

**ISRA 009 - Area I - B1-2 Stockpile.
Soil Sampling for Radionuclides.
Results and Statistical Analysis.
Waste Certification.**

This data package provides the laboratory results and statistical analysis of the 4 samples taken from the soil in the ISRA 009 B1-2 stockpile. This analysis and data interpretation complies with the procedure approved by the California Department of Public Health¹.

Samples taken for waste disposal characterization were analyzed for strontium-90, tritium and gamma emitting radionuclides by gamma spectroscopy, using an off-site laboratory. Minimum detectable activity (MDA) for cesium-137 and strontium-90 averaged ~0.035 pCi/g and ~0.048 pCi/g respectively. Minimum detectable activity for tritium averaged ~1.0 pCi/g. The gamma spectroscopy library also included the following contaminants-of-concern: Na-22, K-40, Mn-54, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Th-228, Th-232, U-235, U-238 and Am-241.

Statistical evaluation of sample analytical results to determine whether or not the sampled waste contains Cs-137 or Sr-90 activity elevated above local background was conducted using the Wilcoxon Rank Sum Test using protocols described in NUREG-1505² and DTSC guidance³ (See Appendix 1). Appendix 2 shows the complete analytical results for all radionuclides. Complete laboratory data packages are available on request.

Local background data for cesium-137 and strontium-90 was taken from Tables 11 through 18 and Table 20 of the 1995 McLaren/Hart report⁴ and Tables 8-8, 8-10 and 8-14 of the 1993 McLaren/Hart report⁴. Background for tritium in soil is not well established, and is not reported in the 1995 McLaren/Hart report, therefore tritium background in soil is conservatively assumed to be zero. Tritium data is therefore compared to the MDA of the analysis and the EPA preliminary remediation goal (PRG)⁵ for residential 10⁻⁶ risk.

¹ Boeing, "Northern Drainage Waste Sampling for Radionuclides." Revision 9, November 5, 2007. (Attachment 3 to Northern Drainage Work Plan) and "ISRA Waste Sampling for Radionuclides", Attachment A to the ISRA Soil Management Plan.

² NUREG-1505, Nuclear Regulatory Commission, "A Non-parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys." January 1998. http://www.philrutherford.com/Radiation_Cleanup_Standards/NUREG-1505.pdf

³ DTSC, "Selecting Inorganic Constituents as Chemicals of Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities." February 1997.

⁴ McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. <http://www.etc.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf>. Multimedia Sampling Report for the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy", March 10, 1993. http://www.etc.energy.gov/Health-and-Safety/Documents/BrandeisBardin/MultMedSamRep_V1.pdf.

⁵ EPA preliminary remediation goals for radionuclides (Effective January 1, 2007) - <http://epa-prgs.ornl.gov/radionuclides/>.

Results and Conclusions

Cesium-137 - Based on the results of the statistical analysis of Appendix 1, the soil does not exceed local background for Cs-137. All Cs-137 results are non-detect. The mean Cs-137 is 0.006 pCi/g which is less than the mean background Cs-137 of 0.086 pCi/g. The effective incremental dose from background subtracted Cs-137 is therefore zero mrem/y⁶. The highest Cs-137 result is 0.014 pCi/g which is less than the highest background result of 0.213 pCi/g. The highest non-background subtracted, non-detect Cs-137 result is equivalent to an effective dose of 0.0131 mrem/y⁶. See Appendix 3.

Strontium-90 - Based on the results of the statistical analysis of Appendix 1, the soil does not exceed local background for Sr-90. All Sr-90 results are non-detect. The mean Sr-90 is 0.012 pCi/g which is less than the mean background Sr-90 of 0.049 pCi/g. The effective incremental dose from background subtracted Sr-90 is therefore zero mrem/y⁶. The highest Sr-90 result is 0.039 pCi/g which is less than the highest background result of 0.13 pCi/g. The highest non-background subtracted, non-detect Sr-90 result is equivalent to an effective dose of 0.0023 mrem/y⁶. See Appendix 3.

