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Hematite Decommissioning Project
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Our ref: HEM-15-25
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Subject: Hematite Decommissioning Project – Additional Statistical Analysis of Backfill
Soil from an Off-site Borrow Location (License No. SNM-00033, Docket No.
070-00036)

By letter sent to the U.S. Nuclear Regulatory Commission (NRC) dated November 19, 2014, (HEM-14-89, ML14323A238), Westinghouse Electric Company LLC (Westinghouse) provided a statistical assessment (HDP-RPT-FSS-301, Attachment 1 to HEM-14-89) to demonstrate the suitability of soil from a potential off-site borrow location for onsite backfill at the Hematite Decommissioning Project (HDP). The statistical analysis performed by Westinghouse was based on *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, EPA 540-R-01-003. This analysis did not include outlier data points identified in both the reference area and borrow material. In a March 12, 2015, public telephone conference call, the NRC staff stated that removing the outliers from the data set was inconsistent with NRC guidance, and therefore requested that the analysis be performed with the outliers included. In a March 19, 2015, public telephone conference call, the NRC staff stated that the statistical analysis should be performed according to the guidance set forth either in NUREG-1505, *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*, and/or NUREG-1575 Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)*.

As requested, a re-analysis was performed with the outliers that had been removed in the HDP-RPT-FSS-301 assessment placed back into the data set. This re-analysis was conducted according to the guidance in NUREG-1505 and NUREG-1575 Supplement 1. The outliers were from sample 9574-SS-140910-01-34, from one of the reference areas for Th-232, with a value of 0.225 picoCuries per gram (pCi/g), and sample 9498-RU-140903-71-01 from the borrow area for U-234 and U-238 with concentrations of 1.52 and 1.80 pCi/g, respectively. No outliers exist within the data set for Ra-226. Tc-99 results from both the borrow area and the reference area were less than laboratory minimum detectible concentrations (MDC) and were not subjected to statistical analysis. The U-235 data set was also not subjected to analysis due to the large numbers of non-detects. The following text details the results of the re-analysis.

Background Distinguishability

The Th-232 outlier result from sample 9574-SS-140910-01-34 was placed into the data set and the Kruskal-Wallis test was performed on the reference area data set to determine variability in background in accordance with Section 13.2 of NUREG-1505. The results of the tests indicate

that Th-232 has a significant difference among the mean at a 95% confidence level between the reference areas. This was also the case for the Th-232 data set in HDP-RPT-FSS-301.

The concentration level that is indistinguishable from background was then calculated utilizing the methodology presented in Section 13.3 and 13.4 of NUREG-1505. The default value of 3ω was calculated as 0.12 for Th-232 and used for the Wilcoxon Rank Sum (WRS) test. The concentrations relating to the value of 3ω for the other radionuclides of concern were not affected by outliers and did not change from the values presented in HDP-RPT-FSS-301. These values of 3ω follow:

Ra-226 – 0.18 pCi/g

U-234 – 0.59 pCi/g

U-238 – 0.37 pCi/g

Wilcoxon Rank Sum Test

WRS tests were performed for each radionuclide in accordance with Section 6.3 of NUREG-1505. Scenario B of the test was used, with a null hypothesis that the median concentration of radioactivity in the borrow material and in the reference area is less than the lower boundary of the gray region (LBGR). The value of 3ω was used for each radionuclide as the LBGR and the width of the gray region is the derived concentration guideline level (DCGL) per Section 13.4 of NUREG-1505. The Type I error rate, $\alpha_w = \alpha/2$ was set at 0.025 (0.05/2). The power, $1-\beta$, was set at 0.1.

The critical value for the WRS test was calculated using the following formula from Table A.4 of NUREG-1505. Please note that the roles of m and n are reversed in the formula in Table A.4 for Scenario B in NUREG-1505.

$$\text{Critical Value} = \frac{n(m + n + 1)}{2} + z\sqrt{mn(m + n + 1)/12} = 1135$$

Where,

n = number of adjusted survey units measurements = 31

m = number of reference area measurements = 32

z = percentile of a standard normal distribution for 0.025 = 1.96

The WRS tests concluded that the median concentration of radioactivity in the borrow material and in the reference area is less than the LBGR for all radionuclides since the sum of the ranks for the borrow materials were less than the critical value. Attachment 1 presents the WRS tests.

Quantile Tests

Quantile tests were performed for each radionuclide to detect differences between the borrow materials and reference area that consist of a shift to higher values in a fraction of the borrow population.

Table A.7 of NUREG-1505 provides values of r , q and α_Q for associated m , n , and α_Q . In the test, if q or more of the r results are from the borrow data set, then the null hypothesis is rejected and the borrow materials would fail the Quantile test.

The value for α_Q is calculated in the same manner as the WRS test above. The value for α_Q is 0.025. As presented above, the values for m and n are 32, and 31, respectively. Table A.7b provides values of $r = 5$, $q = 5$, and $\alpha_Q = 0.02$ for $m = 30$ and $n = 30$. None of the rankings have five of the highest five rankings originating from the borrow area. Per section 7.2 of NUREG-1505, other entries from Table A.7b were checked for the test. For $m = 30$ and $n = 25$, values of $r = 7$, $q = 6$, and $\alpha_Q = 0.029$ are obtained. For $m = 25$ and $n = 30$, values of $r = 6$, $q = 6$, and $\alpha_Q = 0.02$ are obtained. For $m = 35$ and $n = 35$, values of $r = 5$, $q = 5$, and $\alpha_Q = 0.027$ are obtained. None of the rankings have any q of the highest r rankings originating from the borrow area for these r and q values. The null hypothesis is not rejected, and the borrow materials pass the Quantile test. Attachment 2 contains the ranked borrow and reference sample results.

Retrospective Power

Retrospective power curves were created for each WRS test to determine if an appropriate number of samples had been collected. The DCGL was used for each radionuclide as the upper bound of the gray region. The DCGLs utilized are for the Uniform stratum, the most restrictive DCGLs present at HDP. Individual U-234 and U-238 DCGLs were calculated by multiplying the individual DCGL by the activity fractions for natural uranium (0.4829 for U234, and 0.4941 for U-238). The standard deviation of the borrow data set was input and the lower bound of the gray region was set at the 3σ value. A 0.025 alpha error and 0.1 beta error was utilized. The resulting sample sizes follow:

Ra-226 – 9 samples

Th-232 – 9 samples

U-234 – 9 samples

U-238 – 9 samples

Attachment 3 presents the retrospective power curves for each radionuclide's WRS test.

Conclusion

The statistical test outcomes for both the WRS and Quantile tests for all radionuclides analyzed (Th-232, Ra-226, U-234 and U-238) passed. Therefore the soil from the offsite borrow soil is representative native Missouri soil and is suitable for backfill material at the HDP site.

