ATTACHMENT 12

EVALUATION RESULTS FOR THE RADIOLOGICAL SUM OF THE FRACTIONS AND SIGNS TEST

Attachment 12

Evaluation Results for the Radiological Sum of the Fractions and Signs Test

Samples have been collected and analyzed for radiological activity concentrations in support of the fan removal work at the Brookhaven Graphite Research Reactor (BGRR) Decommissioning Project.

As per MARSSIM guidance (NUREG-1575), Appendix Section I.11.3: if the concentrations of the different radionuclides appear to be unrelated in the survey unit, there is little alternative but to measure the concentration of each radionuclide and use the unity rule. The unity rule sums the ratio between each measured concentration and its related Derived Concentration Guideline Level (DCGL). Residual radionuclides are considered to comply with the release criterion when the result of this summation is less than or equal to one.

The unity rule:

$$C_1/ D_1 + C_2/ D_2 + \ldots + C_n/ D_n \leq 1$$

Where:

C_i = Measured concentration of each radionuclide activity in a sample
D_i = DCGL value for each radionuclide

Results of the unity rule test for each set of sample data can be found on the attached sample data sheets, located in the row labeled "SUM OF FRACTIONS". Review of these data reveals that the sum of fractions for each sample is below the limiting value of one. It should be noted that wherever possible, actual result values were used and negative values were made zero and not added to the sum of fractions results. Results reported as ND (not detected) in data set COC #6345 were, for conservatism, replaced with the detection limit (DL) value.

Although each sample data set, as analyzed, passed the unity rule test, for illustrative purposes the Sign test was performed on the sum of fractions data. The results are attached as Table 1. The Sign test was generated and conducted as per NUREG-1575, Section 8.3.2. The input data used for the Sign test is the "SUM OF FRACTIONS" data used for the unity rule test.

Although we have some idea of what background concentrations are for these nuclides, we did not perform a background assessment in accordance with MARSSIM. As a result, we could not use the MARSSIM statistical method that allows for comparison of survey unit concentrations to background concentrations. This test is called the Wilcoxon Rank Sum Test.

Instead we used the Signs Test which assumes that the background concentration is zero. This means that all measure activity is assumed to be a contaminant. Because we know that background is not zero for many of these nuclides, this means that we are assuming that contamination concentrations above background are higher than they really are. This is obviously a conservative assumption.

Results of the Sign Test calculated for the BGRR samples indicate that residual radionuclide concentrations in this survey unit do not exceed the dose-based criteria. Using an alpha value of 0.005 and a sample number (N) of 52, the lowest S+ value that passes the Sign test is 35, as extrapolated from the data shown in Table I.3 of MARSSIM. The S+ value calculated for the BGRR samples is 52, which is well above the guideline for the S+ value.

SUMMARY OF RADIOLOGICAL RESULTS										
Sample Number		075-001000203-36	BD-1	075-002000203-36						
COC Number		6324	6324	6324						
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g						
Alpha Spectroscopy										
Americium-241	39	0.0227	-0.0141	0.0776						
Plutonium-238	65	-0.005	0.043	-0.0079						
Plutonium-239/240	40	0.0006	0.0173	0.0069						
Thorium-228[3]	NA	0.416	0.243	0.398						
Thorium-230[2]	5	0.294	0.149	0.147						
Thorium-232	5	0.328	0.217	0.341						
Uranium-233/234	9	0.147	0.116	0.161						
Uranium-235/236	9	0	0.0154	-0.0114						
Uranium-238	9	0.231	0.0864	0.152						
Gamma Spectroscopy										
Iodine-129	2.4	0.163	-0.0037	0.0064						
Americium-241	NA	0.0145	0.0048	0.0039						
Beryllium-7	NA	-0.024	-0.0035	-0.0065						
Cesium-134	NA	-0.001	0.0065	0.0092						
Cesium-137	23	0.02	0.0388	0.0128						
Cobalt-57	NA	-0.0015	0.0059	0.0064						
Cobalt-60	1100	-0.0039	-0.0016	0.0067						
Europium-152	49	0.0072	-0.0227	-0.0023						
Europium-154	170	0.0199	-0.0058	-0.0125						
Europium-155	1.50E+05	0.014	0	0.0453						
Managanese-54	NA	0.0055	-0.0048	0.0003						
Radium-226	5	0.242	0.181	0.274						
Sodium-22	NA	0.0072	-0.0021	-0.0048						
Vandium-48	NA	-0.0206	0.0067	-0.0068						
Zinc-65	NA	-0.0077	0.0316	0.0046						
Proportional Counter										
Gross Alpha	NA	3.19	2.51	1.79						
Gross Beta	NA	5.57	3.57	3.2						
Strontium-90	15	0.334	0.248	-0.375						
Liquid Scintiallion										
Tritium	1010	1.86	-0.339	1.01						
Carbon-14	31	0.0583	0.0559	0.032						
Nickel-63	2.90E+05	-0.417	0.172	-0.964						
Technetium-99	44	-0.231	-0.368	-0.399						
SUM OF FRACTIONS		0.262	0.119	0.140						

