FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 1:20:00 PM
LOT,RPT DB ID:	J9H190178-11 9D1J2010	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-11-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:** D1J20101												
U-235HP	6.36E-01	2.9E-01	2.9E-01	2.66E-01	pCi/g		(2.4)	(4.4)	8/27/99 01:19 p	324.7	g	GER7$1	RICHRC5017
U-238	1.23E-01	9.3E-02	9.3E-02	1.22E-01	pCi/g		(1.)	(2.6)	8/27/99 01:19 p	324.7	g	GER7$1	RICHRC5017
U-238DHP	2.53E+01	3.9E+00	3.9E+00	2.13E+00	pCi/g		(11.9)	(13.)	8/27/99 01:19 p	324.7	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/17/99

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 1:50:00 PM
LOT,RPT DB ID:	J9H190178-12 9D1J2410	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-12-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:**	D1J24101											
U-235HP	5.61E-01	2.6E-01	2.6E-01	3.21E-01	pCi/g		(1.7)	(4.3)	8/27/99 03:10 p	346.9	g	GER1$1	RICHRC5017
U-238	3.36E-01	9.4E-02	9.4E-02	1.41E-01	pCi/g		(2.4)	(7.1)	8/27/99 03:10 p	346.9	g	GER1$1	RICHRC5017
U-238DHP	2.34E+01	3.9E+00	3.9E+00	2.60E+00	pCi/g		(9.)	(12.1)	8/27/99 03:10 p	346.9	g	GER1$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 2:15:00 PM
LOT,RPT DB ID:	J9H190178-13 9D1J2510	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-16-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2σ)	TOTAL ERROR (2σ)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:**	D1J25101											
U-235HP	2.79E+00	7.1E-01	7.1E-01	7.05E-01	pCi/g		(3.9)	(7.8)	8/27/99 03:08 p	341.4	g	GER3$1	RICHRC5017
U-238	2.92E-01	1.3E-01	1.3E-01	1.53E-01	pCi/g		(1.9)	(4.6)	8/27/99 03:08 p	341.4	g	GER3$1	RICHRC5017
U-238DHP	1.60E+02	2.0E+01	2.0E+01	1.15E+01	pCi/g		(14.)	(16.3)	8/27/99 03:08 p	341.4	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 2:20:00 PM
LOT,RPT DB ID:	J9H190178-14 9D1J2810	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-14-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:** D1J28101												
U-235HP	7.03E+00	1.1E+00	1.1E+00	7.61E-01	pCi/g		(9.2)	(12.5)	8/27/99 03:12 p	358.2	g	GER4$1	RICHRC5017
U-238	2.96E-01	1.9E-01	1.9E-01	2.06E-01	pCi/g		(1.4)	(3.1)	8/27/99 03:12 p	358.2	g	GER4$1	RICHRC5017
U-238DHP	3.51E+02	3.8E+01	3.8E+01	8.45E+00	pCi/g		(41.5)	(18.6)	8/27/99 03:12 p	358.2	g	GER4$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 3:05:00 PM
LOT,RPT DB ID:	J9H190178-15 9D1J2910	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-15-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:**	D1J29101											
U-235HP	1.65E+00	5.7E-01	5.7E-01	6.20E-01	pCi/g		(2.7)	(5.8)	8/27/99 03:13 p	345.8	g	GER5$1	RICHRC5017
U-238	2.46E-01	1.3E-01	1.3E-01	1.94E-01	pCi/g		(1.3)	(3.7)	8/27/99 03:13 p	345.8	g	GER5$1	RICHRC5017
U-238DHP	6.15E+01	6.7E+00	6.7E+00	2.55E+00	pCi/g		(24.1)	(18.2)	8/27/99 03:13 p	345.8	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/12/99 3:20:00 PM
LOT,RPT DB ID:	J9H190178-16 9D1J2C10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-13-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order:	D1J2C101											
U-235HP	5.73E-01	3.2E-01	3.2E-01	3.16E-01	pCi/g		(1.8)	(3.5)	8/27/99 01:11 p	311.5	g	GER3$1	RICHRC5017
U-238	2.86E-01	1.0E-01	1.0E-01	9.35E-02	pCi/g		(3.1)	(5.6)	8/27/99 01:11 p	311.5	g	GER3$1	RICHRC5017
U-238DHP	1.34E+01	5.7E+00	5.7E+00	4.46E+00	pCi/g		(3.)	(4.7)	8/27/99 01:11 p	311.5	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/13/99 9:20:00 AM
LOT,RPT DB ID:	J9H190178-17 9D1J2F10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-19-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order:	D1J2F101											
U-235HP	2.45E-01	1.8E-01	1.8E-01	3.21E-01	pCi/g		0.76	(2.7)	8/27/99 01:16 p	340.9	g	GER4$1	RICHRC5017
U-238	3.23E-01	9.8E-02	9.8E-02	1.34E-01	pCi/g		(2.4)	(6.6)	8/27/99 01:16 p	340.9	g	GER4$1	RICHRC5017
U-238DHP	1.69E+01	3.3E+00	3.3E+00	2.50E+00	pCi/g		(6.8)	(10.2)	8/27/99 01:16 p	340.9	g	GER4$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/13/99 9:55:00 AM
LOT,RPT DB ID:	J9H190178-18 9D1J2G10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-18-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order:	D1J2G101											
U-235HP	9.65E-01	3.1E-01	3.1E-01	3.31E-01	pCi/g		(2.9)	(6.3)	8/27/99 01:17 p	370.0	g	GER5$1	RICHRC5017
U-238	2.53E-01	1.0E-01	1.0E-01	1.12E-01	pCi/g		(2.3)	(5.)	8/27/99 01:17 p	370.0	g	GER5$1	RICHRC5017
U-238DHP	6.86E+01	7.4E+00	7.4E+00	2.00E+00	pCi/g		(34.3)	(18.6)	8/27/99 01:17 p	370.0	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/13/99 10:10:00 AM