Please contact Ken Pallagi at 314-810-3353, should you have questions or need additional information.

Sincerely,



Gay M. Fussell
Deputy Director,
Hematite Decommissioning Project

Attachment: 1) Wilcoxon Rank Sum Test Results
 2) Quantile Test Ranked Sums
 3) Retrospective Power Curves

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Attachment 1

Wilcoxon Rank Sum Test Results

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

LBGR = 0.12

Thorium-232					
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks	Borrow Ranks
9574-SS-140910-01-01	1.15	R	1.15	50.5	0
9574-SS-140910-01-02	0.749	R	0.749	4	0
9574-SS-140910-01-03	0.936	R	0.936	12	0
9574-SS-140910-01-04	0.962	R	0.962	16	0
9574-SS-140910-01-05	0.948	R	0.948	13	0
9574-SS-140910-01-07	0.831	R	0.831	7	0
9574-SS-140910-01-08	0.979	R	0.979	20	0
9574-SS-140910-01-09	0.768	R	0.768	5	0
9574-SS-140910-01-10	1.16	R	1.16	52	0
9574-SS-140910-01-11	0.977	R	0.977	18	0
9574-SS-140910-01-12	1.14	R	1.14	47	0
9574-SS-140910-01-13	0.978	R	0.978	19	0
9574-SS-140910-01-14	0.889	R	0.889	10	0
9574-SS-140910-01-15	0.871	R	0.871	9	0
9574-SS-140910-01-16	1.07	R	1.07	34	0
9574-SS-140910-01-17	1.1	R	1.1	39.5	0
9574-SS-140910-01-18	1.19	R	1.19	55.5	0
9574-SS-140910-01-20	1.01	R	1.01	25.5	0
9574-SS-140910-01-21	0.982	R	0.982	21	0
9574-SS-140910-01-22	1.21	R	1.21	58.5	0
9574-SS-140910-01-23	1.37	R	1.37	61	0
9574-SS-140910-01-24	1.39	R	1.39	62.5	0
9574-SS-140910-01-25	0.99	R	0.99	22	0
9574-SS-140910-01-26	1.21	R	1.21	58.5	0
9574-SS-140910-01-27	1.05	R	1.05	29.5	0
9574-SS-140910-01-28	1.39	R	1.39	62.5	0
9574-SS-140910-01-29	0.955	R	0.955	15	0
9574-SS-140910-01-30	0.851	R	0.851	8	0
9574-SS-140910-01-31	1.1	R	1.1	39.5	0
9574-SS-140910-01-32	1.17	R	1.17	53	0
9574-SS-140910-01-33	0.954	R	0.954	14	0
9574-SS-140910-01-34	0.225	R	0.225	1	0
9498-RU-140903-31-01	1.09	S	0.97	17	17
9498-RU-140903-31-02	1.31	S	1.19	55.5	55.5
9498-RU-140903-32-01	0.932	S	0.812	6	6
9498-RU-140903-32-02	1.12	S	1	23	23
9498-RU-140903-41-01	1.31	S	1.19	55.5	55.5
9498-RU-140903-41-02	0.788	S	0.668	2	2
9498-RU-140903-42-01	1.31	S	1.19	55.5	55.5
9498-RU-140903-42-02	1.04	S	0.92	11	11
9498-RU-140903-43-01	1.26	S	1.14	48	48
9498-RU-140903-43-02	1.22	S	1.1	39.5	39.5
9498-RU-140903-44-01	1.22	S	1.1	39.5	39.5
9498-RU-140903-44-02	1.14	S	1.02	26.5	26.5
9498-RU-140903-51-01	0.812	S	0.692	3	3
9498-RU-140903-51-02	1.18	S	1.06	30	30
9498-RU-140903-52-01	1.27	S	1.15	50.5	50.5
9498-RU-140903-52-02	1.19	S	1.07	32	32
9498-RU-140903-61-01	1.21	S	1.09	36	36
9498-RU-140903-61-02	1.26	S	1.14	48	48
9498-RU-140903-62-01	1.19	S	1.07	32	32
9498-RU-140903-62-02	1.14	S	1.02	26.5	26.5
9498-RU-140903-63-01	1.26	S	1.14	48	48
9498-RU-140903-63-02	1.13	S	1.01	24.5	24.5
9498-RU-140903-71-01	1.2	S	1.08	34	34
9498-RU-140903-71-02	1.23	S	1.11	43	43
9498-RU-140903-81-01	1.26	S	1.14	48	48
9498-RU-140903-82-01	1.17	S	1.05	28.5	28.5
9498-RU-140903-82-02	1.21	S	1.09	36	36
9498-RU-140903-91-01	1.34	S	1.22	60	60
9498-RU-140903-91-02	1.23	S	1.11	43	43
9498-RU-140903-92-01	1.23	S	1.11	43	43
9498-RU-140903-92-02	1.21	S	1.09	36	36
Sum =				2024	1081