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS										
Sample Number		065-001000208-30	065-002000208-30	065-003000208-30	065-004000208-30	065-005000208-30	065-006000208-30	065-007000208-30		
COC Number		6345	6345	6345	6345	6345	6345	6345		
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g		
Alpha Spectroscopy										
Americium-241	39	0.11	0.126	0.0958	0.134	0.21	0.194	0.178		
Plutonium-238	65	0.116	0.225	0.241	0.159	0.174	0.299	0.0822		
Plutonium-239/240	40	0.0714	0.118	0.123	0.0808	0.0724	0.155	0.0596		
Thorium-228	NA	0.23	0.2	0.212	0.16	0.132	0.194	0.185		
Thorium-230[2]	5	0.137	0.0872	0.0953	0.0997	0.0615	0.149	0.123		
Thorium-232	5	0.122	0.18	0.0585	0.176	0.0582	0.121	0.165		
Uranium-233/234	9	0.101	0.13	0.132	0.117	0.263	0.146	0.206		
Uranium-235/236	9	0.0342	0.039	0.0288	0.0827	0.0367	0.0986	0.12		
Uranium-238	9	0.132	0.0901	0.0287	0.0592	0.121	0.118	0.0977		
Gamma Spectroscopy										
Iodine-129	2.4	0.244	0.201	0.257	0.216	0.178	0.328	0.212		
Americium-241	NA	0.0397	0.0433	0.0301	0.029	0.101	0.0917	0.0464		
Beryllium-7	NA	0.307	0.162	0.244	0.218	0.156	0.157	0.188		
Cesium-134	NA	0.0284	0.0183	0.0234	0.0202	0.0134	0.0141	0.0195		
Cesium-137	23	0.0322	0.0166	0.0276	0.0754	0.109	0.0754	0.161		
Cobalt-57	NA	0.0165	0.0117	0.013	0.0124	0.0103	0.0101	0.0131		
Cobalt-60	1100	0.0311	0.0207	0.0272	0.0229	0.0151	0.0157	0.021		
Europium-152	49	0.0737	0.0439	0.0598	0.05	0.0391	0.0381	0.0503		
Europium-154	170	0.0961	0.0577	0.0805	0.0632	0.0506	0.0425	0.0624		
Europium-155	1.50E+05	0.0638	0.048	0.0507	0.0461	0.0452	0.0441	0.0491		
Managanese-54	NA	0.0319	0.019	0.0251	0.0213	0.0147	0.0157	0.0198		
Radium-226	5	0.057	0.114	0.158	0.161	0.0294	0.167	0.15		
Sodium-22	NA	0.0347	0.0208	0.029	0.0228	0.0182	0.0154	0.0225		
Vandium-48	NA	0.095	0.0606	0.0704	0.0691	0.0456	0.0387	0.0568		
Zinc-65	NA	0.0705	0.0487	0.058	0.0466	0.0311	0.0346	0.0499		
Proportional Counter										
Gross Alpha	NA	2.27	4.17	1.6	1.35	1.52	1.65	2.44		
Gross Beta	NA	3.13	3.51	5	2	2.32	2.78	3.87		
Strontium-90	15	1.1	2.06	2.28	2.09	2.3	1.69	3.11		
Liquid Scintiallion										
Tritium	1010	2.14	1.71	1.75	1.76	2.12	1.61	2.24		
Carbon-14	31	0.209	0.208	0.216	0.222	0.217	0.217	1.6		
Nickel-63	2.90E+05	3.64	3.67	4.13	3.6	3.52	3.79	4.22		
Technetium-99	44	0.702	0.771	0.815	0.893	0.727	0.85	0.964		
SUM OF FRACTIONS		0.291	0.341	0.350	0.355	0.340	0.389	0.492		