LOT,RPT DB ID:	J9H190178-19 9D1J2J10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-17-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order: D1J2J101												
U-235HP	1.55E+00	4.2E-01	4.2E-01	3.34E-01	pCi/g		(4.6)	(7.4)	8/27/99 01:15 p	353.3	g	GER6$1	RICHRC5017
U-238	4.13E-01	1.2E-01	1.2E-01	8.99E-02	pCi/g		(4.6)	(7.)	8/27/99 01:15 p	353.3	g	GER6$1	RICHRC5017
U-238DHP	8.18E+01	9.4E+00	9.4E+00	2.77E+00	pCi/g		(29.5)	(17.4)	8/27/99 01:15 p	353.3	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:** 12884	**COLLECTION DATE:** 8/13/99 10:55:00 AM
LOT,RPT DB ID:	J9H190178-20 9D1J2M10	**REPORT NBR:** 8676	**RECEIVED DATE:** 8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-20-0.5	**ORDER NBR:**	**MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J2M101											
U-235HP	-7.00E-02	1.4E-01	1.4E-01	2.35E-01	pCi/g		-0.3	-(1.)	8/30/99 08:35 a	330.5	g	GER1$1	RICHRC5017
U-238	2.18E-01	9.5E-02	9.5E-02	1.14E-01	pCi/g		(1.9)	(4.6)	8/30/99 08:35 a	330.5	g	GER1$1	RICHRC5017
U-238DHP	6.46E-02	9.1E-01	9.1E-01	1.55E+00	pCi/g		0.04	0.14	8/30/99 08:35 a	330.5	g	GER1$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/11/99 3:00:00 PM
LOT,RPT DB ID:	J9H190178-21 9D1J2T10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-06-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order: D1J2T101												
U-235HP	1.21E+00	4.8E-01	4.8E-01	5.19E-01	pCi/g		(2.3)	(5.)	8/30/99 08:32 a	331.9	g	GER3$1	RICHRC5017
U-238	3.39E-01	1.3E-01	1.3E-01	1.18E-01	pCi/g		(2.9)	(5.1)	8/30/99 08:32 a	331.9	g	GER3$1	RICHRC5017
U-238DHP	5.85E+01	1.2E+01	1.2E+01	7.70E+00	pCi/g		(7.6)	(10.1)	8/30/99 08:32 a	331.9	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 3:10:00 PM
LOT,RPT DB ID:	J9H190178-22 9D1J2V10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-38-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J2V101											
U-235HP	2.31E+00	7.0E-01	7.0E-01	6.44E-01	pCi/g		(3.6)	(6.6)	8/30/99 08:37 a	340.6	g	GER5$1	RICHRC5017
U-238	4.38E-01	1.6E-01	1.6E-01	1.50E-01	pCi/g		(2.9)	(5.4)	8/30/99 08:37 a	340.6	g	GER5$1	RICHRC5017
U-238DHP	1.29E+02	1.4E+01	1.4E+01	3.11E+00	pCi/g		(41.6)	(18.9)	8/30/99 08:37 a	340.6	g	GER5$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 3:15:00 PM
LOT,RPT DB ID:	J9H190178-23 9D1J2W10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-38-1.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J2W101											
U-235HP	7.67E-01	2.7E-01	2.7E-01	2.89E-01	pCi/g		(2.7)	(5.7)	8/30/99 08:34 a	365.0	g	GER6$1	RICHRC5017
U-238	3.21E-01	9.1E-02	9.1E-02	7.50E-02	pCi/g		(4.3)	(7.)	8/30/99 08:34 a	365.0	g	GER6$1	RICHRC5017
U-238DHP	4.11E+01	4.8E+00	4.8E+00	2.07E+00	pCi/g		(19.9)	(17.1)	8/30/99 08:34 a	365.0	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 3:20:00 PM
LOT,RPT DB ID:	J9H190178-24 9D1J3010	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-38-1.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J30101											
U-235HP	1.11E+01	1.5E+00	1.5E+00	1.10E+00	pCi/g		(10.)	(14.5)	8/30/99 12:24 p	354.9	g	GER5$1	RICHRC5017
U-238	4.11E-01	2.1E-01	2.1E-01	2.61E-01	pCi/g		(1.6)	(3.9)	8/30/99 12:24 p	354.9	g	GER5$1	RICHRC5017
U-238DHP	6.51E+02	6.6E+01	6.6E+01	6.30E+00	pCi/g		(103.3)	(19.8)	8/30/99 12:24 p	354.9	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/17/99 11:40:00 AM
LOT,RPT DB ID:	J9H190178-25 9D1J3210	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-34-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J32101											
U-235HP	-2.65E-02	1.6E-01	1.6E-01	2.65E-01	pCi/g		-0.1	-0.34	8/30/99 12:22 p	345.6	g	GER6$1	RICHRC5017
U-238	9.11E-01	1.6E-01	1.6E-01	8.48E-02	pCi/g		(10.7)	(11.7)	8/30/99 12:22 p	345.6	g	GER6$1	RICHRC5017
U-238DHP	1.88E+00	1.2E+00	1.2E+00	1.23E+00	pCi/g		(1.5)	(3.)	8/30/99 12:22 p	345.6	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/17/99 1:15:00 PM
LOT,RPT DB ID:	J9H190178-26 9D1J3410	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-35-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J34101											
U-235HP	2.83E-02	1.5E-01	1.5E-01	2.57E-01	pCi/g		0.11	0.39	8/30/99 12:26 p	348.1	g	GER7$1	RICHRC5017
U-238	7.87E-01	1.4E-01	1.4E-01	7.90E-02	pCi/g		(10.)	(11.3)	8/30/99 12:26 p	348.1	g	GER7$1	RICHRC5017
U-238DHP	6.33E-01	8.0E-01	8.0E-01	1.41E+00	pCi/g		0.45	(1.6)	8/30/99 12:26 p	348.1	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME: QUANTERRA, Richland **SDG:** 12884 **COLLECTION DATE:** 8/17/99 1:50:00 PM