Tritium - All tritium results are non-detect. The average tritium result is 0.018 pCi/g and the highest tritium result is 0.221 pCi/g. The effective incremental dose from mean non-background subtracted tritium is therefore 0.0038 mrem/y⁶. The highest non-detected, non-background subtracted tritium result is equivalent to an effective dose of 0.0471 mrem/y⁶. See Appendix 3.

This waste is certified to be “radiologically” acceptable for shipment to, and disposal at, any waste disposal facility. The waste requires no further radiological controls.

This waste meets the requirements of disposal facility permits^{7,8} and complies with the California Health & Safety Code⁹.

⁶ EPA dose compliance considerations for radionuclides (Effective August 3, 2010) - <http://epa-dccs.ornl.gov/>. Soil concentrations that meet the 10⁻⁶ residential risk PRG are < 0.5 mrem/y. The Cs-137 residential PRG of 0.0597 pCi/g is equivalent to 0.056 mrem/y. The Sr-90 residential PRG of 0.231 pCi/g is equivalent to 0.014 mrem/y. The tritium residential PRG of 2.28 pCi/g is equivalent to 0.486 mrem/y. See Appendix 3.

⁷ This waste is exempt from regulation and licensing or is expressly authorized for disposal under the Radiation Control Law (Division 104, Part 9, Chapter 8 of the California Health & Safety Code).

⁸ This waste is not prohibited from disposal by any government agency with jurisdictional authority over this waste.

⁹ Division 104, Part 9, Chapter 5, Article 1, Section 114715, “No person shall bury, throw away, or in any manner dispose of radioactive wastes within the state except in a manner and at locations as will result in no significant radioactive contamination of the environment.” For the purposes of this requirement, “significant” is defined in Section 114710 as amounts of radioactive materials that are likely to expose persons to ionizing radiation greater than the guide levels published by the Federal Radiation Council (FRC). The FRC no longer exists, but the applicable guide level last published by the FRC was 500 mrem per year to a member of the public. Because the regulatory dose limit to members of the public has since been lowered to 100 mrem per year, CDPH/RHB conservatively utilizes the lower dose for purposes of defining “significant” radioactive contamination in this Article of the California Health and Safety Code.

<http://www.leginfo.ca.gov/cgi-bin/displaycode?section=hsc&group=114001-115000&file=114705-114780>

The Governor's Executive Order D-62-02 prohibits the *"disposal of decommissioned materials to Class III landfills or unclassified management units."* The soil is not decommissioned material, and does not originate from the proximity of any radiological facility. The sampling in this certification has therefore been conducted as a best management practice that complies with the requirements of D-62-02. Verification sampling and/or approval by the California Department of Public Health (CDPH) Radiologic Health Branch (RHB) are not required for the off-site disposal of decommissioned material or of the subject material¹⁰.



Phil Rutherford
Manager, Health, Safety & Radiation Services

¹⁰ The California Department of Public Health (CDPH) Radiologic Health Branch (RHB) has stated in a November 9, 2007 email to Phil Rutherford (Boeing) ... *"The Governor's Executive Order D-62-02, does not specifically require the Department of Health Services (now the Department of Public Health) to perform verification sampling of decommissioned material or to provide approval for disposal of specific decommissioned material shipped offsite (e.g., to Class I or II landfills). The California DPH has not imposed a requirement that Boeing or the Department of Energy (DOE) seek DPH verification sampling or approval of all decommissioned material destined for Class I or II landfills in compliance with the Governor's Executive Order."*

