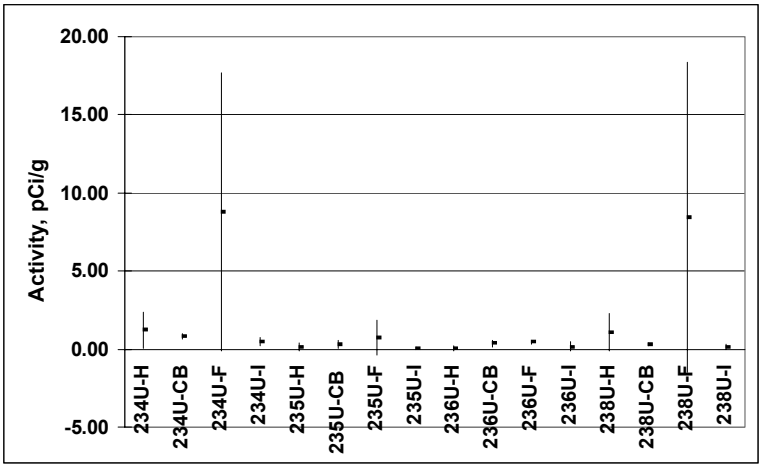

Fig. 11. Average uranium isotopic activities.

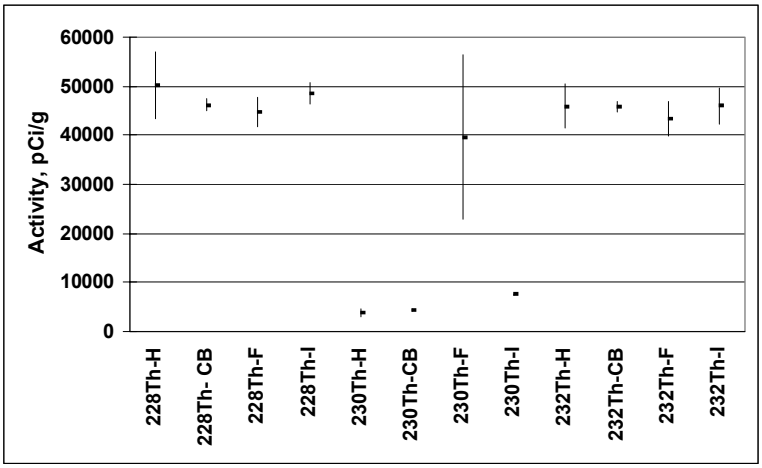

Fig. 12. Average thorium isotopic activities.

7.5 GAMMA SPECTROMETRY

The average gamma activities measured in the samples and the error associated with the average are presented in Table 30. The nuclides that could be of concern for the project and their action-level activities are listed in Table 31. The nuclide data were obtained from Table E-1 in *Nevada Test Site Waste Acceptance Criteria* (DOE 2002).

The activities for the nuclides of concern at NTS were calculated from the average data found in Tables 29 and 30 and were compared with the action levels. The measured density of the domestic ThN from Curtis Bay (1.887 g/cm^3) was used to convert the activities, measured in picocuries per gram, so that they could be compared with the action levels which are expressed in becquerels per cubic meter). The results are presented in Table 31. Both ^{230}Th and ^{232}Th are found to be above their respective action levels. The alpha data were used for these two nuclides. The nuclides ^{231}Pa , ^{237}Np, and ^{226}Ra are close to their respective action levels. However these nuclides were flagged as estimated during the data validation process. The laboratory indicated that there was interference causing "isotope presence and/or quantitation questionable." The other radionuclides are significantly below their respective action levels.

Table 30. Average activities obtained by gamma spectrometry
[Units are pCi/g]

	Origin											
Nuclide	Domestic Hammond			Domestic Curtis Bay			French			Indian		
^{208}Tl	10617	±	561	11613	±	181	11806	±	341	12762	±	351
^{212}Bi	29222	±	8603	30551	±	3360	35982	±	1023	38861	±	750
^{212}Pb	12566	±	4072	14995	±	2129	9789	±	755	15218	±	2870
^{224}Ra	431375	±	28251	478165	±	10115	469464	±	18062	531236	±	17926
^{228}Ac	30481	±	3926	33818	±	1103	34566	±	834	38280	±	746
^{228}Th	38076	±	2473	42647	±	1285	42269	±	2205	47665	±	1537
^{211}Bi	102	±	25	125	±	10	1596	±	156	257	±	33
^{219}Rn	10101	±	567	11784	±	773	12001	±	1352	14265	±	1121
^{231}Pa	10568	±	23374	16404	±	8461	21059	±	11425	13672	±	13816
^{231}Th	174833	±	7558	186737	±	3860	191629	±	6502	189320	±	32719
^{233}Ra	40655	±	35304	9040	±	8804	1571	±	63	1775	±	84
^{235}U	26	±	8	35	±	1	ND[a]		—	47	±	4
^{229}Th	567	±	74	673	±	48	683	±	61	771	±	110
^{237}Np	1743	±	80	1854	±	121	1639	±	63	2373	±	401
^{214}Bi	ND[a]		—	ND[a]		—	517	±	73	ND[a]		—
^{214}Pb	ND[a]		—	ND[a]		—	531	±	41	107	±	39
^{226}Ra	489	±	69	527	±	40	747	±	135	477	±	118
^{234m}Pa	7396	±	674	7124	±	521	7655	±	544	8503	±	705
^{234}Th	256	±	38	296	±	15	282	±	25	335	±	20
^{40}K	2626	±	154	2784	±	40	2784	±	82	3088	±	98
^{94m}Nb	21	±	2	24	±	2	ND[a]		—	ND[a]		—
^{137}Cs	ND[a]		—	25	±	2	38	±	3	ND[a]		—
^{146}Pm	3030	±	180	3164	±	253	3254	±	110	3699	±	120
^{155}Eu	89998	±	45972	108783	±	19958	73161	±	18977	112185	±	34692

[a]ND = not detected

Table 31. Comparison of the activity of the ThN with the WAC from NTS
[Units are Bq/m^3]

Nuclide	Origin				NTS WAC[a] action level
	Domestic Hammond	Domestic Curtis Bay	French	Indian	
^{229}Th	3.96E+07	4.70E+07	4.77E+07	5.38E+07	4.10E+09
^{230}Th	2.70E+08	3.00E+08	2.76E+09	5.26E+08	9.60E+07
^{232}Th	3.20E+09	3.20E+09	3.20E+09	3.21E+09	8.10E+08
^{231}Pa	7.38E+08	1.15E+09	1.47E+09	9.55E+08	1.40E+09
^{234}U	8.59E+04	5.86E+04	6.14E+05	3.56E+04	1.90E+10
^{235}U	9.08E+03	2.09E+04	5.31E+04	3.49E+03	1.20E+10
^{236}U	1.40E+03	2.58E+04	3.07E+04	1.19E+04	1.20E+11
^{238}U	7.68E+04	2.02E+04	5.89E+05	7.68E+03	5.90E+10
^{237}Np	1.22E+08	1.29E+08	1.14E+08	1.66E+08	7.00E+08
^{137}Cs	3.14E+06	1.75E+06	2.65E+06	3.14E+06	3.40E+11
^{226}Ra	3.41E+07	3.68E+07	5.22E+07	3.33E+07	3.60E+07

[a] From Table E-1 in *Nevada Test Site Waste Acceptance Criteria* (DOE/NV-325-Rev. 4) U.S. Department of Energy Nevada Operations Office, February 2002.

8. DATA QUALITY OBJECTIVES

8.1 REPRESENTATIVENESS

EPA requires "that *representative* samples of waste be collected and defines representative samples as exhibiting average properties of the whole waste" (SW-846, Chap. 9). The ThN stockpile is formed by four groups of different origins, and the ThN project has treated them as four different populations because they were produced by slightly different processes. However, regardless of the origin, the material was the result of a chemical process that was applied to produce a commercial product having a defined targeted composition. This material is different from a waste or even an ore; it was purified to meet the specifications for that final material. The process used was the same, and the only difference that may occur within one origin is the difference between batches during production. The sampling effort collected samples from all the lots within each group. Both the historical data and the results collected during the sampling and analysis effort show that the material is homogeneous even between lots. Therefore, the samples collected are representative of the entire stockpile.

8.2 ACCURACY

Sample accuracy is usually achieved by using a simple random selection. In this project each lot was considered homogeneous because it originated from a series of batches having the same characteristics (e.g., materials were processed during the same time frame, processing chemicals had the same origin). The various lots were treated as the source of heterogeneity for the population. After the number of drums to sample (see Sect. 3) was selected, a random selection by computer software was performed.

For each point of origin, a true random number of drums to sample was generated. The numbers identified were then reported in the layouts of the depots. The drums selected were matched with the lot numbers they were issued. However, for maintaining exposure as low as reasonably achievable for workers performing the task, it was not possible to retrieve the exact drum selected by the software; too much drum handling would have caused too much radiation exposure to the workers. It was therefore decided that instead of a specific drum, one drum from the lot it belonged to, easily accessible from the aisles of the warehouse, would be sampled.

At the Curtis Bay Depot each lot was sampled, resulting in more samples collected than determined using statistics.

8.3 PRECISION

As stated in SW-846, "the sampling precision is most commonly achieved by taking an appropriate number of samples from the population." Equation 8 in Chap. 9 of SW-846, which uses statistical data collected from previous analyses, was not applicable in this case because there is no threshold value for the thorium concentration. Similarly, there are no hazardous elements present in ThN for which threshold values exist. Therefore, because many drums were involved, the method of taking the cubic root of the total number of drums was used to determine the number to sample. This method is used by Bechtel Jacobs at ORNL for determining the

number of samples to analyze prior to disposal of ORNL wastes at Envirocare or NTS (Bechtel Jacobs 2000a,b,c) and provides a conservative approach given that this project was dealing with a pure material and not a heterogeneous waste.

The lot sizes at Curtis Bay are between 250 and 300 drums each, and the average lot size at Hammond is 45 drums. The 50 lots at Hammond were divided into 8 groups of 6 or 7 lots, each group having an equivalent number of drums as the lots at Curtis Bay. Thus the added cost of testing each lot at Hammond was avoided. Table 32 shows the results of applying the cubic-root method to calculate the number of drums to sample for each point of origin. Considering that the sampling event required extensive safety precautions and was costly, a second sampling could not be considered—even if an inadequate number of samples was taken. Therefore, a sufficient number of drums was sampled to address not only the statistical needs but also a margin for error. Extra samples were archived and used only if the need arose. In summary, the conservative approach was to sample 50% more drums than necessary.

Table 32. Number of drums to sample by country of origin

	U.S.	France	India
Total number of drums	18,924	1,901	760
Cubic root of total number	26.6	12.39	9.13
Number of drums to analyze	27	13	10
Number of drums to sample	40	20	15

8.4 COMPLETENESS

The data received from SWRI were evaluated according to the EPA guidelines for data validation. None of the data was rejected by the data validator; therefore, all the data are usable and the completeness is 100%.

8.5 COMPARABILITY

It was possible to compare some of the data that were collected by different techniques. The comparisons are presented in Table 33. In the tables, the ICP results have been transformed to express a composition on an as-received basis, allowing the comparison with the rad data that were provided on a as-received basis. The comparison is good when the elements are present in sufficient quantity, but when the concentrations are close to the detection limit, the correlation is not satisfactory.

Because the instruments used for the analyses were properly tuned, all the QA/QC controls were found to be within acceptable limits as set for per the relevant EPA methods, and it showed that the instruments were “in control” during the analyses; therefore, the results obtained are comparable.

Table 33. Comparison of data obtained by different techniques

	^{235}U activity[a] (pCi/g)		Total U (mg/kg)		^{228}Th activity (pCi/g)		Total Th (wt %)	
Sample	alpha	gamma	alpha	ICP	alpha	gamma	alpha	ICP
				Hammond samples				
HD0807061	0.0769	38.4	5.72	0.42	54600	40400	44.6	39.5
Q	UJ	NJ		U	=	J	=	=
HD1010061		30.5		0.42		38510		38.7
Q		NJ		U		J		=
HD2307061		23.7		0.44		32600		39.4
Q		NJ		U		J		=
HD2907061		24		0.42		41430		39.1
Q		NJ		U		J		=
HD3007061	0	12.2	2.48	0.43	49200	38400	40.5	40.1
Q	UJ	UJ		U	=	J	=	=
HD3810061		ND		0.43		39890		39.1
Q				U		J		=
HD4710061		ND		0.41		34800		39.7
Q				U		J		=
HD4810061	0.311	ND	1.83	0.45	46800	38580	40.3	39.4
Q	UJ			U	=	J	=	=

Table 33. (*continued*)

Sample	^{235}U activity[a] (pCi/g) alpha	gamma	Total U (mg/kg) alpha	ICP	^{228}Th activity (pCi/g) alpha	gamma	Total Th (wt %) alpha	ICP
Domestic Curtis Bay samples								
CD021207		ND		1.0		44210		42.9
Q				UJ		J		=
CD031107		ND		0.92		39870		42.7
Q				UJ		J		=
CD111107	1.22	40.3	1.24	0.90	44040	39390	39.6	42.6
Q	=	NJ		UJ	=	J	=	=
CD121207		35.9		0.87		38750		43.4
Q		NJ		UJ		J		=
CD141207		ND		0.90		42000		45.3
Q				UJ		J		=
CD151107	0.4	33.6	1.14	0.92	46190	38690	40.3	43.7
Q	=	NJ		UJ	=	J	=	=
CD171007		ND		1.01		39350		43.6
Q				UJ		J		=
CD180907		ND		0.80		41380		43.7
Q				UJ		J		=
CD201007	0	33	1	0.90	46500	48150	42.5	42.8
Q	U	NJ		UJ	=	J	=	=
CD221007	0.11	ND	0.06	0.78	50810	41850	45.4	43.1
Q	U			UJ	=	J	=	=
CD280107	0.28	32.6	1.72	0.89	45900	40520	41.6	43.1
Q	U	NJ		NJ	=	J	=	=
CD290407	0.37	30.3	0.77	0.86	45910	45260	41.5	43.2
Q	=	NJ		UJ	=	J	=	=
CD302806		ND		0.80		41180		43.1
Q				UJ		J		=
CD360107		ND		0.77		36940		42.4
Q				UJ		J		=
CD371007	0.04	ND	0.67	1.0	45410	40420	42.3	42.6
Q	U			UJ	=	J	=	=
CD441207		ND		0.83		39780		43.1
Q				UJ		J		=
CD452706		ND		0.90		45450		43.2
Q				UJ		J		=
CD482706	0.28	ND	1.46	0.95	45740	42940	42.0	40.3
Q	U			UJ	=	J	=	=
CD521007		ND		0.88		47310		43.4
Q				UJ		J		=
CD581207		39.6		0.88		50780		41.7
Q		NJ		UJ		J		=
CD610907	0	ND	1.0	0.91	45460	46870	40.2	43.2
Q	U			UJ	=	J	=	=
CD650907		ND		0.82		43310		45.0
Q				UJ		J		=

Table 33. (*continued*)

Sample	^{235}U activity[a] (pCi/g)		Total U (mg/kg)		^{228}Th activity (pCi/g)		Total Th (wt %)	
	alpha	gamma	alpha	ICP	alpha	gamma	alpha	ICP
French samples								
CF010807		ND		12.8		44500		41.1
Q				J		J		=
CF020807	0.73	ND	26.09	19.7	43080	44980	37.5	43.0
Q	=			J	=	J	=	=
CF030807		50.2		15.3		48780		41.7
Q		NJ		J		J		=
CF040807		ND		28.9		45110		42.5
Q				J		J		=
CF060807		ND		9.5		34910		42.6
Q				J		J		=
CF090807		ND		43.1		37180		43.4
Q				J		J		=
CF100207	0.12	ND	7.35	29.0	44580	45270	39.6	42.8
Q	U			J	=	J	=	=
CF110207		ND		16.2		50330		42.6
Q				J		J		=
CF130807		ND		32.1		42330		45.3
Q				J		J		=
CF140307		ND		22.7		37640		41.8
Q				J		J		=
CF160807		ND		6.5		39730		43.1
Q				J		J		=
CF170807		ND		26.5		41270		43.4
Q				J		J		=
CF190807	1.42	ND	43.02	21.7	46530	36340	41.4	41.0
Q	=			J	=	J	=	=

Table 33 (*continued*)

Sample		^{235}U activity[a] (pCi/g) alpha	^{235}U activity[a] (pCi/g) gamma	Total U (mg/kg) alpha	Total U (mg/kg) ICP	^{228}Th activity (pCi/g) alpha	^{228}Th activity (pCi/g) gamma	Total Th (wt %) alpha	Total Th (wt %) ICP
Indian samples									
CI040307		0.03	ND	0.09	0.79	48180	48480	40.6	46.9
	Q	U			UJ	=	J	=	=
CI050307			ND		0.85		51300		46.5
	Q				UJ		J		=
CI060307			ND		0.93		42160		44.5
	Q				UJ		J		=
CI070307			ND		0.94		43920		42.2
	Q				UJ		J		=
CI090307		0.13	ND	0.36	0.89	49880	45200	44.2	44.2
	Q	=			UJ	=	J	=	=
CI110207			ND		0.91		50500		45.1
	Q				UJ		J		=
CI120207			ND		0.93		48980		44.4
	Q				UJ		J		=
CI130207			51.6		0.94		47770		44.4
	Q		NJ		UJ		J		=
CI140207			ND		0.93		49670		44.7
	Q				UJ		J		=

[a] ND = not detected

9. DOMESTIC DRUMS PRESSURIZATION

On April 7 and 8, 2003, another inspection took place at the Curtis Bay Depot for obtaining more information on the MD-1 (30-gal drums from domestic origin) pressure build-up for industrial safety purposes and specific NTS acceptance requirements associated with the MD-1 drum type. The NTS WAC document requires (in Sect. 3.1.7) that "LLW gases ***must*** be packaged at a pressure that does not exceed 1.5 atmospheres at 20°C." Also, in Sect. 3.1.8, "Chemical stability and compatibility ***must*** be demonstrated to ensure that no reactions occur and significant quantities of harmful gases, vapors, or liquids are not generated." A complete description of the phenomenon explaining this gas generation is found in Hylton et al. (2003).

9.1 MECHANISMS OF GASES FORMATION

The solidified thorium nitrate was formed from a crystallization technique. The objective was to have the thorium solidified as a nitrate matrix, so excess nitric acid was necessary. Thus, some nitric acid remained in the thorium nitrate matrix. Over time, the nitric acid seeped from internal packaging and reached slaked lime that was placed there to neutralize the acid (Hylton et al. 2003).

Equation [1] shows the chemical reaction that occurs when nitric acid reacts with calcium hydroxide. Initially, the water that is formed would be present as hydrate molecules on the calcium nitrate product rather than a free liquid.

$$Ca(OH)_2 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + 2H_2O \qquad [1]$$

Equation [1] also shows that gaseous products would not be expected; however, Eqn. [2] shows that carbon dioxide would be formed if nitric acid reacted with calcium carbonate.

$$CaCO_3 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + CO_2 + H_2O \qquad [2]$$

Since historical records indicate that slaked lime (i.e., not calcium carbonate) was used in the drums, a mechanism for the presence of calcium carbonate in the drums would have to be defined for the reaction shown in Eq. [2] to explain the presence of CO_2. Two potential mechanisms have been identified.

The first potential mechanism for calcium carbonate to be present in the slaked lime is that it was present in the slaked lime when the slaked lime was originally purchased. The purity of the slaked lime that was used by the drum repackaging vendor is not known, but the vendor probably did not use slaked lime of high purity. The second potential mechanism for the presence of calcium carbonate in the slaked lime would be by direct reaction of carbon dioxide (in air) with the calcium hydroxide as shown by Eqn. [3].

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O \qquad [3]$$

In view of these reactions, one can expect to find the following major gases in the headspace of the drums: O_2, N_2, and CO_2. NO_x could also be present because it exists as vapor pressure when nitric acid is present, but it is not anticipated to be a major component.

9.2 SELECTION OF THE DRUMS TO SAMPLE AND OBSERVATIONS ON THE DRUMS SELECTED

The ORNL team inspected the top layer of drums and made a selection from those (limited to the aisle-ways access) that appeared to have internal pressure. This methodology was followed to maximize the chances to bound pressure conditions and ensure more chance to collect gas from the headspace for analysis. Table 34 contains the pressure data obtained on the selected drums and lists the samples collected and the analytical laboratories that received them. It should be emphasized that when the ThN will be transported for disposal at the NTS site, the drums will be packed in ISO containers, and the ISO containers will be vented with HEPA filter systems. Therefore, the data presented here are for information only.

Table 34. Measurement of the headspace pressure present in selected drums

Lot number	Drum number	Headspace pressure (psi)	Canister sent to
4	55	12	Y-12 and SWRI
6	83	0.5	SWRI
6	84	5	SWRI
8	18	9	Y-12 and SWRI
14	244	2	SWRI
21	176	16	SWRI (2 canisters)
27	79	4	Y-12 and SWRI
31	34	7.5	SWRI
33	117	7.5	Y-12 and SWRI
44	262	9	SWRI
63	60	3	SWRI

The following observations were made during the opening of the drums.

- Lot 8, drum 18 had 9 psig in the headspace, which is more than enough to collect 2 samples. That drum had the Y-12 sample taken first, followed by the 2.4-L canister for SWRI. The results obtained by SWRI showed that the gas collected was regular air indicating a sampling problem; therefore, the SWRI analysis was not reported in the tables.

- Lot 21, drum 205 was an inner bag sample taken from the open drum. The bag resisted little when pushed, but it did appear somewhat inflated. The analysis results indicated that the gas was regular air, and it is reasonable to think that the bag equilibrated with ambient conditions.
- Lot 21, drum 176 was a bulged drum. The headspace pressure was 16 psig, and SWRI was sent two gas samples. There is good correlation between the results for these two samples.
- Lot 63, drum 60 had an internal pressure of 3 psig. The analysis results indicate that the canister was empty, albeit the NucFil team thought they did open the sample's valve. Because of sampling uncertainty, the results for that sample are not provided in the table of results.
- Lot 27, drum 79 had a headspace pressure of 4 psig and had a duplicate sample collected. The pressure typically went down by 2–3 psig after each sample was taken based on intermediate pressure data observations.

The headspace of the selected drums were sampled and analyzed for major and minor constituents SWRI received all the samples for testing by GC and GC-MS, and ACO at Y-12 received 4 samples for analysis by GC-MS for cross reference with the results provided by SWRI. A 1-L tedlar bag was also filled out of every drum tested for semi-quantitative analyses with field instruments used in industrial hygiene.

9.3 ANALYTICAL RESULTS OF THE GAS HEADSPACE COMPOSITION

The samples sent to Y-12 (ACO) were analyzed by GC-MS only while SWRI used a combination of different techniques. Oxygen and nitrogen were run via Gas Chromatography Thermal Conductivity Detection (GC-TCD) using a gas loop injection. Hydrogen, carbon monoxide, carbon dioxide and methane were run via Gas Chromatography Pulsed Discharge Helium Ionization Detection (GC-PD-HID). Nitrogen oxides (NO_x) were run via Ion Chromatography (IC) after absorbing some of the gas into a basic solution and analyzing the solution for NO_2/NO_3. An analysis using GC-MS was also performed to obtain the trace gas constituents present.

The result obtained by both laboratories are compiled in Table 35 for the major elements and Table 36 for the minor constituents. The laboratory was asked to determinate and identify all the minor constituents that the instrument could detect. The gaseous composition of dry air is also provided in Table 35. The results obtained by the two laboratories are quite different for the concentration of NO_x and O_2. The results obtained at ORNL that are presented later in this chapter confirm the data obtained by SWRI.

The data on the analytical composition of the headspace gas confirm the mechanism advanced for the formation of the gas buildup by the increase of CO_2 and NO_x and the decrease of O_2 and N_2 from the normal composition of air. The amount of hydrocarbons and hydrogen present are much lower than the LEL (lower explosive limit) values for these gases: the LEL for ethane is 3 vol %, for methane is 5 vol %, for ethene is 3.1 vol %, and for hydrogen is 4 vol %. The minor constituents are present at the trace level, micrograms per liter, and none of these are on the EPA RCRA list for being characteristically hazardous (D018-D043).

Table 35. Analysis of the major constituents present in the drum headspace[a,b]

Sample number	CO_2 vol (%)	NO_x vol (%)	N_2 vol (%)	O_2 vol (%)	CO (mg/L)	H_2 (mg/L)	CH_4 (mg/L)	ethane (mg/L)	ethene (mg/L)
ACO - Lot 4 Drum 55	35.98	18.79	44.09	0.02	6500	180	30	—	—
SWRI - Lot 4 Drum 55	39.5 (38.6)	0.1578	45.8 (43.0)	11.2 (10.2)	1051	21.5	28.7	1.45	6.05
SWRI - Lot 6 Drum 83	40.9 (40.8)	0.0929	44.7 (45.2)	ND (ND)	886	ND	25.8	1.39	4.99
SWRI - Lot 6 Drum 84	42.2 (42.4)	0.1383	47.1 (45.4)	9.81 (9.3)	1030	ND	27	1.5	6.2
ACO - Lot 8 Drum 18	34.05	16.13	47.88	0.16	11800	200	40	—	—
SWRI - Lot 14 Drum 244	41.4 (41.3)	0.1035	61.9 (50.6)	ND (ND)	986	ND	42.7	ND	5.54
SWRI - Lot 21 Drum 176	44.6 (45.4)	0.2867	36.5 (35.2)	12.2 (11.9)	1360	18.2	16.4	0.99	5.38
SWRI - Lot 21 Drum 176	42.8	0.2540	31.5	9.75	1270	20.4	16.6	1.02	5.91
ACO - Lot 27 Drum 79	39.96	18.95	39.11	0.24	12500	170	30	—	—
SWRI - Lot 27 Drum 79	42.2 (43.9)	0.1446	41.6 (44)	ND (ND)	1170	ND	35.9	1.5	6.28
SWRI - Lot 31 Drum 34	44.3 (43)	0.1225	38.9 (46.9)	9.85 (12.2)	1220	18	32	1.48	6.33
ACO - Lot 33 Drum 117	45.25	16.89	36.38	0.06	9600	200	20	—	—
SWRI - Lot 33 Drum 117	31.9 (30.5)	0.0974	48.2 (45.5)	12.9 (11.9)	831	ND	28.1	ND	5.42
SWRI - Lot 44 Drum 262	35.5 (36)	0.0979	51.8 (49.6)	11.2 (10.4)	1210	18.6	31.1	1.06	6.21
Gaseous composition of dry air	0.035	Tr	78.084	20.947	0.25	0.53	1.7	Tr	Tr

[a]ND = not detected, Tr = traces.
[b]Results in parentheses are those of duplicate analyses made by the laboratory.

Table 36. Minor constituents found in the headspace of the drums

[Units are µg/L]

Constituent	Sample[a]									
	Lot 4 Drum 55	Lot 6 Drum 83	Lot 6 Drum 84	Lot 14 Drum 244	Lot 21 Drum 176	Lot 21 Drum 176 dup	Lot 27 Drum 79	Lot 31 Drum 34	Lot 33 Drum 117	Lot 44 Drum 262
propene	220	260	300	1000	220	220	420	320	240	270
chloromethane	230	290	270	300	130	160	290	250	200	260
chloroethane	190	110	63	ND	250	290	140	98	67	58
acetone	380	580	740	1500	430	510	920	500	520	630
methylene chloride	ND	280	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichlorotri-fluoroethane	ND	7500	ND	ND	ND	ND	ND	1800	260	ND
carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	22
2-butanone	ND	ND	ND	ND	ND	14	ND	ND	ND	ND
hexane	ND	ND	ND	ND	26	32	ND	ND	ND	29
benzene	72	72	49	ND	81	99	74	58	ND	47
cyclohexane	1600	ND	54	ND	62	78	110	83	90	77
heptane	ND	ND	ND	ND	32	39	ND	ND	67	66
toluene	110	160	110	ND	130	150	73	56	150	150
tetrachloroethene	81	ND	110	330	300	110	150	120	180	35
propane	280	300	230	350	120	110	150	120	130	140
isobutane	2700	2900	2100	1300	1400	1300	650	400	770	1000
1-propene, 2-methyl-	49	150	ND	210	ND	ND	ND	100	ND	ND
butane	230	230	170	230	140	150	130	120	120	96
propane, 2,2-dimethyl-	110	120	ND	ND	70	74	3100	ND	ND	ND
acetonitrile	420	460	650	800	260	270	580	520	460	610
1,1-dichloro-1-fluoroethane	ND	ND	ND	ND	ND	ND	ND	ND	2200	1600
ethane, 1,2-dichloro-1,1,2-trifluoro-	ND	7400	ND	ND	ND	ND	ND	1000	ND	ND
pentane	140	150	130	210	70	70	ND	ND	ND	84
2-propanol, 2-methyl-	ND	ND	56	ND	ND	ND	ND	ND	ND	ND
hexane, 3-methyl-	ND	ND	ND	ND	45	48	ND	ND	100	91
acetic acid, methyl ester	ND	ND	ND	ND	45	48	ND	210	ND	300
1-pentene, 2,4,4-trimethyl-	ND	ND	ND	ND	45	48	ND	130	ND	ND

[a]ND: not detected

9.4 FIELD TYPE MEASUREMENTS ON THE SAMPLES COLLECTED IN TEDLAR BAGS

The tedlar bags containing headspace gases collected from some pressurized MD-1 drums from Curtis Bay were shipped to ORNL for analysis. Upon receipt, the content of the bags varied from partially full (~ ½) to empty. Analyses were performed on the available samples using a Draeger Miniwarn instrument commonly used for industrial safety purpose to monitor the gases present in air. This instrument is equipped with catalytic sensors for CH_4, NO, NO_2 and O_2, that provide semi-quantitative data.

The instrument was first calibrated with fresh air from the room and the reading was: 0 % LEL CH_4, 0 ppm NO, 0 ppm NO_2, and 20.9% O_2. Measurements were then made on the gases contained inside the bags. In some bags, the concentration of NO_2 exceeded the range of measure of the instrument—50 ppm. Therefore, dilutions of the gases with clean room air was necessary to obtain a concentration within the measuring range. The results of the measurements are compiled in Table 37.

Table 37. Gases analyses using a Draeger Miniwarn instrument

Sample ID	Dilution used	%LEL CH_4	NO (ppm)	NO_2 (ppm)	vol % O_2
G04-055-B-HS-030407	3.5	21	8.7	46	13.5
G06-084-B-HS-030407	1	16	6	19.8	14.7
G08-018-B-HS-030407	5	25	15	70	10.4
G21-176-B-HS-030408	3.5	31.5	24.5	149	11.1
G27-079-B-HS-030407[a]	3.5	17.5	5.2	2.5	17.7
G31-034-B-HS-030407	1	17	5.5	6.7	17.3
G33-117-B-HS-030407	3.5	21	5.2	18	15.6
G44-262-B-HS-030407	3.5	24.5	19.2	93	12.1
G63-060-B-HS-30407			EMPTY		

[a] Sample G27 may have been containing too little gas: the results for that sample are suspect.

The results obtained are quite reproducible in measuring the % LEL CH_4 , with a measured average of 19 ± 2 % LEL . With a LEL for methane of 5.53 vol %, this measured value corresponds to a concentration of 105 ppm of CH_4. This value is comparable to those found by the analytical laboratories, considering the limitations of this instrument.

Most combustible gas detectors measure the contaminant by combustion at a catalytic detector, with the heat produced used as a measure of the "explosivity" of the contaminant in air. The meter responds differently to different chemical mixtures in air.

Another limitation of this type of sensor is that if the concentration of oxygen in air is different from the normal condition (20.9%), the data obtained may result in underestimating the explosive hazard of the gas mixture. The response of the meter depends on its ability to burn the combustible gas. If there is not enough oxygen to support the combustion, the meter would read 0% LEL, even if high levels of combustible gas were present. As shown in Table 37, the level of oxygen measured is low (10–17%) and one can expect that the combustible gas data are impaired because of it.

The concentration of NO was found to vary from 5 to 24 ppm, while the concentration of NO_2 was found within the range of 2 to 149 ppm. These values are lower than those found by SWRI but still in the same range. The data obtained by Y-12 are substantially higher and cannot be explained by the physical mechanisms that appear to be present. Oxygen concentration was found in the range of 10.4 to 17.7 vol %. These values are closer to those found by SWRI, 9.8 to 12.9 vol %, while those obtained by Y-12 are substantially lower, in the range of 0.02 to 0.24 vol %. In view of these results, the data from Y-12 should not be considered reliable.

10. CONCLUSIONS

The characterization of the ThN stockpile was achieved by analyzing 53 samples that included 30 samples of domestic origin (8 from Hammond and 22 from Curtis Bay), 13 samples of French origin, and 10 samples of Indian origin.

The observation of the material confirmed that it does not contain free liquids; only small droplets of condensation were found on the sides of the packaging.

The samples were analyzed for total composition by using a combination of ICP-AES and ICP-MS and for radiological composition by both gamma and alpha spectrometry. The samples were also tested to determine whether the material was an oxidizer per the DOT definition. The data from the total analysis of the ThN material provided information on the purity of the material as well as the possibility of its being characteristically toxic per EPA definition. The ThN was found to be pure with a maximum impurities being less than 2500 mg/kg or 0.25 wt %. These results confirmed the historical data existing on the material.

The concentration of thorium was found to be between 42 and 51.8 wt % for the domestic origin, between 43.4 and 52.9 wt % for the French origin, and between 45 to 53.3 wt % for the Indian origin. Sodium was found to be the largest impurity found in the domestic material stored at Hammond with a maximum concentration of ~2500 mg/kg. The domestic material from Curtis Bay did not show such high levels of sodium; the maximum of at 156 mg/kg was found in only one sample. Barium was the second largest impurity found in three samples of the domestic material with a maximum of 647 mg/kg. Lead, thallium, manganese, sodium, and silicon were also measured in some samples at very low concentrations. The French ThN contained sodium and uranium in all the samples analyzed at maximum concentrations of 819 and 46 mg/kg, respectively. Chromium, lead, and nickel were found in some samples at concentration lower than 16 mg/kg. The Indian material contained aluminum at the maximum concentration of 467 mg/kg in nine of the ten samples analyzed. Other impurities detected in the total metals analyses were barium (max. 19.6 mg/kg), copper (max. 14 mg/kg), lead (max. 5 mg/kg), silicon (max. 120 mg/kg), and sodium (max. 119 mg/kg). Assuming that all that concentration of RCRA elements could be leached in a TCLP test, the results that would have been obtained in a TCLP test would be 20 times lower than the total concentration measured and presented in this report.

From these results, it was proven that the ThN material from all origins was not characteristically hazardous because of toxicity according to RCRA criteria.

The material was also analyzed for radiological content. Gamma spectrometry was used on all samples; alpha spectrometry was used on about a third of them. The results obtained by alpha spectrometry confirmed the ICP analyses for the thorium content of the samples. However, because uranium was undetected or was detected near the detection limit, the comparison between the two techniques is not as good for uranium content. The gamma spectra were too complex to interpret because of the large amount of interference caused by radioisotopes such as ^{228}Ac, which has a very large number of peaks. The radiological analyses indicated that the activities for ^{230}Th and ^{232}Th are above the action levels in the NTS WAC and that the activities for ^{231}Pa, ^{237}Np, and ^{226}Ra are close to their respective action levels. It should be noted however, that the laboratory estimated that ^{231}Pa and ^{237}Np activities were probably caused by interference from another radioelement (probably ^{228}Ac) and that the validation process characterized these data as “estimated.”

The samples were tested according to the UN document *Recommendations on the Transportation of Dangerous Goods—Manual of Tests and Criteria.* (UN 1999) to determine whether any met the criteria for being a DOT Division 5.1 oxidizer. None of the 53 samples tested was found to have a mean burn time less than that of the 3:7 reference mixture $KBrO_3$ to cellulose. Therefore, no sample is a Division 5.1 oxidizer as per the DOT definition.

The mechanism of gas formation that was found to have occurred in some domestic drums at Curtis Bay (MD-1 drums) is understood and was confirmed by the analytical data collected.

11. REFERENCES

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APPENDIX A

Continuing Qualification Audit Report of Southwest Research Institute Made by the Department of Energy's Environmental Management Consolidated Audit Program

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DEPARTMENT OF ENERGY
OFFICE OF ENVIRONMENTAL MANAGEMENT
NATIONAL ANALYTICAL MANAGEMENT PROGRAM
ENVIRONMENTAL MANAGEMENT CONSOLIDATED AUDIT PROGRAM

CONTINUING QUALIFICATION AUDIT
SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO, TEXAS

NOVEMBER 14-16, 2001

DRAFT AUDIT REPORT

Environmental Management Consolidated Audit Program
Continuing Qualification Audit
Southwest Research Institute
San Antonio, Texas

1.0 OBJECTIVE

The Department of Energy (DOE) Environmental Management Consolidated Audit Program (EMCAP) conducted a continuing qualification audit of the Southwest Research Institute located in San Antonio, Texas (hereafter referred to as SwRI) November 14-16, 2001. The specific audit objectives were to assess the ability of SwRI to produce data of acceptable and documented quality through analytical operations that follow approved and technically sound methods. EMCAP is also concerned with ensuring that commercial laboratories that handle DOE samples and analysis derived waste conduct these operations in a manner that is protective of human health and the environment.

2.0 SCOPE

The audit focused on all areas of the facility that could potentially be involved with DOE Environmental Management sample analysis, processing, and handling. Specific functional areas that were reviewed included: (1) quality assurance management systems and general laboratory practices, (2) data quality for organic analyses, (3) data quality for inorganic and wet chemistry analyses, and (4) hazardous and radioactive materials management. Detailed EMCAP Checklists were used to guide the auditors questions and lines of inquiry.

3.0 CONDUCT OF THE AUDIT

The audit was led by a EMCAP qualified lead auditor. The audit team consisted of representatives of DOE Operations and Field Offices. Their names, affiliations, and areas of review during the audit included:

Team Member	Organization	Functional Area
James Chambers	DOE Ohio Field Office, Fluor Fernald, Inc.	Team Lead, Data Quality for Inorganic and Wet Chemistry Analyses
Cheryl D. Prince	DOE, Nevada Operations Office, IT Corporation	Quality Assurance Management Systems and General Laboratory Practices
Howard Johnson	DOE Rocky Flats Field Office, Bechtel BWXT	Data Quality for Organic Analyses
Peggy Wilson	DOE Oak Ridge Operations Office	Hazardous and Radioactive Materials Management
Marie Meszaros	DOE Oak Ridge Operations Office, NFT Inc.	Hazardous and Radioactive Materials Management

A draft summary of the results was compiled during the audit and was presented at the audit out brief meeting conducted November 16, 2001.

Key SwRI personnel contacted during the audit included:

JoAnn Boyd	Radonna Spies	Chris Hobson	Jesse Rodriguez
Mike Dammon	Doritza Rosita	Jac Harding	Joseph Pan
Mike MacNaughton	Khaled Edris	Chee-Kai Tan	Joe Morin
Reza Karimi	John Hageman	Latrice Smith	Hamed Edrisi
Herbert Schattenberg	R. Chris Gourley	Kevin Villalobos	John Chapman
Jackie Ranger	Cynthia Sauceda	Lorraine Scheller	

4.0 RESULTS

4.1 Proficiencies

1. SwRI personnel interviewed were extremely knowledgeable and technically competent. The knowledge and technical ability of the technical leads and the lab staff was very high. Members of the staff made every effort to provide answers to each question and no effort was spared in retrieving documents necessary to address items of concern.

2. SwRI personnel in the wet chemistry and metals area should be commended for their performance in following requirements of the Lock/Tag-out procedure for equipment that does not meet the laboratory quality specifications.

3. The personnel in the organic section are highly skilled, knowledgeable, dedicated and exhibited enthusiasm and enjoyment in their work.

4. Throughout the organic section, personnel demonstrated awareness and detailed planning when difficult matrices or minimal sample quantities are encountered.

5. In the organic extraction laboratory, glassware is dedicated for different concentrations, effectively eliminating potential for cross contamination during sample extraction.

6. Proficiencies in this area include the intranet posting of controlled documents, which makes plans, procedures, and some key operating information available to all personnel throughout the lab while assuring that the latest document and information revision is available.

7. The spare parts inventory system provides an efficient tool for monitoring parts on hand both within each lab and across labs.

8. The centralized refrigerator temperature monitoring system that alarms and provides notification during off hours when a refrigerator exceeds control criteria.

4.2 Findings

SwRI has expertise in environmental monitoring demonstrated by years of performing years of chemical analysis on environmental samples. The laboratory are designed to analyze large numbers of samples quickly and efficiently using methodologies promulgated by the Environmental Protection Agency (EPA) [Contract Laboratory Program (CLP), SW-846, etc.]. The extraction laboratory has extensive experience in all types of methods and is equipped for extraction of organic compounds from all matrices. SwRI capabilities include gas chromatography, mass spectrometry, high-resolution mass spectrometry, high performance liquid chromatography, atomic emission, absorption spectroscopy, atomic emission mass spectrometry, ion chromatography, and spectrophotometry with a defined quality assurance program, analyses are performed to provide accurate, precise, and defensible data. The laboratories at SwRI are equipped with a large number of each instrument types to meet the requirements of fast turnaround request.

XXX Proficiencies were identified by the audit team. XXX findings from the previous audit were closed and XXX remain open. There are XXX new priority II findings and XX priority I findings. In addition, XXX observations were identified.

4.2.1 Quality Assurance Management Systems and General Laboratory Practices

Three (3) Proficiencies were identified by the audit team. 3 findings from the previous audit were closed and 1 remains open. There are 3 new priority II findings and no priority I findings. In addition, 3 observations were identified.

The laboratory has developed a Quality Assurance Plan that incorporates many of the elements of DOE Order 414.1A and SW-846. Where the QAP does not specifically address some criteria, other laboratory documents do specify the laboratory practices for the control of quality-affecting activities in the laboratory. Plans and procedures exist that direct the work performed, are accessible to all laboratory personnel, and are controlled in a manner sufficient to ensure that the latest versions are used to perform work. However, a large percentage of the Technical and Analytical Procedures are past due for the required annual review.

SRI holds a State of Utah Department of Health certification for Organic and Inorganic analyses, is certified to the ISO 9002 quality standard, and is in the process of obtaining NVLAP accreditation. The lab participates in DOE's MAPEP and EML Radiochemistry Intercomparison Studies. They also participate in EPA Drinking Water and Waste Water Performance Evaluation Programs and Radiochemistry Intercomparison Study, as well as other state and agency Performance Evaluation programs. Acceptable results were observed in most cases for these programs.

