

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:

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

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 measured 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 Scintilllotion						
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:
- 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
 - 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.
 - 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							
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	
Manganese-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 Scintillation									
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 Scintilllion								
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:
- 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
 - 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.
 - 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			
Manganese-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 Scintillation							
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		065-00400306-36	065-00500306-36	065-00600306-36	065-00600306-31	
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 Scintillat						
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:
- 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
 - 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.
 - 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 Scintillation							
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:
- 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
 - 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.
 - 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													
Americium-241	39	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 Scintillation															
Tritium	1010	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:
- 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
 - 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.
 - 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 Scintillillion							
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:
- 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
 - 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.
 - 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 Scintilllition						
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