Appendix 1

Wilcoxon Rank Sum Statistical Test for Cesium-137 and Strontium-90

Area I - B1-2 Stockpile

No.	Sample ID	Stockpile ID	Sampling Date	Laboratory Batch	Cesium-137 (pCi/g)				Strontium-90 (pCi/g)				Tritium (pCi/g)			
					Activity	+/- 2σ Error	MDA	Non-detect?	Activity	+/- 2σ Error	MDA	Non-detect?	Activity	+/- 2σ Error	MDA	Non-detect?
1	B1ST0001S001	B1-2	9/2/2010	261989	0.00335	0.0197	0.0351	NDA	0.0109	0.0265	0.0474	NDA	0.15	0.61	1.04	NDA
2	B1ST0002S001	B1-2	9/2/2010	261989	-0.00535	0.0172	0.0304	NDA	-0.0102	0.0241	0.0487	NDA	0.105	0.598	1.03	NDA
3	B1ST0003S001	B1-2	9/2/2010	261989	0.0144	0.0189	0.0345	NDA	0.00985	0.0271	0.0486	NDA	0.221	0.604	1.03	NDA
4	B1ST0004S001	B1-2	9/2/2010	261989	0.0131	0.0272	0.0391	NDA	0.0389	0.0303	0.0483	NDA	-0.405	0.576	1.01	NDA

	Cesium-137 (pCi/g)				Strontium-90 (pCi/g)				Tritium (pCi/g)			
	Activity	+/- 2σ Error	MDA	Non-detect?	Activity	+/- 2σ Error	MDA	Non-detect?	Activity	+/- 2σ Error	MDA	Non-detect?
Average	0.006		0.035		0.012		0.048		0.018		1.028	
Maximum	0.014		0.039		0.039		0.049		0.221		1.040	
Minimum	-0.005		0.030		-0.010		0.047		-0.405		1.010	
Count				4				4				4
Number of Non-Detects				4				4				4
% Non-Detects				100%				100%				100%

Area I - B1-2 Stockpile

Wilcoxon Rank Sum Test -- (Cesium-137)**General Information:**

The Wilcoxon Rank Sum method tests whether or not measurements of samples from a survey area (S) tend to be consistently larger than those from a background reference area (R) by more than the DCGL.

The null hypothesis, H_0 , is: Survey sample concentrations exceed those in the background by more than the DCGL.

The alternative hypothesis, H_a , is: Survey sample concentrations do not exceed those in the background by more than the DCGL.

How to use this template:

- 1) Enter analysis results in Data Tab.
- 2) The Wilcoxon Rank Sum test is prescribed in,
 - NUREG-1505, Nuclear Regulatory Commission, "A Non-parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys." January 1998.

Derived Concentration Guideline Level, DCGL (pCi/g)	0.00
Type I Error Rate, alpha:	0.05
Type II Error Rate, beta:	0.05
Number of Background Samples, m:	53
Number of Survey Samples, n:	4
z-value for alpha	1.645
No. of groups of tied measurements, g	11
Critical Value (excluding ties)	1589.7
Critical Value (including ties)	1589.6
Sum of Reference Ranks	1643.0
Sum of Survey Ranks	10.0
Sum of All Ranks	1653
Check Rank Sum $(n+m)*(n+m+1)/2$	1653

If the sum of the reference ranks is larger than the critical value, there is enough evidence to reject the null hypothesis and accept the alternative hypothesis. Otherwise the null hypothesis is accepted.

Test Result:

Survey sample concentrations do not exceed those in the background by more than the DCGL

	Bkgd Ref (R)	Survey (S)
Mean	0.086	0.006
Max	0.213	0.014
Min	0.015	-0.005
σ	0.061	0.009
$m-1.96*\sigma$	-0.033	-0.012
$m+1.96*\sigma$	0.204	0.024

No.	Soil ID	Year	Cs-137	Adjusted Cs-137	Area	Ranks	Reference Ranks
1	BG-01-005	1992	0.092	0.092	R	33	33
2	BG-01-008	1992	0.020	0.020	R	11.5	11.5
3	BG-01-016	1994	0.020	0.020	R	11.5	11.5
4	BG-01-034	1994	0.100	0.100	R	38.5	38.5
5	BG-01-082	1994	0.020	0.020	R	11.5	11.5
6	BG-01-087	1994	0.158	0.158	R	49.5	49.5
7	BG-01-090	1994	0.175	0.175	R	52	52
8	BG-01-100	1992	0.180	0.180	R	53	53
9	BG-02-007	1992	0.170	0.170	R	51	51
10	BG-02-007	1994	0.030	0.030	R	20	20
11	BG-02-017	1994	0.213	0.213	R	57	57
12	BG-02-074	1994	0.025	0.025	R	17	17
13	BG-02-074	1992	0.020	0.020	R	11.5	11.5
14	BG-02-076	1992	0.099	0.099	R	36.5	36.5
15	BG-02-076	1994	0.020	0.020	R	11.5	11.5
16	BG-02-085	1994	0.020	0.020	R	11.5	11.5
17	BG-05-016	1992	0.074	0.074	R	29	29
18	BG-05-017	1994	0.147	0.147	R	45	45