Roles and responsibilities of the laboratory personnel are defined in program documentation. Quality Assurance personnel are empowered to operate in an oversight role with sufficient independence from laboratory operations. Training records are maintained for each individual with proficiency evaluations required for analysts.

Physical and administrative controls are in place to provide adequate security of samples. An internal chain-of-custody procedure has been implemented to manage samples from their receipt at the lab through their disposal or return to the customer.

The lab maintains statistical control charts that are generated and maintained by each lab and which are reviewed periodically by QA personnel to assure that any negative trends are identified and corrective actions are initiated. Refrigerator temperatures are monitored by a centralized system that alarms when readings exceed established limits.

Both Division and Institute QA personnel perform independent assessments that are reported to Division and/or Institute management. The multiple levels of oversight provide for a broader evaluation from different perspectives within the organization.

A regular schedule of LIMS and instrument backups is maintained with copies stored at more than one location. The software used with the analytical instruments is purchased with the instrument and verified with the functional checks of the instruments.

4.2.1.1 New Quality Assurance Management Systems and General Laboratory Practices Findings

M1-011116-A: The annual reviews of Test/Analytical Procedures (TAPs) required are not being performed within the time frame required. (Priority II) (SOP-01-5.3, Preparation and Revision of Test/Analytical Procedures)

Discussion:

The procedure requires that "TAPs shall be reviewed on a minimum frequency of once per year to assess applicability, currentness, and adequacy of the document contents." Contrary to this requirement, a large percentage of the TAPs had not been reviewed within the annual time frame.

M1-011116-B: The majority of responses to Corrective Action Requests reviewed did not meet the requirements of the procedure. (Priority II) (SOP-01-14.1, Corrective Action)

Discussion:
SOP-01-014.1, Corrective Action, requires that specific information be provided in response to the issuance of a CAR. CARs reviewed had e-mail responses attached that did not contain the required information.

M1-011116-C: SwRI's SOPs do not adequately define a process for controlling the shelf life of reagents. Reagent, Standards and stock solution information shall be maintained or written directly on containers or on labels (Priority II) (GLP, ICPT BOA, Attachment B; Criterion 5)

Discussion:

SwRI SOP does not include the expiration date of reagents. Also, the SOP does not require that the expiration date of reagents be tracked. Currently, no expiration labels are located on reagents that include date received, date opened and the expiration dates; however, these labels are completed inconsistently. Each laboratory shall develop and implement a SOP specifying the policy for the shelf life, labeling, re-certification of reagents and stock solutions.

4.2.1.2 Status of Previous Quality Assurance Management Systems and General Laboratory Practices Findings

M1-000929-A: The laboratory QAP is not consistent with DOE Order 414.1A or the Basic Ordering Agreement (BOA). (Priority II) (ICPT BOA, Attachments B & C, Criterion 1) *(OPEN)*

Discussion:

The QAP has been revised (01-QAP-004-0400, Rev 1, Nov., 2001) but does not yet meet all criteria of 414.1A and does not define how the sections of the BOA will be implemented. While some of the missing criteria are addressed in Division SOPs, they are not referenced in the QAP that covers DOE work and, therefore, does not acknowledge those criteria as requirements for DOE work.

M1-000929-B: The corrective action procedure does not adequately address actions for failed PE samples. (Priority II) (ICPT BOA, Attachment B, Criterion 3) *(CLOSED)*

Discussion:
TAP-01-0407-025, Performance Evaluation Reporting and Archiving, Rev. 2, dated August, 2001, has been revised to include a requirement for a Corrective Action Request to be initiated by the Division QA Manager whenever any PE result is reported as "Unacceptable." The CAR is then required to be tracked to closure.

M1-000929-C: Required training and system updates are not current. (Priority II) (ICPT BOA, Attachment B, Criterion 2) *(CLOSED)*

Discussion:
An annual refresher class for Radiological Safety Training has been conducted on March 13 and 15, 2001, for applicable personnel. Training files reviewed indicated proficiency evaluations, where applicable, were current.

M1-000929-D: The laboratory does not maintain a current inventory of available spare parts. (Priority II) (ICPT BOA, Attachment B, Criterion 8) (*CLOSED*)

Discussion:

An intranet-based computer program has been developed and implemented for maintaining laboratory spare parts inventory lists. An inventory list of critical parts is maintained in the software program by each individual lab.

4.2.2 Data Quality for Organic Analyses

The audit team identified three (3) Proficiencies. There are No priority II findings and No priority I findings. In addition, Four (4) observations were identified.

The data quality review of the organics section of SRI included current procedures, on-line instrumentation, sample preparation and clean-up equipment where the laboratory maintains adequate capability to perform all of the organic analyses identified in the ICPT BOA. In addition to the ICPT BOA analyses for volatiles, semivolatiles, pesticides, PCBs and Dioxins/Furans, SRI performs analyses for herbicides, explosives, gases, and a large selection of ASTM methods. SRI has capabilities to perform more EPA methods than those listed in the ICPT BOA and performs many specialized organic analyses beyond the scoop of this report. The reader is encouraged to contact SRI for capability for specialized or non-routine organic analytical needs. A complete equipment list is also beyond the scoop of this report; however a partial list of current equipment will demonstrate some of SRIs organic analytical capacity. SRI has 5 volatile GC/MSs, 2 GC/FIDs, 1 GC/PID and 1 GC/PDHID for volatiles, 6 semivolatile GC/MSs, 18 GCs, 2 HPLCs, 3 HR GC/MSs, over 300 Soxhlet extractors, 135 to 150 separatory funnels in various sizes from 250 mls to 2 L, 4 sonicators, 3 Waters HPLC/GPCs, 6 TCLP ZHE extractors over 300 Summa® canisters and a mobile laboratory that can be equipped to meet specialized requests.

The organic group is very qualified, experienced and dedicated. 22 trained technicians, scientists, researchers, group leaders and managers including 4 M.S. and 3 Ph.D. chemists comprise the group that performs the work assessed during this audit.

The SRI organic section participates in the MAPEP, WP and WS performance evaluation programs. For MAPEP-01-S8, SRI had 94% participation and 100% acceptable performance; WP75, 89% participation and 98% acceptable performance and WS57, 94% participation and 86% acceptable performance.

The assessment of the SRI organics section included reviewing the analytical procedures to the actual analytical practices in the laboratory. Analytical procedures were compared to the referenced EPA procedures, primarily those found in SW-846. Specific areas of review included sample tracking, preparation, clean-up, storage and analyses; acceptability of reagents and standards; use of laboratory control samples; record keeping; instrument troubleshooting, maintenance, calibration and operation; along with data calculation, review and reporting.

The organic section of SRI was found to meet the requirements of DOE EM and the ICPT BOA.

4.2.2.1 Status of Previous Data Quality for Organic Analyses Findings

None

4.2.2.2 New Data Quality for Organic Analyses Findings

None

4.2.3 Data Quality for Inorganic and Wet Chemistry Analyses

There were 7 of 8 previous findings closed, 1 remains open, and 2 new priority II findings were identified. There were none observations noted.

Data Quality - Inorganics

The data quality review of SwRI inorganic capabilities included assessments of methods for metals analysis and wet chemistry. For the most part, no significant issues were noted with respect to conformance to EPA method requirements or DOE contractual requirements. However, some minor deviations to EPA accepted practices and SwRI internal procedures were noted. A summary of the assessments in each of these areas follows:

Metals Analysis

The inorganic sections of SwRI were evaluated during the course of the audit and were found to generally meet the requirements of the ICPT BOA except as noted in the findings and observations of this report. It should be noted that SWRI has implemented the requirements of the ICPT BOA. SwRI has the necessary instrumentation and equipment to perform the required analytes listed in the BOA. The SwRI staff has many years of experience performing SW-846 and CLP methodologies. SwRI maintains certification in ISO-9002, Utah certification, USDA, SCDH. SwRI participates in DOE/ MAPEP, EML, WP and WS intralaboratory performance evaluation programs. SwRI mixed Analyte Performance Evaluation Program results for Inorganic were acceptable.

For each method, the laboratory standard operating procedure were reviewed and compared to the actual analytical practices that are being employed to identify any discrepancies. The actual practices were also compared to EPA standard methods and DOE contractual requirements to identify any areas of nonconformance and areas for improvement. Specific analytical testing practices that were reviewed included sample handling and sample preparation, establishment of method detection limits and reporting limits, instrument calibration, adequacy of analytical equipment, adequacy of reagents and standards, run sequences, use of quality control samples, quality control data evaluation practices, and data calculations and reduction.

SwRI weekly capabilities for ICP metals are ~400, ICP/MS ~200, and Mercury ~400 samples. SwRIs analytical instrumentation include Two Thermo-Jarrell Ash ICP-Trace analyzers, 1 spectro ICP, one Perkin Elmer ICP-MS, One Perkin Elmer Trace Mercury Analyzer (Fims 400). and capabilities to perform TOX, TOC, pH, and additional wet chemistry analyses.

General Chemistry

The general chemistry section assessment included reviews of SwRI laboratory procedures for oil and grease, total petroleum hydrocarbons, total organic carbon, total organic halides, extractable organic halides, flashpoint, specific gravity, turbidity, cyanides, anions by ion chromatography, and chemical oxygen demand. For each method, the laboratory standard operating procedure was reviewed and compared to the actual analytical practices that are being employed to identify any discrepancies. The actual practices were also compared to EPA standard methods and DOE contractual requirements to identify any areas of nonconformance and areas for improvement. Specific analytical testing practices that were reviewed included sample handling and sample preparation, establishment of method detection limits and reporting limits, instrument calibration, adequacy of analytical equipment, adequacy of reagents and standards, run sequences, use of quality control samples, quality control data evaluation practices, and data calculations and reduction. The quality assurance protocols for data review and record-keeping were also reviewed.

The review of SwRI quality assurance protocols for log-keeping and data review indicated no major issues. Most logsheets reviewed contained adequate detail to determine what instruments, standards, and reagents were used and how the specific analytical process was performed. Adequate information is present to reconstruct the quality of the analytical work. In the area of data review, it was noted that the analyst reviews and initials the analytical raw data and that an independent analyst also reviews and initials the data. A SOP exists for that defines what is to be included in the data review process.

4.2.3.1 Status of Previous Data Quality for Inorganic and Wet Chemistry Analyses Findings

M3-000929-A: The temperatures of the metals Block and/or Digestion Plates are not being monitored and recorded. (Priority II) (SW-846, Chapter One, Section 4) ***(CLOSED)***

Discussion:

The requirements to monitor hot plate temperatures were verified and are included in the lab procedures. The lab General chemistry section has logbooks and procedure that includes or documents the monitoring of temperatures for analytical digestion of samples as indicated in TAP-01-0406-113, [FRM-191].

M3-000929-B: The Inorganic section/General chemistry section logbooks in the Inorganic section are not maintained, reviewed and/or well documented. (Priority II) (SW-846, Chapter One) ***(CLOSED)***

Discussion:

The Supervisory logbook review requirements, as identified in SOP-01-5.6, Section 6.9 has been verified.

The requirements identified in SOP-01-5.6, Section 6.12.1, data printouts or attachments of paper are have been verified as signed, dated and secured in the laboratory notebooks.

M3-000929-C: The TCLP Procedure, documentation on log sheets, and execution of the TCLP procedure does not meet requirements. (Priority II) (SW-846, Method 1311; SW-846, Chapter 1, Section 4) (*CLOSED*)

Discussion:

SwRI TAP-01-0406-108 has been revised to reflect compliance with Method 1311 in the following general areas:

1. For volatile extractions, documentation was recorded for the following:
   (a) whether particle size reduction is required and how reduction was performed if required
   (b) final filtration date and time
   (c) tumbler rotation rate
   (d) extraction vessel (ZHE) number
   (e) frequency of extraction vessel blanks
   (f) the ambient temperature
2. For non-volatile extractions, comments are made to describe the methods of particle size reduction, when required.
3. Metals spikes are added before preservation of extracts with nitric acid per section 8.2.1 of SW-846.
4. The technician for non-volatile extractions does record pH calibration information (e.g., Std. pH values and lot numbers) and does have an applicable SOP with acceptance criteria for a pH meter calibration Verification Standard that is within ± 0.05 pH units of the true value of the verification standard. The pH procedure, 01-0406-055 does not have acceptability limits.
5. The TCLP inorganic logbooks have been revised to include required documentation headers that are being hand written repetitively for each batch.
6. The TCLP procedure, TAP-0406-027 has been made inactive and TAP-01-0406-108 has been revised to include forms FRM-241 and FRM-239.

M3-000929-D: Reagent information shall be maintained or written directly on the container or on labels. (Priority II) (SRI TAP 0406-007, Section 5.2; ICPT BOA, Attachment B, Criterion 3) (*CLOSED*)

Discussion:

All reagents in the general chemistry/inorganic sections were verified to contain the information outlined in SwRI TAP-0406-007section 5.2.

1. Reagent name/concentration/lot #, if applicable
2. Date/time prepared
3. Expiration date
4. Name of preparer
5. Preparation log book number and page number
6. Hazard warnings

M3-000929-E: This number is not assigned to a finding in the previous report.

M3-000929-F: The inorganic metal section does not adequately document and/or maintain instrument maintenance logbooks. (Priority II) (SRI SOP-01-11.1, Section 4.5) *(CLOSED)*

Discussion:

M&TE maintenance logs were verified that entries include date and time the equipment was returned to service. The laboratory maintains and documents instrument system changes or installation of system replacement parts, as identified in Quality system procedure SOP-01-11.1.

M3-000929-G: The general chemistry/inorganic sections failed to implement procedures for spreadsheet verification and development and/or version control. (Priority II) (Good Automated Laboratory Practices (GALP), ICPT BOA, Attachments B & C, Special QA Requirements, Section A-2, Software Control; SRI SOP RM-0012) (*OPEN*)

Discussion:

Verification of computer generated spreadsheets programs are not being performed. The general chemistry/inorganic sections maintains ~50 to 100 sample result calculation spreadsheets. SRI procedure and SOP-01-5.5 and/or TAP-01-0406-019 fail to address the use and/or verification of spreadsheets for result calculation. SOP-01-5.5 requires revision to section 6.6.6 "Where are referenced ...".

M3-000929-H: Some inorganic section SOPs do not provide specific direction for documenting the work process. (Priority II) (ICPT BOA, Attachments B & C, Section 5, Work Process; SRI SOP RM-0012) (*CLOSED*)

Discussion:

TAP 01-0407-027 was verified to link Form 112 to the procedure and provide instruction for completing the TCLP Logbooks and the TCLP Bottle Log for Daily Balance checks. Procedure TAP 01-0406-082 and TAP-0406-027 have been made inactive.

M3-000929-I: The general chemistry/inorganic sections do not identify nonconforming instruments. (Priority II) (SRI SOP-01-11.1; ICPT BOA, Attachment B, Criterion 8; 29CFR 1910) (*CLOSED*)

Discussion:

Verification was performed that the laboratory has conformed to the process of labeling nonconforming equipment to identify limitation of usage

4.2.3.2 New Data Quality for Inorganic and Wet Chemistry Analyses Findings

Inorganic

M3-011116-A: Method Detection Limit (MDL) studies are not current for the ~~organic~~ methods. (Priority II) (ICPT Analytical Agreement, BOA Attachment 1, Section 3.1.5.5.3)

Discussion:

The ICPT Analytical Agreement requires that MDL studies must be updated on an annual basis. The laboratory is in the process of preparing and analyzing the individual aliquots for each methodology. The MDLs must be completed and updated on an annual basis.

M3-011116-B: Inorganic section balances procedure fails to address daily checks which bracket the range of use. (PriorityII) ICPT/RM-0012 section 5, Work process.

Discussion:

The check weight used to verify the calibration of the balance in the inorganic laboratory does not bracket the actual weight being used on the balance. The lower end-check weight is 2.0 grams; however, the balance is being used to verify the sample prep volumes of 50.00 grams. SOP 01.11.1 requires revision it fails to address daily checks, TAP-01-0407-028 fails to address bracketing the range of use.

4.2.4 Data Quality for Radiochemistry

No additional assessment of the radiochemical section was performed as part of this assessment. The past status of corrective actions has not been assessed for closure.

4.2.4.1 Status of Previous Data Quality for Radiochemistry Analyses Findings

M4-000929-A: SRI radiochemistry capabilities are not sufficiently matured to meet ICPT requirements. (Priority I) (ICPT BOA, Attachment J, Radiochemistry Requirements) ***(OPEN)***

Discussion:

A review the radiochemistry area indicated several major deficiencies in operations and documentation. Most of the areas of concern can be corrected through better documentation of the processes that are already in place. The following concerns must be adequately addressed and audited prior to SRI gaining approval to accept DOE work for radiochemical analysis:

1. SRI staffing is not adequate to provide full range of radioanalytical services. The primary concern is that one person is being asked to perform all of the necessary functions required to operate a radiochemistry laboratory. One person cannot adequately run analytical procedures, count samples, review data, generate the requisite QC for quality data in addition to being the laboratory Radiation Safety Officer.
2. There is insufficient laboratory space to meet the full range of radioanalytical requirements.
3. The SOPs for the radiochemistry sections do not reflect the current practices of the laboratory and should be updated on a routine basis. This is critical for the counting room activities.
4. A root cause analysis has not been completed for all unacceptable performance evaluation studies. Assistance should be provided by the QA organization to monitor and track the corrective actions.
5. Counting room instrumentation is not current. In particular, the software for the low background alpha/beta counter is no longer supported by the vendor. In addition, the changer design for this instrument is notoriously unreliable.
6. There are no network connections for counting instrumentation. Networking these systems would facilitate information flow into SRI's LIMS.

4.2.4.2 New Data Quality for Radiochemistry Analyses Findings

No review performed

4.2.5 Laboratory Information Management System (LIMS)/Electronic Data Deliverables (EDD)

There were 2 of 3 previous findings closed, 2 remain open, and no new priority II findings were

identified. There were no observations noted.

4.2.5.1 Status of Previous LIMS/EDD Findings

M5-000929-A: No SOP exists for how LIMS raw data are to be entered, processed, maintained or reported. (Priority II) (EPA 2185, 8.4.1) *(OPEN)*

Discussion:

Currently, raw data is processed by each individual laboratory section. Each section and/or sub-section has a unique program or programs to process the forms. "Help screens" are available in some instances but not all.

There is no upper tier procedure to guide people through the process of preparing the forms prior to moving them over for producing the EDDs. A SOP needs to be developed that describes the processes that import or insert data, what changes or modifications are allowed and not allowed, who verifies the final product, etc.

M5-000929-B: No SOP exists for creating electronic data deliverables (EDDs). (Priority II) (EPA 2185, 8.111.2) (*OPEN*)

Discussion:

Currently, there still is no procedure exists for creating EDDs. EDDs are manually produced from all the different sections. The process needs to be formalized in a procedure.

In addition, the EDDs that are produced do not have a formal validation/verification review done by someone other than the person who did the EDD. A process needs to be implemented that mandates review of the entries by someone other than the originator.

M5-000929-C: There is no formal process in place for acceptance of changed software. (Priority II) (EPA 2185, 8.5.1.3) (*CLOSED*)

Discussion:

Procedure SOP-01-9.3 verifies closure for acceptance of changed software. While his procedure exists for software modification, the formal process noted for who or how the changes are accepted. A formal process may needs to be implemented along with a procedural update that defines the acceptance process at SRI.

4.2.5.2 New LIMS/EDD Findings

None

4.2.6 Hazardous and Radioactive Materials Management

There were two of three previous findings closed, 1 remain open, and 6 new priority II findings were identified. There were three observations noted.

SRI, the Institute, has documents at the Institute, Division01, and Department level governing the areas of radiological material control, chemical hygiene, and waste management. Interviews were held with applicable individuals from both the Department, laboratory, for continuing EMCAP certification and higher officers for the division and institute as needed. For some expertise, the Department is reliant on the "umbrella" services of the Division or Institute.

SRI has the radiological material license and resources to handle almost any type of sample from a DOE site including samples with transuranic radionuclides and tritium as well as uranium and technetium-99. The license is for the Institute complex as a whole so the environmental laboratory Radiation Safety Officer should be consulted for whether a sample of high activity or unusual isotopes is acceptable for the audited SRI facility buildings. Chemical hygiene practices are in place for handling biological, radioactive and chemically hazardous materials. As with any laboratory, hazards will be best managed though with prior communication from the site to the laboratory of potential hazards of concern. SRI, by policy, prefers to return samples to the client. The Institute has adequate resources to perform disposal of radiological, mixed, and TSCAI materials; however, at the time of the audit, processes to adequately manage all waste materials were not fully implemented.

4.2.6.1 Status of Previous Hazardous and Radioactive Materials Management Findings

M6-000929-A: SRI practices for disposal of spent chemical containers, unused chemicals, glass, and sample containers are unacceptable. (Priority II) (SRI SOP TAP-01-0407-005; TAP-01-0407-008, Chemical Hygiene Plan, 01-CHP-008, Revision 1; Safety Policy and Procedures Manual)*(CLOSED)*

Discussion:

During walk-downs of SRI waste operations during the September, 2000 audit, several items were noted in, around or under the sanitary trash dumpster which violates both SRI and regulatory requirements. During the course of this 2001 audit, modifications to the procedures were reviewed. These modifications clarify the instructions for empty container disposal and defacing of labels. The area around the dumpster was walked-down. No improperly disposed items were found. Corrective actions were found to be implemented and sufficient to close this finding.

M6-000929-B: SRI compliance with work clothing and Personal Protective Equipment (PPE) requirements is inadequate. (Priority II) (SRI CHP, 01-CHP-008, Revision 1) *(OPEN)*

Discussion:

In the September, 2000 audit or SRI, it was found that work clothing and Personal Protective Equipment (PPE) requirements were not being followed by SRI personnel. The following examples were noted in that prior audit report:

1. Several violations of employees not wearing laboratory coats and safety glasses when required in violation of Section 8.3.3 of 01-CHP-008, Revision 1.
2. An employee was observed working in a laboratory area wearing a lab coat and safety glasses while also wearing heels (>1 inch) and a dress.
3. Several violations of employees wearing laboratory coats and safety glasses in common areas in violation of Section 8.3.3 of 01-CHP-008, Revision 1.

During the course of this audit it was found that the CHP had been modified to remove all specific clothing restrictions and only make a general statement that clothing should be appropriate for the work. It also stated that use of safety glasses and lab coats were needed for laboratory work. Compliance appears to be inconsistently applied, possibly due to the vagueness of the requirements. Inconsistencies were found in implementation, i.e., a visitor must only wear safety glasses while moving chemical bottles in a cabinet, but laboratory would wear safety glasses and a lab coat. There were also inconsistencies in the use of signage, i.e., some laboratories post safety glasses required, but other laboratories that also require safety glasses for entry are not posted. SRI should implement and enforce effective work clothing/PPE requirements that are consistent throughout the SRI analytical laboratory. Mandatory items should be safety glasses and lab coats while working in the laboratory areas. This finding remains open.

M6-000929-C: An eyewash station is not present in the glassware washing room. (Priority II) (29 CFR 1910.151(c)) (*CLOSED*)

Discussion:

The glassware cleaning room was found to not be equipped with a safety eyewash station during the September, 2000 EMCAP audit. Upon learning of this concern, SRI ordered an eyewash for this location and removed an out of service kiln from that area.

It was verified that this eyewash was in place. This finding is closed.

4.2.6.2 New Hazardous and Radioactive Materials Management Findings

M6-01116-A: Airborne releases of radioactivity to the environment are not quantitatively documented that releases are evaluated and controlled. (Priority II) (References [10 CFR 20, 1301 (a) (1), 1501 (a) and 101, EPA NESHAPS])

Discussion:

Documentation is not available to show that airborne releases are being controlled. Calculations can be performed to satisfy this requirement. It was noted that SwRI does not normally perform calculations for DOE samples.

M6-011116-B: For RCRA wastes, ... containers are not marked with the words "HAZARDOUS WASTE" identifying contents. (Priority II) (Reference TAP-01-0407-005, Rev1, dated 4/00)

Discussion:

In the Hazardous Waste and Product Holding Area, seven drums were noted as having missing or faded Hazardous Waste labels. The labels had originally been on the containers but due to weathering conditions and time spent in storage the labels were not legible. This was corrected during the audit with hazardous labels applied to each of the containers. The identification numbers that were on top of the containers and written with paint markers were still legible but any information on paper that had been in plastic was not legible. The paper identification placed on the container needs to be placed in a more secure manner.

M6-011116-C: The following deficiencies were noted in the secured Spent Chemical Collection Area: (Priority II) (References TAP-01-0407-005. Revision 1 dated 4/00).

(a) Stall number 4 – A 55 gallon drum marked "May Contain PCB's" did not have a PCB label.
(b) Stall number 6 – Second drum from the end has a noticeably bulging top. ID is not secured and label is faded. This was corrected during this audit.
(c) Stall number 7 - A cardboard box approximately 30 inches high containing glass was observed sitting on the concrete pad with 3-4 inches high water marks and rain dampened crumpled edges. This was removed and corrected during the audit.
(d) Drum on top of a drum showing no ID. Further investigation revealed sheet of paper on top stating "Not-in –Use". However, this could not be read from ground level.
(e) One gallon dark glass jug was sitting on the concrete pad. It was labeled Spent Organic non-halogenated but was not in a container.
(f) Stall number 10 - Environmental Lab container identified as trace Metals/Acid label is faded and needs to be replaced.

M6-01116-D: The laboratory does not have a quantitative definition of a "radioactive sample". (Priority II) (References)

Discussion:

During interview with sample log-in personnel, it was noted that samples were appropriately screened/surveyed for projects and clients where radioactive samples might be suspected. However, the sample log-in procedure does not contain a definition of when a sample is considered radioactive. The definition of "radioactive sample" could not be located in any of the

SRI documents reviewed.

M6-01116-E: The laboratory has waste over 180 days stored in the accumulation area. (Priority II) (40 CFR 262.34(d),(e)) QC action

Discussion:
At the time of the audit, November 14-16, 2001, seven containers of waste were present in the accumulation area. For a Small Quantity Generator such as SRI, waste containers must be moved within 180 days. Of the seven containers, five (SNSC-002, 003 CAQ01) had start dates of 4/18/01 and one was as old as August of 2000.

M6-01116-F: Drums in the accumulation area must be labeled with accumulation start dates. (Priority I) (40 CFR 262.34 (a)(3)) QC action on containers

Discussion: No dates were present on any of the seven drums present in the accumulation area at the time of the audit. SRI procedures do not require this date to be placed on the container; however, an accumulation start date is a regulatory requirement.

4.3 Observations

4.3.1 Quality Assurance Management Systems and General Laboratory Practices

O1-011116-A: The current QAP does not address the procurement criterion of DOE Order 414.1A even though the quality system incorporates this requirement. The QAP should include the requirements, or reference the ISO SOPs that detail the requirements, of the procurement program.

O1-011116-B: The QAP does not clearly address the management and independent assessment criteria of DOE Order 414.1A although these types of assessments are mentioned in various locations in the plan.

O1-011116-C: Corrective Action Request responses #s 085, 086, and 087 for unacceptable PE results were verified and closed prior to the review by the Quality Council. While SOP-01-14.1, *Corrective Action,* does not require that the council review the proposed corrective action prior to closure, it is implied and would prevent reopening the CAR if the Quality Council had comment or required further action.

4.3.2 Data Quality for Organic Analyses

O2-011116-A: Quality control charts are produced manually in the laboratory. The laboratory could realize efficiencies if the charts could be produced through SRIs LIMS.

O2-011116-B: The Lot number and supplier of the EPA-8290STOCK standard were not recorded in the logbook BNA/DIOXIN volume Dioxin Std Prep, page 22. The Lot #, EP909704ST and the supplier, Wellington Labs were verified and the correction was made in the logbook.

O2-011116-C: A resent decontamination activity of volatile instrument TRIO-1L was not documented. This appeared to be an isolated case as previous decontamination activities were noted in other instrument maintenance and run logbooks.

O2-011116-D: For semivolatiles, samples are screened and extraction levels determined following CLP guidelines when client supplied information or the condition of an extract (viscous, dark) indicates an extraction level should be determined. If high concentrations of volatiles are suspected or client information dictates, dilutions are initially run, in part, as a screening process, however the practice could lead to occasional instrument contamination. To minimize instrument contamination and downtime of volatile instruments the laboratory should document a procedure and employ sample screening on a more regular basis.

SRI responded to a previous observation (Audit 000929-SRI, organic observation 1) where documentation was not maintained for the tuning of the sonication equipment. A notebook is provided for documenting the tuning of the sonication equipment. The logbook and tuning entries were verified in Lab 23 Sonicator Tuning Logbook I, logbook number 01-0402-001. In response to organic observation 4 of the 000929-SRI audit it was verified that the laboratory is implementing the analysis of refrigerator storage blanks every 14 days and is documented in the logbooks for refrigerators #7 and #45. The effective implementation date was 9/22/00 as observed in logbook 99-0404-008 for refrigerator #7.

4.3.3 Data Quality for Inorganic and Wet Chemistry Analyses

NONE

4.3.4 Data Quality for Radiochemistry Analyses

NONE

4.3.5 Laboratory Information Management Systems/Electronic Data Deliverables

NONE

4.3.6 Hazardous and Radioactive Materials Management

O6-011116-A: Although proper operation and function of emergency eye washes and safety showers are checked monthly by the Division 01 Safety Representative, the safety shower located at the High Radiation Sample Receipt Bay has not been inspected since 1997.

O6-011116-B: Per 10 CFR 20.1101, the radiation protection program (RPP) content and

implementation must be reviewed annually. The most recent revision of SRI's RPP was issued in 1996 and has been reviewed annually as required although the lab's radiological materials license has changed during this time. The process of annual review should be considered to determine if it is sufficient to detect potential changes in the RPP.

O6-011116-C: Labs with potential to have radioactive material areas set up are continuously posted as radiological areas even when there are no radioactive material handling activities occurring.

APPENDIX B

Analytical Data from Southwest Research Institute

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SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATELLE, LLC
SDG: 208093
SwRI Project Number: 05421.01.006
SwRI Work Order No.: 22680
VTSR: June 13, 2002

NARRATIVE

Client: Battelle Memorial Institute
Project No.: 05421.01.006
SwRI Work Order: 22680
Page: 1

SwRI CASE NARRATIVE

1. Eight (8) monolith samples were received for Metals, Wetchem, and Radchem analysis:

SwRI ID	Customer ID
208093	HD08070612002
208094	HD10100612002
208095	HD23070612002
208096	HD29070612002
208097	HD30070612002
208098	HD38100612002
208099	HD47100612002
208100	HD48100612002

2. Samples were received on June 13, 2002 for a forty-five (45) day turnaround from Validated Time of Sample Receipt (VTSR).

3. Electronic version to follow.

3. Quality Control Identification:

HD0807061 S/D	Metals analysis
HD080761-2002 Dup	Radchem (Alpha Spec)
LCS-H22T1	Radchem (Alpha Spec)
HD0807061-2002 Dup	Radchem (Gamma Spec)

METALS ANALYSIS

The samples were prepared and analyzed for mercury by SW846 Method 7471A. The samples were diluted in 4% nitric acid for the remaining metals. The samples were analyzed for Al, As, Cu, Pb, Mg, Se, Ag and U by ICP-MS SW846 Method 6020 and the remaining metals by ICP SW846 Method 6010B. The samples are reported on a dry weight basis. The holding times were met for all samples.

No analytes were detected in the preparation blanks above the laboratory's reporting limits. Two laboratory control samples are reported with the samples. When the samples were initially diluted, all analytes were spiked at the laboratory's normal spiking levels in the first laboratory control sample (or blank spike). The recoveries for this QC sample were within 80-120% for all analytes. The other laboratory control sample(s) were spiked at the instrument at the time of analysis for the ICP and ICP-MS analytes. The elements were spiked at their respective reporting limits into a thorium standard at the same concentration than that in the samples. The recoveries obtained for this QC sample ranged from 81.5% to 144.3%.

System id 208093 was QC'd. A second aliquot of the original sample is reported as the duplicate. A third aliquot was spiked with the analytes of interest and reported as the matrix spike. The results are "N" flagged for Fe and V due to the matrix spike recoveries being outside of the limits of 75-125%. A post-digestion (or analytical) spike was reported for the spike outliers, Fe and V. A portion of the diluted QC sample (at df1000) was spiked and reported for thorium as a post-digestion spike sample.

The QC criteria were met for the duplicate analyses. A control limit of 20% for the RPD would have been used for sample values greater than or equal to 5 times the laboratory's reporting limit. The QC criteria for the serial dilution analyses were met. If an analyte concentration is high (at least 50 times the lab reporting limit), a five fold dilution (or serial dilution) must agree within 10% of the original determination after correction for dilution.

Due to the elevated thorium concentration in the samples, a number of elements had to be manually calculated to correct for the thorium interferences. The elements affected were cadmium, chromium, manganese, zirconium, calcium, iron and vanadium.

WETCHEM ANALYSIS

Oxidizer Test

Equipment and Material Specifications

Potassium Bromate – Alfa Azar, ACS, 99.8% minimum assay (P/N 40013). Only the KBrO4 that passed a No. 50 sieve but was retained on a No.100 sieve was used for the oxidizer test. This 0.15 – 0.3 mm fraction of KBrO4 was then dried in an oven at 65°C overnight.

Cellulose – Whatman CF-11, fibrous cellulose powder (P/N 4021500). According to the manufacturer, the fiber length is between 50 -250 um with a mean of 200 um; and the average diameter thickness is 20-25 um. The cellulose was dried at 105°C in an oven overnight, also.

Wire – Fisherbrand, 80% nickel / 20% chromium, 24 gauge, with a diameter of 0.51 mm and a resistance of 5.28 ohm/m (P/N 15-540-2D).

Low Heat Conducting Plate - ZIRCAR Alumina Insulations, ZAL-45 (P/N A10509). An "All-Alumina" board having high strength, uniform, rigid, refractory structures composed of alumina fibers and high purity inorganic binders. The product has optimum fiber density of 45 lbs/ft^3 (0.72 gm/cc), fine open pore structure and excellent thermal insulating property. It has superior hot strength and dimensional stability to 1650°C (3000°F) and withstands intermittent use to 1700°C (3192°F). With an increase in temperature, the ZAL-45's thermal conductivity increases; giving a range of 0.16 - 0.43 W/m°K from 250 – 1650°C, respectively.

Fume Cupboard - Atlas Fire Science Products (VFC) Vertical Flame Chamber (14' x 14' x 31') was placed inside a radioisotope fume hood. All burns were performed inside the VFC. The top of the chamber was slightly ajar to allow the smoke to escape, therefore not hindering the view during the burn.

Since the samples are compared to the results of the average burn times of the reference materials tested over the course of the project, the average burn times reported will change slightly as we finish up the last of the tests this week. A revised report will follow.

RADCHEM ANALYSIS (ALPHA SPEC)

The solids were weighed and digested using HNO3 and HCl for ICP, ICP-MS and Radchem. Portions of the digestion were used for column separations of the actinides. After separation the liquids were filtered and the filter was mounted on a steel planchet, which was analyzed by alpha spectroscopy. The soils are reported on an as received basis.

A preparation blank was analyzed for uranium and thorium and found to contain levels above the MDA but less than RMAs for uranium and thorium. All analytes in the laboratory control samples were within the laboratory acceptance limits, of 70-130%. All QC and client sample tracer recoveries were within acceptance limits, of 50-135%.

The sample raw data tabulates and subtracts the weekly chamber background for the chamber the sample was analyzed in.

RADCHEM ANALYSIS (GAMMA SPEC)

All samples were run for gamma emmiting isotopes. Sample results are reported on an "as received" basis. Please note that Actinium-228 has a great abundance of lines and that several of the identified nuclides are either miss identified or miss quantitated due to interferences with this and other isotopes found at high levels. Suspect isotopes are flagged with an "I" qualifier to indicate that they should be treated as either being not present or reported at much higher levels than are actually found in the sample. These would have normally been removed prior to reporting, but they have been included to allow others to make the judgment as to whether they are present or not.

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"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Director or his designee, as verified by the following signature. This report shall not be reproduced except in full, without the written approval of SwRI."

9/11/02

Jo Ann Boyd **Date**
Manager
Quality Assurance Unit Division 01

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
SDG: 208093
SwRI Project Number: 05421.01.006
SwRI Work Order No.: 22680, 22835
VTSR: July 17, 2002

NARRATIVE

Client: Battelle Memorial Institute
Project No.: 05421.01.006
SwRI Work Order: 22680, 22835
Page: 1

SwRI CASE NARRATIVE

1. The following samples were received for Metals, Wetchem, and Radchem analysis:

SwRI ID	Customer ID	Matrix	Required Analysis
208093	HD08070612002	MONOLITH	Oxidizer
208094	HD10100612002	MONOLITH	Oxidizer
208095	HD23070612002	MONOLITH	Oxidizer
208096	HD29070612002	MONOLITH	Oxidizer
208097	HD30070612002	MONOLITH	Oxidizer
208098	HD38100612002	MONOLITH	Oxidizer
208099	HD47100612002	MONOLITH	Oxidizer
208100	HD48100612002	MONOLITH	Oxidizer
209420	CD02120712002	MONOLITH	Oxidizer, Metals, Radchem
209421	CD03110712002	MONOLITH	Oxidizer, Metals, Radchem
209422	CD11110712002	MONOLITH	Oxidizer, Metals, Radchem
209423	CD12120712002	MONOLITH	Oxidizer, Metals, Radchem
209424	CD14120712002	MONOLITH	Oxidizer, Metals, Radchem
209425	CD15110712002	MONOLITH	Oxidizer, Metals, Radchem
209426	CD7100712002	MONOLITH	Oxidizer, Metals, Radchem
209427	CD18090712002	MONOLITH	Oxidizer, Metals, Radchem
209428	CD20100712002	MONOLITH	Oxidizer, Metals, Radchem
209429	CD22100712002	MONOLITH	Oxidizer, Metals, Radchem
209430	CD28010712002	MONOLITH	Oxidizer, Metals, Radchem
209431	CD29040712002	MONOLITH	Oxidizer, Metals, Radchem
209432	CD30280612002	MONOLITH	Oxidizer, Metals, Radchem
209433	CD36010712002	MONOLITH	Oxidizer, Metals, Radchem
209434	CD44120712002	MONOLITH	Oxidizer, Metals, Radchem
209435	CD45270612002	MONOLITH	Oxidizer, Metals, Radchem
209436	CD48270612002	MONOLITH	Oxidizer, Metals, Radchem
209437	CD52100712002	MONOLITH	Oxidizer, Metals, Radchem
209438	CD37100712002	MONOLITH	Oxidizer, Metals, Radchem
209439	CD61090712002	MONOLITH	Oxidizer, Metals, Radchem
209440	CD65090712002	MONOLITH	Oxidizer, Metals, Radchem
209442	CF1080712002	POWDER	Oxidizer, Metals, Radchem
209443	CF11020712002	POWDER	Oxidizer, Metals, Radchem
209444	CF13080712002	POWDER	Oxidizer, Metals, Radchem
209445	CF14030712002	POWDER	Oxidizer, Metals, Radchem
209446	CF16080712002	POWDER	Oxidizer, Metals, Radchem
209447	CF17080712002	POWDER	Oxidizer, Metals, Radchem

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Project No.: 05421.01.006
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SwRI ID	Customer ID	Matrix	Required Analysis
209448	CF19080712002	POWDER	Oxidizer, Metals, Radchem
209449	CF2080712002	POWDER	Oxidizer, Metals, Radchem
209450	CF3080712002	POWDER	Oxidizer, Metals, Radchem
209451	CF10020712002	POWDER	Oxidizer, Metals, Radchem
209452	CF4080712002	POWDER	Oxidizer, Metals, Radchem
209453	CF6080712002	POWDER	Oxidizer, Metals, Radchem
209454	CF9080712002	POWDER	Oxidizer, Metals, Radchem
209455	CI11020712002	CUBES	Oxidizer, Metals, Radchem
209456	CI12020712002	CUBES	Oxidizer, Metals, Radchem
209457	CI13020712002	CUBES	Oxidizer, Metals, Radchem
209458	CI4030712002	CUBES	Oxidizer, Metals, Radchem
209459	CI5030712002	CUBES	Oxidizer, Metals, Radchem
209460	CI6030712002	CUBES	Oxidizer, Metals, Radchem
209461	CI7030712002	CUBES	Oxidizer, Metals, Radchem
209462	CI9030712002	CUBES	Oxidizer, Metals, Radchem
209463	CI3070712002	CUBES	Oxidizer, Metals, Radchem
210181	CD58120712002	MONOLITH	Oxidizer, Metals, Radchem
210182	CI14020712002	CUBES	Oxidizer, Metals, Radchem

2. Samples were received on July 17, 2002 for a forty-five (45) day turnaround from Validated Time of Sample Receipt (VTSR).

3. See Item Receipt Attached.

4. Electronic version included.

5. Quality Control Identification:

CD14120712002 S/D	Metals analysis
CD7100712002 S/D	Metals analysis
CD28010712002 S/D	Metals analysis
CD65090712002 S/D	Metals analysis
CF1080712002 S/D	Metals analysis
CI3070712002 S/D	Metals analysis
CD20100712002 Dup	Wetchem analysis (Bulk Density)
CI3070712002 Dup	Radchem analysis (Alpha)
LCSW, LCSW2	Radchem analysis (Alpha)
CF1080712002 Dup	Radchem analysis (Gamma)
CI11020712002 Dup	Radchem analysis (Gamma)

METALS ANALYSIS

The samples were prepared and analyzed for mercury by SW846 Method 7471A. The samples were diluted in 4% nitric acid for the remaining metals. The samples were analyzed for Al, As, Cu, Pb, Mg, Se, Ag and U by ICP-MS SW846 Method 6020 and the remaining metals by ICP SW846 Method 6010B. The samples are reported on a dry weight basis.

The twenty eight (28) day mercury holding time was missed for system ids 209426, 209427, 209428, 209429, 209431, 209437, 209438, 209439 and 209440. These samples were analyzed on the 29th and 30th day past the collection end date.