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

SUMMARY OF RADIOLOGICAL RESULTS										
Sample Number		065-005000215-30	065-006000215-30	065-001000215-30	065-002000215-30	065-003000215-30	065-004000215-30			
COC Number		6361	6361	6361	6361	6361	6361			
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g			
Alpha Spectroscopy										
Americium-241	39	0.0086	0.0427	0.027	0.0225	0.0514	0.027			
Plutonium-238	65	0.0421	-0.022	0.038	-0.0233	0.0467	0.0149			
Plutonium-239/240	40	0.0006	0.0006	8E-04	0.0342	0.0052	-0.0094			
Thorium-228[3]	NA	0.158	0.0689	0.124	0.172	0.141	0.741			
Thorium-230[2]	5	0.280	0.185	0.155	0.114	0.149	0.412			
Thorium-232	5	0.232	0.0486	0.109	0.0495	0.149	0.708			
Uranium-233/234	9	0.0135	0.15	0.087	0.125	0.171	0.199			
Uranium-235/236	9	0.0491	0	-0.01	0.0243	-0.009	0.029			
Uranium-238	9	0.130	0.0924	0.032	0.0452	0.074	0.318			
Gamma Spectroscopy										
Iodine-129	2.4	-0.017	0.131	0.132	-0.081	0.0004	-0.0435			
Americium-241	NA	0.0049	0.003	0.007	0.004	0.0058	-0.008			
Beryllium-7	NA	-0.028	-0.050	-0.027	0.099	0.0083	0.141			
Cesium-134	NA	-0.005	-0.014	-0.008	0.003	0.0268	-0.007			
Cesium-137	23	-0.005	0.001	0.029	-0.001	0.0185	0.00394			
Cobalt-57	NA	0.0014	0.000	0.004	-0.003	-0.002	0.00175			
Cobalt-60	1100	0.0188	0.005	0.006	-0.016	-9E-04	0.00362			
Europium-152	49	-0.025	-0.003	-0.011	-0.003	-0.072	0.0269			
Europium-154	170	-0.006	-0.020	-0.005	-0.033	0.0194	0.00791			
Europium-155	1.50E+05	-0.006	0.041	0.038	0.015	0.0613	0.0179			
Managanese-54	NA	0.0107	0.010	-0.002	-0.005	0.0046	0.00571			
Radium-226	5	0.280	0.171	0.230	0.284	0.209	0.325			
Sodium-22	NA	-0.002	-0.007	-0.002	-0.012	0.007	0.00263			
Vandium-48	NA	-0.022	-0.002	-0.012	-0.009	-0.032	0.0139			
Zinc-65	NA	-0.009	-0.027	-0.025	-0.040	-0.002	0.0215			
Proportional Counter										
Gross Alpha	NA	0.853	3.13	1.35	1.41	1.69	2.31			
Gross Beta	NA	8.31	2.86	2.87	2.65	2.2	3.53			
Strontium-90	15	-0.357	-0.375	0.013	-0.454	-0.175	-0.0199			
Liquid Scintiallion										
Tritium	1010	-0.385	0.588	-0.29	0.581	0.295	1.42			
Carbon-14	31	0.081	-0.045	0.317	0.102	0.037	0.048			
Nickel-63	2.90E+05	0.860	-0.977	1.06	0.578	0.792	-0.384			
Technetium-99	44	-0.105	-0.227	-0.02	0.330	-0.207	0.378			
SUM OF FRACTIONS		0.183	0.164	0.181	0.124	0.133	0.363			

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS											
Sample Number		065-001000215-36	065-002000215-36	065-003000215-36							
COC Number		6362	6362	6362							
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g							
Alpha Spectroscopy											
Americium-241	39	ND	ND	ND							
Plutonium-238	65	ND	ND	ND							
Plutonium-239/240	40	ND	ND	ND							
Thorium-228[3]	NA	0.353	0.236	0.313							
Thorium-230[2]	5	0.286	0.257	0.244							
Thorium-232	5	0.654	0.219	0.273							
Uranium-233/234	9	ND	0.242	ND							
Uranium-235/236	9	ND	ND	ND							
Uranium-238	9	0.151	ND	ND							
Gamma Spectroscopy											
Iodine-129	2.4	ND	ND	ND							
Americium-241		ND	ND	ND							
Beryllium-7		ND	ND	ND							
Cesium-134		ND	ND	ND							
Cesium-137	23	ND	0.04	0.083							
Cobalt-57		ND	ND	ND							
Cobalt-60	1100	ND	ND	ND							
Europium-152	49	ND	ND	ND							
Europium-154	170	ND	ND	ND							
Europium-155	1.50E+05	ND	ND	ND							
Managanese-54		ND	ND	ND							
Radium-226	5	0.275	0.341	0.278							
Samarium-151	4.00E+06	ND	ND	ND							
Sodium-22		ND	ND	ND							
Vandium-48		ND	ND	ND							
Zinc-65		ND	ND	ND							
Proportional Counter											
Gross Alpha	NA	2.64	3.74	3.57							
Gross Beta	NA	3.98	4.82	5.29							
Strontium-90	15	ND	ND	ND							
Liquid Scintiallion											
Tritium	1010	ND	ND	ND							
Carbon-14	31	ND	0.274	ND							
Nickel-63	2.90E+05	ND	ND	ND							
Technetium-99	44	ND	ND	ND							
SUM OF FRACTIONS		0.26	0.20	0.16							