No.	Soil ID	Year	Cs-137	Adjusted Cs-137	Area	Ranks	Reference Ranks
19	BG-05-026	1992	0.067	0.067	R	27.5	27.5
20	BG-05-027	1994	0.099	0.099	R	36.5	36.5
21	BG-05-050	1994	0.101	0.101	R	40	40
22	BG-05-056	1994	0.148	0.148	R	46	46
23	BG-05-074	1992	0.100	0.100	R	38.5	38.5
24	BG-05-074	1994	0.153	0.153	R	48	48
25	BG-09-003	1994	0.025	0.025	R	17	17
26	BG-09-005	1994	0.188	0.188	R	54	54
27	BG-09-013	1994	0.198	0.198	R	56	56
28	BG-09-057	1994	0.030	0.030	R	20	20
29	BG-09-096	1994	0.079	0.079	R	30	30
30	BG-11-010	1994	0.158	0.158	R	49.5	49.5
31	BG-11-011	1994	0.109	0.109	R	41	41
32	BG-11-031	1994	0.059	0.059	R	26	26
33	BG-11-036	1994	0.067	0.067	R	27.5	27.5
34	BG-11-075	1994	0.113	0.113	R	42	42
35	BG-12-001	1994	0.015	0.015	R	6	6
36	BG-12-002	1994	0.031	0.031	R	22	22
37	BG-12-003	1994	0.042	0.042	R	25	25
38	BG-12-004	1994	0.097	0.097	R	34.5	34.5
39	BG-12-005	1994	0.015	0.015	R	6	6
40	BG-14-001	1994	0.020	0.020	R	11.5	11.5
41	BG-14-002	1994	0.085	0.085	R	32	32
42	BG-14-003	1994	0.080	0.080	R	31	31
43	BG-14-004	1994	0.015	0.015	R	6	6
44	BG-14-005	1994	0.020	0.020	R	11.5	11.5
45	BG-03-001	1992	0.035	0.035	R	23.5	23.5
46	BG-03-019	1992	0.035	0.035	R	23.5	23.5
47	BG-03-059	1992	0.025	0.025	R	17	17
48	BG-04-025	1992	0.150	0.150	R	47	47
49	BG-04-029	1992	0.140	0.140	R	43.5	43.5
50	BG-04-090	1992	0.190	0.190	R	55	55
51	BG-06-033	1992	0.097	0.097	R	34.5	34.5
52	BG-06-089	1992	0.030	0.030	R	20	20
53	BG-06-096	1992	0.140	0.140	R	43.5	43.5
54	B1ST0001S001	2010	0.003	0.003	S	2	0
55	B1ST0002S001	2010	-0.005	-0.005	S	1	0
56	B1ST0003S001	2010	0.014	0.014	S	4	0
57	B1ST0004S001	2010	0.013	0.013	S	3	0
Sum						1653.0	1643.0

Area I - B1-2 Stockpile

Wilcoxon Rank Sum Test -- (Strontium-90)

General Information:

The Wilcoxon Rank Sum method tests whether or not measurements of samples from a survey area (S) tend to be consistently larger than those from a background reference area (R) by more than the DCGL.

The null hypothesis, H_0 , is: Survey sample concentrations exceed those in the background by more than the DCGL.

The alternative hypothesis, H_a , is: Survey sample concentrations do not exceed those in the background by more than the DCGL.