Due to the large number of samples, the samples were prepared in three batches. Calcium was detected in one of the preparation blanks at 2.555 mg/Kg, which is slightly above the reporting limit of 2.5 mg/Kg for Ca. No other analytes were detected in the preparation blanks above the laboratory's reporting limits. For the mercury analyses, solid laboratory control samples were prepared with the samples and the reported results were within the manufacturer's acceptance limits. For the remaining analytes, four aqueous laboratory control samples (LCS) are reported with the samples. When the samples were initially diluted, all analytes were spiked at the laboratory's normal spiking levels in the laboratory control samples (or blank spikes). Three of these QC samples are reported. They are on the first three Form 7s. The recoveries for these QC samples were within 80-120% for all analytes, expect for Mo and Sr in one LCS. For this LCS, the recoveries were 120.5% for Mo and 121.6% for Sr. The other laboratory control sample was spiked at the instrument at the time of analysis for the ICP and ICP-MS analytes. The elements were spiked at their respective reporting limits into a thorium standard at the same concentration than that in the samples. The recoveries obtained for this QC sample ranged from 59.9% to 123.0%.

System ids 209430, 209442 and 209426 were QC'd for mercury and system ids 209424, 209440 and 209463 were QC'd for the remaining metals. Second aliquots of the original samples are reported as the duplicates. Third aliquots were spiked with the analytes of interest and reported as the matrix spikes. All samples are flagged with the same qualifiers. All QC criteria were met for the mercury analyses.

QC sample 209424 - The results are "N" flagged for Al, Fe, Ag, Mg and Mn due to the matrix spike recoveries being outside of the limits of 75-125%. A post-digestion (or analytical) spike was reported for the spike outliers. A portion of the diluted QC sample (at df1000) was spiked and reported for thorium as a post-digestion spike sample. The results are "*" flagged for Mn and Zn due to the high RPD between the QC sample and its duplicate. For both analytes, the original sample results are less than the reporting limit and the duplicate result is above the reporting limit. The QC criteria for the serial dilution analyses were met. If an analyte concentration is high (at least 50 times the lab reporting limit), a five fold dilution (or serial dilution) must agree within 10% of the original determination after correction for dilution.

QC sample 209440 - The results are "N" flagged for Cr, Ag, Mg, U and V due to the matrix spike recoveries being outside of the limits of 75-125%. A post-digestion (or analytical) spike was reported for the spike outliers. A portion of the diluted QC sample (at df1000) was spiked and reported for thorium as a post-digestion spike sample. The QC criteria were met for the duplicate analyses. A control limit of 20% for the RPD would have been used for sample values greater than or equal to 5 times the laboratory's reporting limit. The QC criteria for the serial dilution analyses were met. If an analyte concentration is high (at least 50 times the lab reporting limit), a five fold dilution (or serial dilution) must agree within 10% of the original determination after correction for dilution.

QC sample 209463 - The results are "N" flagged for Al, Be, Cr, Cd, Ag, Mg, Mn and U due to the matrix spike recoveries being outside of the limits of 75-125%. A post-digestion (or analytical) spike was reported for the spike outliers. A portion of the diluted QC sample (at df1000) was spiked and reported for thorium as a post-digestion spike sample. The QC criteria were met for the duplicate analyses. A control limit of 20% for the RPD would have been used for sample values greater than or equal to 5 times the laboratory's reporting limit. The QC criteria for the serial dilution analyses were met. If an analyte concentration is high (at least 50 times the lab reporting limit), a five fold dilution (or serial dilution) must agree within 10% of the original determination after correction for dilution.

Due to the elevated thorium concentration in the samples, a number of elements had to be manually calculated to correct for the thorium interferences. The elements affected were cadmium, chromium, manganese, antimony, silicon, thallium, calcium, iron and vanadium.

WETCHEM ANALYSIS

Bulk density

The bulk density of seven domestic thorium nitrates was determined using a modified ASTM D5057 method. The method was modified to accommodate the thorium nitrate. In the method, water displacement is used to determine the bulk density. A container, having a known volume, was filled with fine sand and weighed. This was done in triplicate to determine the density of the sand. One single piece (15 - 25g) of the thorium nitrate was placed in the container and then filled the container with the sand. Using the density of the sand and the weight of sand displaced, the volume was calculated.

Wetchem narrative

Fifty-five (55) thorium nitrate (ThN) samples were tested following the guidelines specified in "Classification Procedures, Test Methods and Criteria Relating to Oxidizing Substances of Division 5.1" located in *Recommendations on the Transport of Dangerous Goods – Manual of Tests and Criteria*, UN 1999, 3rd revision. The thorium nitrates had three origins: domestic, French and Indian.

Equipment and Material Specifications

Potassium Bromate – Alfa Azar, ACS, 99.8% minimum assay (P/N 40013). Only the KBrO4 that passed a No. 50 sieve but was retained on a No.100 sieve was used for the oxidizer test. This 0.15 – 0.3 mm fraction of $KBrO_3$ was then dried in an oven at 65°C overnight.

Cellulose – Whatman CF-11, fibrous cellulose powder (P/N 4021500). According to the manufacturer, the fiber length is between 50 -250 um with a mean of 200 um; and the average diameter thickness is 20-25 um. The cellulose was dried at 105°C in an oven overnight, also.

Wire – Fisherbrand, 80% nickel / 20% chromium, 24 gauge, with a diameter of 0.51 mm and a resistance of 5.28 ohm/m (P/N 15-540-2D).

Low Heat Conducting Plate - ZIRCAR Alumina Insulations, ZAL-45 (P/N A10509). An "All-Alumina" board having high strength, uniform, rigid, refractory structures composed of alumina fibers and high purity inorganic binders. The product has optimum fiber density of 45 lbs/ft^3 (0.72 gm/cc), fine open pore structure and excellent thermal insulating property. It has superior hot strength and dimensional stability to 1650°C (3000°F) and withstands intermittent use to 1700°C (3192°F). With an increase in temperature, the ZAL-45's thermal conductivity increases, giving a range of 0.16 - 0.43 W/m°K from 250 – 1650°C, respectively.

Fume Cupboard- Atlas Fire Science Products (VFC) Vertical Flame Chamber (14' x 14' x 31') was placed inside a radioisotope fume hood. All burns were performed inside the VFC. The top of the chamber was slightly ajar to allow the smoke to escape, therefore not hindering the view during the burn. The air velocity in the chamber was measured using a Alnor Hot Wire Anemometer Model 8570 (Serial No. 99017063) calibrated Apr 17, 2002. The flow rates were measured at 2-5 fpm (0.01-0.025 m/s), which is well below that listed in the method.

Testing Procedures

Standardization

Potassium bromate was used as the reference material. The reference material was mixed with cellulose and burned at three ratios (3:7, 2:3, 3:2). A full series of reference burns consisted of testing five replicates at each ratio (5 replicates x 3 ratios = 15 burns). Three full series of reference burns were performed over the duration of the project: beginning, approximate middle and end. In addition to the full series of reference burns, one replicate at each ratio was analyzed every day samples were burned. A total of 37 replicates at each ratio were then evaluated for "outliers". This was accomplished by plotting a control chart using a simple moving average. A moving sigma or moving range was used to monitor for out of control data points. An upper/lower Warning Limit of ± 2 sigma, and an upper/lower Control Limit of ± 3 sigma was used. Any replicate exceeding 3-sigma would be determined out of control . In the 3:7 ratio chart, no replicate exceeded the Warning Limit. Replicate 8 and 9 were barely above the Warning Limit on the 2:3 ratio chart. Replicate 19 was just below the Warning Limit on the 3:2 chart. Therefore, no replicate exceeded the upper or lower Control Limit. No points were excluded, and the average of all 37 replicates was used as the "Mean Burn Time" for the ratio of reference material to cellulose. Below, the experimentally determined mean burn times are compared to those given as an example in Section 34.1.4.5.

Ratio	Experimentally Determined Mean Burn Time, sec	Example in Method Mean Burn Time, sec
3:7	108.76	100
2:3	58.64	54
3:2	11.95	4

Sample Burns

As per the client's request, the weight of the domestic monoliths (core or chunk) along with the weight of the loose powder was to be determined.

> *Section 34.4.1.2.6. The substance, in the form in which it will be transported, should be inspected for any particles less than 500 um in diameter. If that powder constitutes more than 10% (mass) of the total, or if the substance is friable, then the whole of the test sample should be ground to a powder before testing to allow for a reduction in particle size during handling and transport.*

Initially, the loose material in the storage bag was place in a No.35 (500um) sieve to determine the percent powder, but very little of the loose material passed though the sieve. The particle size of the thorium nitrate was larger than 500 um. Therefore, a conservative approach was taken; the entire weight of the "loose" material found in the bag was used to determine the *"% Powder"*. None of the domestic samples consisted of > 10 % Powder.

Each thorium nitrate sample was tested five times at 1:1 and 1:4 (sample to cellulose) ratios. Power was applied to sample/cellulose mixtures for a maximum of three minutes, even if the "burning" had not ended. The time at which the burn concluded was recorded for those samples that had burn times less than 4 minutes. If any sample/cellulose mixture continued to burn longer than 4 minutes, the test was concluded and "> 4 min" was recorded. Due to the amount of cellulose in the 1:4 sample to cellulose (24 g), the majority had a burn times of > 4 minutes. The mean burn time of each sample at each ratio was calculated and compared to the mean burn time of the three ratios of the reference materials to determine the classification.

Neither of the sample-to-cellulose ratios, 4:1 and 1:1, for any of the thorium nitrates had mean burn times greater than that of the 3:7 potassium bromate and cellulose mixture. All thorium nitrate samples were classified as "**Not Division 5.1**".

Observations:

1) Domestic Thorium Nitrates: Although the sample/cellulose mixtures burned, there were signs of an oxidizing reaction. The burns were slow and controlled, unlike the reference material. While the cellulose burned, the thorium nitrate became molten and evolved orange fumes.

2) Indian Thorium Nitrates: Behaved very similarly to domestic thorium nitrate.

3) French Thorium Nitrates: Unlike the other thorium nitrate samples, the French samples were all powder. This made the mixture with cellulose very intimate compared to the solid pieces of the domestic and Indian samples. The French thorium nitrate almost acted like a flame retardant. At the 1:1 ratio, a typical burn started with a very delayed onset of flame production, dense yellowish orange fumes evolved, and the flame luminosity was often very low. In some cases, the piles consolidated, expanded, split, and/or simply lifted off the filament. The self-disorganizing behavior of these effects gave different burn rates. Although the burn times recorded were shorter than the domestic and Indian, most exceeded 2 minutes. This resulted in mean burn times that still exceeded that of the 3:7 reference burn. It should be noted that the problems above apply ONLY to the 1:1 ratio. The French material mixed in the 1:4 ratio gave results essentially identical with the domestic and Indian samples (< 4 min = > 240 sec)

Client: Battelle Memorial Institute
Project No.: 05421.01.006
SwRI Work Order: 22680, 22835
Page: 8

RADCHEM ANALYSIS (ALPHA SPEC)

The solids were weighed and digested using HNO3 and HCl for ICP, ICP-MS and Radchem. Portions of the digestion were used for column separations of the actinides. After separation the liquids were filtered and the filter was mounted on a steel planchet, which was analyzed by alpha spectroscopy. The soils are reported on an as received basis.

A preparation blank was analyzed for uranium and thorium and found to contain levels above the MDA but less than RMAs for uranium and thorium. All analytes in the laboratory control samples were within the laboratory acceptance limits, of 70-130%. All QC and client sample tracer recoveries were within acceptance limits, of 50-135%.

The sample raw data tabulates and subtracts the weekly chamber background for the chamber the sample was analyzed in.

RADCHEM ANALYSIS (GAMMA SPEC)

All samples were run for gamma emmiting isotopes. Sample results are reported on an "as received" basis. Please note that Actinium-228 has a great abundance of lines and that several of the identified nuclides are either miss-identified or miss-quantitated due to interferences with this and other isotopes found at high levels. Suspect isotopes are flagged with an "I" qualifier to indicate that they should be treated as either being not present or reported at much higher levels than are actually found in the sample. These would have normally been removed prior to reporting, but they have been included to allow others to make the judgment as to whether they are present or not.

"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Director or his designee, as verified by the following signature. This report shall not be reproduced except in full, without the written approval of SwRI."

Jo Ann Boyd 10/10/02

Jo Ann Boyd **Date**
Manager
Quality Assurance Unit Division 01

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: JULY 17, 2002
PROJECT # : 05421.01.006

WETCHEM ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: JULY 17, 2002
PROJECT # : 05421.01.006

SAMPLE DATA

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 020001

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: DLA Hammond

SDG: 208093
Date Received: 07/17/02
Date Analyzed: 10/03/02
Sample Matrix: Thorium Nitrate

Sample ID	Lab System ID	Bulk Density Result (g/mL)
CD20100712002	209428	1.931
Duplicate result	209428	1.831
RPD	209428	5.32%
CD11110712002	209422	1.870
CD15110712002	209425	1.876
CD02120712002	209420	1.929
CD22100712002	209429	1.869
CD29040712002	209431	1.787
CD48270612002	209436	2.014
CD37100712002	209438	1.695
CD61090712002	209439	2.013

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SOUTHWEST RESEARCH INSTITUTE

REFERENCE SUBSTANCE

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020002

Client: UT Battelle, LLC Project No: 05421.01.006

3:7 Potassium Bromate/Cellulose

Date Analyzed	Replicate	Temp °C	Humidity %	Burning Time, sec
07/14/02	1	24.9	56	102.93
07/14/02	2	24.9	56	89.22
07/14/02	3	24.9	56	117.37
07/14/02	4	24.9	56	106.63
07/14/02	5	24.9	56	117.59
07/15/02	6	20.3	66	109.19
07/17/02	7	20.7	68	136.81
07/18/02	8	20.2	72	104.03
07/30/02	9	22.5	58	143.91
07/31/02	10	21.5	59	143.47
08/01/02	11	22.3	61	130.78
08/06/02	12	21.8	60	109.25
08/07/02	13	22.4	57	154.75
08/08/02	14	22.3	61	99.44
08/13/02	15	21.8	66	107.16
08/15/02	16	21.6	65	118.81
08/16/02	17	21.9	65	91.54
08/19/02	18	21.7	67	91.60
08/20/02	19	23.6	55	120.93
08/22/02	20	23.7	55	109.50
08/23/02	21	23.0	56	117.65
08/27/02	22	23.9	52	108.41
08/28/02	23	22.9	59	85.90
08/28/02	24	22.9	59	82.94
08/28/02	25	22.9	59	70.72
08/28/02	26	22.9	59	116.16
08/28/02	27	22.9	59	97.53
09/03/02	28	23.7	53	114.41
09/05/02	29	22.4	60	91.34
09/10/02	30	22.7	61	137.25
09/11/02	31	23.4	54	88.78
09/12/02	32	23.1	54	111.47
09/18/02	33	19.1	82	89.25
09/18/02	34	19.1	82	110.28
09/18/02	35	19.1	82	109.03
09/18/02	36	19.1	82	101.44
09/18/02	37	19.1	82	86.75
			Mean	108.76

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REFERENCE SUBSTANCE

020003

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC Project No: 05421.01.006

2:3 Potassium Bromate/Cellulose

Date Analyzed	Replicate	Temp °C	Humidity %	Burning Time, sec
07/14/02	1	24.9	56	77.35
07/14/02	2	24.9	56	51.65
07/14/02	3	24.9	56	85.59
07/14/02	4	24.9	56	60.03
07/14/02	5	24.9	56	78.40
07/15/02	6	20.3	66	71.93
07/17/02	7	20.7	68	63.62
07/18/02	8	20.2	72	111.06
07/30/02	9	22.5	58	129.22
07/31/02	10	21.5	59	73.44
08/01/02	11	22.3	61	78.78
08/06/02	12	21.8	60	67.47
08/07/02	13	22.4	57	87.03
08/08/02	14	22.3	61	65.78
08/13/02	15	21.8	66	48.91
08/15/02	16	21.6	65	47.44
08/16/02	17	21.9	65	44.91
08/19/02	18	21.7	67	63.20
08/20/02	19	23.6	55	56.29
08/22/02	20	23.7	55	61.90
08/23/02	21	23.0	56	50.68
08/27/02	22	23.9	52	70.66
08/28/02	23	22.9	59	44.62
08/28/02	24	22.9	59	41.65
08/28/02	25	22.9	59	42.16
08/28/02	26	22.9	59	41.72
08/28/02	27	22.9	59	43.29
09/03/02	28	23.7	53	55.63
09/05/02	29	22.4	60	33.91
09/10/02	30	22.7	61	38.91
09/11/02	31	23.4	54	39.21
09/12/02	32	23.1	54	35.63
09/18/02	33	19.1	82	43.91
09/18/02	34	19.1	82	33.56
09/18/02	35	19.1	82	45.03
09/18/02	36	19.1	82	48.54
09/18/02	37	19.1	82	36.72
			Mean	58.64

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REFERENCE SUBSTANCE

REFERENCE SUBSTANCE

020004

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC Project No: 05421.01.006

3:2 Potassium Bromate/Cellulose

Date Analyzed	Replicate	Temp °C	Humidity %	Burning Time, sec
07/14/02	1	24.9	56	21.53
07/14/02	2	24.9	56	9.75
07/14/02	3	24.9	56	10.32
07/14/02	4	24.9	56	10.22
07/14/02	5	24.9	56	22.31
07/15/02	6	20.3	66	8.90
07/17/02	7	20.7	68	17.34
07/18/02	8	20.2	72	9.50
07/30/02	9	22.5	58	15.75
07/31/02	10	21.5	59	14.28
08/01/02	11	22.3	61	16.07
08/06/02	12	21.8	60	13.32
08/07/02	13	22.4	57	15.38
08/08/02	14	22.3	61	12.04
08/13/02	15	21.8	66	11.69
08/15/02	16	21.6	65	9.68
08/16/02	17	21.9	65	10.25
08/19/02	18	21.7	67	13.50
08/20/02	19	23.6	55	3.87
08/22/02	20	23.7	55	14.15
08/23/02	21	23.0	56	14.85
08/27/02	22	23.9	52	17.50
08/28/02	23	22.9	59	7.15
08/28/02	24	22.9	59	11.41
08/28/02	25	22.9	59	6.84
08/28/02	26	22.9	59	10.59
08/28/02	27	22.9	59	9.78
09/03/02	28	23.7	53	11.41
09/05/02	29	22.4	60	8.82
09/10/02	30	22.7	61	10.60
09/11/02	31	23.4	54	8.15
09/12/02	32	23.1	54	10.94
09/18/02	33	19.1	82	9.65
09/18/02	34	19.1	82	9.32
09/18/02	35	19.1	82	10.06
09/18/02	36	19.1	82	10.72
09/18/02	37	19.1	82	14.50
			Mean	11.95

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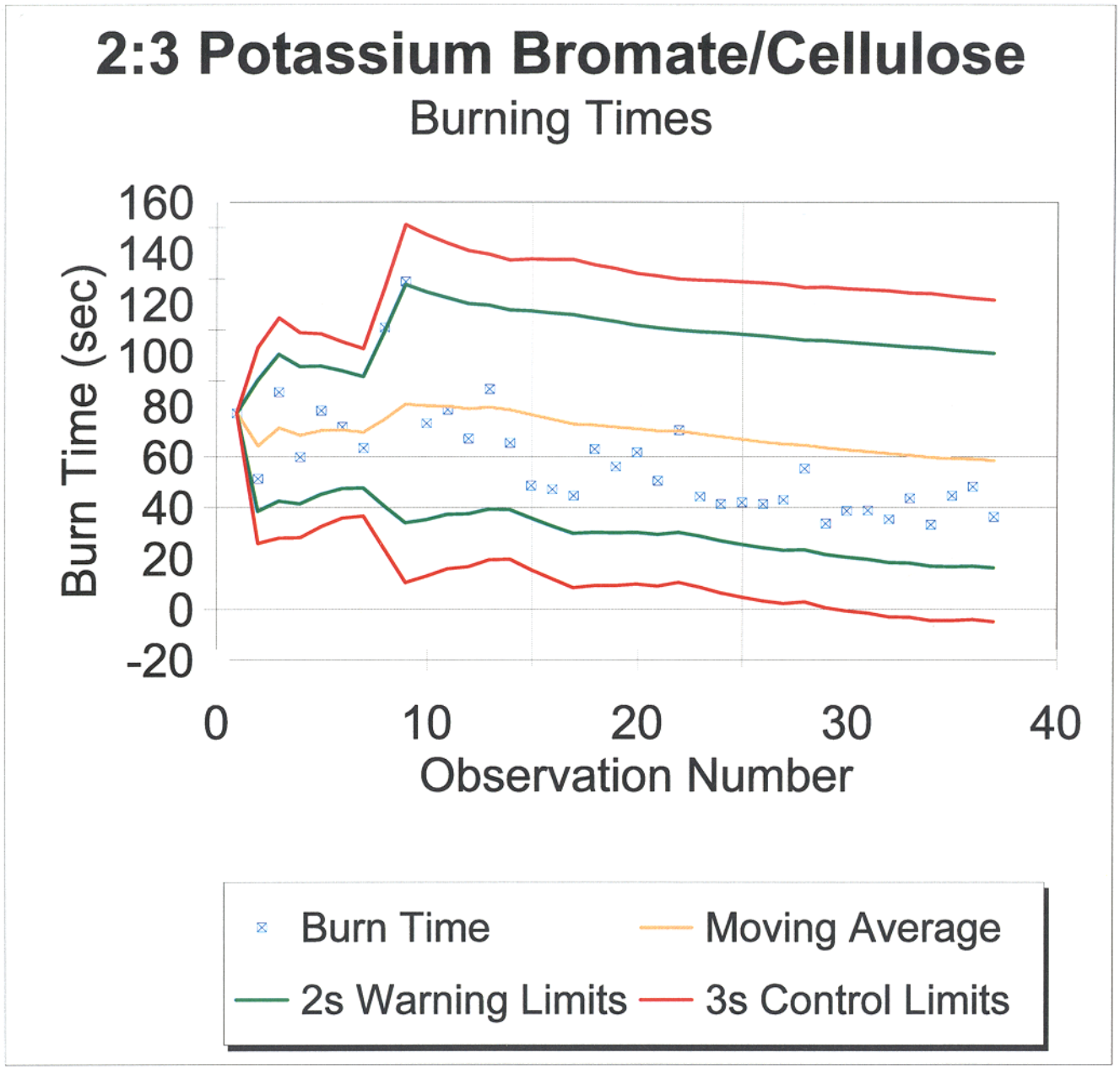
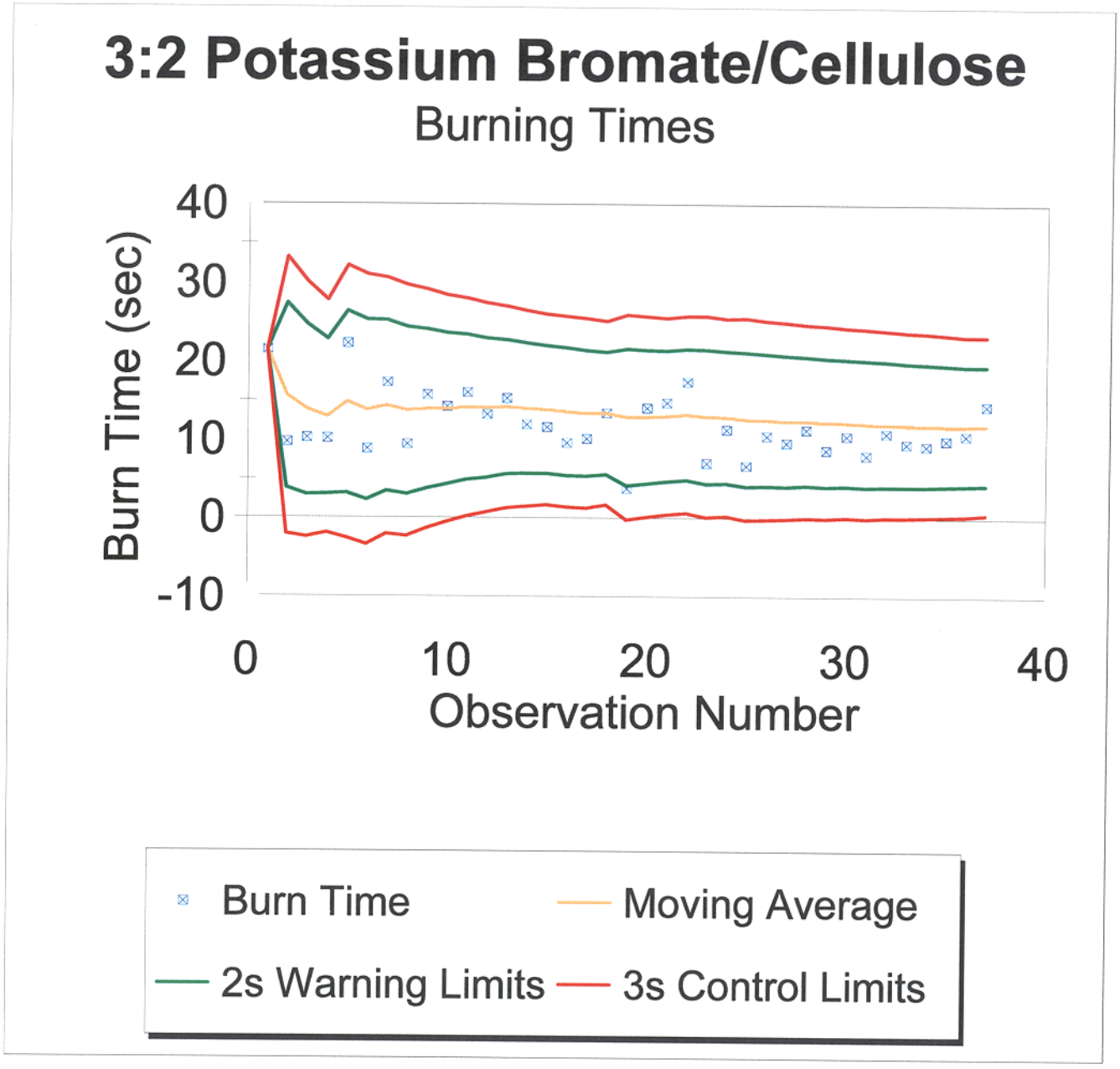
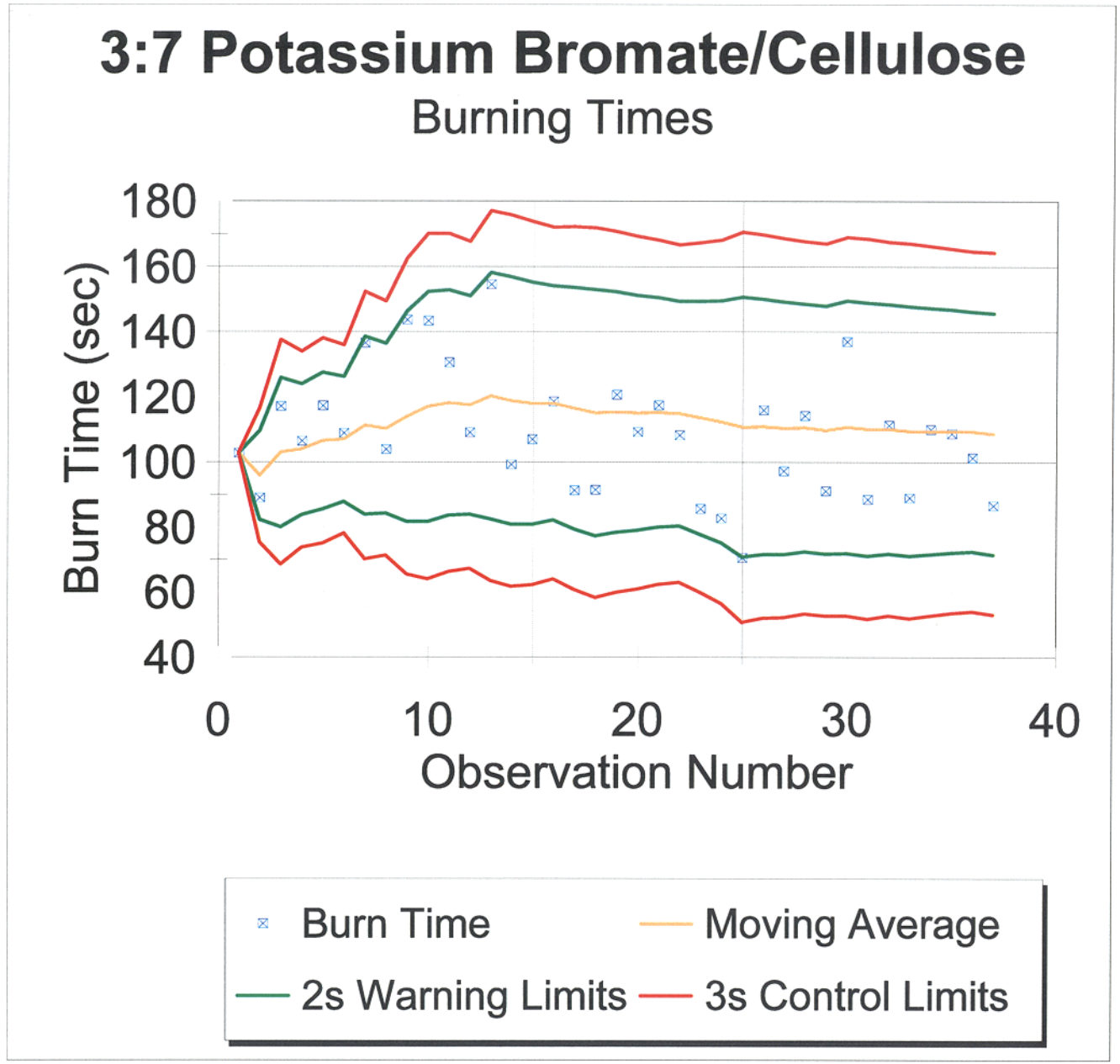

2:3 Potassium Bromate/Cellulose
Burning Times
Burn Time (sec)
160
140
120
100
80
60
40
20
0
-20
0
10
20
30
40
Observation Number
Burn Time
Moving Average
2s Warning Limits
3s Control Limits

020005


3:2 Potassium Bromate/Cellulose
Burning Times
Burn Time (sec)
40
30
20
10
0
-10
0
10
20
30
40
Observation Number
Burn Time
Moving Average
2s Warning Limits
3s Control Limits

020006


3:7 Potassium Bromate/Cellulose
Burning Times
Burn Time (sec)
180
160
140
120
100
80
60
40
0
10
20
30
40
Observation Number
Burn Time
Moving Average
2s Warning Limits
3s Control Limits

020007

SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020008

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD0807061-2002
Project No:	05421.01.006	SwRI Sample ID:	208093
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	7/15/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	180
4:1	2	180
4:1	3	180
4:1	4	180
4:1	5	180
	Mean	180
1:1	1	478
1:1	2	293
1:1	3	287
1:1	4	369
1:1	5	233
	Mean	332

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	~30
Temperature, °C :	21.4
Humidity, %:	67

Burning Process:

Temperature, °C :	20.3
Humidity, %:	66

Bulk Weight, g:	1365.70
Loose Weight, g:	46.30
"Powder", %:	3.28

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OXIDIZER TEST

020009

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD1010061-2002
Project No:	05421.01.006	SwRI Sample ID:	208094
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	7/17/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	160.14
4:1	2	180.10
4:1	3	203.53
4:1	4	158.46
4:1	5	192.81
	Mean	179.01
1:1	1	365
1:1	2	306
1:1	3	344
1:1	4	225
1:1	5	298
	Mean	308

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	38
Temperature, °C :	23.4
Humidity, %:	66

Burning Process:

Temperature, °C :	20.9
Humidity, %:	68

Bulk Weight, g:	1600.58
Loose Weight, g:	86.52
"Powder", %:	5.13

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OXIDIZER TEST

020010

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD2307061-2002
Project No:	05421.01.006	SwRI Sample ID:	208095
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	7/18/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	136.09
4:1	2	180.04
4:1	3	204.56
4:1	4	191.41
4:1	5	205.97
	Mean	183.61
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	27
Temperature, °C :	23.5
Humidity, %:	66

Burning Process:

Temperature, °C :	20.4
Humidity, %:	70

Bulk Weight, g:	1103.79
Loose Weight, g:	13.00
"Powder", %:	1.16

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020011

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD2907061-2002
Project No:	05421.01.006	SwRI Sample ID:	208096
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	7/30/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	166.52
4:1	2	171.35
4:1	3	194.06
4:1	4	236.25
4:1	5	193.84
	Mean	192.40
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	21
Temperature, °C :	20.5
Humidity, %:	70

Burning Process:

Temperature, °C :	22.2
Humidity, %:	58

Bulk Weight, g:	1001.55
Loose Weight, g:	50.39
"Powder", %:	4.79

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020012

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD3007061-2002
Project No:	05421.01.006	SwRI Sample ID:	208097
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	7/31/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	204.04
4:1	2	208.47
4:1	3	188.72
4:1	4	202.50
4:1	5	274.25
	Mean	215.60
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	27
Temperature, °C :	22.2
Humidity, %:	60

Burning Process:

Temperature, °C :	22.2
Humidity, %:	59

Bulk Weight, g:	969.69
Loose Weight, g:	59.37
"Powder", %:	5.77

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020013

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD3810061-2002
Project No:	05421.01.006	SwRI Sample ID:	208098
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	8/01/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	194.06
4:1	2	189.97
4:1	3	221.81
4:1	4	205.91
4:1	5	193.84
	Mean	201.12
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	41
Temperature, °C :	22.1
Humidity, %:	60

Burning Process:

Temperature, °C :	22
Humidity, %:	60

Bulk Weight, g:	1075.61
Loose Weight, g:	4.69
"Powder", %:	0.43

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020014

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD4710061-2002
Project No:	05421.01.006	SwRI Sample ID:	208099
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	8/06/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	184.38
4:1	2	217.54
4:1	3	216.57
4:1	4	194.41
4:1	5	192.13
	Mean	201.01
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	36
Temperature, °C :	22.3
Humidity, %:	63

Burning Process:

Temperature, °C :	22.1
Humidity, %:	62

Bulk Weight, g:	1409.04
Loose Weight, g:	59.68
"Powder", %:	4.06

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OXIDIZER TEST

020015

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	HD4810061-2002
Project No:	05421.01.006	SwRI Sample ID:	208100
Work Order:	22680	Date Received:	6/13/02
Case:	DLA Hammond	Date Analyzed:	8/06/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	239.15
4:1	2	181.38
4:1	3	211.81
4:1	4	187.47
4:1	5	187.69
	Mean	201.50
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	19
Temperature, °C :	21.8
Humidity, %:	60

Burning Process:

Temperature, °C :	21.8
Humidity, %:	60

Bulk Weight, g:	1203.06
Loose Weight, g:	68.73
"Powder", %:	5.40

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020016

Client:	UT Battelle, LLC	Client Sample ID:	CD02120712002
Project No:	05421.01.006	SwRI Sample ID:	209420
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ • DLA Curtis Bay	Date Analyzed:	08/19/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	190.84
4:1	2	186.50
4:1	3	181.37
4:1	4	197.25
4:1	5	205.47
	Mean	192.29
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	14
Temperature, °C :	22.1
Humidity, %:	60

Burning Process:

Temperature, °C :	23.7
Humidity, %:	54

Bulk Weight, g:	1135.65
Loose Weight, g:	18.65
"Powder", %:	1.62

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OXIDIZER TEST

020017

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	CD03110712002
Project No:	05421.01.006	SwRI Sample ID:	209421
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	08/15/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	204.03
4:1	2	205.41
4:1	3	193.40
4:1	4	219.03
4:1	5	209.04
	Mean	206.18
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	21
Temperature, °C :	22.0
Humidity, %:	60

Burning Process:

Temperature, °C :	21.9
Humidity, %:	61

Bulk Weight, g:	1110.37
Loose Weight, g:	32.54
"Powder", %:	2.85

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OXIDIZER TEST

020018

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	CD11110712002
Project No:	05421.01.006	SwRI Sample ID:	209422
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	08/16/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	188.90
4:1	2	197.06
4:1	3	192.08
4:1	4	212.01
4:1	5	189.63
	Mean	195.94
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	21
Temperature, °C :	21.9
Humidity, %:	61

Burning Process:

Temperature, °C :	22.2
Humidity, %:	61

Bulk Weight, g:	955.15
Loose Weight, g:	55.50
"Powder", %:	5.49

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020019

Client:	UT Battelle, LLC	Client Sample ID:	CD12120712002
Project No:	05421.01.006	SwRI Sample ID:	209423
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	08/22/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	200.72
4:1	2	228.22
4:1	3	189.25
4:1	4	225.09
4:1	5	195.37
	Mean	207.73
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	16
Temperature, °C :	23.8
Humidity, %:	53

Burning Process:

Temperature, °C :	24.2
Humidity, %:	52

Bulk Weight, g:	1647.02
Loose Weight, g:	31.72
"Powder", %:	1.89

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020020

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD14120712002
SwRI Sample ID: 209424
Date Received: 07/17/02
Date Analyzed: 08/22/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	186.50
4:1	2	216.84
4:1	3	210.90
4:1	4	187.97
4:1	5	199.07
	Mean	200.26
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	19
Temperature, °C :	23.8
Humidity, %:	54

Burning Process:

Temperature, °C :	24.1
Humidity, %:	52

Bulk Weight, g:	1177.03
Loose Weight, g:	34.85
"Powder", %:	2.88

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020021

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD15110712002
SwRI Sample ID: 209425
Date Received: 07/17/02
Date Analyzed: 08/20/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	189.22
4:1	2	195.03
4:1	3	209.78
4:1	4	>240
4:1	5	225.66
	Mean	211.94
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	19
Temperature, °C :	22.3
Humidity, %:	59

Burning Process:

Temperature, °C :	22.1
Humidity, %:	59

Bulk Weight, g:	989.70
Loose Weight, g:	59.12
"Powder", %:	5.64

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OXIDIZER TEST

020022

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

CD17100712002

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: ~~CD7100712002~~
SwRI Sample ID: 209426
Date Received: 07/17/02
Date Analyzed: 09/18/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	190.91
4:1	2	210.56
4:1	3	193.66
4:1	4	193.19
4:1	5	190.07
	Mean	195.68
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	13
Temperture, °C :	19.6
Humidity, %:	75

Burning Process:

Temperature, °C :	19.6
Humidity, %:	77

Bulk Weight, g:	1142.2
Loose Weight, g:	0.75
"Powder", %:	0.07

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020023

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD18090712002
SwRI Sample ID: 209427
Date Received: 07/17/02
Date Analyzed: 08/22/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	202.40
4:1	2	207.37
4:1	3	237.88
4:1	4	201.78
4:1	5	186.35
	Mean	207.16
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	21
Temperature, °C :	23.7
Humidity, %:	54

Burning Process:

Temperature, °C :	24.0
Humidity, %:	51

Bulk Weight, g:	1020.13
Loose Weight, g:	14.84
"Powder", %:	1.43

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020024

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD20100712002
SwRI Sample ID: 209428
Date Received: 07/17/02
Date Analyzed: 08/23/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	191.07
4:1	2	190.41
4:1	3	204.28
4:1	4	216.87
4:1	5	209.37
	Mean	202.40
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	16
Temperature, °C :	23.9
Humidity, %:	53

Burning Process:

Temperature, °C :	23.8
Humidity, %:	54

Bulk Weight, g:	1189.05
Loose Weight, g:	32.84
"Powder", %:	2.69

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OXIDIZER TEST

020025

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD22100712002
SwRI Sample ID: 209429
Date Received: 07/17/02
Date Analyzed: 08/22/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	221.35
4:1	2	221.16
4:1	3	183.72
4:1	4	200.37
4:1	5	197.47
	Mean	204.81
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	16
Temperature, °C :	23.8
Humidity, %:	53

Burning Process:

Temperature, °C :	24.3
Humidity, %:	51

Bulk Weight, g:	1222.90	
Loose Weight, g:	31.64	1254.54
"Powder", %:	2.52	

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OXIDIZER TEST

020026

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD28010712002
SwRI Sample ID: 209430
Date Received: 07/17/02
Date Analyzed: 08/07/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	208.13
4:1	2	184.03
4:1	3	186.59
4:1	4	185.03
4:1	5	194.31
	Mean	191.62
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	16
Temperature, °C :	22.3
Humidity, %:	57

Burning Process:

Temperature, °C :	22.2
Humidity, %:	58

Bulk Weight, g:	1194.86
Loose Weight, g:	30.6
"Powder", %:	2.50

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020027

Client:	UT Battelle, LLC	Client Sample ID:	CD29040712002
Project No:	05421.01.006	SwRI Sample ID:	209431
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	08/20/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	192.25
4:1	2	210.81
4:1	3	160.75
4:1	4	216.66
4:1	5	208.78
	Mean	197.85
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	23
Temperature, °C :	23.5
Humidity, %:	60

Burning Process:

Temperature, °C :	23.8
Humidity, %:	54

Bulk Weight, g:	1142.08
Loose Weight, g:	49.97
"Powder", %:	4.19

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020028

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD30280612002
SwRI Sample ID: 209432
Date Received: 07/17/02
Date Analyzed: 09/05/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	197.53
4:1	2	205.13
4:1	3	227.19
4:1	4	196.13
4:1	5	193.25
	Mean	203.85
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	15
Temperature, °C :	23.4
Humidity, %:	56

Burning Process:

Temperature, °C :	23.7
Humidity, %:	54

Bulk Weight, g:	1401.29
Loose Weight, g:	0.00
"Powder", %:	0.00

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020029

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD36010712002
SwRI Sample ID: 209433
Date Received: 07/17/02
Date Analyzed: 08/08/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	154.62
4:1	2	213.94
4:1	3	205.25
4:1	4	188.03
4:1	5	189.50
	Mean	190.27
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	15
Temperature, °C :	22.3
Humidity, %:	57

Burning Process:

Temperature, °C :	22.2
Humidity, %:	57

Bulk Weight, g:	1362.29
Loose Weight, g:	13.70
"Powder", %:	1.00

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020030

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD44120712002
SwRI Sample ID: 209434
Date Received: 07/17/02
Date Analyzed: 08/16/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	199.22
4:1	2	203.93
4:1	3	194.97
4:1	4	190.10
4:1	5	209.84
	Mean	199.61
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	13
Temperature, °C :	22.0
Humidity, %:	60

Burning Process:

Temperature, °C :	22.2
Humidity, %:	58

Bulk Weight, g:	1009.18
Loose Weight, g:	30.68
"Powder", %:	2.95

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020031

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD45270612002
SwRI Sample ID: 209435
Date Received: 07/17/02
Date Analyzed: 08/13/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	204.10
4:1	2	196.40
4:1	3	190.12
4:1	4	192.68
4:1	5	200.53
	Mean	196.77
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	14
Temperature, °C :	22.2
Humidity, %:	60