m 32
n 31
α 1.96
Critical Value 1135

LBGR = 0.18

Radium-226					
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks	Borrow Ranks
9574-SS-140910-01-01	1.15	R	1.15	53	0
9574-SS-140910-01-02	0.719	R	0.719	5	0
9574-SS-140910-01-03	1.04	R	1.04	41.5	0
9574-SS-140910-01-04	1.01	R	1.01	37	0
9574-SS-140910-01-05	0.995	R	0.995	35	0
9574-SS-140910-01-07	0.858	R	0.858	16	0
9574-SS-140910-01-08	1.03	R	1.03	39.5	0
9574-SS-140910-01-09	1.08	R	1.08	49	0
9574-SS-140910-01-10	1.17	R	1.17	54	0
9574-SS-140910-01-11	0.972	R	0.972	33	0
9574-SS-140910-01-12	1.22	R	1.22	57	0
9574-SS-140910-01-13	1.02	R	1.02	38	0
9574-SS-140910-01-14	1.05	R	1.05	43.5	0
9574-SS-140910-01-15	0.805	R	0.805	11	0
9574-SS-140910-01-16	1.32	R	1.32	62	0
9574-SS-140910-01-17	1.19	R	1.19	55	0
9574-SS-140910-01-18	1.34	R	1.34	63	0
9574-SS-140910-01-20	1.26	R	1.26	59	0
9574-SS-140910-01-21	1.07	R	1.07	47	0
9574-SS-140910-01-22	0.922	R	0.922	26	0
9574-SS-140910-01-23	1.13	R	1.13	52	0
9574-SS-140910-01-24	1.2	R	1.2	56	0
9574-SS-140910-01-25	1.23	R	1.23	58	0
9574-SS-140910-01-26	1.08	R	1.08	49	0
9574-SS-140910-01-27	1.31	R	1.31	61	0
9574-SS-140910-01-28	1.28	R	1.28	60	0
9574-SS-140910-01-29	1.08	R	1.08	49	0
9574-SS-140910-01-30	0.96	R	0.96	29	0
9574-SS-140910-01-31	1.06	R	1.06	45.5	0
9574-SS-140910-01-32	1.06	R	1.06	45.5	0
9574-SS-140910-01-33	1.03	R	1.03	39.5	0
9574-SS-140910-01-34	0.618	R	0.618	2	0
9498-RU-140903-31-01	1.1	S	0.92	25	25
9498-RU-140903-31-02	1.15	S	0.97	31.5	31.5
9498-RU-140903-32-01	1.23	S	1.05	43.5	43.5
9498-RU-140903-32-02	1.14	S	0.96	29	29
9498-RU-140903-41-01	1.22	S	1.04	41.5	41.5
9498-RU-140903-41-02	0.721	S	0.541	1	1
9498-RU-140903-42-01	1.03	S	0.85	15	15
9498-RU-140903-42-02	0.862	S	0.682	4	4
9498-RU-140903-43-01	0.99	S	0.81	13	13
9498-RU-140903-43-02	0.948	S	0.768	9	9
9498-RU-140903-44-01	0.931	S	0.751	7	7
9498-RU-140903-44-02	0.946	S	0.766	8	8
9498-RU-140903-51-01	1.08	S	0.9	22	22
9498-RU-140903-51-02	0.929	S	0.749	6	6
9498-RU-140903-52-01	1.08	S	0.9	22	22
9498-RU-140903-52-02	1.09	S	0.91	24	24
9498-RU-140903-61-01	1.18	S	1	36	36
9498-RU-140903-61-02	0.846	S	0.666	3	3
9498-RU-140903-62-01	1.27	S	1.09	51	51
9498-RU-140903-62-02	1.08	S	0.9	22	22
9498-RU-140903-63-01	1.17	S	0.99	34	34
9498-RU-140903-63-02	1.13	S	0.95	27	27
9498-RU-140903-71-01	1.07	S	0.89	20	20
9498-RU-140903-71-02	0.964	S	0.784	10	10
9498-RU-140903-81-01	1.02	S	0.84	14	14
9498-RU-140903-82-01	1.05	S	0.87	18.5	18.5
9498-RU-140903-82-02	0.988	S	0.808	12	12
9498-RU-140903-91-01	1.15	S	0.97	31.5	31.5
9498-RU-140903-91-02	1.05	S	0.87	18.5	18.5
9498-RU-140903-92-01	1.14	S	0.96	29	29
9498-RU-140903-92-02	1.04	S	0.86	17	17
Sum =				2016	645

m 32
n 31
 α 1.96
Critical Value 1135

LBGR = 0.59

Uranium-234					
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks	Borrow Ranks
9574-SS-140910-01-01	0.671	R	0.671	45	0
9574-SS-140910-01-02	0.353	R	0.353	32	0
9574-SS-140910-01-03	0.518	R	0.518	39	0
9574-SS-140910-01-04	0.39	R	0.39	34	0
9574-SS-140910-01-05	0.345	R	0.345	31	0
9574-SS-140910-01-07	0.512	R	0.512	37	0
9574-SS-140910-01-08	0.832	R	0.832	54	0
9574-SS-140910-01-09	0.484	R	0.484	36	0
9574-SS-140910-01-10	0.571	R	0.571	40	0
9574-SS-140910-01-11	0.606	R	0.606	43	0
9574-SS-140910-01-12	0.747	R	0.747	50	0
9574-SS-140910-01-13	0.724	R	0.724	47	0
9574-SS-140910-01-14	0.705	R	0.705	46	0
9574-SS-140910-01-15	0.434	R	0.434	35	0
9574-SS-140910-01-16	0.513	R	0.513	38	0
9574-SS-140910-01-17	0.639	R	0.639	44	0
9574-SS-140910-01-18	0.808	R	0.808	52	0
9574-SS-140910-01-20	1.12	R	1.12	61	0
9574-SS-140910-01-21	1.04	R	1.04	59	0
9574-SS-140910-01-22	0.829	R	0.829	53	0
9574-SS-140910-01-23	1.14	R	1.14	62	0
9574-SS-140910-01-24	1.09	R	1.09	60	0
9574-SS-140910-01-25	0.887	R	0.887	57	0
9574-SS-140910-01-26	0.73	R	0.73	48	0
9574-SS-140910-01-27	1.16	R	1.16	63	0
9574-SS-140910-01-28	0.871	R	0.871	56	0
9574-SS-140910-01-29	0.842	R	0.842	55	0
9574-SS-140910-01-30	0.744	R	0.744	49	0
9574-SS-140910-01-31	0.572	R	0.572	41	0
9574-SS-140910-01-32	0.598	R	0.598	42	0
9574-SS-140910-01-33	0.772	R	0.772	51	0
9574-SS-140910-01-34	0.389	R	0.389	33	0
9498-RU-140903-31-01	0.498	S	-0.092	7	7
9498-RU-140903-31-02	0.539	S	-0.051	13	13
9498-RU-140903-32-01	0.746	S	0.156	26	26
9498-RU-140903-32-02	0.82	S	0.23	30	30
9498-RU-140903-41-01	0.59	S	0	19	19
9498-RU-140903-41-02	0.408	S	-0.182	2	2
9498-RU-140903-42-01	0.504	S	-0.086	9	9
9498-RU-140903-42-02	0.508	S	-0.082	10.5	10.5
9498-RU-140903-43-01	0.481	S	-0.109	6	6
9498-RU-140903-43-02	0.577	S	-0.013	16.5	16.5
9498-RU-140903-44-01	0.432	S	-0.158	4	4
9498-RU-140903-44-02	0.596	S	0.006	20	20
9498-RU-140903-51-01	0.585	S	-0.005	18	18
9498-RU-140903-51-02	0.434	S	-0.156	5	5
9498-RU-140903-52-01	0.554	S	-0.036	15	15
9498-RU-140903-52-02	0.606	S	0.016	21	21
9498-RU-140903-61-01	0.538	S	-0.052	12	12
9498-RU-140903-61-02	0.547	S	-0.043	14	14
9498-RU-140903-62-01	0.577	S	-0.013	16.5	16.5
9498-RU-140903-62-02	0.773	S	0.183	28	28
9498-RU-140903-63-01	0.788	S	0.198	29	29
9498-RU-140903-63-02	0.69	S	0.1	24	24
9498-RU-140903-71-01	1.52	S	0.93	58	58
9498-RU-140903-71-02	0.508	S	-0.082	10.5	10.5
9498-RU-140903-81-01	0.426	S	-0.164	3	3
9498-RU-140903-82-01	0.687	S	0.097	23	23
9498-RU-140903-82-02	0.5	S	-0.09	8	8
9498-RU-140903-91-01	0.754	S	0.164	27	27
9498-RU-140903-91-02	0.643	S	0.053	22	22
9498-RU-140903-92-01	0.713	S	0.123	25	25
9498-RU-140903-92-02	0.389	S	-0.201	1	1
			Sum =	2016	523