ND: Not Detected for one of the following reasons

a. Results less than the critical level
b. Results less than the Minimum Detectable Concentration (MDC) but greater than the critical level
c. Results less than twice the total propagated uncertainty.
d. Results greater than the MDC but less than five times the value of the blank

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS										
Sample Number		065-004000306-36	065-005000306-36	065-006000306-36	065-006000306-31					
COC Number		6451	6451	6451	6451					
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g					
Alpha Spectroscopy										
Americium-241	39	0.0073	0.0111	0.0309	0.0196					
Plutonium-238	65	-0.0164	-0.0158	-0.0075	0.019					
Plutonium-239/240	40	0.006	-0.0068	0.0118	0.0212					
Thorium-228[3]	NA	0.503	0.3	0.293	0.33					
Thorium-230[2]	5	0.266	0.202	0.221	0.138					
Thorium-232	5	0.37	0.177	0.255	0.257					
Uranium-233/234	9	0.134	0.173	0.161	0.115					
Uranium-235/236	9	0.0225	0.0005	-0.0089	0.0089					
Uranium-238	9	0.201	0.163	0.19	0.166					
Gamma Spectroscopy										
Iodine-129	2.4	-0.0811	0.131	0.0952	0.137					
Americium-241	NA	-0.0039	0.0631	-0.0081	0.0085					
Beryllium-7	NA	0.139	-0.102	-0.0849	-0.172					
Cesium-134	NA	0.0045	-0.0033	-0.0213	0.0028					
Cesium-137	23	0.0056	0	-0.011	-0.0181					
Cobalt-57	NA	0.0003	0.0018	0.0104	0.0002					
Cobalt-60	1100	0.0089	0.007	0.0005	-0.002					
Europium-152	49	-0.0009	0.042	0.0072	-0.032					
Europium-154	170	0.025	-0.373	-0.0348	-0.0138					
Europium-155	1.50E+05	0.0296	0.0362	0.0022	0.0373					
Managanese-54	NA	0.0064	0.0095	-0.0105	-0.0228					
Radium-226	5	0.272	0.161	0.137	0.283					
Sodium-22	NA	0.009	-0.0134	0.0123	-0.005					
Vandium-48	NA	-0.0245	-0.0066	-0.0265	0.0396					
Zinc-65	NA	0.0019	0.0016	-0.0125	0.0793					
Proportional Counter										
Gross Alpha	NA	2.2	1.52	2.18	1.1					
Gross Beta	NA	4	3.51	4.58	4.57					
Strontium-90	15	-0.444	0.689	0.283	-0.272					
Liquid Scintiallion										
Tritium	1010	3.41	-3	-0.958	0.618					
Carbon-14	31	-0.0889	0.0816	0	0.106					
Nickel-63	2.90E+05	-0.945	-0.0976	0.196	-0.792					
Technetium-99	44	-0.115	-0.968	-0.556	-0.306					
SUM OF FRACTIONS		0.171	0.217	0.194	0.174					