Burning Process:

Temperature, °C :	21.9
Humidity, %:	64

Bulk Weight, g:	1340.42
Loose Weight, g:	6.46
"Powder", %:	0.48

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020032

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD48270612002
SwRI Sample ID: 209436
Date Received: 07/17/02
Date Analyzed: 08/08/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	188.50
4:1	2	210.91
4:1	3	186.68
4:1	4	200.09
4:1	5	193.50
	Mean	195.94
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	15
Temperature, °C :	22.6
Humidity, %:	60

Burning Process:

Temperature, °C :	22.6
Humidity, %:	60

Bulk Weight, g:	1419.78
Loose Weight, g:	51.28
"Powder", %:	3.49

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020033

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD52100712002
SwRI Sample ID: 209437
Date Received: 07/17/02
Date Analyzed: 08/23/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	190.10
4:1	2	190.06
4:1	3	222.40
4:1	4	214.56
4:1	5	202.31
	Mean	203.89
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	17
Temperature, °C :	23.8
Humidity, %:	52

Burning Process:

Temperature, °C :	23.7
Humidity, %:	54

Bulk Weight, g:	1322.26
Loose Weight, g:	35.20
"Powder", %:	2.59

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020034

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD37100712002
SwRI Sample ID: 209438
Date Received: 07/17/02
Date Analyzed: 08/20/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	197.47
4:1	2	>240
4:1	3	188.68
4:1	4	198.22
4:1	5	196.37
	Mean	204.15
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	19
Temperature, °C :	23.4
Humidity, %:	57

Burning Process:

Temperature, °C :	24.0
Humidity, %:	52

Bulk Weight, g:	1132.89
Loose Weight, g:	28.96
"Powder", %:	2.49

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020035

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD61090712002
SwRI Sample ID: 209439
Date Received: 07/17/02
Date Analyzed: 08/19/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	193.28
4:1	2	187.84
4:1	3	189.50
4:1	4	189.37
4:1	5	220.03
	Mean	196.00
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	21
Temperature, °C :	23.8
Humidity, %:	53

Burning Process:

Temperature, °C :	24.1
Humidity, %:	52

Bulk Weight, g:	1116.26
Loose Weight, g:	14.26
"Powder", %:	1.26

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020036

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD65090712002
SwRI Sample ID: 209440
Date Received: 07/17/02
Date Analyzed: 08/20/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	200.75
4:1	2	199.78
4:1	3	>240
4:1	4	190.28
4:1	5	185.22
	Mean	203.21
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	18
Temperature, °C :	23.6
Humidity, %:	54

Burning Process:

Temperature, °C :	23.5
Humidity, %:	55

Bulk Weight, g:	1009.42
Loose Weight, g:	38.15
"Powder", %:	3.64

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020037

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF1080712002
SwRI Sample ID: 209442
Date Received: 07/17/02
Date Analyzed: 09/11/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	137.40
4:1	2	180.50
4:1	3	157.09
4:1	4	189.10
4:1	5	171.78
	Mean	167.17
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	9
Temperature, °C :	23.8
Humidity, %:	54

Burning Process:

Temperature, °C :	23.7
Humidity, %:	53

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020038

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF11020712002
SwRI Sample ID: 209443
Date Received: 07/17/02
Date Analyzed: 09/10/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	217.34
4:1	2	197.40
4:1	3	186.44
4:1	4	220.61
4:1	5	179.72
	Mean	200.30
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	10
Temperature, °C :	23.8
Humidity, %:	54

Burning Process:

Temperature, °C :	24.1
Humidity, %:	51

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020039

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF13080712002
SwRI Sample ID: 209444
Date Received: 07/17/02
Date Analyzed: 09/05/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	226.03
4:1	2	185.22
4:1	3	190.88
4:1	4	216.79
4:1	5	187.03
	Mean	201.19
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	6
Temperature, °C :	23.7
Humidity, %:	54

Burning Process:

Temperature, °C :	23.7
Humidity, %:	54

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OXIDIZER TEST

020040

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA CUrtis Bay
SDG: 208093

Client Sample ID: CF14030712002
SwRI Sample ID: 209445
Date Received: 07/17/02
Date Analyzed: 08/16/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	150.28
4:1	2	159.63
4:1	3	144.62
4:1	4	122.05
4:1	5	153.22
	Mean	145.96
1:1	1	>240
1:1	2	199
1:1	3	>240
1:1	4	216
1:1	5	>240
	Mean	227

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	9
Temperature, °C :	22.4
Humidity, %:	59

Burning Process:

Temperature, °C :	22.2
Humidity, %:	62

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OXIDIZER TEST

020041

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF16080712002
SwRI Sample ID: 209446
Date Received: 07/17/02
Date Analyzed: 09/05/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	183.72
4:1	2	182.65
4:1	3	190.41
4:1	4	186.13
4:1	5	182.84
	Mean	185.15
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	6
Temperature, °C :	22.9
Humidity, %:	56

Burning Process:

Temperature, °C :	23.0
Humidity, %:	57

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OXIDIZER TEST

020042

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF17080712002
SwRI Sample ID: 209447
Date Received: 07/17/02
Date Analyzed: 09/10/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	181.05
4:1	2	180.55
4:1	3	143.06
4:1	4	183.63
4:1	5	184.65
	Mean	174.59
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

* Filament broke at 47 sec

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	7
Temperature, °C :	23.7
Humidity, %:	53

Burning Process:

Temperature, °C :	23.3
Humidity, %:	57

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OXIDIZER TEST

020043

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	CF19080712002
Project No:	05421.01.006	SwRI Sample ID:	209448
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	09/05/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	180.00
4:1	2	172.12
4:1	3	189.44
4:1	4	182.41
4:1	5	187.22
	Mean	182.24
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	6
Temperature, °C :	23.3
Humidity, %:	56

Burning Process:

Temperature, °C :	23.0
Humidity, %:	57

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OXIDIZER TEST

020044

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF2080712002
SwRI Sample ID: 209449
Date Received: 07/17/02
Date Analyzed: 09/11/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	184.25
4:1	2	182.65
4:1	3	180.87
4:1	4	181.59
4:1	5	170.38
	Mean	179.95
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	10
Temperature, °C :	23.8
Humidity, %:	53

Burning Process:

Temperature, °C :	23.4
Humidity, %:	53

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OXIDIZER TEST

020045

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF3080712002
SwRI Sample ID: 209450
Date Received: 07/17/02
Date Analyzed: 09/03/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	182.56
4:1	2	180.32
4:1	3	210.41
4:1	4	172.06
4:1	5	176.87
	Mean	184.44
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min: 13
Temperature, °C : 23.3
Humidity, %: 56

Burning Process:

Temperature, °C : 23.7
Humidity, %: 52

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020046

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF10020712002
SwRI Sample ID: 209451
Date Received: 07/17/02
Date Analyzed: 09/10/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	185.53
4:1	2	181.50
4:1	3	184.44
4:1	4	183.71
4:1	5	178.81
	Mean	182.80
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	10
Temperature, °C :	23.8
Humidity, %:	54

Burning Process:

Temperature, °C :	23.0
Humidity, %:	58

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020047

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF4080712002
SwRI Sample ID: 209452
Date Received: 07/17/02
Date Analyzed: 09/03/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	196.68
4:1	2	186.59
4:1	3	172.66
4:1	4	168.03
4:1	5	136.85
	Mean	172.16
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	6
Temperature, °C :	23.1
Humidity, %:	56

Burning Process:

Temperature, °C :	24.0
Humidity, %:	50

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OXIDIZER TEST

020048

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client:	UT Battelle, LLC	Client Sample ID:	CF6080712002
Project No:	05421.01.006	SwRI Sample ID:	209453
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	09/12/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	152.53
4:1	2	172.57
4:1	3	157.28
4:1	4	153.66
4:1	5	223.88
	Mean	171.98
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	8
Temperature, °C :	23.7
Humidity, %:	52

Burning Process:

Temperature, °C :	23.8
Humidity, %:	52

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OXIDIZER TEST

020049

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CF9080712002
SwRI Sample ID: 209454
Date Received: 07/17/02
Date Analyzed: 09/05/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	165.06
4:1	2	190.22
4:1	3	186.53
4:1	4	210.07
4:1	5	187.44
	Mean	187.86
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min: 6
Temperature, °C : 23.7
Humidity, %: 54

Burning Process:

Temperature, °C : 24.0
Humidity, %: 51

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

020050

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI11020712002
SwRI Sample ID: 209455
Date Received: 07/17/02
Date Analyzed: 08/26/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	224.56
4:1	2	196.50
4:1	3	184.66
4:1	4	207.41
4:1	5	205.53
	Mean	203.73
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	15
Temperature, °C :	24.3
Humidity, %:	49

Burning Process:

Temperature, °C :	23.9
Humidity, %:	53

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OXIDIZER TEST

020051

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI12020712002
SwRI Sample ID: 209456
Date Received: 07/17/02
Date Analyzed: 08/15/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	190.25
4:1	2	229.94
4:1	3	183.22
4:1	4	200.03
4:1	5	>240
	Mean	208.69
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min: 16
Temperature, °C : 22.4
Humidity, %: 59

Burning Process:

Temperature, °C : 22.2
Humidity, %: 60

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020052

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI13020712002
SwRI Sample ID: 209457
Date Received: 07/17/02
Date Analyzed: 08/26/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	202.44
4:1	2	202.03
4:1	3	189.33
4:1	4	196.41
4:1	5	158.40
	Mean	189.72
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	17
Temperature, °C :	24.3
Humidity, %:	49

Burning Process:

Temperature, °C :	24.2
Humidity, %:	50

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020053

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI4030712002
SwRI Sample ID: 209458
Date Received: 07/17/02
Date Analyzed: 08/28/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	176.93
4:1	2	203.59
4:1	3	186.16
4:1	4	208.50
4:1	5	159.03
	Mean	186.84
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min: 12
Temperature, °C : 24.1
Humidity, %: 49

Burning Process:

Temperature, °C : 24.1
Humidity, %: 52

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020054

Client:	UT Battelle, LLC	Client Sample ID:	CI5030712002
Project No:	05421.01.006	SwRI Sample ID:	209459
Work Order:	22835	Date Received:	07/17/02
Case:	~~DLA Hammond~~ DLA Curtis Bay	Date Analyzed:	08/27/02
SDG:	208093	Sample Matrix:	Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	226.97
4:1	2	196.12
4:1	3	198.80
4:1	4	186.96
4:1	5	203.12
	Mean	202.39
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	14
Temperature, °C :	23.7
Humidity, %:	52

Burning Process:

Temperature, °C :	24.3
Humidity, %:	52

Bulk Weight, g:	
Loose Weight, g:	1191.69
Powder", %:	27.98

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OXIDIZER TEST

020055

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI6030712002
SwRI Sample ID: 209460
Date Received: 07/17/02
Date Analyzed: 08/28/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	>240
4:1	2	194.44
4:1	3	187.34
4:1	4	201.36
4:1	5	195.16
	Mean	203.66
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	14
Temperature, °C :	24.2
Humidity, %:	49

Burning Process:

Temperature, °C :	24.1
Humidity, %:	52

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OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020056

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI7030712002
SwRI Sample ID: 209461
Date Received: 07/17/02
Date Analyzed: 08/27/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	195.28
4:1	2	203.97
4:1	3	192.47
4:1	4	190.72
4:1	5	189.85
	Mean	194.46
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	16
Temperature, °C :	23.8
Humidity, %:	51

Burning Process:

Temperature, °C :	24.3
Humidity, %:	50

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OXIDIZER TEST

020057

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI9030712002
SwRI Sample ID: 209462
Date Received: 07/17/02
Date Analyzed: 08/27/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	205.84
4:1	2	227.25
4:1	3	186.50
4:1	4	234.97
4:1	5	202.09
	Mean	211.33
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	17
Temperature, °C :	23.7
Humidity, %:	53

Burning Process:

Temperature, °C :	24.3
Humidity, %:	50

Bulk Weight, g:	1111.87
Loose Weight, g:	39.04
Powder", %:	3.39

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OXIDIZER TEST

020058

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI3070712002
SwRI Sample ID: 209463
Date Received: 07/17/02
Date Analyzed: 08/13/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	227.35
4:1	2	231.96
4:1	3	192.09
4:1	4	232.60
4:1	5	223.68
	Mean	221.54
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	19
Temperature, °C :	22.6
Humidity, %:	60

Burning Process:

Temperature, °C :	22.0
Humidity, %:	60

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

020059

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CD58120712002
SwRI Sample ID: 210181
Date Received: 07/17/02
Date Analyzed: 08/19/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	207.19
4:1	2	200.39
4:1	3	197.51
4:1	4	186.06
4:1	5	185.13
	Mean	195.26
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	13
Temperature, °C :	22.1
Humidity, %:	60

Burning Process:

Temperature, °C :	23.4
Humidity, %:	61

Bulk Weight, g:	1016.80
Loose Weight, g:	75.11
Powder", %:	6.88

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SOUTHWEST RESEARCH INSTITUTE

OXIDIZER TEST

Classification Procedures, Test Methods and Criteria Relating to Oxidizing substances of Division 5.1 020060

Client: UT Battelle, LLC
Project No: 05421.01.006
Work Order: 22835
Case: ~~DLA Hammond~~ DLA Curtis Bay
SDG: 208093

Client Sample ID: CI14020712002
SwRI Sample ID: 210182
Date Received: 07/17/02
Date Analyzed: 09/12/02
Sample Matrix: Thorium Nitrate

Based on results presented in the Table below, this sample is **Not Division 5.1.**

Sample:Cellulose Ratio	Replicate	Burning Time sec
4:1	1	192.87
4:1	2	>240
4:1	3	191.66
4:1	4	187.13
4:1	5	186.78
	Mean	199.69
1:1	1	>240
1:1	2	>240
1:1	3	>240
1:1	4	>240
1:1	5	>240
	Mean	>240

Mean burning times for mixtures of reference substance to cellulose:

3:7 Potassium bromate / cellulose: 108.76
2:3 Potassium bromate / cellulose: 58.64
3:2 Potassium bromate / cellulose: 11.95

Weighing Process

Elapsed time, min:	13
Temperature, °C :	23.7
Humidity, %:	51

Burning Process:

Temperature, °C :	23.8
Humidity, %:	52

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SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006
METALS

METALS ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006
METALS

METALS ANALYSIS
SAMPLE DATA

UT-BATTELLE, LLC.

010001

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract: 05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.:208093

SOW No.: SW 846

BATT Sample No.	Lab Sample ID
_HD0807061____	_208093_____
_HD1010061____	_208094_____
_HD2307061____	_208095_____
_HD2907061____	_208096_____
_HD3007061____	_208097_____
_HD3810061____	_208098_____
_HD4710061____	_208099_____
_HD4810061____	_208100_____
_HD0807061S___	_208093S_____
_HD0807061D___	_208093D_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES

If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments:

____SEE_CASE_NARRATIVE.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on floppy diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: B Spoer for Name: __MIKE_DAMMANN_____

Date: __09/10/02_____ Title: __MANAGER_____

9/11/02

010002

UT-BATTELLE, LLC.

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

HD0807061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208093

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _92.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	22.7	U		PM
7440-36-0	Antimony_	9.1	U		P_
7440-38-2	Arsenic__	4.5	U		PM
7440-39-3	Barium___	4.5	U		P_
7440-41-7	Beryllium	4.5	U		P_
7440-42-8	Boron____	9.1	U		P_
7440-43-9	Cadmium__	4.5	U		P_
7440-70-2	Calcium__	45.5	U		P_
7440-47-3	Chromium_	9.1	U		P_
7440-48-4	Cobalt___	4.5	U		P_
7440-50-8	Copper___	4.5	U		PM
7439-89-6	Iron_____	45.5	U	N	P_
7439-92-1	Lead_____	0.45	U		PM
7439-95-4	Magnesium	22.7	U		PM
7439-96-5	Manganese	9.1	U		P_
7439-97-6	Mercury__	0.02	U		CV
7439-98-7	Molybdenu	4.5	U		P_
7440-02-0	Nickel___	4.5	U		P_
7782-49-2	Selenium_	4.5	U		PM
7440-21-3	Silicon__	22.7	U		P_
7440-22-4	Silver___	0.45	U		PM
7440-23-5	Sodium___	90.9	U		P_
7440-24-6	Strontium	9.1	U		P_
7440-28-0	Thallium_	9.1	U		P_
7440-29-1_	Thorium__	428000			P_
7440-61-1_	Uranium__	0.455	U		PM
7440-62-2_	Vanadium_	9.1	U	N	P_
7440-66-6_	Zinc_____	4.5	U		P_
7440-67-7_	Zirconium	9.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD0807061-2002

UT-BATTELLE, LLC.

010003

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

HD1010061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208094

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _92.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	23.0	U		PM
7440-36-0	Antimony_	9.2	U		P_
7440-38-2	Arsenic__	4.6	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U		P_
7440-42-8	Boron____	9.2	U		P_
7440-43-9	Cadmium__	4.6	U		P_
7440-70-2	Calcium__	46.0	U		P_
7440-47-3	Chromium_	9.2	U		P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	46.0	U	N	P_
7439-92-1	Lead_____	0.46	U		PM
7439-95-4	Magnesium	23.0	U		PM
7439-96-5	Manganese	9.2	U		P_
7439-97-6	Mercury__	0.03	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	4.6	U		PM
7440-21-3	Silicon__	23.0	U		P_
7440-22-4	Silver___	0.46	U		PM
7440-23-5	Sodium___	2440			P_
7440-24-6	Strontium	9.2	U		P_
7440-28-0	Thallium_	9.2	U		P_
7440-29-1_	Thorium__	420000			P_
7440-61-1_	Uranium__	0.460	U		PM
7440-62-2_	Vanadium_	9.2	U	N	P_
7440-66-6_	Zinc_____	4.6	U		P_
7440-67-7_	Zirconium	9.2	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD1010061-2002

UT-BATTELLE, LLC.

010004

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

HD2307061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 208095
Level (low/med): LOW__ Date Received: 06/13/02
% Solids: _92.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	23.5	U		PM
7440-36-0	Antimony_	9.4	U		P_
7440-38-2	Arsenic__	4.7	U		PM
7440-39-3	Barium___	4.7	U		P_
7440-41-7	Beryllium	4.7	U		P_
7440-42-8	Boron____	9.4	U		P_
7440-43-9	Cadmium__	4.7	U		P_
7440-70-2	Calcium__	47.0	U		P_
7440-47-3	Chromium_	9.4	U		P_
7440-48-4	Cobalt___	4.7	U		P_
7440-50-8	Copper___	4.7	U		PM
7439-89-6	Iron_____	47.0	U	N	P_
7439-92-1	Lead_____	0.47	U		PM
7439-95-4	Magnesium	23.5	U		PM
7439-96-5	Manganese	9.4	U		P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.7	U		P_
7440-02-0	Nickel___	4.7	U		P_
7782-49-2	Selenium_	4.7	U		PM
7440-21-3	Silicon__	23.5	U		P_
7440-22-4	Silver___	0.47	U		PM
7440-23-5	Sodium___	93.9	U		P_
7440-24-6	Strontium	9.4	U		P_
7440-28-0	Thallium_	9.4	U		P_
7440-29-1_	Thorium__	425000			P_
7440-61-1_	Uranium__	0.470	U		PM
7440-62-2_	Vanadium_	9.4	U	N	P_
7440-66-6_	Zinc_____	4.7	U		P_
7440-67-7_	Zirconium	9.4	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_HD2307061-2002

UT-BATTELLE, LLC.

010005

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

HD2907061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208096

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _91.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	23.1	U		PM
7440-36-0	Antimony_	9.2	U		P_
7440-38-2	Arsenic__	4.6	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U		P_
7440-42-8	Boron____	9.2	U		P_
7440-43-9	Cadmium__	4.6	U		P_
7440-70-2	Calcium__	46.2	U		P_
7440-47-3	Chromium_	9.2	U		P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	46.2	U	N	P_
7439-92-1	Lead_____	0.72			PM
7439-95-4	Magnesium	23.1	U		PM
7439-96-5	Manganese	9.2	U		P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	4.6	U		PM
7440-21-3	Silicon__	23.1	U		P_
7440-22-4	Silver___	0.46	U		PM
7440-23-5	Sodium___	92.3	U		P_
7440-24-6	Strontium	9.2	U		P_
7440-28-0	Thallium_	9.2	U		P_
7440-29-1_	Thorium__	430000			P_
7440-61-1_	Uranium__	0.462	U		PM
7440-62-2_	Vanadium_	9.2	U	N	P_
7440-66-6_	Zinc_____	4.6	U		P_
7440-67-7_	Zirconium	9.2	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD2907061-2002

UT-BATTELLE, LLC.

010006

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

HD3007061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208097

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _92.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	23.1	U		PM
7440-36-0	Antimony_	9.3	U		P_
7440-38-2	Arsenic__	4.6	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U		P_
7440-42-8	Boron____	9.3	U		P_
7440-43-9	Cadmium__	4.6	U		P_
7440-70-2	Calcium__	46.3	U		P_
7440-47-3	Chromium_	9.3	U		P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	46.3	U	N	P_
7439-92-1	Lead_____	0.46	U		PM
7439-95-4	Magnesium	23.1	U		PM
7439-96-5	Manganese	9.3	U		P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	4.6	U		PM
7440-21-3	Silicon__	23.1	U		P_
7440-22-4	Silver___	0.46	U		PM
7440-23-5	Sodium___	92.5	U		P_
7440-24-6	Strontium	9.3	U		P_
7440-28-0	Thallium_	9.3	U		P_
7440-29-1_	Thorium__	434000			P_
7440-61-1_	Uranium__	0.463	U		PM
7440-62-2_	Vanadium_	9.3	U	N	P_
7440-66-6_	Zinc_____	4.6	U		P_
7440-67-7_	Zirconium	9.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD3007061-2002

UT-BATTELLE, LLC.

010007

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

HD3810061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208098

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _90.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	23.7	U		PM
7440-36-0	Antimony_	9.5	U		P_
7440-38-2	Arsenic__	4.7	U		PM
7440-39-3	Barium___	4.7	U		P_
7440-41-7	Beryllium	4.7	U		P_
7440-42-8	Boron____	9.5	U		P_
7440-43-9	Cadmium__	4.7	U		P_
7440-70-2	Calcium__	47.3	U		P_
7440-47-3	Chromium_	9.5	U		P_
7440-48-4	Cobalt___	4.7	U		P_
7440-50-8	Copper___	4.7	U		PM
7439-89-6	Iron_____	47.3	U	N	P_
7439-92-1	Lead_____	0.47	U		PM
7439-95-4	Magnesium	23.7	U		PM
7439-96-5	Manganese	9.5	U		P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.7	U		P_
7440-02-0	Nickel___	4.7	U		P_
7782-49-2	Selenium_	4.7	U		PM
7440-21-3	Silicon__	23.7	U		P_
7440-22-4	Silver___	0.47	U		PM
7440-23-5	Sodium___	2480			P_
7440-24-6	Strontium	9.5	U		P_
7440-28-0	Thallium_	9.5	U		P_
7440-29-1_	Thorium__	433000			P_
7440-61-1_	Uranium__	0.473	U		PM
7440-62-2_	Vanadium_	9.5	U	N	P_
7440-66-6_	Zinc_____	4.7	U		P_
7440-67-7_	Zirconium	9.5	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD3810061-2002

010008

UT-BATTELLE, LLC.

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

HD4710061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 208099

Level (low/med): LOW__ Date Received: 06/13/02

% Solids: _92.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	22.0	U		PM
7440-36-0	Antimony_	8.8	U		P_
7440-38-2	Arsenic__	4.4	U		PM
7440-39-3	Barium___	4.4	U		P_
7440-41-7	Beryllium	4.4	U		P_
7440-42-8	Boron____	8.8	U		P_
7440-43-9	Cadmium__	4.4	U		P_
7440-70-2	Calcium__	44.1	U		P_
7440-47-3	Chromium_	8.8	U		P_
7440-48-4	Cobalt___	4.4	U		P_
7440-50-8	Copper___	4.4	U		PM
7439-89-6	Iron_____	44.1	U	N	P_
7439-92-1	Lead_____	1.5			PM
7439-95-4	Magnesium	22.0	U		PM
7439-96-5	Manganese	8.8	U		P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.4	U		P_
7440-02-0	Nickel___	4.4	U		P_
7782-49-2	Selenium_	4.4	U		PM
7440-21-3	Silicon__	22.0	U		P_
7440-22-4	Silver___	0.44	U		PM
7440-23-5	Sodium___	88.2	U		P_
7440-24-6	Strontium	8.8	U		P_
7440-28-0	Thallium_	8.8	U		P_
7440-29-1_	Thorium__	431000			P_
7440-61-1_	Uranium__	0.441	U		PM
7440-62-2_	Vanadium_	8.8	U	N	P_
7440-66-6_	Zinc_____	4.4	U		P_
7440-67-7_	Zirconium	8.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_HD4710061-2002

UT-BATTELLE, LLC.

010009
BATT SAMPLE NO.

1
INORGANIC ANALYSES DATA SHEET

HD4810061

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22680_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 208100
Level (low/med): LOW__ Date Received: 06/13/02
% Solids: _91.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	24.9	U		PM
7440-36-0	Antimony_	10	U		P_
7440-38-2	Arsenic__	5.0	U		PM
7440-39-3	Barium___	5.0	U		P_
7440-41-7	Beryllium	5.0	U		P_
7440-42-8	Boron____	10	U		P_
7440-43-9	Cadmium__	5.0	U		P_
7440-70-2	Calcium__	49.8	U		P_
7440-47-3	Chromium_	10	U		P_
7440-48-4	Cobalt___	5.0	U		P_
7440-50-8	Copper___	5.0	U		PM
7439-89-6	Iron_____	49.8	U	N	P_
7439-92-1	Lead_____	0.50	U		PM
7439-95-4	Magnesium	24.9	U		PM
7439-96-5	Manganese	10	U		P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	5.0	U		P_
7440-02-0	Nickel___	5.0	U		P_
7782-49-2	Selenium_	5.0	U		PM
7440-21-3	Silicon__	24.9	U		P_
7440-22-4	Silver___	0.50	U		PM
7440-23-5	Sodium___	99.7	U		P_
7440-24-6	Strontium	10	U		P_
7440-28-0	Thallium_	10	U		P_
7440-29-1_	Thorium__	432000			P_
7440-61-1_	Uranium__	0.498	U		PM
7440-62-2_	Vanadium_	10	U	N	P_
7440-66-6_	Zinc_____	5.0	U		P_
7440-67-7_	Zirconium	10	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_HD4810061-2002

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Batelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006
METALS

METALS ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Batelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006
METALS

METALS ANALYSIS
SAMPLE DATA

UT-BATTELLE, LLC

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract: 05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.:208093

SOW No.: SW 846

BATT Sample No.	Lab Sample ID
_CD021207_____	_209420_____
_CD031107_____	_209421_____
_CD111107_____	_209422_____
_CD121207_____	_209423_____
_CD141207_____	_209424_____
_CD151107_____	_209425_____
_CD180907_____	_209427_____
_CD201007_____	_209428_____
_CD221007_____	_209429_____
_CD280107_____	_209430_____
_CD290407_____	_209431_____
_CD302806_____	_209432_____
_CD360107_____	_209433_____
_CD371007_____	_209438_____
_CD441207_____	_209434_____
_CD452706_____	_209435_____
_CD482706_____	_209436_____
_CD521007_____	_209437_____
_CD581207_____	_210181_____
_CD610907_____	_209439_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments:
____SEE_CASE_NARRATIVE._____

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on floppy diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: _____ Name: __MIKE_DAMMANN_____

Date: __10/09/02_____ Title: __MANAGER_____

JR 10/9/02

UT-BATTELLE, LLC

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract: 05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.:208093

SOW No.: SW 846

BATT Sample No.	Lab Sample ID
_CD650907_____	_209440_____
_CD71007_____	_209426_____
_CF100207_____	_209451_____
_CF10807_____	_209442_____
_CF110207_____	_209443_____
_CF130807_____	_209444_____
_CF140307_____	_209445_____
_CF160807_____	_209446_____
_CF170807_____	_209447_____
_CF190807_____	_209448_____
_CF20807_____	_209449_____
_CF30807_____	_209450_____
_CF40807_____	_209452_____
_CF60807_____	_209453_____
_CF90807_____	_209454_____
_CI110207_____	_209455_____
_CI120207_____	_209456_____
_CI130207_____	_209457_____
_CI140207_____	_210182_____
_CI30707_____	_209463_____

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments:
____SEE_CASE_NARRATIVE._____

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on floppy diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: _____ Name: __MIKE_DAMMANN_____

Date: __10/09/02_____ Title: __MANAGER_____

UT-BATTELLE, LLC **010003**

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract: 05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.:208093

SOW No.: SW 846

BATT Sample No.	Lab Sample ID
CI40307	209458
CI50307	209459
CI60307	209460
CI70307	209461
CI90307	209462
CD141207S	209424S
CD71007S	209426S
CD280107S	209430S
CD650907S	209440S
CF10807S	209442S
CI30707S	209463S
CD141207D	209424D
CD71007D	209426D
CD280107D	209430D
CD650907D	209440D
CF10807D	209442D
CI30707D	209463D

Were ICP interelement corrections applied ? Yes/No YES

Were ICP background corrections applied ? Yes/No YES
If yes - were raw data generated before application of background corrections ? Yes/No NO_

Comments:
SEE_CASE_NARRATIVE.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on floppy diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: _____ Name: MIKE_DAMMANN

Date: 10/09/02 Title: MANAGER

UT-BATTELLE, LLC

010004

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD021207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209420
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _90.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	53.6	U	N	PM
7440-36-0	Antimony_	10.7	U		P_
7440-38-2	Arsenic__	10.7	U		PM
7440-39-3	Barium___	5.4	U		P_
7440-41-7	Beryllium	5.4	U	N	P_
7440-42-8	Boron____	10.7	U		P_
7440-43-9	Cadmium__	5.4	U	N	P_
7440-70-2	Calcium__	53.6	U		P_
7440-47-3	Chromium_	10.7	U	N	P_
7440-48-4	Cobalt___	5.4	U		P_
7440-50-8	Copper___	5.4	U		PM
7439-89-6	Iron_____	53.6	U	N	P_
7439-92-1	Lead_____	1.1	U		PM
7439-95-4	Magnesium	53.6	U	N	PM
7439-96-5	Manganese	10.7	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.4	U		P_
7440-02-0	Nickel___	5.4	U		P_
7782-49-2	Selenium_	10.7	U		PM
7440-21-3	Silicon__	26.8	U		P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	107	U		P_
7440-24-6	Strontium	10.7	U		P_
7440-28-0	Thallium_	11.4	_		P_
7440-29-1_	Thorium__	474000	_		P_
7440-61-1_	Uranium__	1.1	U	N	PM
7440-62-2_	Vanadium_	10.7	U	N	P_
7440-66-6_	Zinc_____	5.4	U	*	P_
7440-67-7_	Zirconium	10.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD02120712002

010005

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD031107

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209421
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	49.3	U	N	PM
7440-36-0	Antimony_	9.9	U		P_
7440-38-2	Arsenic__	9.9	U		PM
7440-39-3	Barium___	45.6			P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.9	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	49.3	U		P_
7440-47-3	Chromium_	9.9	U	N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	4.9	U		PM
7439-89-6	Iron_____	49.3	U	N	P_
7439-92-1	Lead_____	0.99	U		PM
7439-95-4	Magnesium	49.3	U	N	PM
7439-96-5	Manganese	9.9	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	4.9	U		P_
7782-49-2	Selenium_	9.9	U		PM
7440-21-3	Silicon__	24.6	U		P_
7440-22-4	Silver___	0.99	U	N	PM
7440-23-5	Sodium___	98.5	U		P_
7440-24-6	Strontium	9.9	U		P_
7440-28-0	Thallium_	9.9	U		P_
7440-29-1_	Thorium__	459000			P_
7440-61-1_	Uranium__	0.99	U	N	PM
7440-62-2_	Vanadium_	9.9	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.9	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD03110712002

UT-BATTELLE, LLC 010006

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD111107

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209422
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.9	U	N	PM
7440-36-0	Antimony_	9.8	U		P_
7440-38-2	Arsenic__	9.8	U		PM
7440-39-3	Barium___	4.9	U		P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.8	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	48.9	U		P_
7440-47-3	Chromium_	9.8	U	N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	4.9	U		PM
7439-89-6	Iron_____	48.9	U	N	P_
7439-92-1	Lead_____	0.98	U		PM
7439-95-4	Magnesium	48.9	U	N	PM
7439-96-5	Manganese	11.6		N*	P_
7439-97-6	Mercury__	0.03	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	4.9	U		P_
7782-49-2	Selenium_	9.8	U		PM
7440-21-3	Silicon__	24.4	U		P_
7440-22-4	Silver___	0.98	U	N	PM
7440-23-5	Sodium___	97.7	U		P_
7440-24-6	Strontium	9.8	U		P_
7440-28-0	Thallium_	9.8	U		P_
7440-29-1_	Thorium__	462000			P_
7440-61-1_	Uranium__	0.98	U	N	PM
7440-62-2_	Vanadium_	9.8	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD11110712002

UT-BATTELLE, LLC 010007

1 BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD121207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209423
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _90.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.3	U	N	PM
7440-36-0	Antimony_	9.7	U		P_
7440-38-2	Arsenic__	9.7	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.7	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.3	U		P_
7440-47-3	Chromium_	9.7	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	48.3	U	N	P_
7439-92-1	Lead_____	0.97	U		PM
7439-95-4	Magnesium	48.3	U	N	PM
7439-96-5	Manganese	9.7	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.7	U		PM
7440-21-3	Silicon__	24.1	U		P_
7440-22-4	Silver___	0.97	U	N	PM
7440-23-5	Sodium___	96.5	U		P_
7440-24-6	Strontium	9.7	U		P_
7440-28-0	Thallium_	9.7	U		P_
7440-29-1_	Thorium__	482000			P_
7440-61-1_	Uranium__	0.97	U	N	PM
7440-62-2_	Vanadium_	9.7	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD12120712002

UT-BATTELLE, LLC

010008

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD141207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209424
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _89.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	49.8	U	N	PM
7440-36-0	Antimony_	10	U		P_
7440-38-2	Arsenic__	10	U		PM
7440-39-3	Barium___	5.0	U		P_
7440-41-7	Beryllium	5.0	U	N	P_
7440-42-8	Boron____	10	U		P_
7440-43-9	Cadmium__	5.0	U	N	P_
7440-70-2	Calcium__	49.8	U		P_
7440-47-3	Chromium_	10	U	N	P_
7440-48-4	Cobalt___	5.0	U		P_
7440-50-8	Copper___	5.0	U		PM
7439-89-6	Iron_____	49.8	U	N	P_
7439-92-1	Lead_____	1.00	U		PM
7439-95-4	Magnesium	49.8	U	N	PM
7439-96-5	Manganese	10	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.0	U		P_
7440-02-0	Nickel___	5.0	U		P_
7782-49-2	Selenium_	10	U		PM
7440-21-3	Silicon__	24.9	U		P_
7440-22-4	Silver___	1.00	U	N	PM
7440-23-5	Sodium___	99.6	U		P_
7440-24-6	Strontium	10	U		P_
7440-28-0	Thallium_	10	U		P_
7440-29-1_	Thorium__	506000			P_
7440-61-1_	Uranium__	1.00	U	N	PM
7440-62-2_	Vanadium_	10	U	N	P_
7440-66-6_	Zinc_____	5.0	U	*	P_
7440-67-7_	Zirconium	10	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD14120712002

UT-BATTELLE, LLC

010009

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD151107

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209425

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _93.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	49.0	U	N	PM
7440-36-0	Antimony_	9.8	U		P_
7440-38-2	Arsenic__	9.8	U		PM
7440-39-3	Barium___	647			P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.8	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	49.0	U		P_
7440-47-3	Chromium_	9.8	U	N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	4.9	U		PM
7439-89-6	Iron_____	49.0	U	N	P_
7439-92-1	Lead_____	0.98	U		PM
7439-95-4	Magnesium	49.0	U	N	PM
7439-96-5	Manganese	9.8	U	N*	P_
7439-97-6	Mercury__	0.07	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	4.9	U		P_
7782-49-2	Selenium_	9.8	U		PM
7440-21-3	Silicon__	24.5	U		P_
7440-22-4	Silver___	0.98	U	N	PM
7440-23-5	Sodium___	98.0	U		P_
7440-24-6	Strontium	9.8	U		P_
7440-28-0	Thallium_	9.8	U		P_
7440-29-1_	Thorium__	467000			P_
7440-61-1_	Uranium__	0.98	U	N	PM
7440-62-2_	Vanadium_	9.8	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CD15110712002

010010

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD180907

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209427
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	43.2	U	N	PM
7440-36-0	Antimony_	8.6	U		P_
7440-38-2	Arsenic__	8.6	U		PM
7440-39-3	Barium___	4.3	U		P_
7440-41-7	Beryllium	4.3	U	N	P_
7440-42-8	Boron____	8.6	U		P_
7440-43-9	Cadmium__	4.3	U	N	P_
7440-70-2	Calcium__	43.2	U		P_
7440-47-3	Chromium_	8.6	U	N	P_
7440-48-4	Cobalt___	4.3	U		P_
7440-50-8	Copper___	4.3	U		PM
7439-89-6	Iron_____	43.2	U	N	P_
7439-92-1	Lead_____	0.86	U		PM
7439-95-4	Magnesium	43.2	U	N	PM
7439-96-5	Manganese	8.6	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.3	U		P_
7440-02-0	Nickel___	4.3	U		P_
7782-49-2	Selenium_	8.6	U		PM
7440-21-3	Silicon__	21.6	U		P_
7440-22-4	Silver___	0.86	U	N	PM
7440-23-5	Sodium___	86.4	U		P_
7440-24-6	Strontium	8.6	U		P_
7440-28-0	Thallium_	8.6	U		P_
7440-29-1_	Thorium__	468000			P_
7440-61-1_	Uranium__	0.86	U	N	PM
7440-62-2_	Vanadium_	8.6	U	N	P_
7440-66-6_	Zinc_____	4.3	U	*	P_
7440-67-7_	Zirconium	8.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD18090712002

010011

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD201007

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209428
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _91.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	49.2	U	N	PM
7440-36-0	Antimony_	9.8	U		P_
7440-38-2	Arsenic__	9.8	U		PM
7440-39-3	Barium___	295			P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.8	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	49.2	U		P_
7440-47-3	Chromium_	9.8	U	N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	4.9	U		PM
7439-89-6	Iron_____	49.2	U	N	P_
7439-92-1	Lead_____	0.98	U		PM
7439-95-4	Magnesium	49.2	U	N	PM
7439-96-5	Manganese	9.8	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	4.9	U		P_
7782-49-2	Selenium_	9.8	U		PM
7440-21-3	Silicon__	24.6	U		P_
7440-22-4	Silver___	0.98	U	N	PM
7440-23-5	Sodium___	98.5	U		P_
7440-24-6	Strontium	9.8	U		P_
7440-28-0	Thallium_	9.8	U		P_
7440-29-1_	Thorium__	468000			P_
7440-61-1_	Uranium__	0.98	U	N	PM
7440-62-2_	Vanadium_	9.8	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD20100712002

010012

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD221007

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209429
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _88.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	43.9	U	N	PM
7440-36-0	Antimony_	8.8	U		P_
7440-38-2	Arsenic__	8.8	U		PM
7440-39-3	Barium___	4.4	U		P_
7440-41-7	Beryllium	4.4	U	N	P_
7440-42-8	Boron____	8.8	U		P_
7440-43-9	Cadmium__	4.4	U	N	P_
7440-70-2	Calcium__	43.9	U		P_
7440-47-3	Chromium_	8.8	U	N	P_
7440-48-4	Cobalt___	4.4	U		P_
7440-50-8	Copper___	4.4	U		PM
7439-89-6	Iron_____	43.9	U	N	P_
7439-92-1	Lead_____	0.88	U		PM
7439-95-4	Magnesium	43.9	U	N	PM
7439-96-5	Manganese	8.8	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	4.4	U		P_
7440-02-0	Nickel___	4.4	U		P_
7782-49-2	Selenium_	8.8	U		PM
7440-21-3	Silicon__	22.0	U		P_
7440-22-4	Silver___	0.88	U	N	PM
7440-23-5	Sodium___	87.9	U		P_
7440-24-6	Strontium	8.8	U		P_
7440-28-0	Thallium_	8.8	U		P_
7440-29-1_	Thorium__	485000			P_
7440-61-1_	Uranium__	0.88	U	N	PM
7440-62-2_	Vanadium_	8.8	U	N	P_
7440-66-6_	Zinc_____	4.4	U	*	P_
7440-67-7_	Zirconium	8.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD22100712002

010013

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD280107

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209430
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	47.9	U	N	PM
7440-36-0	Antimony_	9.6	U		P
7440-38-2	Arsenic__	9.6	U		PM
7440-39-3	Barium___	4.8	U		P
7440-41-7	Beryllium	4.8	U	N	P
7440-42-8	Boron____	9.6	U		P
7440-43-9	Cadmium__	4.8	U	N	P
7440-70-2	Calcium__	47.9	U		P
7440-47-3	Chromium_	9.6	U	N	P
7440-48-4	Cobalt___	4.8	U		P
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	47.9	U	N	P
7439-92-1	Lead_____	0.96	U		PM
7439-95-4	Magnesium	47.9	U	N	PM
7439-96-5	Manganese	9.6	U	N*	P
7439-97-6	Mercury__	0.03	U		CV
7439-98-7	Molybdenu	4.8	U		P
7440-02-0	Nickel___	4.8	U		P
7782-49-2	Selenium_	9.6	U		PM
7440-21-3	Silicon__	23.9	U		P
7440-22-4	Silver___	0.96	U	N	PM
7440-23-5	Sodium___	95.8	U		P
7440-24-6	Strontium	9.6	U		P
7440-28-0	Thallium_	9.6	U		P
7440-29-1_	Thorium__	466000			P
7440-61-1_	Uranium__	0.96	U	N	PM
7440-62-2_	Vanadium_	9.6	U	N	P
7440-66-6_	Zinc_____	4.8	U	*	P
7440-67-7_	Zirconium	9.6	U		P