m 32
n 31
α 1.96
Critical Value 1135

LBGR = 0.37

Uranium-238					
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks	Borrow Ranks
9574-SS-140910-01-01	0.724	R	0.724	45	0
9574-SS-140910-01-02	0.379	R	0.379	24	0
9574-SS-140910-01-03	0.723	R	0.723	44	0
9574-SS-140910-01-04	0.591	R	0.591	37	0
9574-SS-140910-01-05	0.421	R	0.421	28	0
9574-SS-140910-01-07	0.453	R	0.453	31	0
9574-SS-140910-01-08	0.632	R	0.632	40	0
9574-SS-140910-01-09	0.493	R	0.493	33	0
9574-SS-140910-01-10	0.757	R	0.757	48	0
9574-SS-140910-01-11	0.575	R	0.575	36	0
9574-SS-140910-01-12	0.997	R	0.997	62	0
9574-SS-140910-01-13	0.744	R	0.744	46	0
9574-SS-140910-01-14	0.607	R	0.607	39	0
9574-SS-140910-01-15	0.594	R	0.594	38	0
9574-SS-140910-01-16	0.835	R	0.835	53	0
9574-SS-140910-01-17	0.844	R	0.844	54	0
9574-SS-140910-01-18	0.745	R	0.745	47	0
9574-SS-140910-01-20	0.71	R	0.71	43	0
9574-SS-140910-01-21	0.705	R	0.705	41	0
9574-SS-140910-01-22	0.981	R	0.981	58	0
9574-SS-140910-01-23	0.994	R	0.994	61	0
9574-SS-140910-01-24	0.992	R	0.992	60	0
9574-SS-140910-01-25	0.959	R	0.959	57	0
9574-SS-140910-01-26	0.764	R	0.764	50	0
9574-SS-140910-01-27	0.956	R	0.956	56	0
9574-SS-140910-01-28	0.895	R	0.895	55	0
9574-SS-140910-01-29	0.708	R	0.708	42	0
9574-SS-140910-01-30	0.787	R	0.787	51	0
9574-SS-140910-01-31	0.986	R	0.986	59	0
9574-SS-140910-01-32	0.758	R	0.758	49	0
9574-SS-140910-01-33	0.828	R	0.828	52	0
9574-SS-140910-01-34	0.494	R	0.494	34	0
9498-RU-140903-31-01	0.518	S	0.148	9	9
9498-RU-140903-31-02	0.573	S	0.203	13	13
9498-RU-140903-32-01	0.739	S	0.369	23	23
9498-RU-140903-32-02	0.796	S	0.426	29.5	29.5
9498-RU-140903-41-01	0.446	S	0.076	2	2
9498-RU-140903-41-02	0.61	S	0.24	18	18
9498-RU-140903-42-01	0.557	S	0.187	11	11
9498-RU-140903-42-02	0.505	S	0.135	8	8
9498-RU-140903-43-01	0.561	S	0.191	12	12
9498-RU-140903-43-02	0.703	S	0.333	21	21
9498-RU-140903-44-01	0.601	S	0.231	15.5	15.5
9498-RU-140903-44-02	0.48	S	0.11	6	6
9498-RU-140903-51-01	0.796	S	0.426	29.5	29.5
9498-RU-140903-51-02	0.472	S	0.102	4.5	4.5
9498-RU-140903-52-01	0.601	S	0.231	15.5	15.5
9498-RU-140903-52-02	0.646	S	0.276	20	20
9498-RU-140903-61-01	0.583	S	0.213	14	14
9498-RU-140903-61-02	0.47	S	0.1	3	3
9498-RU-140903-62-01	0.731	S	0.361	22	22
9498-RU-140903-62-02	0.757	S	0.387	25	25
9498-RU-140903-63-01	0.76	S	0.39	26	26
9498-RU-140903-63-02	0.922	S	0.552	35	35
9498-RU-140903-71-01	1.8	S	1.43	63	63
9498-RU-140903-71-02	0.605	S	0.235	17	17
9498-RU-140903-81-01	0.354	S	-0.016	1	1
9498-RU-140903-82-01	0.499	S	0.129	7	7
9498-RU-140903-82-02	0.472	S	0.102	4.5	4.5
9498-RU-140903-91-01	0.619	S	0.249	19	19
9498-RU-140903-91-02	0.776	S	0.406	27	27
9498-RU-140903-92-01	0.844	S	0.474	32	32
9498-RU-140903-92-02	0.55	S	0.18	10	10
Sum =				2016	543