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS										
Sample Number		065-002000314-36	065-003000314-36	065-004000314-36	065-005000314-36	065-005000314-31				
COC Number		6514	6514	6514	6514	6514				
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g				
Alpha Spectroscopy										
Americium-241	39	0.0179	-0.018	-0.0058	0.0202	0.00869				
Plutonium-238	65	-0.0139	0.0587	0.0325	0.0238	-0.00051				
Plutonium-239/240	40	0.0102	-0.0253	-0.0035	-0.0037	0.0219				
Thorium-228[3]	NA	0.353	0.384	0.227	0.159	0.264				
Thorium-230[2]	5	0.286	0.208	0.0875	0.104	0.0563				
Thorium-232	5	0.256	0.309	0.128	0.134	0.134				
Uranium-233/234	9	0.199	0.166	0.292	0.0359	0.128				
Uranium-235/236	9	-0.0025	0.0125	0.0208	-0.0031	0.00828				
Uranium-238	9	0.14	0.24	0.0877	0.0921	0.116				
Gamma Spectroscopy										
Iodine-129	2.4	-0.0816	0.0642	0.0858	-0.0912	0.0096				
Americium-241	NA	-0.0155	0.0143	-0.0209	-0.0074	-0.0008				
Beryllium-7	NA	0.0281	0.0165	0.00649	-0.0309	0.226				
Cesium-134	NA	-0.0152	-0.0154	-0.0019	-0.01	-0.00751				
Cesium-137	23	6.49	1.18	0.0411	0.0531	0.0674				
Cobalt-57	NA	0.0095	0.0123	0.00288	-0.0024	-0.00345				
Cobalt-60	1100	0.0002	-0.0137	-0.0036	0.00252	0.00225				
Europium-152	49	-0.0338	0.031	0.027	0.0111	-0.00016				
Europium-154	170	0.0215	-0.0213	-0.0267	-0.0107	0.0363				
Europium-155	1.50E+05	0.053	0.0116	0.00945	0.0196	0.00405				
Managanese-54	NA	-0.0018	0.006	-0.003	0.00235	0.00742				
Radium-226	5	0.289	0.183	0.159	0.186	0.157				
Sodium-22	NA	0.0077	-0.0076	-0.0095	-0.0038	0.013				
Vandium-48	NA	0.0121	0.0116	-0.0097	-0.0047	0.0281				
Zinc-65	NA	-0.0399	-0.0205	-0.0313	-0.0334	-0.0052				
Proportional Counter										
Gross Alpha	NA	8.1	5.75	0.84	1.62	1.19				
Gross Beta	NA	20.4	7.24	4.44	4.24	4.26				
Strontium-90	15	1.02	-0.338	0.259	0.868	-0.118				
Liquid Scintiallion										
Tritium	1010	1.81	1.28	2.62	2.42	2.47				
Carbon-14	31	0.123	0.117	0.181	0.146	0.129				
Nickel-63	2.90E+05	0.205	0.0699	0.0111	0.395	3.9				
Technetium-99	44	0.255	-0.683	-0.277	0.0092	0.026				
SUM OF FRACTIONS		0.509	0.235	0.152	0.130	0.081				