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD28010712002

UT-BATTELLE, LLC

010014

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD290407

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209431

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _92.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	46.3	U	N	PM
7440-36-0	Antimony_	9.3	U		P_
7440-38-2	Arsenic__	9.3	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U	N	P_
7440-42-8	Boron____	9.3	U		P_
7440-43-9	Cadmium__	4.6	U	N	P_
7440-70-2	Calcium__	46.3	U		P_
7440-47-3	Chromium_	9.3	U	N	P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	46.3	U	N	P_
7439-92-1	Lead_____	0.93	U		PM
7439-95-4	Magnesium	46.3	U	N	PM
7439-96-5	Manganese	9.3	U	N*	P_
7439-97-6	Mercury__	0.07	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	9.3	U		PM
7440-21-3	Silicon__	23.1	U		P_
7440-22-4	Silver___	0.93	U	N	PM
7440-23-5	Sodium___	156			P_
7440-24-6	Strontium	9.3	U		P_
7440-28-0	Thallium_	9.3	U		P_
7440-29-1_	Thorium__	467000			P_
7440-61-1_	Uranium__	0.93	U	N	PM
7440-62-2_	Vanadium_	9.3	U	N	P_
7440-66-6_	Zinc_____	4.6	U	*	P_
7440-67-7_	Zirconium	9.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CD29040712002

UT-BATTELLE, LLC

010015

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD302806

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209432

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _93.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	42.9	U	N	PM
7440-36-0	Antimony_	8.6	U		P_
7440-38-2	Arsenic__	8.6	U		PM
7440-39-3	Barium___	4.3	U		P_
7440-41-7	Beryllium	4.3	U	N	P_
7440-42-8	Boron____	8.6	U		P_
7440-43-9	Cadmium__	4.3	U	N	P_
7440-70-2	Calcium__	42.9	U		P_
7440-47-3	Chromium_	8.6	U	N	P_
7440-48-4	Cobalt___	4.3	U		P_
7440-50-8	Copper___	4.3	U		PM
7439-89-6	Iron_____	42.9	U	N	P_
7439-92-1	Lead_____	0.86	U		PM
7439-95-4	Magnesium	42.9	U	N	PM
7439-96-5	Manganese	8.6	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.3	U		P_
7440-02-0	Nickel___	4.3	U		P_
7782-49-2	Selenium_	8.6	U		PM
7440-21-3	Silicon__	21.4	U		P_
7440-22-4	Silver___	0.86	U	N	PM
7440-23-5	Sodium___	85.7	U		P_
7440-24-6	Strontium	8.6	U		P_
7440-28-0	Thallium_	8.6	U		P_
7440-29-1_	Thorium__	462000			P_
7440-61-1_	Uranium__	0.86	U	N	PM
7440-62-2_	Vanadium_	8.6	U	N	P_
7440-66-6_	Zinc_____	4.3	U	*	P_
7440-67-7_	Zirconium	8.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CD30280612002

010016

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD360107

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209433

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _94.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	40.9	U	N	PM
7440-36-0	Antimony_	8.2	U		P_
7440-38-2	Arsenic__	8.2	U		PM
7440-39-3	Barium___	4.1	U		P_
7440-41-7	Beryllium	4.1	U	N	P_
7440-42-8	Boron____	8.2	U		P_
7440-43-9	Cadmium__	4.1	U	N	P_
7440-70-2	Calcium__	40.9	U		P_
7440-47-3	Chromium_	8.2	U	N	P_
7440-48-4	Cobalt___	4.1	U		P_
7440-50-8	Copper___	4.1	U		PM
7439-89-6	Iron_____	40.9	U	N	P_
7439-92-1	Lead_____	0.82	U		PM
7439-95-4	Magnesium	40.9	U	N	PM
7439-96-5	Manganese	8.2	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.1	U		P_
7440-02-0	Nickel___	4.1	U		P_
7782-49-2	Selenium_	8.2	U		PM
7440-21-3	Silicon__	20.4	U		P_
7440-22-4	Silver___	0.82	U	N	PM
7440-23-5	Sodium___	81.7	U		P_
7440-24-6	Strontium	8.2	U		P_
7440-28-0	Thallium_	8.2	U		P_
7440-29-1_	Thorium__	451000			P_
7440-61-1_	Uranium__	0.82	U	N	PM
7440-62-2_	Vanadium_	8.2	U	N	P_
7440-66-6_	Zinc_____	4.1	U	*	P_
7440-67-7_	Zirconium	8.2	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CD36010712002

010017

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD371007

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209438
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	52.7	U	N	PM
7440-36-0	Antimony_	10.5	U		P_
7440-38-2	Arsenic__	10.5	U		PM
7440-39-3	Barium___	5.3	U		P_
7440-41-7	Beryllium	5.3	U	N	P_
7440-42-8	Boron____	10.5	U		P_
7440-43-9	Cadmium__	5.3	U	N	P_
7440-70-2	Calcium__	52.7	U		P_
7440-47-3	Chromium_	10.5	U	N	P_
7440-48-4	Cobalt___	5.3	U		P_
7440-50-8	Copper___	5.3	U		PM
7439-89-6	Iron_____	52.7	U	N	P_
7439-92-1	Lead_____	1.1	U		PM
7439-95-4	Magnesium	52.7	U	N	PM
7439-96-5	Manganese	10.5	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.3	U		P_
7440-02-0	Nickel___	5.3	U		P_
7782-49-2	Selenium_	10.5	U		PM
7440-21-3	Silicon__	26.3	U		P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	105	U		P_
7440-24-6	Strontium	10.5	U		P_
7440-28-0	Thallium_	10.5	U		P_
7440-29-1_	Thorium__	462000			P_
7440-61-1_	Uranium__	1.1	U	N	PM
7440-62-2_	Vanadium_	10.5	U	N	P_
7440-66-6_	Zinc_____	5.3	U	*	P_
7440-67-7_	Zirconium	10.5	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD37100712002

UT-BATTELLE, LLC **010018**

1 BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD441207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209434
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	44.9	U	N	PM
7440-36-0	Antimony_	9.0	U		P_
7440-38-2	Arsenic__	9.0	U		PM
7440-39-3	Barium___	4.5	U		P_
7440-41-7	Beryllium	4.5	U	N	P_
7440-42-8	Boron____	9.0	U		P_
7440-43-9	Cadmium__	4.5	U	N	P_
7440-70-2	Calcium__	44.9	U		P_
7440-47-3	Chromium_	9.0	U	N	P_
7440-48-4	Cobalt___	4.5	U		P_
7440-50-8	Copper___	4.5	U		PM
7439-89-6	Iron_____	44.9	U	N	P_
7439-92-1	Lead_____	0.90	U		PM
7439-95-4	Magnesium	44.9	U	N	PM
7439-96-5	Manganese	9.0	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.5	U		P_
7440-02-0	Nickel___	4.5	U		P_
7782-49-2	Selenium_	9.0	U		PM
7440-21-3	Silicon__	38.1			P_
7440-22-4	Silver___	0.90	U	N	PM
7440-23-5	Sodium___	89.8	U		P_
7440-24-6	Strontium	9.0	U		P_
7440-28-0	Thallium_	9.0	U		P_
7440-29-1_	Thorium__	468000			P_
7440-61-1_	Uranium__	0.90	U	N	PM
7440-62-2_	Vanadium_	9.0	U	N	P_
7440-66-6_	Zinc_____	4.5	U	*	P_
7440-67-7_	Zirconium	9.0	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD44120712002

UT-BATTELLE, LLC 010019

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD452706

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209435

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _93.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.2	U	N	PM
7440-36-0	Antimony_	9.6	U		P_
7440-38-2	Arsenic__	9.6	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.6	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.2	U		P_
7440-47-3	Chromium_	9.6	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	48.2	U	N	P_
7439-92-1	Lead_____	0.96	U		PM
7439-95-4	Magnesium	48.2	U	N	PM
7439-96-5	Manganese	9.6	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.6	U		PM
7440-21-3	Silicon__	24.1	U		P_
7440-22-4	Silver___	0.96	U	N	PM
7440-23-5	Sodium___	96.5	U		P_
7440-24-6	Strontium	9.6	U		P_
7440-28-0	Thallium_	9.6	U		P_
7440-29-1_	Thorium__	463000			P_
7440-61-1_	Uranium__	0.96	U	N	PM
7440-62-2_	Vanadium_	9.6	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CD45270612002

010020

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD482706

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209436
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _94.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	50.2	U	N	PM
7440-36-0	Antimony_	10.0	U		P_
7440-38-2	Arsenic__	10.0	U		PM
7440-39-3	Barium___	5.0	U		P_
7440-41-7	Beryllium	5.0	U	N	P_
7440-42-8	Boron____	10.0	U		P_
7440-43-9	Cadmium__	5.0	U	N	P_
7440-70-2	Calcium__	50.2	U		P_
7440-47-3	Chromium_	10.0	U	N	P_
7440-48-4	Cobalt___	5.0	U		P_
7440-50-8	Copper___	5.0	U		PM
7439-89-6	Iron_____	50.2	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	50.2	U	N	PM
7439-96-5	Manganese	10.0	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.0	U		P_
7440-02-0	Nickel___	5.0	U		P_
7782-49-2	Selenium_	10.0	U		PM
7440-21-3	Silicon__	25.1	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	100	U		P_
7440-24-6	Strontium	10.0	U		P_
7440-28-0	Thallium_	10.0	U		P_
7440-29-1_	Thorium__	425000			P_
7440-61-1_	Uranium__	1.0	U	N	PM
7440-62-2_	Vanadium_	10.0	U	N	P_
7440-66-6_	Zinc_____	5.0	U	*	P_
7440-67-7_	Zirconium	10.0	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD48270612002

UT-BATTELLE, LLC **010021**

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD521007

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209437
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _90.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.4	U	N	PM
7440-36-0	Antimony_	9.7	U		P_
7440-38-2	Arsenic__	9.7	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.7	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.4	U		P_
7440-47-3	Chromium_	9.7	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	48.4	U	N	P_
7439-92-1	Lead_____	0.97	U		PM
7439-95-4	Magnesium	48.4	U	N	PM
7439-96-5	Manganese	9.7	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.7	U		PM
7440-21-3	Silicon__	24.2	U		P_
7440-22-4	Silver___	0.97	U	N	PM
7440-23-5	Sodium___	96.8	U		P_
7440-24-6	Strontium	9.7	U		P_
7440-28-0	Thallium_	9.7	U		P_
7440-29-1_	Thorium__	479000			P_
7440-61-1_	Uranium__	0.97	U	N	PM
7440-62-2_	Vanadium_	9.7	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD52100712002

UT-BATTELLE, LLC

010022

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CD581207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 210181
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _97.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	45.0	U	N	PM
7440-36-0	Antimony_	9.0	U		P_
7440-38-2	Arsenic__	9.0	U		PM
7440-39-3	Barium__	4.5	U		P_
7440-41-7	Beryllium	4.5	U	N	P_
7440-42-8	Boron____	9.0	U		P_
7440-43-9	Cadmium__	4.5	U	N	P_
7440-70-2	Calcium__	45.0	U		P_
7440-47-3	Chromium_	9.0	U	N	P_
7440-48-4	Cobalt___	4.5	U		P_
7440-50-8	Copper___	4.5	U		PM
7439-89-6	Iron_____	45.0	U	N	P_
7439-92-1	Lead_____	0.90	U		PM
7439-95-4	Magnesium	45.0	U	N	PM
7439-96-5	Manganese	9.0	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.5	U		P_
7440-02-0	Nickel___	4.5	U		P_
7782-49-2	Selenium_	9.0	U		PM
7440-21-3	Silicon__	22.5	U		P_
7440-22-4	Silver___	0.90	U	N	PM
7440-23-5	Sodium___	90.1	U		P_
7440-24-6	Strontium	9.0	U		P_
7440-28-0	Thallium_	9.0	U		P_
7440-29-1_	Thorium__	428000			P_
7440-61-1_	Uranium__	0.90	U	N	PM
7440-62-2_	Vanadium_	9.0	U	N	P_
7440-66-6_	Zinc_____	4.5	U	*	P_
7440-67-7_	Zirconium	9.0	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD58120712002

010023

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD610907

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209439
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _90.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	52.0	U	N	PM
7440-36-0	Antimony_	10.4	U		P_
7440-38-2	Arsenic__	10.4	U		PM
7440-39-3	Barium___	5.2	U		P_
7440-41-7	Beryllium	5.2	U	N	P_
7440-42-8	Boron____	10.4	U		P_
7440-43-9	Cadmium__	5.2	U	N	P_
7440-70-2	Calcium__	52.0	U		P_
7440-47-3	Chromium_	10.4	U	N	P_
7440-48-4	Cobalt___	5.2	U		P_
7440-50-8	Copper___	5.2	U		PM
7439-89-6	Iron_____	52.0	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	52.0	U	N	PM
7439-96-5	Manganese	10.4	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	5.2	U		P_
7440-02-0	Nickel___	5.2	U		P_
7782-49-2	Selenium_	10.4	U		PM
7440-21-3	Silicon__	26.0	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	104	U		P_
7440-24-6	Strontium	10.4	U		P_
7440-28-0	Thallium_	10.4	U		P_
7440-29-1_	Thorium__	476000			P_
7440-61-1_	Uranium__	1.0	U	N	PM
7440-62-2_	Vanadium_	10.4	U	N	P_
7440-66-6_	Zinc_____	5.2	U	*	P_
7440-67-7_	Zirconium	10.4	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD61090712002

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CD650907

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209440
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _88.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	46.3	U	N	PM
7440-36-0	Antimony_	9.3	U		P_
7440-38-2	Arsenic__	9.3	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U	N	P_
7440-42-8	Boron____	9.3	U		P_
7440-43-9	Cadmium__	4.6	U	N	P_
7440-70-2	Calcium__	46.3	U		P_
7440-47-3	Chromium_	9.3	U	N	P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	46.3	U	N	P_
7439-92-1	Lead_____	0.93	U		PM
7439-95-4	Magnesium	46.3	U	N	PM
7439-96-5	Manganese	9.3	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	9.3	U		PM
7440-21-3	Silicon__	23.2	U		P_
7440-22-4	Silver___	0.93	U	N	PM
7440-23-5	Sodium___	92.6	U		P_
7440-24-6	Strontium	9.3	U		P_
7440-28-0	Thallium_	9.3	U		P_
7440-29-1_	Thorium__	509000			P_
7440-61-1_	Uranium__	0.93	U	N	PM
7440-62-2_	Vanadium_	9.3	U	N	P_
7440-66-6_	Zinc_____	4.6	U	*	P_
7440-67-7_	Zirconium	9.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD65090712002

010025

UT-BATTELLE, LLC

CD171007

BATT SAMPLE NO.

1

INORGANIC ANALYSES DATA SHEET

~~CD71007~~

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209426
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _84.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	58.3	U	N	PM
7440-36-0	Antimony_	11.7	U		P_
7440-38-2	Arsenic__	11.7	U		PM
7440-39-3	Barium___	5.8	U		P_
7440-41-7	Beryllium	5.8	U	N	P_
7440-42-8	Boron____	11.7	U		P_
7440-43-9	Cadmium__	5.8	U	N	P_
7440-70-2	Calcium__	58.3	U		P_
7440-47-3	Chromium_	11.7	U	N	P_
7440-48-4	Cobalt___	5.8	U		P_
7440-50-8	Copper___	5.8	U		PM
7439-89-6	Iron_____	58.3	U	N	P_
7439-92-1	Lead_____	1.2	U		PM
7439-95-4	Magnesium	58.3	U	N	PM
7439-96-5	Manganese	11.7	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.8	U		P_
7440-02-0	Nickel___	5.8	U		P_
7782-49-2	Selenium_	11.7	U		PM
7440-21-3	Silicon__	29.1	U		P_
7440-22-4	Silver___	1.2	U	N	PM
7440-23-5	Sodium___	117	U		P_
7440-24-6	Strontium	11.7	U		P_
7440-28-0	Thallium_	11.7	U		P_
7440-29-1_	Thorium__	518000			P_
7440-61-1_	Uranium__	1.2	U	N	PM
7440-62-2_	Vanadium_	11.7	U	N	P_
7440-66-6_	Zinc_____	5.8	U	*	P_
7440-67-7_	Zirconium	11.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CD7100712002

UT-BATTELLE, LLC

010026

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF100207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209451
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _81.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	50.5	U	N	PM
7440-36-0	Antimony_	10.1	U		P_
7440-38-2	Arsenic__	10.1	U		PM
7440-39-3	Barium___	5.0	U		P_
7440-41-7	Beryllium	5.0	U	N	P_
7440-42-8	Boron____	10.1	U		P_
7440-43-9	Cadmium__	5.0	U	N	P_
7440-70-2	Calcium__	50.5	U		P_
7440-47-3	Chromium_	10.1	U	N	P_
7440-48-4	Cobalt___	5.0	U		P_
7440-50-8	Copper___	5.0	U		PM
7439-89-6	Iron_____	50.5	U	N	P_
7439-92-1	Lead_____	9.3			PM
7439-95-4	Magnesium	50.5	U	N	PM
7439-96-5	Manganese	10.1	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.0	U		P_
7440-02-0	Nickel___	6.0			P_
7782-49-2	Selenium_	10.1	U		PM
7440-21-3	Silicon__	25.2	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	472			P_
7440-24-6	Strontium	10.1	U		P_
7440-28-0	Thallium_	10.1	U		P_
7440-29-1_	Thorium__	522000			P_
7440-61-1_	Uranium__	35.4		N	PM
7440-62-2_	Vanadium_	10.1	U	N	P_
7440-66-6_	Zinc_____	5.0	U	*	P_
7440-67-7_	Zirconium	10.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF10020712002

UT-BATTELLE, LLC

010027

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF10807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209442

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _94.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	43.2	U	N	PM
7440-36-0	Antimony_	8.6	U		P_
7440-38-2	Arsenic__	8.6	U		PM
7440-39-3	Barium___	4.3	U		P_
7440-41-7	Beryllium	4.3	U	N	P_
7440-42-8	Boron____	8.6	U		P_
7440-43-9	Cadmium__	4.3	U	N	P_
7440-70-2	Calcium__	43.2	U		P_
7440-47-3	Chromium_	8.6	U	N	P_
7440-48-4	Cobalt___	4.3	U		P_
7440-50-8	Copper___	4.3	U		PM
7439-89-6	Iron_____	43.2	U	N	P_
7439-92-1	Lead_____	0.86	U		PM
7439-95-4	Magnesium	43.2	U	N	PM
7439-96-5	Manganese	8.6	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.3	U		P_
7440-02-0	Nickel___	4.3	U		P_
7782-49-2	Selenium_	8.6	U		PM
7440-21-3	Silicon__	21.6	U		P_
7440-22-4	Silver___	0.86	U	N	PM
7440-23-5	Sodium___	422			P_
7440-24-6	Strontium	8.6	U		P_
7440-28-0	Thallium_	8.6	U		P_
7440-29-1_	Thorium__	434000			P_
7440-61-1_	Uranium__	13.5		N	PM
7440-62-2_	Vanadium_	8.6	U	N	P_
7440-66-6_	Zinc_____	4.3	U	*	P_
7440-67-7_	Zirconium	8.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CF1080712002

UT-BATTELLE, LLC

010028

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF110207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209443
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	45.7	U	N	PM
7440-36-0	Antimony_	9.1	U		P_
7440-38-2	Arsenic__	9.1	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U	N	P_
7440-42-8	Boron____	9.1	U		P_
7440-43-9	Cadmium__	4.6	U	N	P_
7440-70-2	Calcium__	45.7	U		P_
7440-47-3	Chromium_	9.1	U	N	P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	4.6	U		PM
7439-89-6	Iron_____	45.7	U	N	P_
7439-92-1	Lead_____	2.5			PM
7439-95-4	Magnesium	45.7	U	N	PM
7439-96-5	Manganese	9.1	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	9.1	U		PM
7440-21-3	Silicon__	22.9	U		P_
7440-22-4	Silver___	0.91	U	N	PM
7440-23-5	Sodium___	176			P_
7440-24-6	Strontium	9.1	U		P_
7440-28-0	Thallium_	9.1	U		P_
7440-29-1_	Thorium__	460000			P_
7440-61-1_	Uranium__	17.5		N	PM
7440-62-2_	Vanadium_	9.1	U	N	P_
7440-66-6_	Zinc_____	4.6	U	*	P_
7440-67-7_	Zirconium	9.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF11020712002

010029

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF130807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209444
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.1	U	N	PM
7440-36-0	Antimony_	9.6	U		P_
7440-38-2	Arsenic__	9.6	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.6	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.1	U		P_
7440-47-3	Chromium_	9.6	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	48.1	U	N	P_
7439-92-1	Lead_____	6.0			PM
7439-95-4	Magnesium	48.1	U	N	PM
7439-96-5	Manganese	9.6	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.6	U		PM
7440-21-3	Silicon__	24.1	U		P_
7440-22-4	Silver___	0.96	U	N	PM
7440-23-5	Sodium___	273			P_
7440-24-6	Strontium	9.6	U		P_
7440-28-0	Thallium_	9.6	U		P_
7440-29-1_	Thorium__	488000			P_
7440-61-1_	Uranium__	34.6		N	PM
7440-62-2_	Vanadium_	9.6	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF13080712002

UT-BATTELLE, LLC

010030

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF140307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209445

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _91.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	44.0	U	N	PM
7440-36-0	Antimony_	8.8	U		P_
7440-38-2	Arsenic__	8.8	U		PM
7440-39-3	Barium___	4.4	U		P_
7440-41-7	Beryllium	4.4	U	N	P_
7440-42-8	Boron____	8.8	U		P_
7440-43-9	Cadmium__	4.4	U	N	P_
7440-70-2	Calcium__	44.0	U		P_
7440-47-3	Chromium_	8.8	U	N	P_
7440-48-4	Cobalt___	4.4	U		P_
7440-50-8	Copper___	4.4	U		PM
7439-89-6	Iron_____	44.0	U	N	P_
7439-92-1	Lead_____	15.0			PM
7439-95-4	Magnesium	44.0	U	N	PM
7439-96-5	Manganese	8.8	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.4	U		P_
7440-02-0	Nickel___	6.2			P_
7782-49-2	Selenium_	8.8	U		PM
7440-21-3	Silicon__	22.0	U		P_
7440-22-4	Silver___	0.88	U	N	PM
7440-23-5	Sodium___	819			P_
7440-24-6	Strontium	8.8	U		P_
7440-28-0	Thallium_	8.8	U		P_
7440-29-1_	Thorium__	456000			P_
7440-61-1_	Uranium__	24.8		N	PM
7440-62-2_	Vanadium_	8.8	U	N	P_
7440-66-6_	Zinc_____	4.4	U	*	P_
7440-67-7_	Zirconium	8.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CF14030712002

UT-BATTELLE, LLC **010031**

1 BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF160807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209446
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _83.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	51.6	U	N	PM
7440-36-0	Antimony_	10.3	U		P_
7440-38-2	Arsenic__	10.3	U		PM
7440-39-3	Barium___	5.2	U		P_
7440-41-7	Beryllium	5.2	U	N	P_
7440-42-8	Boron____	10.3	U		P_
7440-43-9	Cadmium__	5.2	U	N	P_
7440-70-2	Calcium__	51.6	U		P_
7440-47-3	Chromium_	10.3	U	N	P_
7440-48-4	Cobalt___	5.2	U		P_
7440-50-8	Copper___	5.2	U		PM
7439-89-6	Iron_____	51.6	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	51.6	U	N	PM
7439-96-5	Manganese	10.3	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.2	U		P_
7440-02-0	Nickel___	5.2	U		P_
7782-49-2	Selenium_	10.3	U		PM
7440-21-3	Silicon__	25.8	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	171			P_
7440-24-6	Strontium	10.3	U		P_
7440-28-0	Thallium_	10.3	U		P_
7440-29-1_	Thorium__	516000			P_
7440-61-1_	Uranium__	7.8		N	PM
7440-62-2_	Vanadium_	10.3	U	N	P_
7440-66-6_	Zinc_____	5.2	U	*	P_
7440-67-7_	Zirconium	10.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF16080712002

UT-BATTELLE, LLC

010032

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF170807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209447
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	42.4	U	N	PM
7440-36-0	Antimony_	8.5	U		P_
7440-38-2	Arsenic__	8.5	U		PM
7440-39-3	Barium___	4.2	U		P_
7440-41-7	Beryllium	4.2	U	N	P_
7440-42-8	Boron____	8.5	U		P_
7440-43-9	Cadmium__	4.2	U	N	P_
7440-70-2	Calcium__	42.4	U		P_
7440-47-3	Chromium_	8.5	U	N	P_
7440-48-4	Cobalt___	4.2	U		P_
7440-50-8	Copper___	4.2	U		PM
7439-89-6	Iron_____	42.4	U	N	P_
7439-92-1	Lead_____	2.5			PM
7439-95-4	Magnesium	42.4	U	N	PM
7439-96-5	Manganese	8.5	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.2	U		P_
7440-02-0	Nickel___	4.2	U		P_
7782-49-2	Selenium_	8.5	U		PM
7440-21-3	Silicon__	21.2	U		P_
7440-22-4	Silver___	0.85	U	N	PM
7440-23-5	Sodium___	530			P_
7440-24-6	Strontium	8.5	U		P_
7440-28-0	Thallium_	8.5	U		P_
7440-29-1_	Thorium__	471000			P_
7440-61-1_	Uranium__	28.8		N	PM
7440-62-2_	Vanadium_	8.5	U	N	P_
7440-66-6_	Zinc_____	4.2	U	*	P_
7440-67-7_	Zirconium	8.5	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF17080712002

UT-BATTELLE, LLC

010033

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF190807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209448
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _89.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	52.0	U	N	PM
7440-36-0	Antimony_	10.4	U		P_
7440-38-2	Arsenic__	10.4	U		PM
7440-39-3	Barium___	5.2	U		P_
7440-41-7	Beryllium	5.2	U	N	P_
7440-42-8	Boron____	10.4	U		P_
7440-43-9	Cadmium__	5.2	U	N	P_
7440-70-2	Calcium__	52.0	U		P_
7440-47-3	Chromium_	16.3		N	P_
7440-48-4	Cobalt___	5.2	U		P_
7440-50-8	Copper___	5.2	U		PM
7439-89-6	Iron_____	52.0	U	N	P_
7439-92-1	Lead_____	7.5			PM
7439-95-4	Magnesium	52.0	U	N	PM
7439-96-5	Manganese	10.4	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.2	U		P_
7440-02-0	Nickel___	9.4			P_
7782-49-2	Selenium_	10.4	U		PM
7440-21-3	Silicon__	26.0	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	250			P_
7440-24-6	Strontium	10.4	U		P_
7440-28-0	Thallium_	10.4	U		P_
7440-29-1_	Thorium__	460000			P_
7440-61-1_	Uranium__	24.3		N	PM
7440-62-2_	Vanadium_	10.4	U	N	P_
7440-66-6_	Zinc_____	5.2	U	*	P_
7440-67-7_	Zirconium	12.1			P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF19080712002

UT-BATTELLE, LLC 010034

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CF20807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209449
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _86.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	48.4	U	N	PM
7440-36-0	Antimony_	9.7	U		P_
7440-38-2	Arsenic__	9.7	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.7	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.4	U		P_
7440-47-3	Chromium_	9.7	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	4.8	U		PM
7439-89-6	Iron_____	48.4	U	N	P_
7439-92-1	Lead_____	11.9			PM
7439-95-4	Magnesium	48.4	U	N	PM
7439-96-5	Manganese	9.7	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.7	U		PM
7440-21-3	Silicon__	24.2	U		P_
7440-22-4	Silver___	0.97	U	N	PM
7440-23-5	Sodium___	232			P_
7440-24-6	Strontium	9.7	U		P_
7440-28-0	Thallium_	9.7	U		P_
7440-29-1_	Thorium__	495000			P_
7440-61-1_	Uranium__	22.7		N	PM
7440-62-2_	Vanadium_	9.7	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF2080712002

UT-BATTELLE, LLC

010035
BATT SAMPLE NO.

1
INORGANIC ANALYSES DATA SHEET

CF30807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209450
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _80.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	53.4	U	N	PM
7440-36-0	Antimony_	10.7	U		P_
7440-38-2	Arsenic__	10.7	U		PM
7440-39-3	Barium___	5.3	U		P_
7440-41-7	Beryllium	5.3	U	N	P_
7440-42-8	Boron____	10.7	U		P_
7440-43-9	Cadmium__	5.3	U	N	P_
7440-70-2	Calcium__	53.4	U		P_
7440-47-3	Chromium_	10.7	U	N	P_
7440-48-4	Cobalt___	5.3	U		P_
7440-50-8	Copper___	5.3	U		PM
7439-89-6	Iron_____	53.4	U	N	P_
7439-92-1	Lead_____	4.3			PM
7439-95-4	Magnesium	53.4	U	N	PM
7439-96-5	Manganese	10.7	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.3	U		P_
7440-02-0	Nickel___	5.3	U		P_
7782-49-2	Selenium_	10.7	U		PM
7440-21-3	Silicon__	26.7	U		P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	356			P_
7440-24-6	Strontium	10.7	U		P_
7440-28-0	Thallium_	10.7	U		P_
7440-29-1_	Thorium__	517000			P_
7440-61-1_	Uranium__	18.9		N	PM
7440-62-2_	Vanadium_	10.7	U	N	P_
7440-66-6_	Zinc_____	5.3	U	*	P_
7440-67-7_	Zirconium	10.7	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF3080712002

010036

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF40807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209452
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _80.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	54.1	U	N	PM
7440-36-0	Antimony_	10.8	U		P_
7440-38-2	Arsenic__	10.8	U		PM
7440-39-3	Barium___	5.4	U		P_
7440-41-7	Beryllium	5.4	U	N	P_
7440-42-8	Boron____	10.8	U		P_
7440-43-9	Cadmium__	5.4	U	N	P_
7440-70-2	Calcium__	54.1	U		P_
7440-47-3	Chromium_	10.8	U	N	P_
7440-48-4	Cobalt___	5.4	U		P_
7440-50-8	Copper___	5.4	U		PM
7439-89-6	Iron_____	54.1	U	N	P_
7439-92-1	Lead_____	7.7			PM
7439-95-4	Magnesium	54.1	U	N	PM
7439-96-5	Manganese	10.8	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.4	U		P_
7440-02-0	Nickel___	5.4	U		P_
7782-49-2	Selenium_	10.8	U		PM
7440-21-3	Silicon__	27.0	U		P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	236			P_
7440-24-6	Strontium	10.8	U		P_
7440-28-0	Thallium_	10.8	U		P_
7440-29-1_	Thorium__	529000			P_
7440-61-1_	Uranium__	35.9		N	PM
7440-62-2_	Vanadium_	10.8	U	N	P_
7440-66-6_	Zinc_____	5.4	U	*	P_
7440-67-7_	Zirconium	10.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF4080712002

010037

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF60807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209453
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _83.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	51.7	U	N	PM
7440-36-0	Antimony_	10.3	U		P_
7440-38-2	Arsenic__	10.3	U		PM
7440-39-3	Barium___	5.2	U		P_
7440-41-7	Beryllium	5.2	U	N	P_
7440-42-8	Boron____	10.3	U		P_
7440-43-9	Cadmium__	5.2	U	N	P_
7440-70-2	Calcium__	51.7	U		P_
7440-47-3	Chromium_	10.3	U	N	P_
7440-48-4	Cobalt___	5.2	U		P_
7440-50-8	Copper___	5.2	U		PM
7439-89-6	Iron_____	51.7	U	N	P_
7439-92-1	Lead_____	2.2			PM
7439-95-4	Magnesium	51.7	U	N	PM
7439-96-5	Manganese	10.3	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	5.2	U		P_
7440-02-0	Nickel___	5.2	U		P_
7782-49-2	Selenium_	10.3	U		PM
7440-21-3	Silicon__	25.9	U		P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	597			P_
7440-24-6	Strontium	10.3	U		P_
7440-28-0	Thallium_	10.3	U		P_
7440-29-1_	Thorium__	511000			P_
7440-61-1_	Uranium__	11.4		N	PM
7440-62-2_	Vanadium_	10.3	U	N	P_
7440-66-6_	Zinc_____	5.2	U	*	P_
7440-67-7_	Zirconium	10.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF6080712002

010038

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CF90807

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209454
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	49.3	U	N	PM
7440-36-0	Antimony_	9.9	U		P_
7440-38-2	Arsenic__	9.9	U		PM
7440-39-3	Barium___	4.9	U		P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.9	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	49.3	U		P_
7440-47-3	Chromium_	10.6		N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	4.9	U		PM
7439-89-6	Iron_____	49.3	U	N	P_
7439-92-1	Lead_____	5.8			PM
7439-95-4	Magnesium	49.3	U	N	PM
7439-96-5	Manganese	9.9	U	N*	P_
7439-97-6	Mercury__	0.00	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	5.7			P_
7782-49-2	Selenium_	9.9	U		PM
7440-21-3	Silicon__	24.6	U		P_
7440-22-4	Silver___	0.99	U	N	PM
7440-23-5	Sodium___	213			P_
7440-24-6	Strontium	9.9	U		P_
7440-28-0	Thallium_	9.9	U		P_
7440-29-1_	Thorium__	466000			P_
7440-61-1_	Uranium__	46.3		N	PM
7440-62-2_	Vanadium_	9.9	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.9	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CF9080712002

UT-BATTELLE, LLC

010039

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CI110207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209455
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _95.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	47.6	U	N	PM
7440-36-0	Antimony_	9.5	U		P_
7440-38-2	Arsenic__	9.5	U		PM
7440-39-3	Barium__	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron___	9.5	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	47.6	U		P_
7440-47-3	Chromium_	9.5	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	14.1			PM
7439-89-6	Iron____	47.6	U	N	P_
7439-92-1	Lead____	5.0			PM
7439-95-4	Magnesium	47.6	U	N	PM
7439-96-5	Manganese	9.5	U	N*	P_
7439-97-6	Mercury__	0.02	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.5	U		PM
7440-21-3	Silicon__	35.5			P_
7440-22-4	Silver___	0.95	U	N	PM
7440-23-5	Sodium___	95.2	U		P_
7440-24-6	Strontium	9.5	U		P_
7440-28-0	Thallium_	9.5	U		P_
7440-29-1_	Thorium__	472000			P_
7440-61-1_	Uranium__	0.95	U	N	PM
7440-62-2_	Vanadium_	9.5	U	N	P_
7440-66-6_	Zinc____	4.8	U	*	P_
7440-67-7_	Zirconium	9.5	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI11020712002

UT-BATTELLE, LLC

010040

1

BATT SAMPLE NO.

INORGANIC ANALYSES DATA SHEET

CI120207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209456
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _94.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	72.7		N	PM
7440-36-0	Antimony_	9.8	U		P_
7440-38-2	Arsenic__	9.8	U		PM
7440-39-3	Barium___	19.6			P_
7440-41-7	Beryllium	4.9	U	N	P_
7440-42-8	Boron____	9.8	U		P_
7440-43-9	Cadmium__	4.9	U	N	P_
7440-70-2	Calcium__	48.8	U		P_
7440-47-3	Chromium_	9.8	U	N	P_
7440-48-4	Cobalt___	4.9	U		P_
7440-50-8	Copper___	7.6			PM
7439-89-6	Iron_____	48.8	U	N	P_
7439-92-1	Lead_____	0.98	U		PM
7439-95-4	Magnesium	48.8	U	N	PM
7439-96-5	Manganese	9.8	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.9	U		P_
7440-02-0	Nickel___	4.9	U		P_
7782-49-2	Selenium_	9.8	U		PM
7440-21-3	Silicon__	24.4	U		P_
7440-22-4	Silver___	0.98	U	N	PM
7440-23-5	Sodium___	97.7	U		P_
7440-24-6	Strontium	9.8	U		P_
7440-28-0	Thallium_	9.8	U		P_
7440-29-1_	Thorium__	468000			P_
7440-61-1_	Uranium__	0.98	U	N	PM
7440-62-2_	Vanadium_	9.8	U	N	P_
7440-66-6_	Zinc_____	4.9	U	*	P_
7440-67-7_	Zirconium	9.8	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI12020712002

010041

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI130207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209457
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _85.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	193		N	PM
7440-36-0	Antimony_	11.4	U		P_
7440-38-2	Arsenic__	11.4	U		PM
7440-39-3	Barium___	5.7	U		P_
7440-41-7	Beryllium	5.7	U	N	P_
7440-42-8	Boron____	11.4	U		P_
7440-43-9	Cadmium__	5.7	U	N	P_
7440-70-2	Calcium__	56.9	U		P_
7440-47-3	Chromium_	11.4	U	N	P_
7440-48-4	Cobalt___	5.7	U		P_
7440-50-8	Copper___	8.7			PM
7439-89-6	Iron_____	56.9	U	N	P_
7439-92-1	Lead_____	1.1	U		PM
7439-95-4	Magnesium	56.9	U	N	PM
7439-96-5	Manganese	11.4	U	N*	P_
7439-97-6	Mercury__	0.06	U		CV
7439-98-7	Molybdenu	5.7	U		P_
7440-02-0	Nickel___	5.7	U		P_
7782-49-2	Selenium_	11.4	U		PM
7440-21-3	Silicon__	80.2			P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	114	U		P_
7440-24-6	Strontium	11.4	U		P_
7440-28-0	Thallium_	11.4	U		P_
7440-29-1_	Thorium__	520000			P_
7440-61-1_	Uranium__	1.1	U	N	PM
7440-62-2_	Vanadium_	11.4	U	N	P_
7440-66-6_	Zinc_____	5.7	U	*	P_
7440-67-7_	Zirconium	11.4	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI13020712002

010042

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI140207

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 210182
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _92.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	131		N	PM
7440-36-0	Antimony_	10.1	U		P_
7440-38-2	Arsenic__	10.1	U		PM
7440-39-3	Barium___	5.5			P_
7440-41-7	Beryllium	5.0	U	N	P_
7440-42-8	Boron____	10.1	U		P_
7440-43-9	Cadmium__	5.0	U	N	P_
7440-70-2	Calcium__	50.4	U		P_
7440-47-3	Chromium_	10.1	U	N	P_
7440-48-4	Cobalt___	5.0	U		P_
7440-50-8	Copper___	9.7			PM
7439-89-6	Iron_____	50.4	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	50.4	U	N	PM
7439-96-5	Manganese	10.1	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	5.0	U		P_
7440-02-0	Nickel___	5.0	U		P_
7782-49-2	Selenium_	10.1	U		PM
7440-21-3	Silicon__	38.2			P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	101	U		P_
7440-24-6	Strontium	10.1	U		P_
7440-28-0	Thallium_	10.1	U		P_
7440-29-1_	Thorium__	482000			P_
7440-61-1_	Uranium__	1.0	U	N	PM
7440-62-2_	Vanadium_	10.1	U	N	P_
7440-66-6_	Zinc_____	5.0	U	*	P_
7440-67-7_	Zirconium	10.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI14020712002

010043

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI30707

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209463
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _85.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	86.8		N	PM
7440-36-0	Antimony_	11.2	U		P_
7440-38-2	Arsenic__	11.2	U		PM
7440-39-3	Barium___	5.7			P_
7440-41-7	Beryllium	5.6	U	N	P_
7440-42-8	Boron____	11.2	U		P_
7440-43-9	Cadmium__	5.6	U	N	P_
7440-70-2	Calcium__	55.8	U		P_
7440-47-3	Chromium_	11.2	U	N	P_
7440-48-4	Cobalt___	5.6	U		P_
7440-50-8	Copper___	8.4			PM
7439-89-6	Iron_____	55.8	U	N	P_
7439-92-1	Lead_____	1.1	U		PM
7439-95-4	Magnesium	55.8	U	N	PM
7439-96-5	Manganese	11.2	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	5.6	U		P_
7440-02-0	Nickel___	5.6	U		P_
7782-49-2	Selenium_	11.2	U		PM
7440-21-3	Silicon__	108			P_
7440-22-4	Silver___	1.1	U	N	PM
7440-23-5	Sodium___	112	U		P_
7440-24-6	Strontium	11.2	U		P_
7440-28-0	Thallium_	11.2	U		P_
7440-29-1_	Thorium__	524000			P_
7440-61-1_	Uranium__	1.1	U	N	PM
7440-62-2_	Vanadium_	11.2	U	N	P_
7440-66-6_	Zinc_____	5.6	U	*	P_
7440-67-7_	Zirconium	11.2	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI3070712002

UT-BATTELLE, LLC

010044

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI40307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006

Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093

Matrix (soil/water): SOIL_ Lab Sample ID: 209458

Level (low/med): LOW__ Date Received: 07/17/02

% Solids: _87.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	72.8		N	PM
7440-36-0	Antimony_	9.0	U		P_
7440-38-2	Arsenic__	9.0	U		PM
7440-39-3	Barium___	4.5	U		P_
7440-41-7	Beryllium	4.5	U	N	P_
7440-42-8	Boron____	9.0	U		P_
7440-43-9	Cadmium__	4.5	U	N	P_
7440-70-2	Calcium__	44.8	U		P_
7440-47-3	Chromium_	9.0	U	N	P_
7440-48-4	Cobalt___	4.5	U		P_
7440-50-8	Copper___	6.1			PM
7439-89-6	Iron_____	44.8	U	N	P_
7439-92-1	Lead_____	0.90	U		PM
7439-95-4	Magnesium	44.8	U	N	PM
7439-96-5	Manganese	9.0	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.5	U		P_
7440-02-0	Nickel___	4.5	U		P_
7782-49-2	Selenium_	9.0	U		PM
7440-21-3	Silicon__	37.1			P_
7440-22-4	Silver___	0.90	U	N	PM
7440-23-5	Sodium___	89.6	U		P_
7440-24-6	Strontium	9.0	U		P_
7440-28-0	Thallium_	9.0	U		P_
7440-29-1_	Thorium__	533000			P_
7440-61-1_	Uranium__	0.90	U	N	PM
7440-62-2_	Vanadium_	9.0	U	N	P_
7440-66-6_	Zinc_____	4.5	U	*	P_
7440-67-7_	Zirconium	9.0	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

SAMPLE_ID:_CI4030712002

010045

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI50307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209459
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	467		N	PM
7440-36-0	Antimony_	9.1	U		P_
7440-38-2	Arsenic__	9.1	U		PM
7440-39-3	Barium___	4.6	U		P_
7440-41-7	Beryllium	4.6	U	N	P_
7440-42-8	Boron____	9.1	U		P_
7440-43-9	Cadmium__	4.6	U	N	P_
7440-70-2	Calcium__	45.6	U		P_
7440-47-3	Chromium_	9.1	U	N	P_
7440-48-4	Cobalt___	4.6	U		P_
7440-50-8	Copper___	9.6			PM
7439-89-6	Iron_____	45.6	U	N	P_
7439-92-1	Lead_____	0.91	U		PM
7439-95-4	Magnesium	45.6	U	N	PM
7439-96-5	Manganese	9.1	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	4.6	U		P_
7440-02-0	Nickel___	4.6	U		P_
7782-49-2	Selenium_	9.1	U		PM
7440-21-3	Silicon__	81.9			P_
7440-22-4	Silver___	0.91	U	N	PM
7440-23-5	Sodium___	91.2	U		P_
7440-24-6	Strontium	9.1	U		P_
7440-28-0	Thallium_	9.1	U		P_
7440-29-1_	Thorium__	496000			P_
7440-61-1_	Uranium__	0.91	U	N	PM
7440-62-2_	Vanadium_	9.1	U	N	P_
7440-66-6_	Zinc_____	4.6	U	*	P_
7440-67-7_	Zirconium	9.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI5030712002

010046

UT-BATTELLE, LLC

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI60307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209460
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	91.6		N	PM
7440-36-0	Antimony_	10.1	U		P_
7440-38-2	Arsenic__	10.1	U		PM
7440-39-3	Barium___	5.1	U		P_
7440-41-7	Beryllium	5.1	U	N	P_
7440-42-8	Boron____	10.1	U		P_
7440-43-9	Cadmium__	5.1	U	N	P_
7440-70-2	Calcium__	50.6	U		P_
7440-47-3	Chromium_	10.1	U	N	P_
7440-48-4	Cobalt___	5.1	U		P_
7440-50-8	Copper___	12.1			PM
7439-89-6	Iron_____	50.6	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	50.6	U	N	PM
7439-96-5	Manganese	10.1	U	N*	P_
7439-97-6	Mercury__	0.05	U		CV
7439-98-7	Molybdenu	5.1	U		P_
7440-02-0	Nickel___	5.1	U		P_
7782-49-2	Selenium_	10.1	U		PM
7440-21-3	Silicon__	88.6			P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	101	U		P_
7440-24-6	Strontium	10.1	U		P_
7440-28-0	Thallium_	10.1	U		P_
7440-29-1_	Thorium__	478000			P_
7440-61-1_	Uranium__	1.0	U	N	PM
7440-62-2_	Vanadium_	10.1	U	N	P_
7440-66-6_	Zinc_____	5.1	U	*	P_
7440-67-7_	Zirconium	10.1	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI6030712002

UT-BATTELLE, LLC

010047

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI70307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209461
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	187		N	PM
7440-36-0	Antimony_	10.3	U		P_
7440-38-2	Arsenic__	10.3	U		PM
7440-39-3	Barium___	14.3			P_
7440-41-7	Beryllium	5.1	U	N	P_
7440-42-8	Boron____	10.3	U		P_
7440-43-9	Cadmium__	5.1	U	N	P_
7440-70-2	Calcium__	51.3	U		P_
7440-47-3	Chromium_	10.3	U	N	P_
7440-48-4	Cobalt___	5.1	U		P_
7440-50-8	Copper___	5.1	U		PM
7439-89-6	Iron_____	51.3	U	N	P_
7439-92-1	Lead_____	1.0	U		PM
7439-95-4	Magnesium	51.3	U	N	PM
7439-96-5	Manganese	10.3	U	N*	P_
7439-97-6	Mercury__	0.03	U		CV
7439-98-7	Molybdenu	5.1	U		P_
7440-02-0	Nickel___	5.1	U		P_
7782-49-2	Selenium_	10.3	U		PM
7440-21-3	Silicon__	120			P_
7440-22-4	Silver___	1.0	U	N	PM
7440-23-5	Sodium___	119			P_
7440-24-6	Strontium	10.3	U		P_
7440-28-0	Thallium_	10.3	U		P_
7440-29-1_	Thorium__	450000			P_
7440-61-1_	Uranium__	1.0	U	N	PM
7440-62-2_	Vanadium_	10.3	U	N	P_
7440-66-6_	Zinc_____	5.1	U	*	P_
7440-67-7_	Zirconium	10.3	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI7030712002

UT-BATTELLE, LLC **010048**

1

INORGANIC ANALYSES DATA SHEET

BATT SAMPLE NO.