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Critical Value 1135

Attachment 2

Quantile Test Ranked Sums

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

Thorium-232				
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks
9574-SS-140910-01-34	0.225	R	0.225	1
9498-RU-140903-41-02	0.788	S	0.668	2
9498-RU-140903-51-01	0.812	S	0.692	3
9574-SS-140910-01-02	0.749	R	0.749	4
9574-SS-140910-01-09	0.768	R	0.768	5
9498-RU-140903-32-01	0.932	S	0.812	6
9574-SS-140910-01-07	0.831	R	0.831	7
9574-SS-140910-01-30	0.851	R	0.851	8
9574-SS-140910-01-15	0.871	R	0.871	9
9574-SS-140910-01-14	0.889	R	0.889	10
9498-RU-140903-42-02	1.04	S	0.92	11
9574-SS-140910-01-03	0.936	R	0.936	12
9574-SS-140910-01-05	0.948	R	0.948	13
9574-SS-140910-01-33	0.954	R	0.954	14
9574-SS-140910-01-29	0.955	R	0.955	15
9574-SS-140910-01-04	0.962	R	0.962	16
9498-RU-140903-31-01	1.09	S	0.97	17
9574-SS-140910-01-11	0.977	R	0.977	18
9574-SS-140910-01-13	0.978	R	0.978	19
9574-SS-140910-01-08	0.979	R	0.979	20
9574-SS-140910-01-21	0.982	R	0.982	21
9574-SS-140910-01-25	0.99	R	0.99	22
9498-RU-140903-32-02	1.12	S	1	23
9498-RU-140903-63-02	1.13	S	1.01	24.5
9574-SS-140910-01-20	1.01	R	1.01	25.5
9498-RU-140903-44-02	1.14	S	1.02	26.5
9498-RU-140903-62-02	1.14	S	1.02	26.5
9498-RU-140903-82-01	1.17	S	1.05	28.5
9574-SS-140910-01-27	1.05	R	1.05	29.5
9498-RU-140903-51-02	1.18	S	1.06	30
9498-RU-140903-52-02	1.19	S	1.07	32
9498-RU-140903-62-01	1.19	S	1.07	32
9574-SS-140910-01-16	1.07	R	1.07	34
9498-RU-140903-71-01	1.2	S	1.08	34
9498-RU-140903-61-01	1.21	S	1.09	36
9498-RU-140903-82-02	1.21	S	1.09	36
9498-RU-140903-92-02	1.21	S	1.09	36
9574-SS-140910-01-17	1.1	R	1.1	39.5
9574-SS-140910-01-31	1.1	R	1.1	39.5
9498-RU-140903-43-02	1.22	S	1.1	39.5
9498-RU-140903-44-01	1.22	S	1.1	39.5
9498-RU-140903-71-02	1.23	S	1.11	43
9498-RU-140903-91-02	1.23	S	1.11	43
9498-RU-140903-92-01	1.23	S	1.11	43
9574-SS-140910-01-12	1.14	R	1.14	47
9498-RU-140903-43-01	1.26	S	1.14	48
9498-RU-140903-61-02	1.26	S	1.14	48
9498-RU-140903-63-01	1.26	S	1.14	48
9498-RU-140903-81-01	1.26	S	1.14	48
9574-SS-140910-01-01	1.15	R	1.15	50.5
9498-RU-140903-52-01	1.27	S	1.15	50.5
9574-SS-140910-01-10	1.16	R	1.16	52
9574-SS-140910-01-32	1.17	R	1.17	53
9574-SS-140910-01-18	1.19	R	1.19	55.5
9498-RU-140903-31-02	1.31	S	1.19	55.5
9498-RU-140903-41-01	1.31	S	1.19	55.5
9498-RU-140903-42-01	1.31	S	1.19	55.5
9574-SS-140910-01-22	1.21	R	1.21	58.5
9574-SS-140910-01-26	1.21	R	1.21	58.5
9498-RU-140903-91-01	1.34	S	1.22	60
9574-SS-140910-01-23	1.37	R	1.37	61
9574-SS-140910-01-24	1.39	R	1.39	62.5
9574-SS-140910-01-28	1.39	R	1.39	62.5

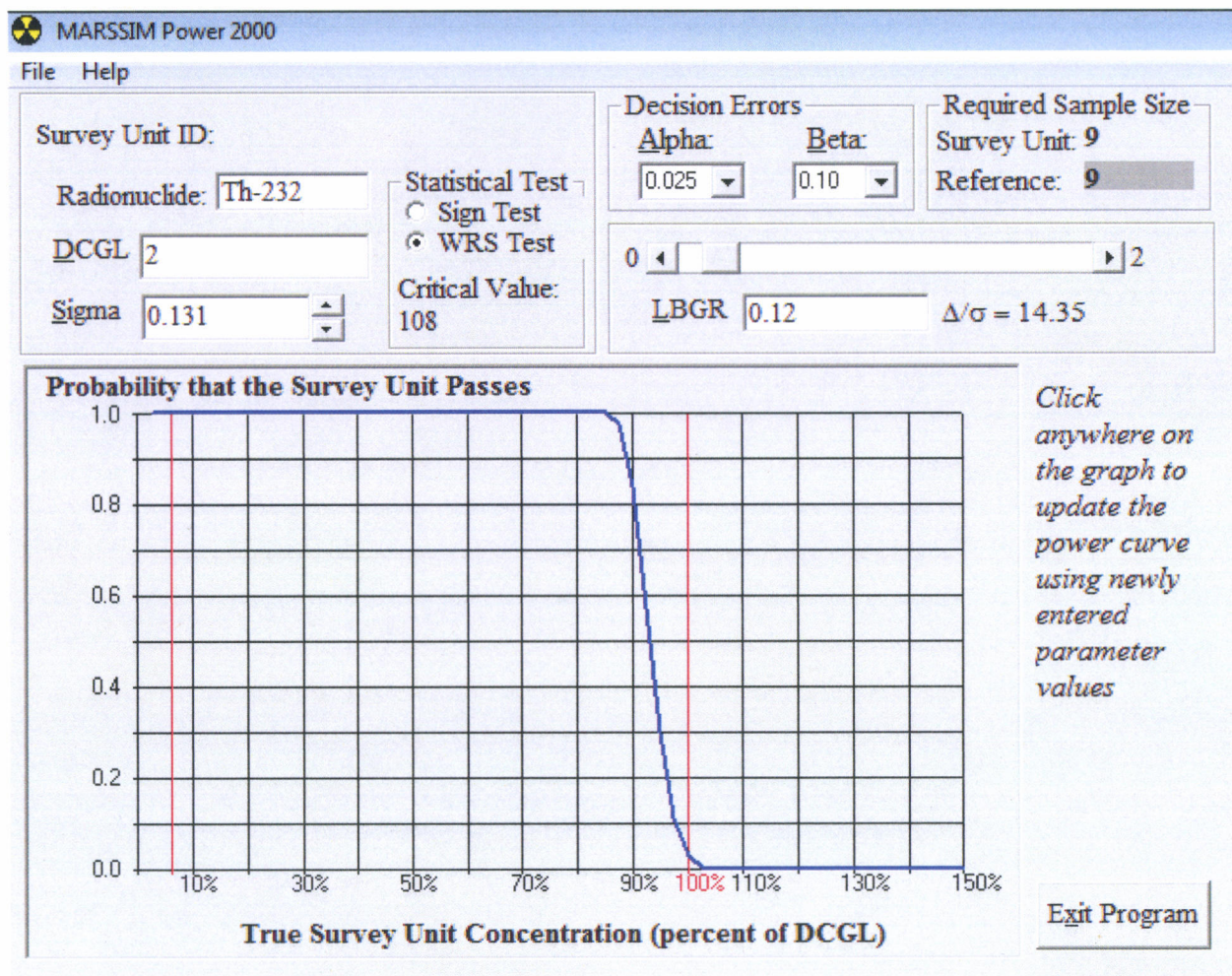
Radium-226				
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks
9498-RU-140903-41-02	0.721 S		0.541	1
9574-SS-140910-01-34	0.618 R		0.618	2
9498-RU-140903-61-02	0.846 S		0.666	3
9498-RU-140903-42-02	0.862 S		0.682	4
9574-SS-140910-01-02	0.719 R		0.719	5
9498-RU-140903-51-02	0.929 S		0.749	6
9498-RU-140903-44-01	0.931 S		0.751	7
9498-RU-140903-44-02	0.946 S		0.766	8
9498-RU-140903-43-02	0.948 S		0.768	9
9498-RU-140903-71-02	0.964 S		0.784	10
9574-SS-140910-01-15	0.805 R		0.805	11
9498-RU-140903-82-02	0.988 S		0.808	12
9498-RU-140903-43-01	0.99 S		0.81	13
9498-RU-140903-81-01	1.02 S		0.84	14
9498-RU-140903-42-01	1.03 S		0.85	15
9574-SS-140910-01-07	0.858 R		0.858	16
9498-RU-140903-92-02	1.04 S		0.86	17
9498-RU-140903-82-01	1.05 S		0.87	18.5
9498-RU-140903-91-02	1.05 S		0.87	18.5
9498-RU-140903-71-01	1.07 S		0.89	20
9498-RU-140903-51-01	1.08 S		0.9	22
9498-RU-140903-52-01	1.08 S		0.9	22
9498-RU-140903-62-02	1.08 S		0.9	22
9498-RU-140903-52-02	1.09 S		0.91	24
9498-RU-140903-31-01	1.1 S		0.92	25
9574-SS-140910-01-22	0.922 R		0.922	26
9498-RU-140903-63-02	1.13 S		0.95	27
9574-SS-140910-01-30	0.96 R		0.96	29
9498-RU-140903-32-02	1.14 S		0.96	29
9498-RU-140903-92-01	1.14 S		0.96	29
9498-RU-140903-31-02	1.15 S		0.97	31.5
9498-RU-140903-91-01	1.15 S		0.97	31.5
9574-SS-140910-01-11	0.972 R		0.972	33
9498-RU-140903-63-01	1.17 S		0.99	34
9574-SS-140910-01-05	0.995 R		0.995	35
9498-RU-140903-61-01	1.18 S		1	36
9574-SS-140910-01-04	1.01 R		1.01	37
9574-SS-140910-01-13	1.02 R		1.02	38
9574-SS-140910-01-08	1.03 R		1.03	39.5
9574-SS-140910-01-33	1.03 R		1.03	39.5
9574-SS-140910-01-03	1.04 R		1.04	41.5
9498-RU-140903-41-01	1.22 S		1.04	41.5
9574-SS-140910-01-14	1.05 R		1.05	43.5
9498-RU-140903-32-01	1.23 S		1.05	43.5
9574-SS-140910-01-31	1.06 R		1.06	45.5
9574-SS-140910-01-32	1.06 R		1.06	45.5
9574-SS-140910-01-21	1.07 R		1.07	47
9574-SS-140910-01-09	1.08 R		1.08	49
9574-SS-140910-01-26	1.08 R		1.08	49
9574-SS-140910-01-29	1.08 R		1.08	49
9498-RU-140903-62-01	1.27 S		1.09	51
9574-SS-140910-01-23	1.13 R		1.13	52
9574-SS-140910-01-01	1.15 R		1.15	53
9574-SS-140910-01-10	1.17 R		1.17	54
9574-SS-140910-01-17	1.19 R		1.19	55
9574-SS-140910-01-24	1.2 R		1.2	56
9574-SS-140910-01-12	1.22 R		1.22	57
9574-SS-140910-01-25	1.23 R		1.23	58
9574-SS-140910-01-20	1.26 R		1.26	59
9574-SS-140910-01-28	1.28 R		1.28	60
9574-SS-140910-01-27	1.31 R		1.31	61
9574-SS-140910-01-16	1.32 R		1.32	62
9574-SS-140910-01-18	1.34 R		1.34	63