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS															
Sample Number		065-007000316-36	065-008000316-36	065-009000316-36	065-001000316-36	065-011000316-36	065-012000316-36	065-014000316-36	065-017000316-36	065-018000316-36	065-019000316-36	065-020000316-36	065-021000316-36	065-022000316-36	065-023000316-36
COC Number		6521	6521	6521	6521	6521	6521	6521	6521	6521	6521	6521	6521	6521	6521
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Alpha Spectroscopy															
Americium-241	39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	65	NA	NA	NA	NA	NA	NA	-0.0003	-0.025	-0.0205	0.0161	0.00818	0	0	0.151
Plutonium-239/240	40	NA	NA	NA	NA	NA	NA	-7.4E-05	0.0119	0.00501	0.00313	0.00809	0.00854	0	0.0288
Thorium-228[3]	NA	NA	NA	NA	NA	NA	NA	0.529	0.551	0.263	0.151	0.385	0.473	0.344	0.308
Thorium-230[2]	5	NA	NA	NA	NA	NA	NA	0.239	0.323	0.143	0.139	0.215	0.257	0.199	0.217
Thorium-232	5	NA	NA	NA	NA	NA	NA	0.338	0.446	0.166	0.0697	0.223	0.263	0.283	0.237
Uranium-233/234	9	NA	NA	NA	NA	NA	NA	0.114	0.274	0.278	0.0744	0.161	0.222	0.218	0.277
Uranium-235/236	9	NA	NA	NA	NA	NA	NA	-0.0181	0.0393	0.00806	0.0209	0.0329	0.0134	0.00061	0.0363
Uranium-238	9	NA	NA	NA	NA	NA	NA	0.268	0.29	0.101	0.0388	0.187	0.173	0.233	0.158
Gamma Spectroscopy															
Iodine-129	2.4	NA	NA	NA	NA	NA	NA	-0.0181	0.141	-0.0185	-0.0701	0.201	-0.108	-0.0529	-0.12
Americium-241	NA	0.0129	-0.016	-0.022	0.0128	0.0297	-0.0269	-0.002	0.135	0.0247	-0.0006	0.0126	-0.012	0.00601	0.0121
Beryllium-7	NA	0.0081	0.0215	0.0686	0.128	-0.0312	0.0347	-0.0789	0.0141	-0.0085	-0.018	0.0178	-0.0303	-0.0398	0.0988
Cesium-134	NA	-0.005	0.007	0.00606	-0.0123	-0.0021	-0.0051	-0.003	4.3E-05	-0.0137	-0.0064	-0.0168	-0.0116	-0.0018	-0.019
Cesium-137	23	0.261	0.0631	0.0609	2.02	0.0551	0.035	1.07	0.33	0.0251	0.163	0.0725	0.0829	0.0502	0.0668
Cobalt-57	NA	0.00315	-0.0068	0.00716	0.0115	0.00278	0.00241	-0.0042	-0.0039	0.0045	0.0039	0.00454	0.00319	-0.002	0.0055
Cobalt-60	1100	0.00281	0.00419	-0.0014	0.115	-0.0237	-0.0034	-0.0132	-0.002	0.00288	0.00545	0.00146	0.00819	0.0164	0.0303
Europium-152	49	-0.0064	0.00936	-0.0124	-0.0246	-0.005	0.00961	0.0102	0.0301	0.00455	-0.0132	-0.0133	-0.0085	-0.0028	0.0195
Europium-154	170	0.00925	-0.0144	0.0323	0.0155	0.0382	0.0111	-0.0383	-0.0374	-0.0062	-0.0028	0.0275	-0.0164	-0.0066	0.585
Europium-155	1.50E+05	0.0493	0.0145	0.0327	-0.0399	0.0259	0.0361	-0.0121	0.04	0.00091	-0.008	0.0484	0.0413	0.0683	0.0125
Managanese-54	NA	0.00169	0.0164	0.00924	0.0307	0.00352	0.00736	0.00359	0.0087	0.00718	-0.0082	-0.0049	0.00379	0.00474	-0.0004
Radium-226	5	0.258	0.236	0.256	0.123	0.324	0.212	0.158	0.255	0.203	0.0824	0.275	0.271	0.342	0.36
Sodium-22	NA	0.0034	-0.0051	0.0115	0.00566	0.0135	0.00397	-0.0136	-0.0134	-0.0021	-0.0011	0.00972	-0.0059	-0.0023	0.0208
Vandium-48	NA	0.00169	0.00356	0.00069	-0.0151	0.00313	0.00408	-0.0062	0.0122	0.00201	-0.0092	0.0131	-0.0144	0.0243	0.00879
Zinc-65	NA	0.00167	-0.0086	0.00511	0.0191	0.00558	-0.0142	-0.0388	-0.0503	-0.021	-0.0341	0.00053	-0.0143	-0.0005	-0.0241
Proportional Counter															
Gross Alpha	NA	2.15	2.5	5.57	3.18	5.89	1.96	1.46	4.92	1.85	2.51	10.2	5.86	7.31	2.72
Gross Beta	NA	5.84	5.96	6.07	3.83	5.73	4.73	6.04	6.01	1.5	9.37	16.7	8.03	8.21	6.08
Strontium-90	15	0.362	-0.0201	0.866	-1.12	0.548	0.211	0.263	-0.135	0.54	0.278	0.225	1.02	1.3	1.5
Liquid Scintiallion															
Tritium	1010	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon-14	31	NA	NA	NA	NA	NA	NA	-0.0754	-0.0053	-0.0053	0.0858	-0.0249	-0.0486	0.0075	-0.0279
Nickel-63	2.90E+05	NA	NA	NA	NA	NA	NA	0.0207	-0.249	0.376	0.169	0.39	-0.0382	0.532	-0.894
Technetium-99	44	NA	NA	NA	NA	NA	NA	0.117	0.208	0.394	0.239	0.264	0.235	-0.0385	0.354
SUM OF FRACTIONS		0.036	0.003	0.061	0.088	0.039	0.016	0.225	0.300	0.151	0.091	0.238	0.227	0.236	0.261