CI90307

Lab Name: SOUTHWEST_RESEARCH_INSTIT Contract:05421.01.006
Lab Code: SWRI__ Case No.: DLA__ WO No.: 22835_ SDG No.: 208093
Matrix (soil/water): SOIL_ Lab Sample ID: 209462
Level (low/med): LOW__ Date Received: 07/17/02
% Solids: _93.1

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_	178		N	PM
7440-36-0	Antimony_	9.6	U		P_
7440-38-2	Arsenic__	9.6	U		PM
7440-39-3	Barium___	4.8	U		P_
7440-41-7	Beryllium	4.8	U	N	P_
7440-42-8	Boron____	9.6	U		P_
7440-43-9	Cadmium__	4.8	U	N	P_
7440-70-2	Calcium__	48.0	U		P_
7440-47-3	Chromium_	9.6	U	N	P_
7440-48-4	Cobalt___	4.8	U		P_
7440-50-8	Copper___	9.2			PM
7439-89-6	Iron_____	48.0	U	N	P_
7439-92-1	Lead_____	0.96	U		PM
7439-95-4	Magnesium	48.0	U	N	PM
7439-96-5	Manganese	9.6	U	N*	P_
7439-97-6	Mercury__	0.04	U		CV
7439-98-7	Molybdenu	4.8	U		P_
7440-02-0	Nickel___	4.8	U		P_
7782-49-2	Selenium_	9.6	U		PM
7440-21-3	Silicon__	117			P_
7440-22-4	Silver___	0.96	U	N	PM
7440-23-5	Sodium___	95.9	U		P_
7440-24-6	Strontium	9.6	U		P_
7440-28-0	Thallium_	9.6	U		P_
7440-29-1_	Thorium__	475000			P_
7440-61-1_	Uranium__	0.96	U	N	PM
7440-62-2_	Vanadium_	9.6	U	N	P_
7440-66-6_	Zinc_____	4.8	U	*	P_
7440-67-7_	Zirconium	9.6	U		P_

Color Before: _____ Clarity Before: _____ Texture: _____
Color After: _____ Clarity After: _____ Artifacts: _____

Comments:
SAMPLE_ID:_CI9030712002

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006

ALPHA SPEC ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006

SAMPLE DATA

SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET 030001

Sample ID
HD0807061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208093

Client: UT-Battelle, LLC.

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				120%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	1.86	B	0.71	0.974
^{235}U	0.0769	U	0.88	0.328
^{236}U	0.133	U	0.36	0.266
^{238}U	1.91	B	0.32	0.964
Total U	3.98	B	2.3	1.43
Total U (mg/Kg)	5.72	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				64.4%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	54600		37	4210
^{230}Th	4470		26	437
^{232}Th	49000		44	3790
Total Th	108070		107	8437
Total Th (wt %)	44.6%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

030002

Sample ID
HD0807061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208093

Client: UT-Battelle, LLC.

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

^{232}U Tracer Recovery					133%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error	RPD
^{234}U	6.82		0.29	1.83	114.3%
^{235}U	0.401	B	0.36	0.464	135.6%
^{236}U	0.000	U	0.32	0.000	200.0%
^{238}U	2.91	B	0.29	1.15	41.5%
Total U	10.1		1.3	2.21	87.2%
Total U (mg/Kg)	8.85		NA	NA	42.9%

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pci/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery					72.1%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error	RPD
^{228}Th	46200		28	3850	16.7%
^{230}Th	3690		11	384	19.1%
^{232}Th	42100		23	3510	15.1%
Total Th	91990		62	5224	16.1%
Total Th (wt %)	38.3%		NA	NA	15.1%

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET 030003

Sample ID
HD4810061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208100

Client: UT-Battelle, LLC.

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				123%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.505	B	0.34	0.507
^{235}U	0.311	U	0.42	0.441
^{236}U	0.000	U	0.38	0.000
^{238}U	0.568	U	0.74	0.577
Total U	1.38	U	1.9	0.885
Total U (mg/Kg)	1.83	U	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				71.3%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	46800		19	3530
^{230}Th	3550		6	314
^{232}Th	44200		15	3330
Total Th	94550		40	4863
Total Th (wt %)	40.3%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030004

Sample ID
HD3007061-2002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

Case #: DLA Hammond

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22680

Date Received: 06/13/02

Lab System ID: 208097

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				123%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	1.32	B	0.32	0.803
^{235}U	0.000	U	0.40	0.000
^{236}U	-0.064	U	0.79	0.128
^{238}U	0.835	B	0.32	0.635
Total U	2.09	B	1.8	1.03
Total U (mg/Kg)	2.48	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				71.1%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	49200		21	3280
^{230}Th	3570		14	288
^{232}Th	44500		26	2970
Total Th	97270		61	4434
Total Th (wt %)	40.5%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

BLANK SUMMARY

030005

Sample ID
PBW-H22T1

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

Case #: DLA Hammond

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22680

Date Received: NA

Lab System ID: NA

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				129%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.411	U	1.2	0.651
^{235}U	0.580	U	0.98	0.679
^{236}U	0.077	U	0.88	0.328
^{238}U	1.59	B	0.36	0.931
Total U	2.66	B	3.4	1.36
Total U (mg/Kg)	5.01	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				92.0%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	13.7	U	27	17.9
^{230}Th	133	B	22	33.7
^{232}Th	27.0	B	17	15.8
Total Th	174	B	65	41.3
Total Th (mg/Kg)	245	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

LABORATORY CONTROL SUMMARY 030006

Sample ID
LCSW-H22T1

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

Case #: DLA Hammond

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22680

Date Received: NA

Lab System ID: NA

Project No.: 01.05421.01.006

^{232}U Tracer Recovery						57.8%
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{234}U	30.0		0.016	3.43	37.8	79.4%
^{235}U	1.26		0.020	0.238	1.74	72.5%
^{236}U	0.46		0.018	0.122	NA	NA
^{238}U	30.2		0.050	3.45	37.7	80.1%
Total U	61.9		0.10	4.87	NA	NA
Total U (mg/Kg)	90.5		NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery						65.6%
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{228}Th	36.8		0.033	2.82	NA	NA
^{230}Th	12.5		0.0069	0.999	NA	NA
^{232}Th	61.3		0.030	4.66	55.5	110%
Total Th	111		0.070	5.54	NA	NA
Total Th (mg/Kg)	558		NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006

Alpha Spec ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006

Alpha Spec Analysis
SAMPLE DATA

SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030001

Sample ID
CD11110712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209422

DLA Curtis Bay

Client: UT-Battelle, LLC.

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				95.2%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	1.21	B	0.30	0.736
^{235}U	1.22	B	0.37	0.820
^{236}U	1.22	B	0.33	0.777
^{238}U	0.22	U	0.30	0.310
Total U	3.87	B	1.29	1.38
Total U (mg/Kg)	1.24	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				93.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	44040		18.4	3346
^{230}Th	4058		6.01	357
^{232}Th	43510		14.7	3306
Total Th	91608		39.1	7009
Total Th (wt %)	39.6%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030002

Sample ID
CD15110712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209425

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				98.1%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.86	B	0.29	0.610
^{235}U	0.40	B	0.36	0.459
^{236}U	0.00	U	0.32	0.000
^{238}U	0.32	B	0.29	0.371
Total U	1.58	B	1.26	0.85
Total U (mg/Kg)	1.14	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				85.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	46190		20.6	3548
^{230}Th	4436		6.73	395
^{232}Th	44290		20.6	3405
Total Th	94916		47.8	7348
Total Th (wt %)	40.3%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET 030003

Sample ID
CD20100712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209428

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				100.2%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.82	B	0.28	0.583
^{235}U	0.00	U	0.34	0.000
^{236}U	0.11	U	0.31	0.227
^{238}U	0.33	U	0.68	0.434
Total U	1.27	U	1.60	0.76
Total U (mg/Kg)	1.00	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				83.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	46500		23.5	3189
^{230}Th	4579		6.68	373
^{232}Th	46670		6.66	3200
Total Th	97749		37	6762
Total Th (wt %)	42.5%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030004

Sample ID
CD22100712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209429

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				98.1%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.30	U	0.60	0.385
^{235}U	0.11	U	0.30	0.223
^{236}U	0.30	B	0.27	0.347
^{238}U	0.00	U	0.24	0.000
Total U	0.71	U	1.42	0.56
Total U (mg/Kg)	0.06	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				77.6%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	50810		19.0	3918
^{230}Th	4984		15.2	435
^{232}Th	49810		18.9	3842
Total Th	105604		53.1	8195
Total Th (wt %)	45.4%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030005

Sample ID
CD28010712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209430

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				99.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	1.31	B	0.27	0.736
^{235}U	0.28	U	0.83	0.468
^{236}U	0.45	B	0.30	0.449
^{238}U	0.53	U	0.67	0.515
Total U	2.58	B	2.08	1.11
Total U (mg/Kg)	1.72	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				83.8%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	45900		15.9	3141
^{230}Th	3652		16.0	308
^{232}Th	45690		6.48	3127
Total Th	95242		38.4	6576
Total Th (wt %)	41.6%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET 030006

Sample ID
CD29040712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209431

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				97.5%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.71	B	0.27	0.536
^{235}U	0.37	B	0.34	0.432
^{236}U	0.25	U	0.74	0.419
^{238}U	0.20	U	0.27	0.284
Total U	1.53	U	1.63	0.85
Total U (mg/Kg)	0.77	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				85.3%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	45910		24.2	3513
^{230}Th	4524		15.2	396
^{232}Th	45600		15.2	3489
Total Th	96034		54.6	7398
Total Th (wt %)	41.5%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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ALPHA ANALYSIS DATA SHEET

030007

Sample ID
CD48270612002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209436

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				98.4%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.78	B	0.30	0.595
^{235}U	0.28	U	0.37	0.391
^{236}U	0.62	B	0.34	0.556
^{238}U	0.45	B	0.30	0.447
Total U	2.12	B	1.31	1.01
Total U (mg/Kg)	1.46	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				84.0%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	45740		24.7	1959
^{230}Th	4156		17.3	266
^{232}Th	46150		7.02	1975
Total Th	96046		49.0	4200
Total Th (wt %)	42.0%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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ALPHA ANALYSIS DATA SHEET

030008

Sample ID
CD37100712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209438

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				101.3%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.77	B	0.30	0.582
^{235}U	0.04	U	0.90	0.033
^{236}U	0.12	U	0.33	0.243
^{238}U	0.22	U	0.30	0.309
Total U	1.15	U	1.82	0.70
Total U (mg/Kg)	0.67	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				83.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	45410		22.3	3503
^{230}Th	4099		7.29	374
^{232}Th	46460		22.3	3583
Total Th	95969		51.8	7460
Total Th (wt %)	42.3%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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ALPHA ANALYSIS DATA SHEET

030009

Sample ID
CD61090712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209439

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				98.0%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.78	B	0.30	0.596
^{235}U	0.00	U	0.37	0.000
^{236}U	0.25	U	0.34	0.351
^{238}U	0.33	B	0.30	0.387
Total U	1.37	B	1.32	0.79
Total U (mg/Kg)	1.00	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				88.2%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	45460		23.4	3099
^{230}Th	4121		6.65	340
^{232}Th	44180		6.64	3014
Total Th	93761		36.7	6453
Total Th (wt %)	40.2%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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ALPHA ANALYSIS DATA SHEET

030010

Sample ID
CF1080712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209442

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				99.4%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	4.07	B	0.26	1.276
^{235}U	0.12	U	0.32	0.234
^{236}U	0.52	B	0.28	0.470
^{238}U	2.45	B	0.26	0.978
Total U	7.16	B	1.11	1.69
Total U (mg/Kg)	7.35	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				92.6%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	44580		16.7	3377
^{230}Th	49950		13.4	3777
^{232}Th	43530		16.7	3298
Total Th	138060		46.8	10452
Total Th (wt %)	39.6%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030011

Sample ID
CF19080712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209448

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				100%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	14.48		0.28	2.729
^{235}U	1.42	B	0.35	0.866
^{236}U	0.46	B	0.31	0.466
^{238}U	14.23		0.70	2.707
Total U	30.60		1.65	3.97
Total U (mg/Kg)	43.02	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				81.8%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	46530		17.1	3198
^{230}Th	38740		17.1	2675
^{232}Th	45440		6.95	3124
Total Th	130710		41.1	8997
Total Th (wt %)	41.4%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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ALPHA ANALYSIS DATA SHEET

030012

Sample ID
CF2080712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209449

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				96.6%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	7.83		0.66	1.862
^{235}U	0.73	B	0.33	0.599
^{236}U	0.33	B	0.30	0.380
^{238}U	8.65		0.27	1.950
Total U	17.54		1.55	2.79
Total U (mg/Kg)	26.09		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				93.2%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	43080		19.6	3266
^{230}Th	30070		13.7	2295
^{232}Th	41220		13.7	3127
Total Th	114370		47.0	8688
Total Th (wt %)	37.5%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030013

Sample ID
CI4030712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209458

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				101%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.35	B	0.24	0.356
^{235}U	0.03	U	0.73	0.270
^{236}U	0.10	U	0.27	0.197
^{238}U	0.02	U	0.59	0.218
Total U	0.51	U	1.82	0.53
Total U (mg/Kg)	0.09	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				88.4%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	48180		19.5	3268
^{230}Th	7632		5.54	566
^{232}Th	44580		5.53	3028
Total Th	100392		30.5	6862
Total Th (wt %)	40.6%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030014

Sample ID
CI9030712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209462

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				100%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.51	B	0.28	0.461
^{235}U	0.13	U	0.34	0.254
^{236}U	0.03	U	0.76	0.281
^{238}U	0.10	U	0.28	0.205
Total U	0.77	U	1.66	0.63
Total U (mg/Kg)	0.36	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				83.4%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	49880		20.2	3822
^{230}Th	7450		16.2	623
^{232}Th	48530		20.2	3720
Total Th	105860		56.5	8165
Total Th (wt %)	44.2%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

ALPHA ANALYSIS DATA SHEET

030015

Sample ID
CI3070712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209463

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				99.8%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.66	B	0.30	0.543
^{235}U	0.00	U	0.37	0.000
^{236}U	0.37	B	0.33	0.424
^{238}U	0.22	U	0.30	0.311
Total U	1.25	U	1.30	0.76
Total U (mg/Kg)	0.66	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				87.7%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	47330		16.4	3219
^{230}Th	7532		16.4	570
^{232}Th	44770		6.66	3049
Total Th	99632		39.4	6838
Total Th (wt %)	40.8%		NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

030016

Sample ID
CI3070712002

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209463

Project No.: 01.05421.01.006

^{232}U Tracer Recovery					93.3%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error	RPD
^{234}U	0.68	B	0.31	0.55	2.0%
^{235}U	-0.100	U	0.92	0.200	0.0%
^{236}U	0.624	B	0.34	0.559	51.9%
^{238}U	0.34	B	0.30	0.39	200.0%
Total U	1.5	U	1.9	0.90	20.7%
Total U (mg/Kg)	0.96	B	NA	NA	37.6%

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pci/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery					84.9%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error	RPD
^{228}Th	51260		26	3921	7.97%
^{230}Th	7611		16	635	1.04%
^{232}Th	49550		16	3792	10.1%
Total Th	108421		59	5491	8.45%
Total Th (wt %)	45.1%		NA	NA	10.1%

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

BLANK SUMMARY

030017

Sample ID
PBW

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: NA

Lab System ID: NA

Project No.: 01.05421.01.006

^{232}U Tracer Recovery				98.0%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{234}U	0.94	B	0.32	0.668
^{235}U	0.14	U	0.39	0.290
^{236}U	0.30	U	0.87	0.488
^{238}U	0.35	B	0.32	0.406
Total U	1.73	B	1.9	0.97
Total U (mg/Kg)	1.12	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery				94.7%
Analyte	Activity pCi/gram	Q	MDA pCi/gram	TPU Error
^{228}Th	124	B	25.7	37.3
^{230}Th	174	B	20.2	43.4
^{232}Th	61	B	16.2	25.3
Total Th	359		62.0	63
Total Th (mg/Kg)	559	B	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

LABORATORY CONTROL SUMMARY

030018

Sample ID
LCSW

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: NA

Lab System ID: NA

Project No.: 01.05421.01.006

^{232}U Tracer Recovery						45.0%
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{234}U	37.3		0.014	3.38	37.8	98.6%
^{235}U	1.88		0.017	0.273	1.74	108%
^{236}U	0.28		0.015	0.083	NA	NA
^{238}U	39.2		0.034	3.55	37.7	104%
Total U	78.7		0.08	4.91	NA	NA
Total U (mg/Kg)	117.6		NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery						76.8%
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{228}Th	31.9		0.025	2.51	NA	NA
^{230}Th	10.8		0.008	0.902	NA	NA
^{232}Th	61.8		0.008	4.79	55.5	111%
Total Th	104		0.041	5.48	NA	NA
Total Th (mg/Kg)	562		NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE

LABORATORY CONTROL SUMMARY

030019

Sample ID
LCSW2

Lab Name: Southwest Research Institute

Client: UT-Battelle, LLC.

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: NA

Lab System ID: NA

Project No.: 01.05421.01.006

^{232}U Tracer Recovery						97.8%
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{234}U	6.25		0.006	0.395	6.44	97.0%
^{235}U	0.32		0.019	0.063	0.308	104%
^{236}U	0.04	B	0.007	0.022	NA	NA
^{238}U	6.4		0.006	0.40	6.68	96.0%
Total U	13.0		0.04	0.57	NA	NA
Total U (mg/Kg)	19.2		NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (5 pCi/g).
Q - Qualifier NA - Not Applicable

^{229}Th Tracer Recovery						
Analyte	Activity pCi/each	Q	MDA pCi/each	TPU Error	True Value	Recovery
^{228}Th	NA	NA	NA	NA	NA	NA
^{230}Th	NA	NA	NA	NA	NA	NA
^{232}Th	NA	NA	NA	NA	NA	NA
Total Th	NA	NA	NA	NA	NA	NA
Total Th (mg/Kg)	NA	NA	NA	NA	NA	NA

U - Result lower than MDA. B - Result is greater than MDA, but less than RMA (200 pCi/g).
Q - Qualifier NA - Not Applicable

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SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006

GAMMA SPEC ANALYSIS

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-BATTELLE, LLC
WORK ORDER: 22680
SDG: 208093
VTSR: June 13, 2002
PROJECT#: 05421.01.006

SAMPLE DATA

SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040001

Sample ID

HD0807061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208093

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11370		1400	19.8
	^{212}Bi	33130		4136	306
	^{212}Pb	21190		34830	33.2
	^{224}Ra	458000	I	143700	351
	^{228}Ac	33840		2019	74.7
	^{228}Th	40400		35200	397
^{235}U Series	^{211}Bi	126	I	69.2	114
	^{219}Rn	10620	I	1878	132
	^{231}Pa	466	IU	581	594
	^{233}Ra	85940	I	17760	103.6
	^{235}U	38.4	I	56.0	21.0
^{237} Series	^{229}Th	586	I	806	127.5
^{238}U Series	^{234M}Pa	6681	I	2605	2477
	^{234}Th	272		120	90.8
Other Series	^{40}K	2712	I	717	172
	^{146}Pm	3186	I	1092	368
	^{155}Eu	59540	I	9184	438

U = Less than MDA.

I = Probable Interference, Isotope presence and/or quantitation questionable.

NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

040002

Sample ID
HD0807061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208093

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY						
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)	RPD
^{232}Th Series	^{208}Tl	11610		1427	20.5	2.1%
	^{212}Bi	34660		4324	316	4.5%
	^{212}Pb	21290		34180	34.4	0.5%
	^{224}Ra	474900		148900	364	3.6%
	^{228}Ac	35200		2041	76.7	3.9%
	^{228}Th	44120		38400	416	8.8%
^{235}U Series	^{219}Rn	10880	I	1924	136	2.4%
	^{233}Ra	34420	I	10470	107	85.6%
^{237} Series	^{229}Th	687	I	813	134	15.9%
	^{233}Pa	51.8	I	26.6	39.5	200%
^{238}U Series	^{234M}Pa	8253	I	3108	2558	21.1%
	^{234}Th	285		129	97.8	4.8%
Other Series	^{40}K	2831	I	750	177	4.3%
	^{146}Pm	3443	I	1173	384	7.8%
	^{155}Eu	43400	I	9332	459	31.4%

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040003

Sample ID
HD1010061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208094

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	10370		1282	19.4
	^{212}Bi	32370		4037	289
	^{212}Pb	9079		6325	31.7
	^{224}Ra	434500	I	136200	335
	^{228}Ac	31750		1893	74.3
	^{228}Th	38510		33610	379
^{235}U Series	^{219}Rn	10070	I	1781	125
	^{231}Pa	824	I	614	565
	^{233}Ra	1394	I	382	98.1
	^{235}U	30.5	I	45.2	20.1
^{237} Series	^{229}Th	454	I	627	122
^{238}U Series	^{234M}Pa	7289	I	2624	2337
	^{234}Th	282		125	87.0
Other Series	^{40}K	2550	I	676	163
	^{146}Pm	3148	I	1087	354
	^{155}Eu	54300	I	8586	418

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040004

Sample ID
HD2307061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208095

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	9530		1172	16.4
	^{212}Bi	29410		3668	251
	^{212}Pb	11590		6075	27.1
	^{224}Ra	368900		116000	287
	^{228}Ac	29690		1764	62.7
	^{228}Th	32600		28440	312
^{235}U Series	^{219}Rn	8766	I	1550	108
	^{231}Pa	790	I	556	485
	^{233}Ra	68300.0	I	14160	84.4
	^{235}U	23.7	I	35.3	16.9
^{237} Series	^{229}Th	479	I	659	100
^{238}U Series	^{234M}Pa	7205	I	2686	2096
	^{234}Th	210		94.9	74.0
Other Series	^{40}K	2207	I	585	144
	^{146}Pm	2668	I	913	302
	^{155}Eu	31600	I	7547	345

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS 040005

Sample ID
HD2907061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208096

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11460		1412	20.9
	^{212}Bi	33910		4229	311
	^{212}Pb	17620		30590	34.0
	^{224}Ra	467400		146800	360
	^{228}Ac	33640		2010	75.5
	^{228}Th	41430		36130	415
^{235}U Series	^{219}Rn	10780	I	1907	134
	^{231}Pa	667	I	589	608
	^{231}Th	180300	I	52430	76.6
	^{233}Ra	87290	I	18040	105
	^{235}U	24.0	I	37.2	21.6
^{237} Series	^{229}Th	645	I	885	134
^{238}U Series	^{234M}Pa	8776	I	3259	2508
	^{234}Th	324		142	98.6
Other Series	^{40}K	2779	I	739	172
	^{94x}NB	22.8	I	9.4	18.8
	^{155}Eu	65450	I	10290	458
	^{146}Pm	3032	I	1080	374

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040006

Sample ID
HD3007061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208097

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	10730		1322	19.0
	^{212}Bi	32340		4036	290
	^{212}Pb	14950		25780	31.7
	^{224}Ra	435200		136800	335
	^{228}Ac	32870		1956	71.7
	^{228}Th	38400		33560	379
^{235}U Series	^{211}Bi	113	I	65.1	109
	^{219}Rn	10130	I	1791	125
	^{231}Pa	635	I	597.8	566
	^{233}Ra	77600	I	16140	99.0
	^{235}U	12.2	IU	20.8	20.0
^{237} Series	^{229}Th	455	I	628	122
	^{233}Pa	25.9	IU	23.0	36.6
^{238}U Series	^{234M}Pa	7028	I	2596	2404
	^{234}Th	254.1		115	86.5
Other Series	^{40}K	2678	I	708	164
	^{94x}NB	18.9	I	8.3	17.6
	^{155}Eu	43890	I	9553	419
	^{146}Pm	3125	I	1065	357

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040007

Sample ID
HD3810061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208098

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	10420		1210	18.4
	^{212}Bi	4157		2566	285
	^{212}Pb	8651		2124	30.2
	^{224}Ra	424100		124800	333
	^{228}Ac	19500		1624	67.2
	^{228}Th	39890		34170	374
^{235}U Series	^{219}Rn	10020	I	1779	123
	^{231}Pa	613	I	542	558
	^{231}Th	164400	I	47730	69.1
	^{233}Ra	1555	I	412	96.3
^{238}U Series	^{226}Ra	401	I	618	315
	^{234}Th	203		95.1	85.9
^{237} Series	^{229}Th	623	I	747	120
	^{237}Np	1847	I	1329	37.7
Other Series	^{40}K	2652	I	703	163
	^{146}Pm	2889	I	1001	349
	^{155}Eu	150700	I	28910	413

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040008

Sample ID
HD4710061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208099

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	9997		1160	17.4
	^{212}Bi	32550		6291	268
	^{212}Pb	7608		2038	29.6
	^{224}Ra	399800		118000	315
	^{228}Ac	30010		2425	64.2
	^{228}Th	34800		29800	347
^{235}U Series	^{211}Bi	57.6	IU	56.4	102
	^{219}Rn	9631	I	1711	116
	^{231}Pa	802	I	585	529
	^{233}Ra	1512	I	396	92.1
^{238}U Series	^{226}Ra	500	I	764	295
	^{234}Th	208		94.6	79.7
^{237} Series	^{229}Th	638	I	737	112
	^{237}Np	1660	I	1213	35.0
Other Series	^{40}K	2662	I	705	156
	^{146}Pm	2853	I	982	331
	^{155}Eu	150600	I	28860	383

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040009

Sample ID
HD4810061-2002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22680

Lab System ID: 208100

Client: UT Battelle

Case #: DLA Hammond

Method #: SW846-6020-7471

Date Received: 06/13/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11060		1285	19.9
	^{212}Bi	35910		6925	311
	^{212}Pb	9843		2416	34.1
	^{224}Ra	463100		136700	361
	^{228}Ac	32550		2636	73.4
	^{228}Th	38580		33140	413
^{235}U Series	^{211}Bi	112	IU	75.3	117
	^{219}Rn	10790	I	1917	134
	^{231}Pa	79750	I	22660	607
	^{231}Th	179800	I	52200	76.1
	^{233}Ra	1646	I	439	106
^{238}U Series	^{226}Ra	565	I	851	344
	^{234}Th	294		129	93.6
^{237} Series	^{229}Th	652		770	133
	^{237}Np	1723	I	1362	41.6
Other Series	^{40}K	2769	I	733	175
	^{146}Pm	3340	I	1153	379
	^{155}Eu	163900	I	31430	456

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006

Gamma Analysis

SOUTHWEST RESEARCH INSTITUTE
CLIENT: UT-Battelle, LLC
WORK ORDER: 22835
SDG: 208093
VTSR: July 17, 2002
PROJECT#: 05421.01.006

Gamma Analysis
SAMPLE DATA

SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040001

Sample ID
CD02120712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209420

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11600		1520	20.5
	^{212}Bi	12340		3180	313
	^{212}Pb	9627		2349	34.8
	^{224}Ra	472800	I	140300	369
	^{228}Ac	33330		2700	74.6
	^{228}Th	44210		37930	419
^{235}U Series	^{219}Rn	11130	I	1980	136
	^{231}Pa	1238	I	833	619
	^{231}Th	184300	I	53500	77.4
	^{233}Ra	1578	I	429	107
^{238}U Series	^{226}Ra	552	I	827	350
	^{234M}Pa	9033	I	3070	2597
	^{234}Th	266	I	119	96.4
^{237} Series	^{229}Th	881	I	1025	135
Other Series	^{40}K	2733	I	724	178
	^{146}Pm	3254	I	1127	388
	^{155}Eu	53390	I	9020	464

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY 040002

Sample ID
CD02120712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209420

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY						
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)	RPD
^{232}Th Series	^{208}Tl	11730		1530	20.7	1.11%
	^{212}Bi	10510		2740	322	16.0%
	^{212}Pb	10150		7550	34.5	5.29%
	^{224}Ra	479800	I	142300	373	1.47%
	^{228}Ac	25200		2090	75.4	27.8%
	^{228}Th	46470		39900	424	4.98%
^{235}U Series	^{211}Bi	110	IU	77.7	121	- - - -
	^{219}Rn	11200	I	1990	138	0.63%
	^{231}Pa	50970	I	23220	628	191%
	^{231}Th	188200	I	54600	78.2	2.09%
	^{233}Ra	1581	I	429	109	0.19%
^{238}U Series	^{226}Ra	589	I	880	355	6.43%
	^{234M}Pa	2458	IU	1442	2632	114%
	^{234}Th	277	I	123	98.2	4.10%
^{237} Series	^{229}Th	851	I	983	136	3.44%
Other Series	^{40}K	2803	I	743	182	2.53%
	^{137}Cs	21.3	U	22.1	40.0	- - - -
	^{146}Pm	3456	I	1193	392	6.02%
	^{155}Eu	69340	I	11260	469	26.0%

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040003

Sample ID
CD03110712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209421

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11910		1560	21.1
	^{212}Bi	10350		2740	327
	^{212}Pb	9588		2408	34.6
	^{224}Ra	491400	I	145800	381
	^{228}Ac	25340		2100	77.0
	^{228}Th	39870		34200	430
^{235}U Series	^{219}Rn	11340	I	2010	141
	^{231}Pa	569	IU	636	642
	^{233}Ra	1589	I	435	111
^{238}U Series	^{226}Ra	518	I	783	362
	^{234M}Pa	7553	I	3102	2684
	^{234}Th	271	I	121	103
^{237} Series	^{229}Th	749	I	868	138
Other Series	^{40}K	2843	I	752	184
	^{137}Cs	28.1	U	24.9	40.9
	^{146}Pm	327	IU	1128	399
	^{155}Eu	68300	I	10760	476

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040004

Sample ID
CD11110712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209422

DLA Curtis bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11420		1490	20.0
	^{212}Bi	9941		2726	308
	^{212}Pb	9315		2333	33.6
	^{224}Ra	464100	I	137600	362
	^{228}Ac	32850		2660	74.5
	^{228}Th	39390		33750	413
^{235}U Series	^{211}Bi	100	IU	67.7	117
	^{219}Rn	10820	I	1920	134
	^{231}Pa	963	I	725	609
	^{231}Th	179500	I	52100	76.1
	^{233}Ra	1470	I	392	105
	^{235}U	40.3	I	60.1	21.5
^{238}U Series	^{234M}Pa	7027	I	2703	2546
	^{234}Th	293	I	129	94.2
^{237} Series	^{229}Th	641	I	875	133
	^{237}Np	1598	I	1320	41.6
Other Series	^{40}K	2754	I	728	175
	^{146}Pm	3068	I	1065	381
	^{155}Eu	163400	I	31300	457

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040005

Sample ID
CD12120712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209423

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11090		1370	19.4
	^{212}Bi	35250		4990	300
	^{212}Pb	13370		7140	32.9
	^{224}Ra	446100	I	137200	348
	^{228}Ac	33710		2020	71.0
	^{228}Th	38750		33570	390
^{235}U Series	^{211}Pb	432	I	266	400
	^{231}Pa	1185	I	793	579
	^{233}Ra	1543	I	414	102
	^{235}U	35.9	I	52.5	20.6
^{238}U Series	^{214}Pb	41.9		21.6	38.5
	^{234M}Pa	7168	I	2674	2444
	^{234}Th	279	I	124	88.5
^{237} Series	^{229}Th	376	I	523	125
Other Series	^{40}K	2711	I	722	168
	^{146}Pm	3196	I	1090	368
	^{155}Eu	59400	I	9100	433

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS 040006

Sample ID
CD14120712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209424

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11670		1440	20.8
	^{212}Bi	34150		4280	320
	^{212}Pb	21390		5270	35.3
	^{224}Ra	473800	I	145400	373
	^{228}Ac	34750		2020	75.1
	^{228}Th	42000		36450	427
^{235}U Series	^{211}Bi	136	I	80.0	121
	^{219}Rn	11000	I	1950	138
	^{231}Th	184300	I	53600	78.8
	^{233}Ra	1452	I	407	109
^{238}U Series	^{226}Ra	410	I	632	357
	^{234M}Pa	6055	I	2175	2604
	^{234}Th	307	I	137	98.3
^{237} Series	^{229}Th	669	I	807	137
Other Series	^{40}K	2815	I	746	180
	^{146}Pm	3260	I	1125	396
	^{155}Eu	60480	I	10210	474

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040007

Sample ID
CD15110712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209425

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11070		1360	19.4
	^{212}Bi	32970		4130	297
	^{212}Pb	15820		7560	32.5
	^{224}Ra	439100	I	134800	344
	^{228}Ac	33100		1910	70.9
	^{228}Th	38690		33490	384
^{235}U Series	^{211}Bi	194	I	83.0	112
	^{219}Rn	10320	I	1830	127
	^{231}Pa	758	I	599	583
	^{233}Ra	1710	I	445	101
	^{235}U	33.6	I	49.4	20.4
^{238}U Series	^{234M}Pa	6606	I	2473	2407
	^{234}Th	222	I	102	91.6
^{237} Series	^{229}Th	517	I	708	123
Other Series	^{40}K	2592	I	688	169
	^{146}Pm	3263	I	1110	121
	^{94x}Nb	20.3	I	8.21	17.9
	^{155}Eu	59720	I	9580	426

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040008

CD17100712002

Sample ID

~~CD7100712002~~

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209426

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11620		1430	20.6
	^{212}Bi	33700		4210	318
	^{212}Pb	26130		5720	34.8
	^{224}Ra	473000	I	146600	367
	^{228}Ac	34140		1990	76.7
	^{228}Th	39350		34220	422
^{235}U Series	^{219}Rn	19940	I	7790	138
	^{231}Th	180300	I	52400	77.9
	^{233}Ra	1642	I	440	108
^{238}U Series	^{226}Ra	489	I	742	356
	^{234M}Pa	7261	I	2859	2541
	^{234}Th	310	I	139	97.3
^{237} Series	^{229}Th	651	I	303	136
	^{237}Np	1840	I	1408	42.5
Other Series	^{40}K	2797	I	742	176
	^{146}Pm	3268	I	1124	391
	^{155}Eu	163300	I	31100	469

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040009

Sample ID
CD18090712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209427

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11360		1400	20.0
	^{212}Bi	33490		4180	306
	^{212}Pb	26900		5710	33.5
	^{224}Ra	460100	I	144600	354
	^{228}Ac	33640		1910	74.2
	^{228}Th	41380		36090	401
^{235}U Series	^{219}Rn	10530	I	1860	132
	^{231}Th	178000	I	51800	74.0
	^{233}Ra	79250	I	16570	104
^{238}U Series	^{234M}Pa	5797	I	1992	2528
	^{234}Th	274	I	122	95.3
^{237} Series	^{229}Th	564	I	692	129
	^{237}Np	2002	I	1416	40.4
Other Series	^{146}Pm	3246	I	1107	373
	^{155}Eu	164700	I	31400	446

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040010

Sample ID
CD20100712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209428

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12520		1550	23.9
	^{212}Bi	37710		4710	356
	^{212}Pb	17050		9320	39.0
	^{224}Ra	534400	I	167200	413
	^{228}Ac	37780		2260	93.9
	^{228}Th	48150		42000	477
^{235}U Series	^{211}Bi	129	IU	79.3	134
	^{219}Rn	12170	I	2150	154
	^{231}Pa	1254	I	842	697
	^{231}Th	203800	I	59300	88.0
	^{233}Ra	94050	I	19620	121
	^{235}U	33.0	I	49.5	25.0
^{238}U Series	^{234M}Pa	9701	I	3531	2841
	^{234}Th	383	I	167	112
^{237} Series	^{229}Th	743	I	994	153
Other Series	^{40}K	3060	I	813	197
	^{146}Pm	3812	I	1317	440
	^{155}Eu	75350	I	11940	530

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040011

Sample ID
CD22100712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209429

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11420		1410	21.5
	^{212}Bi	34860		4350	321
	^{212}Pb	16330		8550	35.4
	^{224}Ra	477400	I	146600	374
	^{228}Ac	35080		2030	75.5
	^{228}Th	41850		36280	423
^{235}U Series	^{219}Rn	14810	I	5410	138
	^{231}Pa	696	I	611	627
	^{231}Th	188700	I	54800	78.0
	^{233}Ra	1848	I	481	109
^{238}U Series	^{226}Ra	432	I	663	356
	^{234M}Pa	8170		2919	2597
	^{234}Th	254	I	115	96.1
^{237} Series	^{229}Th	567	I	684	136
Other Series	^{40}K	2772	I	736	181
	^{146}Pm	3326	I	1178	390
	^{155}Eu	54140	I	8570	472

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040012

Sample ID
CD28010712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209430

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11450		1420	21.7
	^{212}Bi	34730		4340	323
	^{212}Pb	27910		44950	35.6
	^{224}Ra	483200	I	149100	376
	^{228}Ac	34780		2020	75.3
	^{228}Th	40520		35190	427
^{235}U Series	^{211}Bi	139	I	81.0	122
	^{219}Rn	11100	I	1970	140
	^{231}Th	188800	I	54900	78.7
	^{233}Ra	1814	I	476	110
	^{235}U	32.6	I	48.9	22.4
^{238}U Series	^{234M}Pa	6281	I	2226	2652
	^{234}Th	259	I	117	98.6
^{237} Series	^{229}Th	693	I	945	137
	^{233}Pa	48.2	I	27.0	40.7
Other Series	^{40}K	2768	I	737	180
	^{146}Pm	3431	I	1181	398
	^{155}Eu	48650	I	10820	474

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040013

Sample ID
CD29040712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209431

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11140		1380	20.3
	^{212}Bi	33830		4230	312
	^{212}Pb	15970		7800	34.1
	^{224}Ra	456200	I	140800	361
	^{228}Ac	34500		2000	73.1
	^{228}Th	45260		39270	413
^{235}U Series	^{211}Bi	123	I	76.6	117
	^{219}Rn	10670	I	1890	134
	^{231}Pa	889	I	702	605
	^{231}Th	175500	I	51000	76.2
	^{233}Ra	1687	I	446	106
	^{235}U	30.3	I	45.5	21.6
^{238}U Series	^{234M}Pa	5484	I	2049	2546
	^{234}Th	313	I	140	94.6
^{237} Series	^{229}Th	608	I	830	133
	^{237}Np	1836	I	1379	41.6
Other Series	^{40}K	2824	I	751	173
	^{146}Pm	3340	I	1154	384
	^{155}Eu	159900	I	30500	459

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040014

Sample ID
CD30280612002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209432