LOT,RPT DB ID: J9H190178-27 9D1J3510 **REPORT NBR:** 8676 **RECEIVED DATE:** 8/19/99 10:30:00 AM

CLIENT ID: RW-41-SB-36-0.5 **ORDER NBR:** **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order:	D1J35101											
U-235HP	1.14E-01	1.4E-01	1.4E-01	2.44E-01	pCi/g		0.47	(1.7)	8/27/99 03:11 p	344.4	g	GER6$1	RICHRC5017
U-235HP	1.14E-01	1.4E-01	1.4E-01	2.44E-01	pCi/g		0.47	(1.7)	8/27/99 03:11 p	344.4	g	GER6$1	RICHRC5017
U-238	5.13E-01	9.8E-02	9.8E-02	7.24E-02	pCi/g		(7.1)	(10.5)	8/27/99 03:11 p	344.4	g	GER6$1	RICHRC5017
U-238	5.13E-01	9.8E-02	9.8E-02	7.24E-02	pCi/g		(7.1)	(10.5)	8/27/99 03:11 p	344.4	g	GER6$1	RICHRC5017
U-238DHP	2.34E-01	6.3E-01	6.3E-01	1.07E+00	pCi/g		0.22	0.75	8/27/99 03:11 p	344.4	g	GER6$1	RICHRC5017