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS							
Sample Number		065-001000322-36	065-002000322-36	065-003000322-36	065-004000323-31	065-004000323-36	065-005000323-36
COC Number		6545	6545	6545	6545	6545	6545
Analysis/Analyte	DCGL[1]	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Alpha Spectroscopy							
Americium-241	39	NA	NA	NA	NA	NA	NA
Plutonium-238	65	-0.0138	-0.0077	-0.0115	0.0094	0	-0.0058
Plutonium-239/240	40	-0.0138	0	0.0125	-0.0129	-0.0221	0
Thorium-228[3]	NA	0.449	0.307	0.205	0.106	0.228	0.149
Thorium-230[2]	5	0.125	0.135	0.0627	0.102	0.153	0.107
Thorium-232	5	0.162	0.0973	0.131	0.0218	0.0927	0.148
Uranium-233/234	9	0.0389	0.0502	0.0327	0.11	0.127	-0.0367
Uranium-235/236	9	0	0.0439	-0.0182	0.0095	-0.024	0.0108
Uranium-238	9	0.0813	0.101	0.0926	0.0457	0.0379	0.142
Gamma Spectroscopy							
Iodine-129	2.4	0.0673	0.222	0.143	0.124	-0.155	-0.0461
Americium-241	NA	0.0158	-0.0068	0.00241	0.0004	-0.0161	0.00512
Beryllium-7	NA	-0.0306	0.0201	0.0971	0.0486	-0.0373	0.04
Cesium-134	NA	-0.0117	-0.0149	-0.0014	-0.0071	-0.0148	-0.0048
Cesium-137	23	0.559	0.804	0.052	0.0104	0.0731	0.141
Cobalt-57	NA	-0.0007	0.0011	0.00016	0.0034	-0.0001	-0.0011
Cobalt-60	1100	0.0167	0.0103	0.0113	0.0023	0.00193	0.00483
Europium-152	49	0.0463	-0.0146	0.036	-0.0279	-0.011	-0.0184
Europium-154	170	-0.0023	0.00564	0.00251	0.0369	-0.0142	0.0213
Europium-155	1.50E+05	0.0228	0	0.0142	0.0212	-0.0298	-0.0022
Managanese-54	NA	-0.0032	0.00207	0.00562	0.003	0.00569	0.00027
Radium-226	5	0.216	0.172	0.103	0.214	0.135	0.155
Sodium-22	NA	-0.0008	0.00212	0.00116	0.013	-0.005	0.00763
Vandium-48	NA	0.0018	-0.0078	0.0143	0.0198	0.00983	0.00294
Zinc-65	NA	0.06	0.00041	0.00762	-0.0221	-0.0177	0.0273
Proportional Counter							
Gross Alpha	NA	2.66	1.98	3.32	2.33	0.867	1.14
Gross Beta	NA	4.19	4.33	5.8	3.01	3.02	1.68
Strontium-90	15	-1.12	0.239	0.489	-0.102	-1.38	0.411
Liquid Scintiallion							
Tritium	1010	-1.2	-2.88	-1.66	-3.4	-4.03	-2.7
Carbon-14	31	0.0404	0.0175	0.0125	0.132	0.0196	0.0271
Nickel-63	2.90E+05	-1.03	0.687	0.246	-0.217	0.166	0.128
Technetium-99	44	-0.263	-0.17	-0.265	-0.0282	-0.0793	-0.132
SUM OF FRACTIONS		0.12	0.212	0.149	0.100	0.071	0.103