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11220		1390	20.8
	^{212}Bi	34310		4290	316
	^{212}Pb	9538		2339	35.1
	^{224}Ra	465000	I	141700	370
	^{228}Ac	34140		1980	73.7
	^{228}Th	41180		35580	419
^{235}U Series	^{211}Bi	77.7	IU	73.9	119
	^{219}Rn	10980	I	1950	137
	^{231}Pa	374	IU	528	617
	^{231}Th	183200	I	53200	77.2
	^{233}Ra	1717	I	453	107
^{238}U Series	^{226}Ra	511	I	771	351
	^{234M}Pa	7366	I	2778	2559
	^{234}Th	267	I	120	96.8
^{237} Series	^{229}Th	787	I	915	135
	^{237}Np	2061	I	1481	42.2
Other Series	^{40}K	2783	I	742	176
	^{146}Pm	3254	I	1118	392
	^{155}Eu	169800	I	32500	466

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040015

Sample ID
CD36010712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209433

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	10590		1310	18.6
	^{212}Bi	31990		4000	291
	^{212}Pb	9302		6856	31.3
	^{224}Ra	428500	I	129800	333
	^{228}Ac	31610		1830	68.6
	^{228}Th	36940		31910	372
^{235}U Series	^{219}Rn	9955	I	1765	124
	^{231}Pa	45190	I	20580	564
	^{231}Th	164000	I	47600	68.6
	^{233}Ra	1438	I	389	98.5
^{238}U Series	^{226}Ra	395	I	604	321
	^{234M}Pa	9424	I	3781	2331
	^{234}Th	261	I	114	87.0
^{237} Series	^{229}Th	578	I	693	120
Other Series	^{40}K	2624	I	694	162
	^{146}Pm	2948	I	1013	358
	^{155}Eu	47780	I	8150	414

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040016

Sample ID
CD44120712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209434

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11000		1360	19.8
	^{212}Bi	32670	U	4090	306000
	^{212}Pb	9388		2308	33.2
	^{224}Ra	453000	I	136600	352
	^{228}Ac	33360		1930	70.7
	^{228}Th	39780		34300	395
^{235}U Series	^{219}Rn	10490	I	1860	131
	^{231}Pa	48370	I	22030	594
	^{231}Th	173800	I	50400	72.9
	^{233}Ra	1662	I	439	103
^{238}U Series	^{226}Ra	584	I	878	338
	^{234M}Pa	7842	I	2782	2437
	^{234}Th	296	I	128	93.0
Other Series	^{40}K	2624	I	695	171
	^{146}Pm	3192	I	1095	375
	^{155}Eu	59580	I	7970	440

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040017

Sample ID
CD45270612002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209435

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11740		1450	22.0
	^{212}Bi	35900		4490	329
	^{212}Pb	10440		2540	35.6
	^{224}Ra	499400		151200	379
	^{228}Ac	34820		2020	77.2
	^{228}Th	45450		39220	443
^{235}U Series	^{219}Rn	11210	I	1990	142
	^{231}Pa	51800	I	23590	640
	^{231}Th	191300	I	55500	81.7
	^{233}Ra	1436	I	408	112
^{238}U Series	^{226}Ra	481	I	739	366
	^{234M}Pa	6732	I	2968	2636
	^{234}Th	301	I	133	105
^{237} Series	^{229}Th	705	I	837	142
	^{237}Np	1075	I	1117	44.6
Other Series	^{40}K	2665	I	710	184
	^{146}Pm	3311	I	1149	406
	^{155}Eu	174000	I	33300	493

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040018

Sample ID
CD48270612002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209436

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11850		1680	20.3
	^{212}Bi	34120		4950	316
	^{212}Pb	9789		2402	34.5
	^{224}Ra	467800	I	139600	365
	^{228}Ac	34770		2020	74.1
	^{228}Th	42940		36890	421
^{235}U Series	^{219}Rn	10930	I	1940	136
	^{231}Pa	49110	I	22370	618
	^{233}Ra	1805	I	471	107
^{238}U Series	^{226}Ra	466	I	715	350
	^{234M}Pa	7043	I	2718	2569
	^{234}Th	308	I	133	97.4
^{237} Series	^{229}Th	707	I	820	135
Other Series	^{40}K	2797	I	741	175
	^{146}Pm	2024	I	685	387
	^{155}Eu	64220	I	10280	468

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040019

Sample ID
CD52100712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209437

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11840		1470	21.9
	^{212}Bi	35820		4470	337
	^{212}Pb	13000		7760	37.5
	^{224}Ra	501400	I	153300	396
	^{228}Ac	36200		2100	79.4
	^{228}Th	47310		40820	455
^{235}U Series	^{211}Bi	119	IU	74.6	127
	^{219}Rn	11520	I	2040	146
	^{231}Pa	532	IU	648	659
	^{231}Th	195400	I	56700	84.0
	^{233}Ra	1473	I	418	114
^{238}U Series	^{226}Ra	564	I	849	378
	^{234M}Pa	7572	I	2892	2678
	^{234}Th	343	I	150	105
^{237} Series	^{229}Th	868	I	1013	146
	^{237}Np	2091	I	1550	45.9
Other Series	^{40}K	2716	I	720	189
	^{146}Pm	3465	I	1190	419
	^{155}Eu	176300	I	33700	507

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040020

Sample ID
CD37100712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209438

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11600		1430	20.3
	^{212}Bi	34190		4270	314
	^{212}Pb	19500		9080	34.9
	^{224}Ra	467100	I	142800	369
	^{228}Ac	34200		1980	74.1
	^{228}Th	40420		34960	421
^{235}U Series	^{219}Rn	10870	I	1930	136
	^{231}Pa	485	IU	602	617
	^{231}Th	183800	I	53400	77.6
	^{233}Ra	1937	I	497	107
^{238}U Series	^{226}Ra	556	I	832	350
	^{234M}Pa	6904	I	2689	2547
	^{234}Th	284	I	126	99.1
^{237} Series	^{229}Th	480	I	602	135
	^{237}Np	1834	I	1399	42.4
Other Series	^{40}K	2830	I	751	176
	^{146}Pm	3422	I	1182	391
	^{155}Eu	168900	I	32300	468

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040021

Sample ID
CD61090712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209439

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12500		1540	22.9
	^{212}Bi	36310		4540	353
	^{212}Pb	17430		9420	38.9
	^{224}Ra	518100	I	158200	411
	^{228}Ac	36430		2110	80.6
	^{228}Th	46870		40480	477
^{235}U Series	^{211}Bi	136	I	86.2	132
	^{219}Rn	11800	I	2090	151
	^{231}Pa	891	I	759	686
	^{231}Th	201400	I	58500	88.1
	^{233}Ra	1813	I	486	119
^{238}U Series	^{226}Ra	871	I	1299	394
	^{234M}Pa	7727	I	2980	2777
	^{234}Th	301	I	136	113
^{237} Series	^{237}Np	2132	I	1604	48.1
Other Series	^{40}K	2819	I	747	194
	^{146}Pm	3589	I	1238	423
	^{94x}Nb	26.7	I	9.28	21.6
	^{155}Eu	180900	I	34600	531

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040022

Sample ID
CD65090712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209440

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12140		1500	23.1
	^{212}Bi	36370		4540	346
	^{212}Pb	14930		8190	38.1
	^{224}Ra	508200	I	155100	404
	^{228}Ac	36470		2120	80.0
	^{228}Th	43310		37410	463
^{235}U Series	^{211}Bi	110	IU	75.0	130
	^{219}Rn	14280	I	6030	149
	^{231}Pa	890	I	750	672
	^{231}Th	199700	I	58000	85.4
	^{233}Ra	1648	I	453	117
^{238}U Series	^{226}Ra	490	I	747	385
	^{234M}Pa	7241		3125	2810
	^{234}Th	334	I	147	107
^{237} Series	^{229}Th	838	I	980	149
	^{237}Np	2058	I	1431	46.7
Other Series	^{40}K	2983	I	793	190
	^{146}Pm	3590	I	1243	426
	^{155}Eu	180800	I	34600	515

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040023

Sample ID
CF1080712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209442

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11630		1440	21.6
	^{212}Bi	36050		5110	326
	^{212}Pb	12770		8160	36.3
	^{224}Ra	471600	I	143600	383
	^{228}Ac	35100		2120	76.0
	^{228}Th	44500		38430	430
^{235}U Series	^{211}Bi	2014	I	520	122
	^{219}Rn	11150	I	1980	139
	^{231}Pa	50520	I	23010	633
	^{231}Th	190600	I	55300	79.3
	^{233}Ra	1645	I	443	111
^{238}U Series	^{214}Bi	655		82.9	40.9
	^{214}Pb	676		150	41.9
	^{226}Ra	1252		1786	358
	^{234M}Pa	9237	I	3430	2625
	^{234}Th	286	I	126	98.3
Other Series	^{40}K	2852	I	753	184
	^{146}Pm	3234	I	1122	399
	^{155}Eu	61340	I	8370	478

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY 040024

Sample ID
CF1080712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209442

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY						
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)	RPD
^{232}Th Series	^{208}Tl	11860		1680	20.6	1.96%
	^{212}Bi	35530		5040	321	1.45%
	^{212}Pb	9844		2379	35.2	25.88%
	^{224}Ra	472700	I	141700	373	0.23%
	^{228}Ac	34760		2100	75.3	0.97%
	^{228}Th	43400		37370	426	2.50%
^{235}U Series	^{211}Bi	2000	I	518.0	122	0.70%
	^{219}Rn	16690	I	5450	138	39.80%
	^{231}Pa	865	I	663	623	193.26%
	^{231}Th	187000	I	54300	78.6	1.91%
	^{233}Ra	1677	I	448	109	1.93%
^{238}U Series	^{214}Bi	611		78.5	40.2	6.84%
	^{214}Pb	683		151	41.4	0.96%
	^{226}Ra	879		1262	359	35.01%
	^{234M}Pa	6285	I	2439	2587	38.04%
	^{234}Th	285	I	126	97.1	0.42%
^{237} Series	^{229}Th	672	I	781	137	- - - -
Other Series	^{40}K	2795	I	740	182	2.02%
	^{146}Pm	3157	I	1086	395	2.41%
	^{155}Eu	62600	I	9700	474	2.03%

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040025

Sample ID
CF11020712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209443

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13330		1890	24.2
	^{212}Bi	39820		5660	377
	^{212}Pb	11670		3110	41.0
	^{224}Ra	550300	I	164700	434
	^{228}Ac	38330		2330	87.8
	^{228}Th	50330		43320	514
^{235}U Series	^{219}Rn	19930	I	6920	161
	^{231}Pa	1137	I	816	729
	^{231}Th	213400	I	61900	94.8
	^{233}Ra	1825	I	498	126
^{238}U Series	^{214}Bi	445		73.6	46.9
	^{214}Pb	516		89.9	48.2
	^{226}Ra	1377		1961	415
	^{234M}Pa	8949	I	3173	3005
	^{234}Th	391	I	168	119
^{237} Series	^{229}Th	835	I	968	165
Other Series	^{40}K	3121	I	831	207
	^{137}Cs	34	U	41.5	47.1
	^{146}Pm	3531	I	1220	460
	^{155}Eu	66150	I	10980	572

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040026

Sample ID
CF13080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209444

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11450		1620	19.4
	^{212}Bi	34350		4880	303
	^{212}Pb	8135		2096	33.0
	^{224}Ra	448800	I	134600	350
	^{228}Ac	33350		2010	71.5
	^{228}Th	42330		36380	398
^{235}U Series	^{211}Bi	1283	I	337	113
	^{219}Rn	12410	I	5150	130
	^{231}Pa	991	I	686	587
	^{231}Th	176700	I	51300	73.4
	^{233}Ra	1446	I	398	103
^{238}U Series	^{214}Bi	390		59.6	38.0
	^{214}Pb	409		95.2	38.9
	^{226}Ra	403		602	337
	^{234M}Pa	7394	I	2831	2516
	^{234}Th	217	I	101	90.2
^{237} Series	^{229}Th	474	I	227	128
Other Series	^{40}K	2614	I	692	172
	^{146}Pm	3166	I	1086	372
	^{155}Eu	52610	I	8670	443

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS 040027

Sample ID
CF14030712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209445

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11010		1560	18.7
	^{212}Bi	33130		4710	284
	^{212}Pb	8633		2121	31.2
	^{224}Ra	431000	I	129100	333
	^{228}Ac	32860		1970	68.6
	^{228}Th	37640		32370	376
^{235}U Series	^{211}Bi	1358	I	355	109
	^{219}Rn	9982	I	1771	124
	^{231}Pa	45410	I	20680	563
	^{233}Ra	1402	I	383	97.2
^{238}U Series	^{214}Bi	394		58.1	35.7
	^{214}Pb	443		100	37.3
	^{226}Ra	606		884	320
	^{234M}Pa	9784	I	3702	2371
	^{234}Th	255	I	112	84.8
^{237} Series	^{229}Th	569	I	691	121
Other Series	^{40}K	2474	I	654	165
	^{146}Pm	3108	I	1074	355
	^{155}Eu	33960	I	7940	419

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040028

Sample ID
CF16080712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209446

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11200		1590	19.3
	^{212}Bi	34410		4890	295
	^{212}Pb	8009		2093	32.8
	^{224}Ra	442000	I	132600	348
	^{228}Ac	33410		2010	71.1
	^{228}Th	39730		34200	391
^{235}U Series	^{211}Bi	1759	I	455	113
	^{219}Rn	10330	I	1830	129
	^{231}Pa	46750	I	21290	585
	^{231}Th	175800	I	51000	72.2
	^{233}Ra	1399	I	388	101
^{238}U Series	^{214}Bi	570		75.1	37.8
	^{214}Pb	566		128	38.6
	^{226}Ra	751		1083	333
	^{234M}Pa	7279	I	2697	2503
	^{234}Th	255	I	113	88.2
^{237} Series	^{229}Th	666	I	794	126
Other Series	^{40}K	2815	I	748	171
	^{146}Pm	3125	I	1113	363
	^{155}Eu	50170	I	7880	436

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040029

Sample ID
CF17080712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209447

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11620		1640	19.9
	^{212}Bi	35670		6170	311
	^{212}Pb	8697		2232	33.3
	^{224}Ra	456200	I	136100	360
	^{228}Ac	34670		2330	73.2
	^{228}Th	41270		35540	410
^{235}U Series	^{219}Rn	10710	I	1900	133
	^{231}Pa	48010	I	21870	602
	^{233}Ra	1656	I	440	105
^{238}U Series	^{214}Bi	699		102	38.5
	^{214}Pb	564		96.5	40.0
	^{226}Ra	610		889	344
	^{234M}Pa	7780	I	3029	2557
	^{234}Th	267	I	119	92.4
^{237} Series	^{237}Np	1544	I	1296	41.3
Other Series	^{40}K	2717	I	719	176
	^{146}Pm	3253	I	1120	380
	^{155}Eu	168400	I	32300	456

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040030

Sample ID

CF19080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209448

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11310		1600	19.0
	^{212}Bi	34350		5950	293
	^{212}Pb	8465		2106	32.6
	^{224}Ra	437400	I	130600	345
	^{228}Ac	32770		2120	70.7
	^{228}Th	36340		31200	390
^{235}U Series	^{219}Rn	10200	I	1810	128
	^{231}Pa	703	I	623	579
	^{233}Ra	1650	I	434	100
^{238}U Series	^{214}Bi	244		58.5	37.4
	^{214}Pb	488		84.8	38.3
	^{226}Ra	604		882	329
	^{234M}Pa	6500	I	2470	2469
	^{234}Th	243	I	109	88.4
^{237} Series	^{229}Th	574	I	684	126
	^{237}Np	1733	I	1313	39.4
Other Series	^{40}K	2736	I	726	167
	^{146}Pm	3058	I	1054	365
	^{155}Eu	161600	I	31000	435

U = Less than MDA.

I = Probable Interference, Isotope presence and/or quantitation questionable.

NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040031

Sample ID
CF2080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209449

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12010		1700	21.0
	^{212}Bi	37150		6430	319
	^{212}Pb	10410		2550	35.4
	^{224}Ra	479600	I	143100	375
	^{228}Ac	34890		2260	76.0
	^{228}Th	44980		38650	433
^{235}U Series	^{219}Rn	11130	I	1980	139
	^{231}Pa	1081	I	742	627
	^{233}Ra	1702	I	454	109
^{238}U Series	^{214}Bi	316		62.6	40.7
	^{214}Pb	465		84.1	41.7
	^{226}Ra	502		748	362
	^{234M}Pa	7830	I	2882	2649
	^{234}Th	288	I	127	98.7
^{237} Series	^{229}Th	753	I	874	139
Other Series	^{40}K	2826	I	751	181
	^{146}Pm	3254	I	1119	397
	^{155}Eu	61280	I	9630	483

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040032

Sample ID
CF3080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209450

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12730		1800	22.6
	^{212}Bi	39100		6760	346
	^{212}Pb	11720		2900	38.5
	^{224}Ra	519600	I	155000	409
	^{228}Ac	36920		2330	82.1
	^{228}Th	48780		41900	480
^{235}U Series	^{219}Rn	11890	I	2110	152
	^{231}Pa	1180	I	809	680
	^{231}Th	204200	I	59200	88.6
	^{233}Ra	1496	I	429	119
	^{235}U	50.2	I	70.6	24.9
^{238}U Series	^{214}Bi	610		100	44.1
	^{214}Pb	583		103	45.2
	^{234M}Pa	8952	I	3301	2865
	^{234}Th	358	I	154	109
^{237} Series	^{229}Th	737	I	997	154
Other Series	^{40}K	2939	I	783	196
	^{146}Pm	3528	I	1224	431
	^{155}Eu	62500	I	10290	535

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040033

Sample ID
CF10020712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209451

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12360		1750	22.6
	^{212}Bi	37720		6520	339
	^{212}Pb	10960		2660	36.7
	^{224}Ra	500800	I	149200	394
	^{228}Ac	35480		2300	79.0
	^{228}Th	45270		38910	464
^{235}U Series	^{211}Bi	1246	I	331	128
	^{219}Rn	11700	I	2080	145
	^{231}Pa	1215	I	810	661
	^{231}Th	193700	I	56200	85.6
	^{233}Ra	1519	I	427	115
^{238}U Series	^{214}Pb	408		104	43.8
	^{226}Ra	492		740	382
	^{234M}Pa	6462	I	2411	2754
	^{234}Th	314	I	138	105
^{237} Series	^{229}Th	647	I	785	149
Other Series	^{40}K	2801	I	741	189
	^{137}Cs	44.4		23.9	42.5
	^{146}Pm	3513	I	1210	418
	^{94x}Nb	23.4	I	8.92	21.2
	^{155}Eu	74150	I	10810	517

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040034

Sample ID
CF4080712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209452

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12580		1780	22.0
	^{212}Bi	38570		6680	334
	^{212}Pb	10810		2630	37.1
	^{224}Ra	503500	I	150100	394
	^{228}Ac	36030		2340	80.1
	^{228}Th	45110		38870	458
^{235}U Series	^{211}Bi	1510	I	396	129
	^{219}Rn	11710	I	2080	145
	^{231}Pa	52030	I	23700	659
	^{233}Ra	1648	I	451	115
^{238}U Series	^{214}Pb	507		118	43.7
	^{226}Ra	729		1060	380
	^{234M}Pa	7285	I	2885	2788
	^{234}Th	338	I	146	103
^{237} Series	^{229}Th	904	I	1043	147
Other Series	^{40}K	3029	I	804	190
	^{137}Cs	36.2	U	23.5	42.4
	^{146}Pm	3713	I	130	411
	^{155}Eu	64680	I	10170	510

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040035

Sample ID
CF6080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209453

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	10790		1530	18.3
	^{212}Bi	33350		5770	276
	^{212}Pb	8914		2127	30.7
	^{224}Ra	412700	I	123400	326
	^{228}Ac	31910		2060	66.7
	^{228}Th	34910		30010	363
^{235}U Series	^{219}Rn	9727	I	1726	121
	^{231}Pa	44310	I	20180	543
	^{233}Ra	1511	I	401	95.4
^{238}U Series	^{214}Bi	693		95.1	35.3
	^{214}Pb	578		97.5	36.3
	^{226}Ra	797		1145	310
	^{234M}Pa	6825	I	2533	2357
	^{234}Th	196	I	91.1	82.6
Other Series	^{40}K	2612	I	695	162
	^{146}Pm	2922	I	1012	346
	^{155}Eu	48700	I	6900	404

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040036

Sample ID
CF9080712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209454

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11400		1620	19.4
	^{212}Bi	34550		5980	303
	^{212}Pb	8011		2125	33.1
	^{224}Ra	446300	I	133200	351
	^{228}Ac	33450		2240	71.6
	^{228}Th	37180		31940	401
^{235}U Series	^{219}Rn	10450	I	1850	129
	^{231}Pa	627	I	521	584
	^{233}Ra	1418	I	392	102
^{238}U Series	^{214}Bi	578		88.1	38.0
	^{214}Pb	546		93.4	38.8
	^{226}Ra	713		1032	336
	^{234M}Pa	6612	I	2604	2511
	^{234}Th	257	I	114	90.2
Other Series	^{40}K	2642	I	699	171
	^{146}Pm	2989	I	1029	373
	^{155}Eu	56120	I	7660	446

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040037

Sample ID
CI11020712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209455

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13750		1950	24.5
	^{212}Bi	39710		5770	382
	^{212}Pb	12060		3090	41.8
	^{224}Ra	567800	I	169300	444
	^{228}Ac	39700		2510	89.1
	^{228}Th	50500		43480	517
^{235}U Series	^{211}Bi	188	I	91.0	143
	^{219}Rn	12860	I	2280	164
	^{231}Pa	58150	I	26490	751
	^{233}Ra	1785	I	495	129
^{238}U Series	^{226}Ra	617		930	426
	^{234M}Pa	7948	I	2829	3087
	^{234}Th	348	I	153	118
^{237} Series	^{229}Th	1098	I	1251	166
Other Series	^{40}K	3231	I	858	213
	^{137}Cs	51.9		26.8	47.8
	^{146}Pm	3896	I	1350	469
	^{155}Eu	78130	I	11870	576

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

040038

Sample ID
CI11020712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209455

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY						
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)	RPD
^{232}Th Series	^{208}Tl	12850		1590	23.5	6.77%
	^{212}Bi	39850		5650	360	0.35%
	^{212}Pb	12660		7450	39.7	4.85%
	^{224}Ra	531200	I	162600	418	6.66%
	^{228}Ac	39450		2320	83.0	0.63%
	^{228}Th	48680		42170	478	3.67%
^{235}U Series	^{211}Bi	255	I	104	135	30.1%
	^{219}Rn	13900	I	5570	155	7.77%
	^{231}Pa	898	I	772	694	194%
	^{231}Th	211100	I	61300	88.2	----
	^{233}Ra	1900	I	506	122	6.24%
^{238}U Series	^{214}Pb	84.3		51.9	46.2	----
	^{226}Ra	556		851	399	10.4%
	^{234M}Pa	8936	I	3237	2891	11.7%
	^{234}Th	370	I	159	110	6.16%
^{237} Series	^{229}Th	830	I	985	154	27.8%
Other Series	^{40}K	3007	I	800	199	7.18%
	^{137}Cs	NA		NA	NA	NA
	^{146}Pm	3800	I	1295	444	2.49%
	^{155}Eu	63830	I	10510	533	20.1%

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040039

Sample ID
CI12020712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209456

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12740		1580	24.5
	^{212}Bi	40610		5750	364
	^{212}Pb	17200		9390	40.2
	^{224}Ra	536700	I	164400	425
	^{228}Ac	38450		2260	86.1
	^{228}Th	48980		42370	487
^{235}U Series	^{219}Rn	14710	I	5780	157
	^{231}Pa	983	I	805	708
	^{231}Th	213300	I	61900	89.9
	^{233}Ra	1749	I	480	124
^{238}U Series	^{214}Pb	249		51.1	46.9
	^{226}Ra	347		559	407
	^{234M}Pa	8865	I	3247	2939
	^{234}Th	308	I	139	112
^{237} Series	^{229}Th	959	I	1129	157
	^{237}Np	1867	I	1549	49.1
Other Series	^{40}K	3120	I	827	203
	^{146}Pm	3831	I	1326	450
	^{155}Eu	195200	I	37300	543

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040040

Sample ID
CI13020712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209457

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13140		1630	24.4
	^{212}Bi	40360		5720	376
	^{212}Pb	12260		8290	41.6
	^{224}Ra	554300	I	169700	438
	^{228}Ac	38340		2260	87.6
	^{228}Th	47770		41390	510
^{235}U Series	^{219}Rn	16490	I	5790	162
	^{231}Pa	930	I	750	727
	^{231}Th	217500	I	63200	94.1
	^{233}Ra	2015	I	534	128
	^{235}U	51.6	I	75.1	26.2
^{238}U Series	^{214}Pb	71.0		26.8	48.4
	^{234M}Pa	8723	I	3260	2999
	^{234}Th	383	I	165	117
^{237} Series	^{229}Th	721	I	990	164
Other Series	^{40}K	2966	I	787	210
	^{146}Pm	3791	I	1303	463
	^{155}Eu	81100	I	12000	569

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040041

Sample ID
CI4030712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209458

Client: UT Battelle

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13130		1630	25.3
	^{212}Bi	39390		4920	378
	^{212}Pb	13780		8600	41.7
	^{224}Ra	558900	I	171100	441
	^{228}Ac	38880		2280	87.7
	^{228}Th	48480		41950	509
^{235}U Series	^{211}Bi	257	I	107	142
	^{219}Rn	15700	I	6060	163
	^{231}Pa	58400	I	26590	740
	^{231}Th	221500	I	64300	93.8
	^{233}Ra	1773	I	491	129
^{238}U Series	^{226}Ra	850	I	1268	423
	^{234M}Pa	10650	I	3950	3014
	^{234}Th	334	I	148	117
^{237} Series	^{229}Th	575	I	732	164
Other Series	^{40}K	3466	I	921	210
	^{146}Pm	3979	I	1416	459
	^{155}Eu	68930	I	11250	567

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040042

Sample ID
CI5030712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209459

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13140		1620	24.9
	^{212}Bi	38780		4850	381
	^{212}Pb	14180		9360	42.0
	^{224}Ra	561000	I	171800	444
	^{228}Ac	38380		2240	88.9
	^{228}Th	51300		44400	518
^{235}U Series	^{211}Bi	243	I	106	143
	^{219}Rn	16870	I	6870	163
	^{231}Pa	775	I	710	743
	^{231}Th	218400	I	63400	95.5
	^{233}Ra	1725	I	483	128
^{238}U Series	^{226}Ra	427	IU	671	428
	^{234M}Pa	10440	I	3550	3021
	^{234}Th	396	I	172	121
^{237} Series	^{229}Th	665	I	817	166
	^{237}Np	3386	I	2115	52.2
Other Series	^{40}K	3147	I	840	210
	^{146}Pm	3848	I	1323	470
	^{155}Eu	195900	I	37500	577

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040043

Sample ID
CI6030712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209460

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11880		1460	21.0
	^{212}Bi	37000		5240	321
	^{212}Pb	10980		7150	35.2
	^{224}Ra	473600	I	145300	373
	^{228}Ac	36160		2120	76.8
	^{228}Th	42160		36540	416
^{235}U Series	^{211}Bi	206	I	88.9	121
	^{219}Rn	11020	I	1950	138
	^{231}Pa	1001	I	751	622
	^{231}Th	189900	I	55200	76.8
	^{233}Ra	1691	I	438	109
^{238}U Series	^{214}Pb	51.3		49.9	41.3
	^{226}Ra	685	I	1023	351
	^{234M}Pa	8045	I	3127	2627
	^{234}Th	283	I	125	94.7
^{237} Series	^{229}Th	501	I	629	134
	^{237}Np	1796	I	1385	42.0
Other Series	^{40}K	2771	I	734	182
	^{146}Pm	3468	I	1184	395
	^{155}Eu	179500	I	34300	465

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040044

Sample ID
CI7030712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 209461

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	11580		1430	21.0
	^{212}Bi	36920		5230	326
	^{212}Pb	30150		6200	36.0
	^{224}Ra	480100	I	147200	380
	^{228}Ac	36030		2120	76.5
	^{228}Th	43920		37960	432
^{235}U Series	^{211}Bi	321	I	110	124
	^{219}Rn	11250	I	1990	141
	^{231}Th	190900	I	55400	79.8
	^{233}Ra	1554	I	428	111
^{238}U Series	^{214}PB	94.0		53.4	42.3
	^{226}Ra	316	U	496	362
	^{234M}Pa	7928	I	2917	2645
	^{234}Th	311	I	135	98.5
^{237} Series	^{229}Th	633	I	762	139
Other Series	^{40}K	3130	I	830	183
	^{146}Pm	3348	I	1160	403
	^{155}Eu	55330	I	9370	482

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040045

Sample ID
CI9030712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209462

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12190		1500	22.3
	^{212}Bi	36800		4600	343
	^{212}Pb	14280		8660	37.7
	^{224}Ra	505000	I	154700	398
	^{228}Ac	37070		2200	80.0
	^{228}Th	45200		39110	453
^{235}U Series	^{211}Bi	245	I	99.0	128
	^{219}Rn	15560	I	5720	147
	^{227}Th	205	I	111	111
	^{231}Th	201900	I	58600	83.5
	^{233}Ra	1864	I	492	117
^{238}U Series	^{226}Ra	156	U	334	383
	^{234M}Pa	7792	I	2859	2776
	^{234}Th	286	I	129	104
^{237} Series	^{229}Th	831	I	957	146
Other Series	^{40}K	3157	I	841	190
	^{146}Pm	3372	I	1163	421
	^{155}Eu	60110	I	9990	505

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040046

Sample ID
CI3070712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 209463

Client: UT Battelle

DLA Curtis bay

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	13220		1630	24.8
	^{212}Bi	39170		4900	379
	^{212}Pb	15830		9510	41.8
	^{224}Ra	553500	I	169300	440
	^{228}Ac	40240		2340	88.0
	^{228}Th	47650		41220	511
^{235}U Series	^{211}Bi	217	I	102	142
	^{219}Rn	12740	I	2260	163
	^{231}Pa	945	I	758	747
	^{231}Th	216700	I	62900	94.3
	^{233}Ra	1952	I	521	128
	^{235}U	41.7	I	61.4	26.3
^{238}U Series	^{234M}Pa	8262	I	3211	3016
	^{234}Th	331	I	149	120
^{237} Series	^{237}Np	2441	I	1770	51.5
Other Series	^{40}K	3046	I	805	211
	^{146}Pm	3782	I	1303	467
	^{155}Eu	195500	I	37400	570

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040047

Sample ID
CD58120712002

Lab Name: Southwest Research Institute

Client: UT Battelle

Lab Code: SwRI

DLA Curtis Bay

Case #: ~~DLA Hammond~~

Matrix: Thorium Nitrate

Method #: SW846-6020-7471

Work Order: 22835

Date Received: 07/17/02

Lab System ID: 210181

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12610		1560	23.6
	^{212}Bi	37170		4650	363
	^{212}Pb	12020		2910	39.5
	^{224}Ra	537900	I	163000	419
	^{228}Ac	37620		2190	82.9
	^{228}Th	50780		43850	494
^{235}U Series	^{219}Rn	12180	I	2160	156
	^{231}Pa	55510	I	25280	706
	^{231}Th	204000	I	59200	91.1
	^{233}Ra	1778	I	485	122
	^{235}U	39.6	I	58.2	25.4
^{238}U Series	^{234M}Pa	7397	I	2748	2909
	^{234}Th	404	I	172	115
^{237} Series	^{229}Th	651	I	896	159
Other Series	^{40}K	2937	I	784	51.0
	^{146}Pm	3733	I	1281	447
	^{155}Eu	79670	I	12260	550

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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SOUTHWEST RESEARCH INSTITUTE

GAMMA DATA ANALYSIS

040048

Sample ID
CI14020712002

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Thorium Nitrate

Work Order: 22835

Lab System ID: 210182

DLA Curtis Bay

Client: UT Battelle

Case #: ~~DLA Hammond~~

Method #: SW846-6020-7471

Date Received: 07/17/02

Project No.: 01.05421.01.006

GAMMA SPECTROMETRY					
Nuclide Type	Analyte	Results (pCi/g)	Q	TPU (pCi/g)	MDA (pCi/g)
^{232}Th Series	^{208}Tl	12760		1570	23.8
	^{212}Bi	38880		5510	353
	^{212}Pb	14020		8400	39.0
	^{224}Ra	521500	I	159700	412
	^{228}Ac	38380		2260	83.7
	^{228}Th	49670		42920	469
^{235}U Series	^{211}Bi	382	I	126	133
	^{219}Rn	15810	I	6310	152
	^{231}Pa	968	I	786	687
	^{231}Th	207800	I	60300	86.5
	^{233}Ra	1519	I	434	121
^{238}U Series	^{214}Pb	91.9		52.0	45.5
	^{226}Ra	339	U	532	397
	^{234M}Pa	5949	I	2176	2910
	^{234}Th	340	I	148	107
^{237} Series	^{229}Th	961	I	1108	151
Other Series	^{40}K	2929	I	780	198
	^{146}Pm	3574	I	1240	437
	^{155}Eu	60510	I	9500	523

U = Less than MDA.
I = Probable Interference, Isotope presence and/or quantitation questionable.
NOTE: No other Isotopes were detected above MDAs.

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APPENDIX C

Validation Reports from NFT, Inc.

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INORGANIC DATA VALIDATION REPORT

by

NFT, Incorporated – Oak Ridge, Tennessee

DATA VALIDATION FOR: Metals by SW846 Method 6010B, 6020, 7471A

SDG NUMBER: 208093

LEVEL OF VALIDATION: Forms Plus Raw Data (FR) Deliverables

SITE/PROJECT: Hammond/Defense National Stockpile Center Thorium Nitrate Inventory

CONTRACT LAB/SOW #: SwRI/05421.01.006

DATA VALIDATOR: Eng Tan

DATE VALIDATION COMPLETED: 9/24/02

PEER REVIEWER:

DATE REVIEW COMPLETED:

DATA COMPLETENESS: 100%

MATRIX: Thorium Nitrate monolith (solid)

CLIENT ID	LABORATORY ID
HD0807061-2002	208093
HD1010061-2002	208094
HD2307061-2002	208095
HD2907061-2002	208096
HD3007061-2002	208097
HD3810061-2002	208098
HD4710061-2002	208099
HD4810061-2002	208100

This data package has been reviewed and the quality assurance and performance data summarized. Data review and validation was performed according to guidance provided in USEPA SW-846 Methods 6010B, 6020, 7471A and the NFT, Incorporated standard operating procedure NFT-SMO-022, "Inorganic Data Verification and Validation".

Definition of data validation qualifiers:

U The analyte was not detected above the reported detection limit.
J The analyte was identified; the associated numerical value is approximated.

UJ The analyte was not detected above the reported detection limit, and the associated detection limit is approximated due to quality deficiency.
R The data is not usable for its intended purpose. (Note: the analyte may or may not be present).

Data that, as a result of the validation process, have been determined to meet QA/QC requirements and are considered to be a valid result greater than the reporting limit are presented with no qualifier, or may be shown with a "=", indicating that no qualifier is necessary.

I. DATA DELIVERABLES

All required data deliverables for definitive data were provided in the data package.

II. TECHNICAL HOLDING TIMES

Criteria:

Metals: 180 days (Soil - 4°C; Water – pH <2 with HNO_3)
Mercury: 28 days (Soil - 4°C; Water – pH <2 with HNO_3)

Eight 'monolith' samples of domestic origin were collected from the 'Hammond' site between 6/7/02 and 6/10/02 and received by the laboratory on 6/13/02. Cooler temperature was 22 °C. The CoC request analyses for total metals by ICPMS, mercury by CV and Th/U by Gamma Spectroscopy. However, the samples were analyzed for ICPAES metals 8/29-30/02; ICPMS on 8/29/02; CVAA on 7/5/02. ICP samples were extracted on 8/5/02 and CVAA (Hg) on 7/5/02. The chain of custody, analysis run logs, sample preparation logs, and case narrative were reviewed. No holding time exceedances was noted but samples were not chilled for transport. No action was taken.

Technical Holding Time Exceedances

Sample ID	Analyte	pH/Temperature	Days Exceeding HT	Qualifier for Detects	Qualifier for Nondetects
All	All	Temperature	NA	None	None

III. INITIAL AND CONTINUING CALIBRATION

Criteria:

Frequency: Initial calibration daily
Continuing calibration once every two hours or 10%
QC Criteria: Percent Recovery (%R): All analytes, except mercury & cyanide:90-110%

ICPAES: Was used to analyse for the following metals: Sb, Ba, Be, B, Cd, Ca, Cr, Co, Fe, Mn, Mo, Ni, Si, Na, Sr, Tl, Th, V, Zn. Zr (20 metals). Several runs were performed to achieve this analysis, each with its own calibrations and QC controls. Th was run on its own; Ca, Fe, Na, and V was run as another set; and the rest of the metals (15) comprised its own set. Some target analytes were also re-run. A blank and a one point standard concentration of the analytes were run as the initial calibration of the instrument. Several ICVs and CCVs were checked for compliance %Rs of all analytes were all within limits of 90 – 110%. No action was needed.

ICPMS: Instrument was tuned before start of analysis using Mg, Rh, and Pb and obtaining data for 10 replicates. The %RSD for the isotopes analyzed were <5%; mass calibration within 0.1 amu of True value; and peak width of

specified isotopes were < 0.75 amu. Four analytical runs were performed to analyze the 8 target metals and the ICVs, and CCVs for all analyses met recovery criteria of 90-110%. No action needed.

CVAA: Instrument calibrated with 1 blank and 6 standard concentrations of mercury. The correlation coefficient of the standard curve was 0.999, thus met criterion for acceptability. The %R for the ICV was within 90 – 110 and the CCVs were within 80 – 120%. No action needed.

Calibration %R Exceedances

Analyte	ICV/CCV	%R	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
None			none	J	UJ

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where: %R = percent recovery
F = actual concentration found in ICV and CCV
T = true concentration in ICV and CCV

IV. LABORATORY BLANK RESULTS

Criteria:
Frequency: Initial calibration blank after ICV
Continuing calibration blank after CCV
Preparation blank with every batch digested
QC Criteria: No contaminants should be detected in any laboratory blank

ICPAES: No contaminants was detected in any instrument blanks (ICB, CCB) and the Preparations blank. All results were <IDL. No action needed.

ICPMS: As above for ICPAES

CVAA: As above for ICPAES

Analytes detected in Blank Samples

Blank ID	Analyte	Maximum Conc./Units	Action (5X) Level	Affected Samples	Qualifier Applied
None					

V. INTERFERENCE CHECK SOLUTION (ICS)

Criteria:

Frequency: Beginning and end of each analysis run or a minimum of twice per 8 hour shift, whichever is more frequent

QC Criteria:
- %R of the ICSAB solution must fall within ±20% difference of the true value
- if results > IDL are observed for elements not present in ICS solution, the possibility of false positives may exist
- if negative results are observed for elements not present in the ICS solution, the possibility of false negatives may exist
- Al, Ca, Fe, and Mg are accepted if sample concentration ≤ ICSA concentration

ICPAES: The intent of the ICS in ICP analysis has not been followed by the laboratory. The ICSA solution did not contain any of the inteferents that were necessary to check for verifying the laboratory's interelement and background correction factors. There was no analytes present in the ICSA solution. The ICSAB solution contained spiked levels of target analytes. This QC analysis is very much like that of the LCS QC analysis. For all intent and purposes, no ICSs was run. The recoveries of spiked analytes were all within +/- 20% of the true values. No action taken.

ICPMS. See above for ICPAES

CVAA: ICS analysis not needed.

ICS %R Exceedances and Possible False Positive/Negative Results

Analyte	% Recovery	False Positive/Negative	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
None					

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where: %R = percent recovery
F = actual concentration found in ICS sample
T = true concentration in ICS sample

The calculation check list summarizes the calculations to verify percent recoveries (%Rs) were calculated correctly.

VI. LABORATORY CONTROL SAMPLE (LCS)

Criteria:

Frequency: One LCS with each batch
(Note: A LCS is not required for mercury and cyanide analysis in aqueous matrices).

QC criteria: Aqueous LCS: %R must be between 80-120% (except for Sb and Ag)
Solid LCS: Limits may be provided by LCS supplier, or are based on laboratory control charting.

ICP: %R for all 20 analytes met control limits of 80 – 120%. No action needed.

ICPMS: %R for all 8 analytes met control limits except for Se, which exceeded the upper control limit. However, the second LCS did not show this error. Since the Se results were all <IDL, no action was needed.

CVAA: %R for Hg was within limits. No action needed.

LCS %R Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
Se	%R	All	J	None required

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where: %R = percent recovery
F = actual concentration found in LCS
T = true concentration in LCS

VII. DUPLICATE SAMPLE ANALYSIS

Criteria:
Frequency: One duplicate with each batch
QC criteria: Relative Percent Difference (RPD) must be within ±20% for aqueous samples (±35% for soils) for sample values ≥5X CRDL or reporting limit (RL); and ±CRDL/RL (±2X CRDL/RL for soils) for sample values <5X CRDL/RL, including the case when only one of the sample values is <5X CRDL/RL.

Sample HD08070612002 was selected as the duplicate sample for all 3 analyses.

ICP: %RPD for the only detected analyte, Th was 0.03%, showing excellent precision. No action needed.

ICPMS: All target analytes were non detects. No action needed.

CVAA: Mercury was not detected in the samples. No action needed.

Duplicate RPD Exceedances

Analyte	RL/Units	Sample Conc.	Duplicate Conc.	RPD	Affected Samples	Qualifier Applied
None						

The following equation was used to verify calculations:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} x\ 100$$

where: RPD = relative percent difference
S = sample result
D = duplicate result

VIII. SPIKED SAMPLES

Frequency: One spike sample with each batch
QC criteria: %R between 75 - 125% for sample concentration ≤ 4X spike concentration

Sample HD08070612002 was selected as the predigestion spike sample for all 3 analyses.

ICPAES: Sample was spiked with all 20 target analytes. Two analytes failed to meet the control limits of 75 – 125% Recovery. They were Fe (130 %); and V (133 %). However, both Fe and V were < IDL in all samples and no qualification was necessary. Th was not spiked and the laboratory performed a post digestion spike with Th, Fe, and V. The results showed recoveries that were within 5% of the spiked values. No was action taken.

ICPMS: All spiked analytes of this analysis met the control limit of 75 – 125%. No action needed.

CVAA: %R for Hg met control limit of 75 – 125%. No action needed.