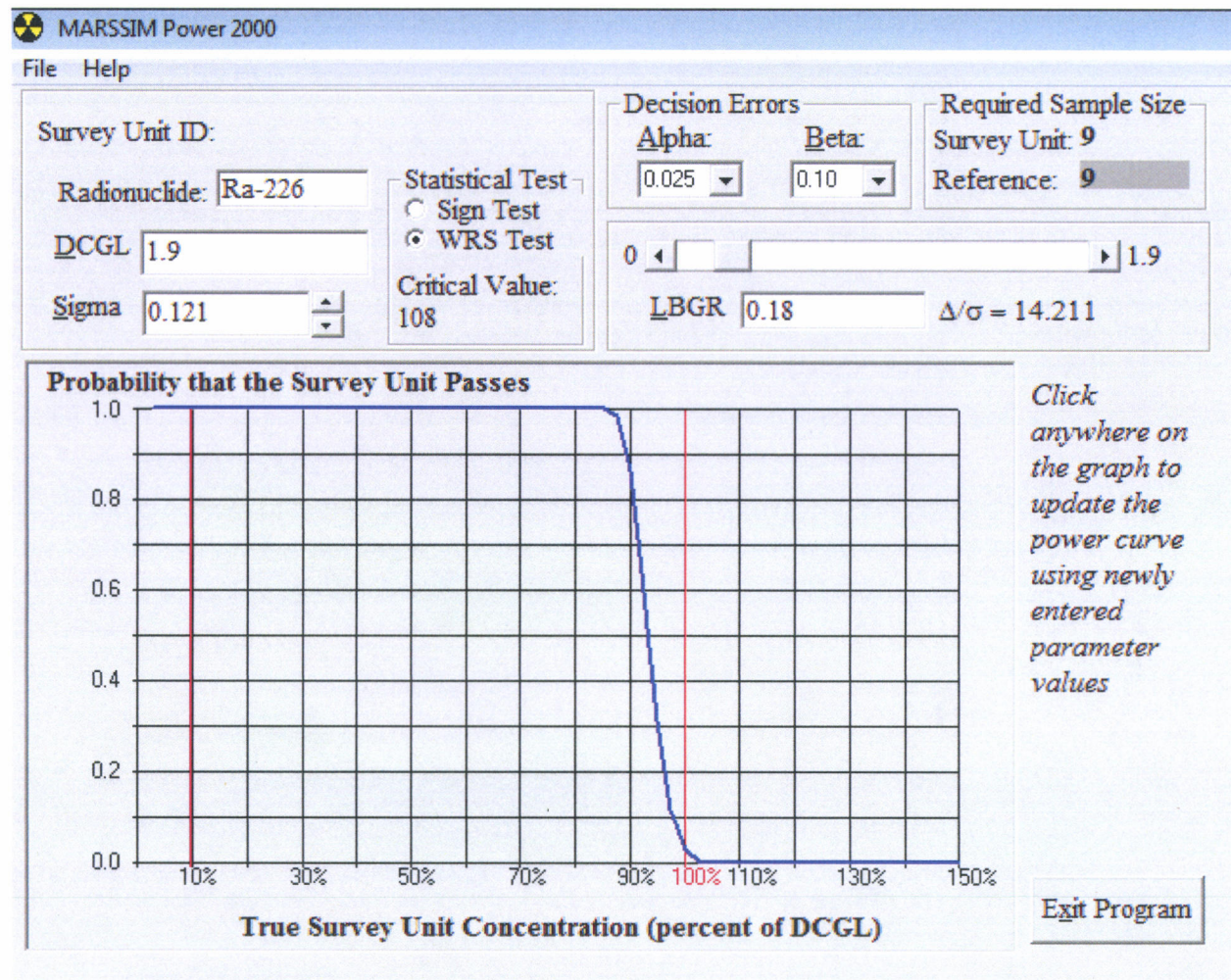
Uranium-234				
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks
9498-RU-140903-92-02	0.389 S		-0.201	1
9498-RU-140903-41-02	0.408 S		-0.182	2
9498-RU-140903-81-01	0.426 S		-0.164	3
9498-RU-140903-44-01	0.432 S		-0.158	4
9498-RU-140903-51-02	0.434 S		-0.156	5
9498-RU-140903-43-01	0.481 S		-0.109	6
9498-RU-140903-31-01	0.498 S		-0.092	7
9498-RU-140903-82-02	0.5 S		-0.09	8
9498-RU-140903-42-01	0.504 S		-0.086	9
9498-RU-140903-42-02	0.508 S		-0.082	10.5
9498-RU-140903-71-02	0.508 S		-0.082	10.5
9498-RU-140903-61-01	0.538 S		-0.052	12
9498-RU-140903-31-02	0.539 S		-0.051	13
9498-RU-140903-61-02	0.547 S		-0.043	14
9498-RU-140903-52-01	0.554 S		-0.036	15
9498-RU-140903-43-02	0.577 S		-0.013	16.5
9498-RU-140903-62-01	0.577 S		-0.013	16.5
9498-RU-140903-51-01	0.585 S		-0.005	18
9498-RU-140903-41-01	0.59 S		0	19
9498-RU-140903-44-02	0.596 S		0.006	20
9498-RU-140903-52-02	0.606 S		0.016	21
9498-RU-140903-91-02	0.643 S		0.053	22
9498-RU-140903-82-01	0.687 S		0.097	23
9498-RU-140903-63-02	0.69 S		0.1	24
9498-RU-140903-92-01	0.713 S		0.123	25
9498-RU-140903-32-01	0.746 S		0.156	26
9498-RU-140903-91-01	0.754 S		0.164	27
9498-RU-140903-62-02	0.773 S		0.183	28
9498-RU-140903-63-01	0.788 S		0.198	29
9498-RU-140903-32-02	0.82 S		0.23	30
9574-SS-140910-01-05	0.345 R		0.345	31
9574-SS-140910-01-02	0.353 R		0.353	32
9574-SS-140910-01-34	0.389 R		0.389	33
9574-SS-140910-01-04	0.39 R		0.39	34
9574-SS-140910-01-15	0.434 R		0.434	35
9574-SS-140910-01-09	0.484 R		0.484	36
9574-SS-140910-01-07	0.512 R		0.512	37
9574-SS-140910-01-16	0.513 R		0.513	38
9574-SS-140910-01-03	0.518 R		0.518	39
9574-SS-140910-01-10	0.571 R		0.571	40
9574-SS-140910-01-31	0.572 R		0.572	41
9574-SS-140910-01-32	0.598 R		0.598	42
9574-SS-140910-01-11	0.606 R		0.606	43
9574-SS-140910-01-17	0.639 R		0.639	44
9574-SS-140910-01-01	0.671 R		0.671	45
9574-SS-140910-01-14	0.705 R		0.705	46
9574-SS-140910-01-13	0.724 R		0.724	47
9574-SS-140910-01-26	0.73 R		0.73	48
9574-SS-140910-01-30	0.744 R		0.744	49
9574-SS-140910-01-12	0.747 R		0.747	50
9574-SS-140910-01-33	0.772 R		0.772	51
9574-SS-140910-01-18	0.808 R		0.808	52
9574-SS-140910-01-22	0.829 R		0.829	53
9574-SS-140910-01-08	0.832 R		0.832	54
9574-SS-140910-01-29	0.842 R		0.842	55
9574-SS-140910-01-28	0.871 R		0.871	56
9574-SS-140910-01-25	0.887 R		0.887	57
9498-RU-140903-71-01	1.52 S		0.93	58
9574-SS-140910-01-21	1.04 R		1.04	59
9574-SS-140910-01-24	1.09 R		1.09	60
9574-SS-140910-01-20	1.12 R		1.12	61
9574-SS-140910-01-23	1.14 R		1.14	62
9574-SS-140910-01-27	1.16 R		1.16	63