How to use this template:

- 1) Enter analysis results in Data Tab.
- 2) The Wilcoxon Rank Sum test is prescribed in, NUREG-1505, Nuclear Regulatory Commission, "A Non-parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys." January 1998.

Derived Concentration Guideline Level, DCGL (pCi/g)	0.00
Type I Error Rate, alpha:	0.05
Type II Error Rate, beta:	0.05
Number of Background Samples, m:	53
Number of Survey Samples, n:	4
z-value for alpha	1.645
No. of groups of tied measurements, g	10
Critical Value (excluding ties)	1589.7
Critical Value (including ties)	1589.3
Sum of Reference Ranks	1619.0
Sum of Survey Ranks	34.0
Sum of All Ranks	1653
Check Rank Sum $(n+m)*(n+m+1)/2$	1653

If the sum of the reference ranks is larger than the critical value, there is enough evidence to reject the null hypothesis and accept the alternative hypothesis. Otherwise the null hypothesis is accepted.

Test Result:

Survey sample concentrations do not exceed those in the background by more than the DCGL

	Bkgd Ref (R)	Survey (S)
Mean	0.049	0.012
Max	0.130	0.039
Min	0.005	-0.010
σ	0.030	0.020
$m-1.96*\sigma$	-0.010	-0.027
$m+1.96*\sigma$	0.109	0.052

No.	Soil ID	Year	Sr-90	Adjusted Sr-90	Area	Ranks	Reference Ranks
1	BG-01-005	1992	0.030	0.030	R	17.5	17.5
2	BG-01-008	1992	0.010	0.010	R	5.5	5.5
3	BG-01-016	1994	0.045	0.045	R	32	32
4	BG-01-034	1994	0.050	0.050	R	41.5	41.5
5	BG-01-082	1994	0.040	0.040	R	24.5	24.5
6	BG-01-087	1994	0.035	0.035	R	20.5	20.5
7	BG-01-090	1994	0.050	0.050	R	41.5	41.5
8	BG-01-100	1992	0.050	0.050	R	41.5	41.5
9	BG-02-007	1992	0.020	0.020	R	10.5	10.5
10	BG-02-007	1994	0.130	0.130	R	56.5	56.5
11	BG-02-017	1994	0.120	0.120	R	55	55
12	BG-02-074	1994	0.040	0.040	R	24.5	24.5
13	BG-02-074	1992	0.005	0.005	R	2.5	2.5
14	BG-02-076	1992	0.030	0.030	R	17.5	17.5
15	BG-02-076	1994	0.045	0.045	R	32	32
16	BG-02-085	1994	0.130	0.130	R	56.5	56.5
17	BG-05-016	1992	0.050	0.050	R	41.5	41.5
18	BG-05-017	1994	0.088	0.088	R	50	50
19	BG-05-026	1992	0.080	0.080	R	47	47