Number of Results: 5

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/17/99 1:50:00 PM
LOT,RPT DB ID:	J9H190178-28 9D1J3610	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-36-0.5-a	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:** D1J36101												
U-235HP	3.95E-02	1.2E-01	1.2E-01	2.05E-01	pCi/g		0.19	0.67	8/30/99 12:24 p	331.8	g	GER8$1	RICHRC5017
U-238	4.00E-01	8.8E-02	8.8E-02	8.07E-02	pCi/g		(5.)	(9.1)	8/30/99 12:24 p	331.8	g	GER8$1	RICHRC5017
U-238DHP	6.01E-01	4.1E-01	4.1E-01	7.48E-01	pCi/g		0.8	(2.9)	8/30/99 12:24 p	331.8	g	GER8$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/17/99 9:00:00 AM
LOT,RPT DB ID:	J9H190178-29 9D1J3710	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-37-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J37101											
U-235HP	1.41E-01	1.6E-01	1.6E-01	2.90E-01	pCi/g		0.49	(1.8)	8/30/99 02:20 p	342.6	g	GER3$1	RICHRC5017
U-238	5.38E-01	1.0E-01	1.0E-01	7.51E-02	pCi/g		(7.2)	(10.3)	8/30/99 02:20 p	342.6	g	GER3$1	RICHRC5017
U-238DHP	3.75E-01	2.1E+00	2.1E+00	3.48E+00	pCi/g		0.11	0.36	8/30/99 02:20 p	342.6	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 9:40:00 AM
LOT,RPT DB ID:	J9H190178-30 9D1J3910	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-44-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J39101											
U-235HP	2.92E-01	1.5E-01	1.5E-01	2.80E-01	pCi/g		(1.)	(3.8)	8/30/99 02:24 p	350.7	g	GER1$1	RICHRC5017
U-238	1.49E-01	8.0E-02	8.0E-02	1.09E-01	pCi/g		(1.4)	(3.7)	8/30/99 02:24 p	350.7	g	GER1$1	RICHRC5017
U-238DHP	7.35E+00	2.2E+00	2.2E+00	1.68E+00	pCi/g		(4.4)	(6.7)	8/30/99 02:24 p	350.7	g	GER1$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 10:15:00 AM
LOT,RPT DB ID:	J9H190178-31 9D1J3A10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-43-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J3A101											
U-235HP	3.32E-01	2.2E-01	2.2E-01	2.26E-01	pCi/g		(1.5)	(3.)	8/30/99 08:38 a	344.4	g	GER7$1	RICHRC5017
U-238	1.62E-01	7.5E-02	7.5E-02	1.13E-01	pCi/g		(1.4)	(4.3)	8/30/99 08:38 a	344.4	g	GER7$1	RICHRC5017
U-238DHP	1.04E+01	2.0E+00	2.0E+00	1.38E+00	pCi/g		(7.5)	(10.3)	8/30/99 08:38 a	344.4	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 10:15:00 AM
LOT,RPT DB ID:	J9H190178-32 9D1J3C10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-43-0.5-a	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:** D1J3C101												
U-235HP	2.14E-01	1.6E-01	1.6E-01	2.96E-01	pCi/g		0.72	(2.6)	8/30/99 10:28 a	332.8	g	GER1$1	RICHRC5017
U-238	1.82E-01	7.2E-02	7.2E-02	1.09E-01	pCi/g		(1.7)	(5.)	8/30/99 10:28 a	332.8	g	GER1$1	RICHRC5017
U-238DHP	1.34E+01	3.4E+00	3.4E+00	1.99E+00	pCi/g		(6.8)	(7.9)	8/30/99 10:28 a	332.8	g	GER1$1	RICHRC5017

Number of Results: 3

Comments.