Uranium-238				
Sample ID	Concentration (pCi/g)	Area	Adjusted Concentration	Ranks
9498-RU-140903-81-01	0.354 S		-0.016	1
9498-RU-140903-41-01	0.446 S		0.076	2
9498-RU-140903-61-02	0.47 S		0.1	3
9498-RU-140903-51-02	0.472 S		0.102	4.5
9498-RU-140903-82-02	0.472 S		0.102	4.5
9498-RU-140903-44-02	0.48 S		0.11	6
9498-RU-140903-82-01	0.499 S		0.129	7
9498-RU-140903-42-02	0.505 S		0.135	8
9498-RU-140903-31-01	0.518 S		0.148	9
9498-RU-140903-92-02	0.55 S		0.18	10
9498-RU-140903-42-01	0.557 S		0.187	11
9498-RU-140903-43-01	0.561 S		0.191	12
9498-RU-140903-31-02	0.573 S		0.203	13
9498-RU-140903-61-01	0.583 S		0.213	14
9498-RU-140903-44-01	0.601 S		0.231	15.5
9498-RU-140903-52-01	0.601 S		0.231	15.5
9498-RU-140903-71-02	0.605 S		0.235	17
9498-RU-140903-41-02	0.61 S		0.24	18
9498-RU-140903-91-01	0.619 S		0.249	19
9498-RU-140903-52-02	0.646 S		0.276	20
9498-RU-140903-43-02	0.703 S		0.333	21
9498-RU-140903-62-01	0.731 S		0.361	22
9498-RU-140903-32-01	0.739 S		0.369	23
9574-SS-140910-01-02	0.379 R		0.379	24
9498-RU-140903-62-02	0.757 S		0.387	25
9498-RU-140903-63-01	0.76 S		0.39	26
9498-RU-140903-91-02	0.776 S		0.406	27
9574-SS-140910-01-05	0.421 R		0.421	28
9498-RU-140903-32-02	0.796 S		0.426	29.5
9498-RU-140903-51-01	0.796 S		0.426	29.5
9574-SS-140910-01-07	0.453 R		0.453	31
9498-RU-140903-92-01	0.844 S		0.474	32
9574-SS-140910-01-09	0.493 R		0.493	33
9574-SS-140910-01-34	0.494 R		0.494	34
9498-RU-140903-63-02	0.922 S		0.552	35
9574-SS-140910-01-11	0.575 R		0.575	36
9574-SS-140910-01-04	0.591 R		0.591	37
9574-SS-140910-01-15	0.594 R		0.594	38
9574-SS-140910-01-14	0.607 R		0.607	39
9574-SS-140910-01-08	0.632 R		0.632	40
9574-SS-140910-01-21	0.705 R		0.705	41
9574-SS-140910-01-29	0.708 R		0.708	42
9574-SS-140910-01-20	0.71 R		0.71	43
9574-SS-140910-01-03	0.723 R		0.723	44
9574-SS-140910-01-01	0.724 R		0.724	45
9574-SS-140910-01-13	0.744 R		0.744	46
9574-SS-140910-01-18	0.745 R		0.745	47
9574-SS-140910-01-10	0.757 R		0.757	48
9574-SS-140910-01-32	0.758 R		0.758	49
9574-SS-140910-01-26	0.764 R		0.764	50
9574-SS-140910-01-30	0.787 R		0.787	51
9574-SS-140910-01-33	0.828 R		0.828	52
9574-SS-140910-01-16	0.835 R		0.835	53
9574-SS-140910-01-17	0.844 R		0.844	54
9574-SS-140910-01-28	0.895 R		0.895	55
9574-SS-140910-01-27	0.956 R		0.956	56
9574-SS-140910-01-25	0.959 R		0.959	57
9574-SS-140910-01-22	0.981 R		0.981	58
9574-SS-140910-01-31	0.986 R		0.986	59
9574-SS-140910-01-24	0.992 R		0.992	60
9574-SS-140910-01-23	0.994 R		0.994	61
9574-SS-140910-01-12	0.997 R		0.997	62
9498-RU-140903-71-01	1.8 S		1.43	63