No.	Soil ID	Year	Sr-90	Adjusted Sr-90	Area	Ranks	Reference Ranks
20	BG-05-027	1994	0.100	0.100	R	54	54
21	BG-05-050	1994	0.069	0.069	R	46	46
22	BG-05-056	1994	0.097	0.097	R	52	52
23	BG-05-074	1992	0.050	0.050	R	41.5	41.5
24	BG-05-074	1994	0.084	0.084	R	49	49
25	BG-10-001	1994	0.098	0.098	R	53	53
26	BG-10-002	1994	0.045	0.045	R	32	32
27	BG-10-003	1994	0.045	0.045	R	32	32
28	BG-10-004	1994	0.020	0.020	R	10.5	10.5
29	BG-10-005	1994	0.045	0.045	R	32	32
30	BG-11-010	1994	0.089	0.089	R	51	51
31	BG-11-011	1994	0.050	0.050	R	41.5	41.5
32	BG-11-031	1994	0.045	0.045	R	32	32
33	BG-11-036	1994	0.050	0.050	R	41.5	41.5
34	BG-11-075	1994	0.045	0.045	R	32	32
35	BG-12-001	1994	0.040	0.040	R	24.5	24.5
36	BG-12-002	1994	0.045	0.045	R	32	32
37	BG-12-003	1994	0.045	0.045	R	32	32
38	BG-12-004	1994	0.045	0.045	R	32	32
39	BG-12-005	1994	0.025	0.025	R	14.5	14.5
40	BG-14-001	1994	0.082	0.082	R	48	48
41	BG-14-002	1994	0.045	0.045	R	32	32
42	BG-14-003	1994	0.040	0.040	R	24.5	24.5
43	BG-14-004	1994	0.035	0.035	R	20.5	20.5
44	BG-14-005	1994	0.025	0.025	R	14.5	14.5
45	BG-03-001	1992	0.005	0.005	R	2.5	2.5
46	BG-03-019	1992	0.020	0.020	R	10.5	10.5
47	BG-03-059	1992	0.010	0.010	R	5.5	5.5
48	BG-04-025	1992	0.020	0.020	R	10.5	10.5
49	BG-04-029	1992	0.020	0.020	R	10.5	10.5
50	BG-04-090	1992	0.050	0.050	R	41.5	41.5
51	BG-06-033	1992	0.030	0.030	R	17.5	17.5
52	BG-06-089	1992	0.030	0.030	R	17.5	17.5
53	BG-06-096	1992	0.020	0.020	R	10.5	10.5
54	B1ST0001S001	2010	0.011	0.011	S	7	0
55	B1ST0002S001	2010	-0.010	-0.010	S	1	0
56	B1ST0003S001	2010	0.010	0.010	S	4	0
57	B1ST0004S001	2010	0.039	0.039	S	22	0
Sum						1653.0	1619.0

Appendix 2
Radionuclide Results

Appendix 3
Dose and Risk

ISRA 009 - Area I - B1-2 Stockpile

Dose & Risk from Soil Using EPA's 2007-01-01 PRGs¹ and 2010-08-03 DCCs²

Parameter	Equation	Units	Cs-137	Sr-90	H-3
Maximum soil concentration	X_{max}	pCi/g	0.014	0.039	0.221
Mean soil concentration	X_{mean}	pCi/g	0.006	0.012	0.018
Mean background soil concentration	$X_{mean, bkgd}$	pCi/g	0.086	0.049	0

Residential					
Parameter	Equation	Units	Cs-137	Sr-90	H-3
EPA 10^{-6} PRG ¹	PRG	pCi/g per 10^{-6} risk	0.0597	0.231	2.28
EPA 1 mrem/y DCC ²	DCC	pCi/g per mrem/y	1.07	16.9	4.69
Dose from PRG	PRG / DCC	mrem/y per 10^{-6} risk	0.056	0.014	0.486
Risk from DCC	$(DCC / PRG) * 10^{-6}$	Risk per mrem/y	1.8E-05	7.3E-05	2.1E-06
Dose from maximum soil	X_{max} / DCC	mrem/y	0.0131	0.0023	0.0471
Dose from mean soil	X_{mean} / DCC	mrem/y	0.0056	0.0007	0.0038
Dose from mean background-subtracted soil	$(X_{mean} - X_{mean, bkgd}) / DCC$	mrem/y	0.0000	0.0000	0.0038
Risk from maximum soil	$(X_{max} / PRG) * 10^{-6}$	Risk	2.3E-07	1.7E-07	9.7E-08
Risk from mean soil	$(X_{mean} / PRG) * 10^{-6}$	Risk	1.0E-07	5.2E-08	7.9E-09
Risk from mean background-subtracted soil	$(X_{mean} - X_{mean, bkgd}) * 10^{-6} / PRG$	Risk	0.0E+00	0.0E+00	7.9E-09

1. PRG = EPA preliminary remediation goals. Dated 2007-01-01.
 2. DCC = EPA dose compliance considerations. Dated 2010-08-03. Downloaded 2010-08-20.

<http://epa-prgs.ornl.gov/radionuclides/>
<http://epa-dccs.ornl.gov/>