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

SUMMARY OF RADIOLOGICAL RESULTS

Sample Number		065-002000328-36	065-004000328-31	065-004000328-36	076-401000328-18			
COC Number		6567	6567	6567	6567			
Analysis/Analyte	**DCGL[1]**	pCi/g	pCi/g	pCi/g	pCi/g			
Alpha Spectroscopy								
Americium-241	39	0.0909	0.0363	0.0712	-0.0215			
Plutonium-238	65	-0.0040	-0.0209	0.0156	-0.0586			
Plutonium-239/240	40	0.0604	-0.0051	0.0430	0.0276			
Thorium-228[3]	NA	0.247	0.120	0.132	0.0254			
Thorium-230[2]	5	0.154	0.168	0.100	0.0253			
Thorium-232	5	0.168	0.0567	0.0634	0.0015			
Uranium-233/234	9	0.241	0.644	0.0672	-0.0124			
Uranium-235/236	9	0.0157	0.307	0.0595	0			
Uranium-238	9	0.189	0.0716	0.218	-0.0044			
Gamma Spectroscopy								
Iodine-129	2.4	0.114	0.0572	0.0635	0.402			
Americium-241	NA	-0.0222	-0.0218	0.0150	0.404			
Beryllium-7	NA	0.0320	-0.0173	-0.0507	-0.411			
Cesium-134	NA	-0.0214	0.0025	-0.0034	-0.844			
Cesium-137	23	0.0204	0.0212	0.0194	0			
Cobalt-57	NA	-0.0006	0.0028	0.0066	0.165			
Cobalt-60	1100	-0.0076	-0.0006	0.0025	-0.469			
Europium-152	49	0.0127	-0.0128	0.0359	0.844			
Europium-154	170	-0.0112	-0.0033	0.0280	-0.192			
Europium-155	1.50E+05	0.0439	0.0021	0.0056	-4.14			
Managanese-54	NA	0.0033	-0.0039	0.0014	-1.16			
Radium-226	5	0.148	0.161	0.156	NA			
Sodium-22	NA	-0.0040	-0.0011	0.0100	-0.0685			
Vandium-48	NA	0.0183	-0.0023	-0.0141	0.135			
Zinc-65	NA	-0.0021	0.00513	0.0059	0.0236			
Proportional Counter								
Gross Alpha	NA	1.24	0.690	2.27	NA			
Gross Beta	NA	2.72	3.00	4.74	NA			
Strontium-90	15	-0.0980	0.581	-0.469	-0.0544			
Liquid Scintiallion								
Tritium	1010	0.253	0.762	0.326	-1.74			
Carbon-14	31	0.0207	-0.0501	-0.0833	1.93			
Nickel-63	2.90E+05	-0.214	0.416	0.124	-32.2			
Technetium-99	44	0.250	0.125	0.0363	-4.17			
SUM OF FRACTIONS		0.203	0.259	0.135	0.253			

NOTES:

1. Target DCGLS obtained from Table B1-3, BGRR-008, Brookhaven Graphite Research Reactor Sampling and Analysis Program For the Cleanup Verification of Soil and Disposal of Debris from the Removal of the Pile Fan Sump, Piping and Aboveground Ducts

2. DCGL for Th-230 not provided (1) above. Used 5 pCi/g because that is the criteria used for both Th-230 and TH-232 in the Uranium Mill Tailings Remediation Control Act.

3. Daughter of Th-232 that is in equilibrium concentration with Th-232. All daughters of Th-232 are included in the DCGL for Th-232

Table 1					
Sign Test					
No.	Data (pCi/g)	$DCGL_W$	$DCGL_W$-Data (pCi/g)	Sample Size Test	Sign
1	0.262	1	0.738	1	1
2	0.119	1	0.881	1	1
3	0.140	1	0.86	1	1
4	0.291	1	0.709	1	1
5	0.341	1	0.659	1	1
6	0.350	1	0.65	1	1
7	0.355	1	0.645	1	1
8	0.340	1	0.66	1	1
9	0.389	1	0.611	1	1
10	0.492	1	0.508	1	1
11	0.183	1	0.817	1	1
12	0.164	1	0.836	1	1
13	0.181	1	0.819	1	1
14	0.124	1	0.876	1	1
15	0.133	1	0.867	1	1
16	0.363	1	0.637	1	1
17	0.285	1	0.715	1	1
18	0.151	1	0.849	1	1
19	0.176	1	0.824	1	1
20	0.509	1	0.491	1	1
21	0.235	1	0.765	1	1
22	0.152	1	0.848	1	1
23	0.130	1	0.87	1	1
24	0.081	1	0.919	1	1
25	0.036	1	0.964	1	1
26	0.003	1	0.997	1	1
27	0.061	1	0.939	1	1
28	0.088	1	0.912	1	1
29	0.039	1	0.961	1	1
30	0.016	1	0.984	1	1
31	0.225	1	0.775	1	1
32	0.300	1	0.7	1	1
33	0.151	1	0.849	1	1
34	0.091	1	0.909	1	1
35	0.238	1	0.762	1	1
36	0.227	1	0.773	1	1
37	0.236	1	0.764	1	1
38	0.261	1	0.739	1	1
39	0.120	1	0.88	1	1
40	0.212	1	0.788	1	1
41	0.149	1	0.851	1	1
42	0.100	1	0.9	1	1
43	0.071	1	0.929	1	1
44	0.103	1	0.897	1	1
45	0.203	1	0.797	1	1
46	0.259	1	0.741	1	1
47	0.135	1	0.865	1	1
48	0.253	1	0.747	1	1
49	0.171	1	0.829	1	1
50	0.217	1	0.783	1	1
51	0.194	1	0.806	1	1
52	0.174	1	0.826	1	1
				Value of S+ :	**52**
				Sample Size (N):	**52**