Attachment 3
Retrospective Power Curves

Westinghouse Electric Company LLC, Hematite Decommissioning Project
Docket No. 070-00036



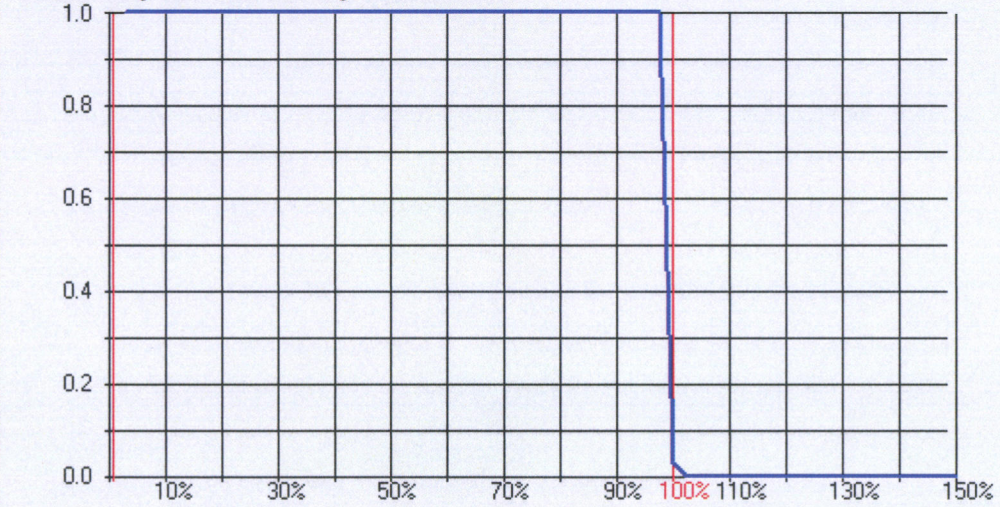


 MARSSIM Power 2000

File Help


Survey Unit ID:		Decision Errors		Required Sample Size	
Radionuclide: U-234		Alpha: 0.025		Survey Unit: 9	
DCGL 94.4		Beta: 0.10		Reference: 9	
Sigma 206		0 94.4			
Statistical Test <input type="radio"/> Sign Test <input checked="" type="radio"/> WRS Test		LBGR 0.59		$\Delta/\sigma = 455.5$	
Critical Value: 108					

Probability that the Survey Unit Passes



Click anywhere on the graph to update the power curve using newly entered parameter values

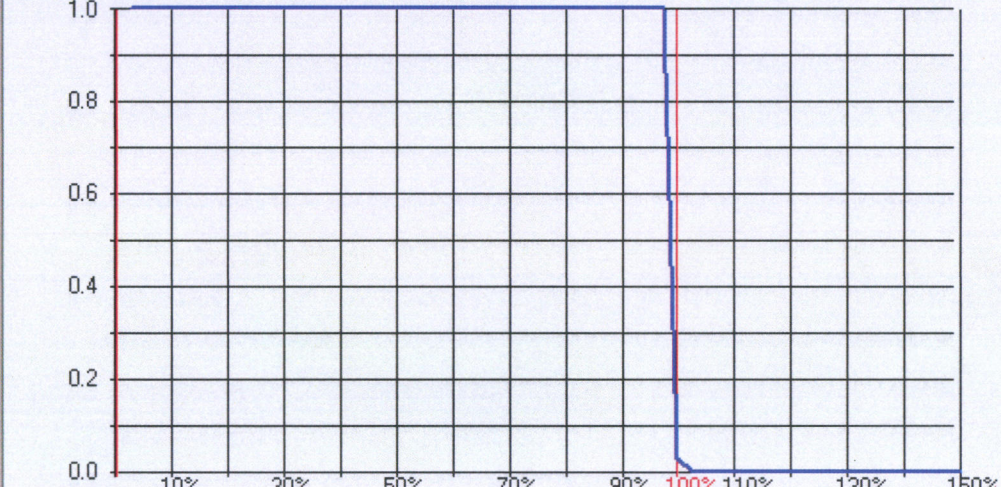
Exit Program

 MARSSIM Power 2000

File Help

Survey Unit ID:		Decision Errors		Required Sample Size	
Radionuclide:	U-238	Alpha:	Beta:	Survey Unit:	9
DCGL	83.4	0.025	0.10	Reference:	9
Sigma	.251	0 83.4			
Statistical Test		LBGR		$\Delta/\sigma = 330.942$	
<input type="radio"/> Sign Test		0.37			
<input checked="" type="radio"/> WRS Test					
Critical Value:					
108					

Probability that the Survey Unit Passes



Click anywhere on the graph to update the power curve using newly entered parameter values

Exit Program