Spiked Sample Exceedances

Analyte	SSR	SR	SA	%R	Affected Samples	Qualifier Applied
None						

The following equation was used to verify calculations:

$$Percent\ Recovery = \frac{SSR - SR}{SA} x\ 100$$

where: SSR = spiked sample result
SR = sample result
SA = spike added

IX. ICP SERIAL DILUTION

Frequency: One serial dilution with each batch
QC criteria: Percent Difference (%D): ≤ 10% for sample concentrations above 10x IDL (SW-846 criteria)

ICPAES: Sample HD08070612002 was selected as the sample for ICP Serial Dilution analyses. The 5X dilution

showed that all target analytes, except for Th and Hg, were below the IDL of the method. Since all these analytes in the original sample were below the IDL, no comparison could be performed. No action needed. It is not known why Thorium was not analyzed.

ICPMS: See above for ICPAES.

CVAA: This analysis was not needed.

ICP Serial Dilution %D Exceedances

Analyte	%D	Affected Samples	Qualifier Applied
None			

The following equation was used to verify calculations:

$$\%D = \frac{|I - S|}{I} x\ 100$$

where: %D = relative percent difference
I = initial sample result
S = serial dilution result

X. SAMPLE RESULTS VERIFICATION

Some reported laboratory results were recalculated for confirmation and no errors were found.

XI. OVERALL ASSESSMENT OF DATA

Eight thorium nitrate 'monolith' samples were collected, received, extracted and analyzed within holding times. 29 target analytes were measured by 3 analytical methods (ICPAES, 20; ICPMS, 8; CVAA, 1).

The analyses and validation process followed procedures that have been promulgated by the EPA for environmental and waste samples. However, although the thorium nitrate stockpile is to be discarded, the characterization of this waste did not or could not follow the prescribed procedures. The analysis of these samples may be better described as trace metal analysis for chemical product specification. Several analytical iterations were performed which if used for the characterization of environmental or waste samples is probably unnecessary. Therefore, the 'validation' of these samples did not strictly adhere to the data validation guidelines provided by responsible organizations, especially in cases of deviations from normally accepted practices of performing QC analyses for the analytical procedures employed. Below is a summary of the validation process and the findings, the details of which can be found in the body of this report.

The calibrations of the instruments used for the analyses were demonstrated to meet acceptable criteria and thus provided evidence that the instruments were capable of performing the analyses for which they were intended. No contamination of target analytes was found in any of the instrument or preparation blanks.
The Interference Check Sample analysis for ICP did not follow the 'usual' method for analysis. No interfering analytes was present in the ICSA solution which in 'normal' situations would have required the addition of Al, Ca, Fe, and Mg. The analysis of this ICSA solution is akin to the analysis of a 'blank' sample. The ICSAB solution

contained all ICP target analytes except for Th and Na and the recoveries of the analytes were within +/- 20% of their true values. This analysis is similar to that of a LCS. Due to the high quantities of Th in the samples, the laboratory manually calculated the values of affected analytes (Ca, Fe, V, Cd, Cr, Mn, Zr) based on the Th concentrations in the samples before reporting the results.
The recoveries of target analytes in the LCS were all within limits except for Se in one LCS (144% cf upper limit of 125%). However, this recovery was within limits in the other LCS (107%) and the value of Se was below the IDL. No qualification was necessary.
Duplicate analysis showed excellent precision in the Th results but the rest of the analytes were non-detects and could not compared in the usual manner.
The pre-digestion spike analysis met control criteria for all analytes except for Fe and V which slightly exceeded the upper limit of 125% by 5% and 8%, respectively. Thorium was not spiked in the pre-digestion sample but was spiked in the post-digestion sample together with Fe and V in accordance with the requirement that any analyte that failed the pre-digestion spike analysis be reanalyzed in a post-digestion sample. The results showed that all 3 analytes met the control limits.
The laboratory performed a Serial Dilution analysis on a sample and since the original sample did not show any target analytes above the IDL (except for Th), no comparison between the samples could be made. It is not known why the laboratory did not report the Th results so that a Serial Dilution comparison could be made.
Thorium was detected in all samples at approximate 42% of the total weight of the samples. Sodium and Pb were detected in 4 samples in approximately 6,000 and 3 ppm, respectively and all other analytes were < IDLs.

In conclusion, no conditions adverse to data quality were identified resulting in the estimation or rejection of any data. The data are acceptable as reported at 100% ‘completeness’.

RADIOCHEMISTRY DATA VALIDATION REPORT

DATA VALIDATION FOR: Isotopic U/Th; γ-Spec

SDG NUMBER: 208093

PROJECT: Hammond/Defense National Stockpile Center Thorium Nitrate Inventory

CONTRACT LAB: Southwest Research Institute

LABORATORY SOW: 05421.01.006

VALIDATED BY: Eng Tan

DATE VALIDATION COMPLETED: September 26, 2002

MATRIX: Thorium Nitrate (monolith)

CLIENT ID	LABORATORY ID
HD0807061-2002	208093
HD1010061-2002	208094
HD2307061-2002	208095
HD2907061-2002	208096
HD3007061-2002	208097
HD3810061-2002	208098
HD4710061-2002	208099
HD4810061-2002	208100

This data package was reviewed against the data validation manual, *Bechtel Jacobs LLC., BJC-ES-01, Radiochemical Data Verification and Validation, Rev.0* and *NFT Inc. Validation/Verification, Radiobioassay, October 9, 2000.*

I. DATA DELIVERABLES

Action: Samples are traceable upon inspection of verification report, CoCs, etc. Qualify samples not traceable as rejected.

Samples	Deficiencies

Eight Thorium Nitrate monolith samples were collected between 6/7 – 10/02, shipped at ambient temperature (22 C) and received by laboratory on 6/13/02. Analysis requested was Gamma spectroscopy for Thorium and Uranium.

II. TECHNICAL HOLDING TIMES AND ANALYSIS

Criteria:

Preservation: pH< 2 (liquids only)
Holding Times: 180 days (Gross Alpha/Beta); Not Applicable (all Others)

Technical Holding Time Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifiers for Detects	Qualifiers for Nondetects

Samples were not chilled but was received intact. All analyses were completed within 90 days of collection. No action taken.

III. CALIBRATION AND BACKGROUNDS

Criteria:

Frequency: Initial calibration (IC) and calibration verification (CV) vary for each method
QC Criteria: Calibration and standard traceability vary for each method

Calibration and Background Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifiers for Detects	Qualifiers for Nondetects

Alpha spectrometers/gamma spectrometers:
Efficiency/background/energy calibrations were performed periodically according to laboratory QA program. Data and charts kept on file in laboratory. Daily calibrations and background determinations were not provided in data package. No action taken.

IV. BLANK RESULTS

Criteria:

Frequency: 1 per 20 samples
QC Criteria: Blank activities < MDC or 2σ counting uncertainty
Blank detects with 0 ≤ ND < 1.96 qualified as J or R
Blank detects with 1.96≤ ND < 2.58 qualified as J
Blank detects with 2.58 ≤ ND not qualified

Analytes detected in Blank Samples

Analyte	Activity±TPU pCi/g	MDA pCi/g	Criteria Failed	Affected Samples	Qualifier	
U-238	1.91 ± 0.46	0.32	ND < 1.96	HD0807061	U	
	0.84 ± 0.32	0.32	ND < 1.96	HD3007061	U	
Th-230			ND > 2.56	All	None	
Th-232			ND > 2.56	All	None	

Alpha Spectroscopy: Blank analysis showed that U 238, Th-230 and Th-232 were greater than their MDAs. When compared with the results of the samples that were > MDA, U-238 values were all not significantly different than the blank value. These values were qualified as undetected (U). However, when the Th-230 and Th-232 values were compared, the differences were significantly different. No qualification of these data was needed.

Gamma Spectroscopy: No blank sample was analyzed or needed. No action taken.

V. LABORATORY CONTROL SAMPLES

Criteria:

Frequency: 1 per 20 samples
QC Criteria: -1.96 ≤ ND ≤ 1.96 not qualified
-2.58 < ND < -1.96 or 1.96 < ND < 2.58 qualified as J, UJ, or U
ND < -2.58 or ND > 2.58 qualified as J, UJ, U, or R

LCS Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

Alpha Spectroscopy: The laboratory spiked the samples with natural Uranium and Thorium 232. Criteria

for acceptability is the recovery of the spiked analyte as compared with the true values. All values were within 75 – 125% of the true values except for U-235 which slightly exceeded the lower limit of acceptability, i.e. 73% . Qualify all U-235 data as estimated.

VI. DUPLICATES

Criteria:

Frequency: One per batch of up to twenty samples
QC Criteria: ND ≤ 1.96 not qualified
ND > 1.96 qualified as J, U, or R

Duplicate Exceedances

Analyte	Criteria Failed	Affected Sample	Qualifiers for Detects	Qualifiers for Nondetects
U234	RPD	All 3 samples analyzed	J	UJ
U235	RPD	All 3 samples analyzed	J	UJ
U236	RPD	All 3 samples analyzed	J	UJ
U238	RPD	All 3 samples analyzed	J	UJ

Duplicate analysis was performed on sample HD0807061-2002 for all analyses.

Gamma Spectroscopy: The reported results consisted of analytes of the Th232, U235, U237, U238 and other miscellaneous radionuclides, for a total of 17 radionuclides. For the purpose of this validation, only the radionuclides, Th-228 and Th-234 were compared. The precision of duplicate analysis was excellent in that the calculated ND was < 1.96 indicating that the results did not differ at the 5% level of confidence. No qualifiers was needed.

Alpha Spectroscopy U/Th: The laboratory calculated the precision as the RPD and the results showed that for Uranium, all isotopes measured (234,235,236, 238) were > 20% (the limit being +/- 20%). Qualify all uranium isotopes as estimated.
The RPD for Thorium isotopes (228,230,232) were all < 20%. No qualifiers needed.

VII. MATRIX SPIKE

Criteria:

Frequency: One per batch of up to twenty samples
QC Criteria: -1.96 ≤ ND ≤ 1.96 not qualified
-2.58 < ND < -1.96 or 1.96 < ND < 2.58 qualified as J, UJ, or U
ND < -2.58 or ND > 2.58 qualified as J, UJ, U, or R
Note: May not be required for methods where a carrier or tracer is used. May not be feasible for solid and some liquid analyses.

Matrix Spike Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

No matrix spike analysis was needed for either gamma or alpha spectroscopy analysis. For the latter, the chemical yield analysis represents this QC analysis (see below).

VIII. CHEMICAL YIELD - TRACERS AND CARRIERS

Criteria:

Frequency: Not applicable
QC Criteria: 20% ≤ Chemical yield (CY) ≤ 105%
Note: Sample results shall not be qualified based solely on chemical yield

Chemical Yield Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
U232	%R	All 3 samples analyzed	J	UJ

Gamma Spectroscopy: This section is not applicable.

Alpha Spectroscopy: For Uranium analysis the tracer used was U-232. The %recovery of this tracer for all analyses, was greater than the control limit of 105%. The recoveries were about 120%. Qualify all uranium data as estimated.
For the Thorium analysis, the tracer used was Th-229. The recoveries of this tracer in all analyses met control limits (20 – 105%) and were between 60 –70%. No action needed.

IX. OVERALL ASSESSMENT OF DATA

Eight Thorium nitrate monolith samples were collected and analyzed by gamma spectroscopy for gamma emitting nuclides and alpha spectroscopy for isotopes of Uranium and Thorium. Although the samples were not chilled for transport, no qualification of data was deemed necessary. Initial calibration and daily calibration data were not provided in the data package. Normally , the initail calibration data are not provided for all data packages but are supplied to the project prior to sample analysis. However, the daily calibration checks should be provided with each data package to verify that the instruments were capable to analyzing samples according to QA requirements. In this validation, no action was taken on this. All 8 samples were analyzed by gamma spectroscopy, but only 3 (HD0807061-2002; HD3007061-2002; HD4810060-2002) were analyzed for uranium and thorium isotopes. In all analyses, the sample HD0807061-2002 was used as the duplicate in the QC analysis. This validation effort consists of a

review of the data presented for completeness and QC acceptability. A limited number of calculations were performed to verify the accuracy of reported data but analysis of the data as they pertain to expected values was not attempted. The acceptability of data in meeting the data quality objectives of the project is not implied. A short account of the analyses is given below:

Gamma Spectroscopy:
All 8 samples were counted for 30 minutes and the identified lines in the spectra reported. The spectroscopist reviewed the data and based on professional judgement and QA acceptance criteria, qualified certain identified radionuclides as impacted by interference. Under normal circumstances, the laboratory would not report these nuclides, but for this project, the laboratory felt it appropriate that the decision of accepting the presence of a nuclide should be left to the project. The laboratory flagged all such nuclides as 'I', denoting interference. For this validation, this qualifier 'I' has been changed to 'NJ' to signify, 'presumably present at an estimated quantity'. The 'dead time' during the counting process was about 30% for all samples. Although the software does correct for dead time, samples with a large dead time should be reanalyzed. Due to this, the results are estimated.

Alpha Spectroscopy:
Extracts of 3 samples plus a duplicate were separated for Uranium and Thorium analysis. As expected, higher activities of thorium than uranium were found. QC analysis showed that for the thorium analysis, control criteria were met while uranium slightly exceeded the control limits. This could be due to lower activities found in the uranium fraction and that the counting times were not long enough. Due to these facts, uranium data were qualified as estmated and thorium data did not require any qualifiers. The laboratory also provided the calculated weight of thorium and uranium based on the specific activities of the isotopes as a comparison to the ICP data. An assessment of this comparison is not attempted in this validation.

INORGANIC DATA VALIDATION REPORT

by

NFT, Incorporated – Oak Ridge, Tennessee

DATA VALIDATION FOR: Metals by SW846 Method 6010B, 6020, 7471A

SDG NUMBER: 208093

LEVEL OF VALIDATION: Forms Plus Raw Data (FR) Deliverables

SITE/PROJECT: Curtis Bay/Defense National Stockpile Center Thorium Nitrate Inventory

CONTRACT LAB/SOW #: SwRI/05421.01.006

DATA VALIDATOR: Eng Tan

DATE VALIDATION COMPLETED: November 4, 2002

PEER REVIEWER: Richard Westmoreland

DATE REVIEW COMPLETED:

DATA COMPLETENESS: 100%

MATRIX: Thorium Nitrate (solid: monolith, powder, cube)

CLIENT ID	LABORATORY ID
See attached	

This data package has been reviewed and the quality assurance and performance data summarized. Data review and validation was performed according to guidance provided in USEPA SW-846 Methods 6010B, 6020, 7471A and the NFT, Incorporated standard operating procedure NFT-SMO-022, "Inorganic Data Verification and Validation".

Definition of data validation qualifiers:

U The analyte was not detected above the reported detection limit.
J The analyte was identified; the associated numerical value is approximated.

UJ The analyte was not detected above the reported detection limit, and the associated detection limit is approximated due to quality deficiency.
R The data is not usable for its intended purpose. (Note: the analyte may or may not be present).

Data that, as a result of the validation process, have been determined to meet QA/QC requirements and are considered to be a valid result greater than the reporting limit are presented with no qualifier, or may be shown with a "=", indicating that no qualifier is necessary.

I. DATA DELIVERABLES

All required data deliverables for definitive data were provided in the data package.

II. TECHNICAL HOLDING TIMES

Criteria:

Metals: 180 days (Soil - 4°C; Water – pH <2 with HNO_3)
Mercury: 28 days (Soil - 4°C; Water – pH <2 with HNO_3)

Forty five (45) solid samples were received by the laboratory on 7/17/02. These samples were collected from the Curtis Bay site of domestic (22 monolith samples), France (13 powder samples) and India (10 cube samples) origin. The dates of collection of the samples were between 6/27/02 to 7/12/02 for domestic samples; 7/02 – 08/02 for French samples; and 7/02-03/02 for Indian samples. There were discrepancies noted by the laboratory between the data on the CoC and on the sample labels, the actual samples received and samples noted on the CoC as sent, etc. The laboratory contacted the project with these findings and it is assumed for this data validation that a resolution had been arrived at between the project and the laboratory. For further details, see *'Electronic Mail Communications'* of the data package.
Nine samples were analyzed for Mercury 1 to 2 days past the Holding time of 28 days. This infraction was not considered serious enough to qualify the data; the technical holding time criterion has only been established for aqueous matrices. No action was taken.
Holding times for the other analyses (metals by ICP-AES and ICP-MS) were within established guidelines of 180 days. No action needed.
All samples were received by the laboratory intact, but with no custody seals, and at ambient temperature (22 °C). No action was taken.

Technical Holding Time Exceedances

Sample ID	Analyte	pH/Temperature	Days Exceeding HT	Qualifier for Detects	Qualifier for Nondetects

III. INITIAL AND CONTINUING CALIBRATION

Criteria:

Frequency: Initial calibration daily
Continuing calibration once every two hours or 10%
QC Criteria: Percent Recovery (%R): All analytes, except mercury & cyanide:90-110%

ICPAES: Was used to analyse for the following metals: Sb, Ba, Be, B, Cd, Ca, Cr, Co, Fe, Mn, Mo, Ni, Si, Na, Sr,

Tl, Th, V, Zn. Zr (20 metals). Several runs were performed to achieve this analysis, each with its own calibrations and QC controls. Th was run on its own; Ca, Fe, Na, and V was run as another set; and the rest of the metals (15) comprised its own set. Some target analytes were also re-run. A blank and a one point standard concentration of the analytes were run as the initial calibration of the instrument. Several ICVs and CCVs were checked for compliance %Rs of all analytes were all within limits of 90 – 110%. No action was needed.

ICPMS: Was used to analyze for the following metals: Al, As, Cu, Pb, Mg, Se, Ag,U (8 metals). Instrument was tuned before start of analysis using Mg, Rh, and Pb as standards. The %RSD for the isotopes analyzed were <5%; mass calibration within 0.1 amu of True value; and peak width of specified isotopes were < 0.75 amu. Several analytical runs of various combinations of the target analytes were performed to analyze the 8 target metals and the ICVs, and CCVs for all analyses met recovery criteria of 90-110%. No action needed.

CVAA: Instrument calibrated with 1 blank and 6 standard concentrations of mercury for the 3 runs. The correlation coefficients of the standard curves were >0.995, and thus met criterion for acceptability. The %R for the ICVs and CCVs were within 90 – 100%, well within the limits of 80 – 120%. No action needed.

Calibration %R Exceedances

Analyte	ICV/CCV	%R	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
None			none	J	UJ

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where: %R = percent recovery
F = actual concentration found in ICV and CCV
T = true concentration in ICV and CCV

IV. LABORATORY BLANK RESULTS

Criteria:
Frequency: Initial calibration blank after ICV
Continuing calibration blank after CCV
Preparation blank with every batch digested
QC Criteria: No contaminants should be detected in any laboratory blank

ICPAES: Ca was detected in a preparation blank at 2.555 mg/Kg and B was detected in a CCB at 23.4 ug/L. However, none of these analytes was detected in any sample above the detection limit. No action needed.

ICPMS: No analytes were detected in any of the blanks. No action needed.

CVAA: No Hg was detected in any of the instrument or preparation blanks above the Detection Limit. No action needed.

Analytes detected in Blank Samples

Blank ID	Analyte	Maximum Conc./Units	Action (5X) Level	Affected Samples	Qualifier Applied
None					

V. INTERFERENCE CHECK SOLUTION (ICS)

Criteria:

Frequency: Beginning and end of each analysis run or a minimum of twice per 8 hour shift, whichever is more frequent

QC Criteria:
- %R of the ICSAB solution must fall within ±20% difference of the true value
- if results > IDL are observed for elements not present in ICS solution, the possibility of false positives may exist
- if negative results are observed for elements not present in the ICS solution, the possibility of false negatives may exist
- Al, Ca, Fe, and Mg are accepted if sample concentration ≤ ICSA concentration

ICPAES: The intent of the ICS in ICP analysis has not been followed by the laboratory because of the unique nature of this project. The ICSA solution did not contain any of the inteferents that were necessary to check for verifying the laboratory's interelement and background correction factors. There was no analytes present in the ICSA solution. The ICSAB solution contained spiked levels of target analytes. This QC analysis is very much like that of the LCS QC analysis. For all intent and purposes, no ICSs was run. The recoveries of spiked analytes were all within +/- 20% of the true values. No action taken.

ICPMS. See above for ICPAES

CVAA: ICS analysis not needed.

ICS %R Exceedances and Possible False Positive/Negative Results

Analyte	% Recovery	False Positive/Negative	Affected Samples	Qualifier for Detects	Qualifier for Nondetects
None					

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where:
- %R = percent recovery
- F = actual concentration found in ICS sample
- T = true concentration in ICS sample

The calculation check list summarizes the calculations to verify percent recoveries (%Rs) were calculated correctly.

VI. LABORATORY CONTROL SAMPLE (LCS)

Criteria:
Frequency: One LCS with each batch
(Note: A LCS is not required for mercury and cyanide analysis in aqueous matrices).
QC criteria: Aqueous LCS: %R must be between 80-120% (except for Sb and Ag)
Solid LCS: Limits may be provided by LCS supplier, or are based on laboratory control charting.

ICPAES: %R for all 20 analytes met control limits of 80 – 120% except for Mo (120.5%) and Sr (121.6%). However, these analytes were not detected in any sample above the detection limit. No action needed. Although an LCS spiked at the instrument into a Th solution of concentration similar to that of the samples was analyzed and the results showed acceptable recoveries (59.9% - 123%), this analysis was not a 'usual' type of QC sample and is not addressed in this validation.

ICPMS: %R for all 8 analytes met control limits. No action was needed.

CVAA: Solid LCSs were analyzed for QC purposes. The %R for all 3 LCSs for the 3 analyses were 71%, 82% and 88%. The control limits for aqueous LCSs are 80 – 120%R. No definite limits are imposed on solid LCSs. According to the laboratory, the recoveries of Hg found were within the limits given by the manufacturer of the standard LCS. No action taken.

LCS %R Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

The following equation was used to verify calculations:

$$\%R = \frac{F}{T} x\ 100$$

where: %R = percent recovery
F = actual concentration found in LCS
T = true concentration in LCS

VII. DUPLICATE SAMPLE ANALYSIS

Criteria:
Frequency: One duplicate with each batch
QC criteria: Relative Percent Difference (RPD) must be within ±20% for aqueous samples (±35% for soils) for sample values ≥5X CRDL or reporting limit (RL); and ±CRDL/RL (±2X CRDL/RL for soils) for sample values <5X CRDL/RL, including the case when only one of the sample values is <5X CRDL/RL.

ICPAES: Three duplicate samples were run, one for each analytical run. In all 3 duplicate analyses, Th was

detected above the Reporting Limit and the RPD were all < 35% (12%, 4.8%, 0.3%). No qualification for Th was necessary.
In one sample duplicate, in addition to Th, Al, Ba, Cu, and Si were detected and they were all > Reporting Limit. The precision measurement %RPD for the analytes all met control criteria (Al 2.1%; Ba 2.8%; Cu 0.8%; Si 1.8%). No action was necessary for these analytes.
In another sample duplicate analysis (CD14120712002), in addition to Th, Mn and Zn were detected in the duplicate sample above the RL while they were not detected in the original sample. The RPD therefore could not be calculated. (If calculated by assuming that the non detects were at their Reporting limit values, then the RPD for Mn will be 25% and Zn, 98%). However, since Mn and Zn were not detected in the original sample and the values of these analytes in the duplicate sample were < 5 times Detection Limit, applying the criterion that the absolute difference between the original sample value and the duplicate sample value is < 2 times the RL (CRDL), then both analytes met the criterion for acceptability. No action was necessary.

ICPMS: All target analytes were non detects except for Al and Cu in one pair (out of 3) of duplicate samples. However, the RPDs met control criterion. No action needed.

CVAA: Three pairs of duplicates were run, a pair for each analytical run. No mercury was found in any of the samples above the detection limits. No evaluation of duplicate precision could be made. No action needed.

Duplicate RPD Exceedances

Analyte	RL/Units	Sample Conc.	Duplicate Conc.	RPD	Affected Samples	Qualifier Applied
None						

The following equation was used to verify calculations:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \, x \, 100$$

where: RPD = relative percent difference
S = sample result
D = duplicate result

VIII. SPIKED SAMPLES

Frequency: One spike sample with each batch
QC criteria: %R between 75 - 125% for sample concentration ≤ 4X spike concentration

ICPAES: Three samples were spiked with all 20 target analytes. Six analytes (Fe, Mn, Cr, V, Be, Cd) failed to meet control limits of %Recovery. Of the 6 failed analytes, Mn, Cr and Be showed recoveries > 125%. In these cases, all non detects were not qualified and all detects were qualified as estimated. The rest of the failed analytes showed recoveries between 30 – 75% and all detects were qualified as estimated (J) and non detects as detection limit uncertain (UJ). Th was not spiked in the original sample because of the massive quantities of this metal present. The laboratory did a 1000 fold dilution of the sample before spiking with Th and used this as an indication that Th could be recovered. Although the original sample concentrations of Th were > 4 times the spike

concentrations, the %Recoveries for all 3 sample analyses were within the control limits (106%, 103%, 88%). No action was taken.

ICPMS:. Three samples were spiked with all 8 target analytes and 4 analytes (Al, Mg, Ag, U), failed to meet control limits and were all between 30 – 75% recoveries. Qualify all detects as estimated (J) and non detects as detection limit uncertain (UJ).

CVAA: %R for Hg of all 3 runs, were 87%, 98%, and 96% and met control limit of 75 – 125%. No action needed.

Spiked Sample Exceedances

Analyte	SSR	SR	SA	%R	Affected Samples	Qualifier Applied

The following equation was used to verify calculations:

$$Percent\ Recovery = \frac{SSR - SR}{SA} x\ 100$$

where: SSR = spiked sample result
SR = sample result
SA = spike added

IX. ICP SERIAL DILUTION

Frequency: One serial dilution with each batch
QC criteria: Percent Difference (%D): ≤ 10% for sample concentrations above 10x IDL (SW-846 criteria)

ICPAES: Three samples were selected and run for ICP Serial Dilution analyses. The 5X dilution showed that all target analytes, except for Th, Al, Ba, Cu, Si were below the IDL of the method. The % Difference for the 3 Th analyses were well within the control limits of 10% (4.8%, 5.1%, 0.3%). The rest of the analytes in the original sample before dilution were all < 10 times the IDL and therefore no comparison could be performed. No action needed.

ICPMS: See above for ICPAES.

CVAA: This analysis was not needed.

ICP Serial Dilution %D Exceedances

Analyte	%D	Affected Samples	Qualifier Applied
None			

The following equation was used to verify calculations:

$$\%D = \frac{|I - S|}{I} x\ 100$$

where: %D = relative percent difference
I = initial sample result
S = serial dilution result

X. SAMPLE RESULTS VERIFICATION

Some reported laboratory results were recalculated for confirmation and an error in the reported detection limit of sample Lab ID 209454 (CF9080712002) for mercury was found. The reported detection limit was 0.00 mg/Kg when it should be 0.04mg/Kg. No other problems was encountered.

XI. OVERALL ASSESSMENT OF DATA

Forty five thorium nitrate samples from Curtis Bay (domestic, French, and Indian origin) were collected, received, extracted and analyzed within holding times except for mercury for some samples. The exceedence in holding times for these samples were < 2 days and were not considered as necessitating qualification of data. 29 target analytes were measured by 3 analytical methods (ICPAES, 20; ICPMS, 8; CVAA, 1).

The analyses and validation process followed procedures that have been promulgated by the EPA for environmental and waste samples. However, although the thorium nitrate stockpile is to be discarded, the characterization of this waste did not or could not follow the prescribed procedures. The analysis of these samples may be better described as trace metal analysis for chemical product specification. Several analytical iterations were performed which if used for the characterization of environmental or waste samples is probably unnecessary. Therefore, the 'validation' of these samples did not strictly adhere to the data validation guidelines provided by responsible organizations, especially in cases of deviations from normally accepted practices of performing QC analyses for the analytical procedures employed. Below is a summary of the validation process and the findings, the details of which can be found in the body of this report.

The calibrations of the instruments used for the analyses were demonstrated to meet acceptable criteria and thus provided evidence that the instruments were capable of performing the analyses for which they were intended. No contamination of target analytes was found in any of the instrument or preparation blanks except for Ca and B but did not affect the data.
The Interference Check Sample analysis for ICP did not follow the 'usual' method for analysis. No interfering analytes was present in the ICSA solution which in 'normal' situations would have required the addition of Al, Ca, Fe, and Mg. The analysis of this ICSA solution is akin to the analysis of a 'blank' sample. The ICSAB solution contained all ICP target analytes except for Th and Na and the recoveries of the analytes were within +/- 20% of their true values. This analysis is similar to that of a LCS. Due to the high quantities of Th in the samples, the laboratory manually calculated the values of affected analytes (Ca, Fe, V, Cd, Cr, Mn, Sb, Si,Tl,) based on the Th concentrations in the samples at 1000 ppm before reporting the results.
The recoveries of target analytes in the LCS were all within limits except for Mo and Sr in one LCS which were only slightly above the upper control limit of 120%. However, the values of both analytes were below the IDL. No qualification was necessary.
Duplicate analysis showed excellent precision in the Th results and no impact on data was found due to the results of the other analytes.
The pre-digestion spike analysis met control criteria for all analytes except for Fe, Mn, Cr,V, Be, Cd, Al, Mg, Ag, and U. These elements were qualified as noted in the text. Thorium was not spiked in the pre-digestion sample but was spiked in the post-digestion sample (1000 fold dilution) together with the elements that failed the pre-digestion spike analysis in accordance with the requirement that any analyte that failed the pre-digestion spike

analysis be reanalyzed in a post-digestion sample. The results showed that Th recovery met the control limits. The laboratory performed a Serial Dilution analysis on 3 samples and no impact on data was observed. The recoveries of Th were good in these analyses.
Thorium was detected in all samples at approximately half the total weight of the samples. Most analytes were not detected above the Detection limits but some differences were noted among the analytes from different sources.

In conclusion, no conditions adverse to data quality was identified resulting in the rejection of any result. The data are acceptable as reported at 100% 'completeness'.

RADIOCHEMISTRY DATA VALIDATION REPORT

DATA VALIDATION FOR:	Isotopic U/Th by α-Spec; γ-Spec
SDG NUMBER:	208093
PROJECT:	Curtis Bay/Defense National Stockpile Center Thorium Nitrate Inventory
CONTRACT LAB:	Southwest Research Institute
LABORATORY SOW:	05421.01.006
VALIDATED BY:	Eng Tan
DATE VALIDATION COMPLETED:	November 6, 2002
REVIEWED BY:	Richard Westmoreland
MATRIX:	Thorium Nitrate (monolith, powder, cube)

CLIENT ID	**LABORATORY ID**
See attached	

This data package was reviewed against the data validation manual, *Bechtel Jacobs LLC., BJC-ES-01, Radiochemical Data Verification and Validation, Rev.0* and *NFT Inc. Validation/Verification, Radiobioassay, October 9, 2000.*

Definition of data validation qualifiers:

U The analyte was not detected above the reported detection limit.
J The analyte was identified; the associated numerical value is approximated.

UJ The analyte was not detected above the reported detection limit, and the associated detection limit is approximated due to quality deficiency.
R The data is not usable for its intended purpose. (Note: the analyte may or may not be present).
NJ The analyte was presumably present at an estimated quantity.
Data that, as a result of the validation process, have been determined to meet QA/QC requirements and are considered to be a valid result greater than the reporting limit are presented with no qualifier, or may be shown with a "=", indicating that no qualifier is necessary.

I. DATA DELIVERABLES

Action: Samples are traceable upon inspection of verification report, CoCs, etc. Qualify samples not traceable as rejected.

Samples	Deficiencies

All data deliverables were present in data package.

II. TECHNICAL HOLDING TIMES AND ANALYSIS

Criteria:
Preservation: pH< 2 (liquids only)
Holding Times: 180 days (Gross Alpha/Beta); Not Applicable (all Others)

Forty five (45) solid samples were received by the laboratory on 7/17/02. These samples were collected from the Curtis Bay site of domestic (22 monolith samples), France (13 powder samples) and India (10 cube samples) origin. The dates of collection of the samples were between 6/27/02 to 7/12/02 for domestic samples; 7/02 – 08/02 for French samples; and 7/02-03/02 for Indian samples. There were discrepancies noted by the laboratory between the data on the CoC and on the sample labels, the actual samples received and samples noted on the CoC as sent, etc. The laboratory contacted the project with these findings and it is assumed for this data validation that a resolution had been arrived at between the project and the laboratory before sample analysis. For further details, see *'Electronic Mail Communications'* of the data package.
Fifteen samples were analyzed for U and Th by alpha spectroscopy while 45 samples were analyzed by gamma spectroscopy.
Holding times for these analyses were met and no action was needed.
All samples were received by the laboratory intact, but with no custody seals, and at ambient temperature (22 °C). No action was taken.

Technical Holding Time Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifiers for Detects	Qualifiers for Nondetects

III. CALIBRATION AND BACKGROUNDS

Criteria:

Frequency: Initial calibration (IC) and calibration verification (CV) vary for each method
QC Criteria: Calibration and standard traceability vary for each method

Calibration and Background Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifiers for Detects	Qualifiers for Nondetects

Alpha spectrometers/gamma spectrometers:
Efficiency/background/energy calibrations were performed periodically according to laboratory QA program. Data and charts kept on file in laboratory. Daily calibrations and background determinations were not provided in data package. No action taken.

IV. BLANK RESULTS

Criteria:

Frequency: 1 per 20 samples
QC Criteria: Blank activities < MDC or 2σ counting uncertainty
Blank detects with 0 ≤ ND < 1.96 qualified as J or R
Blank detects with 1.96≤ ND < 2.58 qualified as J
Blank detects with 2.58 ≤ ND not qualified

Analytes detected in Blank Samples

Analyte	Activity±TPU pCi/g	MDA pCi/g	Criteria Failed	Affected Samples	Qualifier	
U-234	0.94 ± 0.334	0.32	ND < 1.96 or <MDA	All 15 samples except	U	
			ND > 2.56	CF1080712002 CF19080712002 CF2080712002	None	
Th-228			ND > 2.56	All	None	
Th-230			ND > 2.56	All	None	
Th-232			ND > 2.56	All	None	

Alpha Spectroscopy: Blank analysis showed that U 234, Th-228, Th-230 and Th-232 were greater than their MDAs or 2σ counting uncertainty. When compared with the results of the samples that were > MDA, U-234 values were all not significantly different than the blank value or were <MDA for all samples except for the 3 samples noted above. These 12 sample values were qualified as undetected (U) and the 3 samples with ND> 2.56 did not require any qualifiers. However, when the Th-228, Th-230 and

Th-232 values were compared, the differences were significantly different. No qualification of these data was needed.

Gamma Spectroscopy: No blank sample was analyzed or needed. No action taken.

V. LABORATORY CONTROL SAMPLES

Criteria:

Frequency: 1 per 20 samples

QC Criteria: $-1.96 \leq ND \leq 1.96$ not qualified

$-2.58 < ND < -1.96$ or $1.96 < ND < 2.58$ qualified as J, UJ, or U

$ND < -2.58$ or $ND > 2.58$ qualified as J, UJ, U, or R

LCS Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

Alpha Spectroscopy: The laboratory prepared and analyzed two aqueous samples spiked with natural Uranium and Thorium 232 for one of the LCS samples and only natural Uranium for the second. Criteria for acceptability is the recovery of the spiked analyte as compared with the true values. All values were within 75 – 125% of the true values. No qualification of data was necessary.

Gamma Spectroscopy: No LCS sample was analyzed or needed. No action taken.

VI. DUPLICATES

Criteria:

Frequency: One per batch of up to twenty samples

QC Criteria: $ND \leq 1.96$ not qualified

$ND > 1.96$ qualified as J, U, or R

RPD ± 20%

Duplicate Exceedances

Analyte	Criteria Failed	Affected Sample	Qualifiers for Detects	Qualifiers for Nondetects
U236 (Alpha)	RPD	All 15 samples analyzed	J	UJ
U238 (Alpha)	RPD	All 15 samples analyzed	J	UJ
Ac-228 (Gamma)	RPD	All sample of domestic origin	J	

Gamma Spectroscopy: Three samples, one sample per generator, were analyzed in duplicate (CD02120712002; CF1080712002; CI11020712002). The reported results consisted of radionuclides that have been identified and quantitated by the gamma spectroscopy software. The laboratory also reported

the radionuclides that in their opinion suffered from spectral interference and were either not present or present in lesser quantities than that reported. These radionuclides were indicated by the letter 'I'. For the purpose of this validation, only the radionuclides that were definitely identified and quantified were compared. The precision of duplicate analysis was calculated by the laboratory as the RPD. Control limits for precision are +/- 20% and the Normalized Difference between the duplicate results were also calculated. It was determined that only Ac-228 of duplicate sample CD02120712002 had an RPD >20% (27.8%) and a ND >1.96 (4.76). The duplicate precision calculated for Ac-228 for the other 2 duplicate sample pairs were well within the control limits. Although one could argue that this 'domestic' sample contained 'interferents' to the quantitation of Ac-228 not present in the other two sample types (French and Indian), this is considered not likely. However, to be conservative, all Ac-228 results of domestic origin (CD) were qualified as estimated (J). No other qualifiers based on duplicate analysis was necessary.

Alpha Spectroscopy U/Th: The sample analyzed in duplicate was CI 3070712002. The laboratory calculated the precision as the RPD and the results showed that for Uranium (234,235,236, 238), U-235 for both original and duplicate samples, was not detected above the MDA. The RPD for U-234 was 3%, and U-236 and U-238 were 52% and 43% respectively (the limit being +/- 20%). Qualify all U-236 and U-238 isotopes as estimated (J/UJ)
The RPD for Thorium isotopes (228,230,232) were all < 20%. No qualifiers needed.

VII. MATRIX SPIKE

Criteria:

Frequency:	One per batch of up to twenty samples
QC Criteria:	$-1.96 \leq ND \leq 1.96$ not qualified
	$-2.58 < ND < -1.96$ or $1.96 < ND < 2.58$ qualified as J, UJ, or U
	$ND < -2.58$ or $ND > 2.58$ qualified as J, UJ, U, or R
Note:	May not be required for methods where a carrier or tracer is used. May not be feasible for solid and some liquid analyses.

Matrix Spike Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

No matrix spike analysis was needed for either gamma or alpha spectroscopy analysis. For the latter, the chemical yield analysis represents this QC analysis (see below).

VIII. CHEMICAL YIELD - TRACERS AND CARRIERS

Criteria:

Frequency:	Not applicable
QC Criteria:	$20\% \leq$ Chemical yield (CY) $\leq 105\%$
Note:	Sample results shall not be qualified based solely on chemical yield

Chemical Yield Exceedances

Analyte	Criteria Failed	Affected Samples	Qualifier for Detects	Qualifier for Nondetects

Gamma Spectroscopy: This section is not applicable.

Alpha Spectroscopy: For Uranium analysis the tracer used was U-232. The %recovery of this tracer for all analyses, was not greater than the control limit of 105% (laboratory control limits was 70 –130%). The recoveries for all samples were within the control limits of 20 – 105%. No qualification of uranium data needed.
For the Thorium analysis, the tracer used was Th-229. The recoveries of this tracer in all analyses met control limits (20 – 105%). No action needed.

IX. OVERALL ASSESSMENT OF DATA

Forty five Thorium nitrate (monolith, powder, cube) samples were collected and analyzed by gamma spectroscopy for gamma emitting nuclides and alpha spectroscopy for isotopes of Uranium and Thorium. Although the samples were not chilled for transport, no qualification of data was deemed necessary. Initial calibration and daily calibration data were not provided in the data package. Normally , the initial calibration data are not provided for all data packages but are supplied to the project prior to sample analysis. However, the daily calibration checks should be provided with each data package to verify that the instruments were capable of analyzing samples according to QA requirements. In this validation, no action was taken on this. All 45 samples were analyzed by gamma spectroscopy, but only 15 samples were analyzed for uranium and thorium isotopes. This validation effort consists of a review of the data presented for completeness and QC acceptability. A limited number of calculations were performed to verify the accuracy of reported data but analysis of the data as they pertain to expected values was not attempted. The acceptability of data in meeting the data quality objectives of the project is not implied. A short account of the analyses is given below:

Gamma Spectroscopy:
All 45 samples and 3 duplicate samples were counted for 30 minutes and the identified lines in the spectra reported. The spectroscopist reviewed the data and based on professional judgement and QA acceptance criteria, qualified certain identified radionuclides as impacted by interference. Under normal circumstances, the laboratory would not report these nuclides, but for this project, the laboratory felt it appropriate that the decision of accepting the presence of a nuclide should be left to the project. The laboratory flagged all such nuclides as 'I', denoting interference. For this validation, this qualifier 'I' (laboratory qualifier) has been changed to 'NJ' (data validation qualifer) to signify, 'presumably present at an estimated quantity'. The 'dead time' during the counting process was about 30% for all samples. Although the software does correct for dead time, samples with a large dead time should be reanalyzed. Due to this, the results were qualified as estimated.
Sample CD44120712002 incorrectly showed the MDA for Bi-212 as 306000 pCi/g which resulted in the laboratory qualifier U. The MDA should have been reported as 306 pCi/g.
The laboratory should have qualified Ra-224 of sample CD45270612002 with an 'I' so as to be consistent with the qualification of this radionuclide throughout the other samples. This is also true for Pa-234m of sample CD22100712002, CD65090712002.

NB: Gamma spectroscopy analyses were performed during the month of September 2002 but the

sampling date for all samples was entered as January 1, 1980. The reported results were all decay corrected to the sampling date and reported as such. This is approximately a 22 year difference but the decay correction will not impact 'long lived' radionuclides but will certainly do so with 'short lived' ones, such as Cs-137, Pm-146, Eu-155. Technically, there is no reason to reject the data, but based on DQOs, it might be required. However, both sets of data, decay corrected and non corrected are available in the gamma spectroscopy report and the laboratory can easily correct this, if so desired.

Alpha Spectroscopy:

Extracts of 15 samples plus a duplicate were separated for Uranium and Thorium isotopes by column chromatography, precipitated, filtered and mounted for counting. As expected, higher activities of thorium than uranium were found. QC analysis showed that for the thorium analysis, control criteria were met while uranium in some cases slightly exceeded the control limits. This could be due to lower activities found in the uranium fraction and that the counting times were not long enough. Due to these deviations, uranium data were qualified as estmated and thorium data did not require any qualifiers. The laboratory also provided the calculated weight of thorium and uranium based on the specific activities of the isotopes as a comparison to the ICP data. An assessment of this comparison is not attempted in this validation.

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