FORM I

SAMPLE RESULTS

Date: 9/17/99

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 11:20:00 AM
LOT,RPT DB ID:	J9H190178-33 9D1J3D10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-42-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J3D101											
U-235HP	1.06E-01	1.6E-01	1.6E-01	2.86E-01	pCi/g		0.37	(1.3)	8/30/99 10:27 a	326.0	g	GER3$1	RICHRC5017
U-238	2.36E-01	8.0E-02	8.0E-02	8.36E-02	pCi/g		(2.8)	(5.9)	8/30/99 10:27 a	326.0	g	GER3$1	RICHRC5017
U-238DHP	9.29E+00	4.7E+00	4.7E+00	3.79E+00	pCi/g		(2.5)	(3.9)	8/30/99 10:27 a	326.0	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 11:45:00 AM
LOT,RPT DB ID:	J9H190178-34 9D1J3E10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-41-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J3E101											
U-235HP	2.17E-01	1.4E-01	1.4E-01	2.62E-01	pCi/g		0.83	(3.)	8/30/99 10:31 a	335.1	g	GER5$1	RICHRC5017
U-238	2.25E-01	7.7E-02	7.7E-02	7.02E-02	pCi/g		(3.2)	(5.8)	8/30/99 10:31 a	335.1	g	GER5$1	RICHRC5017
U-238DHP	5.24E+00	1.0E+00	1.0E+00	7.97E-01	pCi/g		(6.6)	(10.2)	8/30/99 10:31 a	335.1	g	GER5$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 12:55:00 PM
LOT,RPT DB ID:	J9H190178-35 9D1J3F10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-40-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1J3F101											
U-235HP	1.83E-01	1.7E-01	1.7E-01	2.12E-01	pCi/g		0.87	(2.2)	8/30/99 10:29 a	329.4	g	GER6$1	RICHRC5017
U-238	1.14E-01	8.9E-02	8.9E-02	1.09E-01	pCi/g		(1.)	(2.6)	8/30/99 10:29 a	329.4	g	GER6$1	RICHRC5017
U-238DHP	1.45E+01	2.3E+00	2.3E+00	1.46E+00	pCi/g		(10.)	(12.7)	8/30/99 10:29 a	329.4	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:** 12884	**COLLECTION DATE:** 8/16/99 12:55:00 PM
LOT,RPT DB ID:	J9H190178-36 9D1J3H10	**REPORT NBR:** 8676	**RECEIVED DATE:** 8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-40-0.5-a	**ORDER NBR:**	**MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:** D1J3H101												
U-235HP	2.69E-01	1.8E-01	1.8E-01	2.34E-01	pCi/g		(1.1)	(3.)	8/30/99 10:33 a	323.4	g	GER7$1	RICHRC5017
U-238	1.44E-01	1.1E-01	1.1E-01	1.23E-01	pCi/g		(1.2)	(2.6)	8/30/99 10:33 a	323.4	g	GER7$1	RICHRC5017
U-238DHP	1.51E+01	2.9E+00	2.9E+00	1.60E+00	pCi/g		(9.5)	(10.6)	8/30/99 10:33 a	323.4	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 1:50:00 PM
LOT,RPT DB ID:	J9H190178-37 9D1J3J10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-39-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:** D1J3J101												
U-235HP	1.02E+00	4.1E-01	4.1E-01	4.07E-01	pCi/g		(2.5)	(5.)	8/30/99 10:31 a	340.8	g	GER8$1	RICHRC5017
U-238	2.51E-01	1.2E-01	1.2E-01	1.33E-01	pCi/g		(1.9)	(4.3)	8/30/99 10:31 a	340.8	g	GER8$1	RICHRC5017
U-238DHP	6.86E+01	7.4E+00	7.4E+00	2.15E+00	pCi/g		(31.9)	(18.5)	8/30/99 10:31 a	340.8	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 1:55:00 PM
LOT,RPT DB ID:	J9H190178-38 9D1J3L10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-39-1.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:** D1J3L101												
U-235HP	5.82E-01	2.1E-01	2.1E-01	3.79E-01	pCi/g		(1.5)	(5.6)	8/30/99 12:22 p	333.5	g	GER1$1	RICHRC5017
U-238	2.92E-01	1.1E-01	1.1E-01	1.31E-01	pCi/g		(2.2)	(5.5)	8/30/99 12:22 p	333.5	g	GER1$1	RICHRC5017
U-238DHP	2.54E+01	4.6E+00	4.6E+00	2.64E+00	pCi/g		(9.6)	(11.1)	8/30/99 12:22 p	333.5	g	GER1$1	RICHRC5017

Number of Results: 3

Comments

FORM I

Date: 9/17/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 2:00:00 PM
LOT,RPT DB ID:	J9H190178-39 9D1J3M10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-39-1.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J3M101											
U-235HP	2.51E-01	1.6E-01	1.6E-01	3.04E-01	pCi/g		0.83	(3.1)	8/30/99 12:20 p	338.1	g	GER3$1	RICHRC5017
U-238	3.34E-01	9.6E-02	9.6E-02	1.42E-01	pCi/g		(2.4)	(7.)	8/30/99 12:20 p	338.1	g	GER3$1	RICHRC5017
U-238DHP	1.24E+01	4.1E+00	4.1E+00	3.77E+00	pCi/g		(3.3)	(6.)	8/30/99 12:20 p	338.1	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/17/99

DUPLICATE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/11/99 12:15:00 PM
RPT DB ID/ORIG ID:	D1J1813R / 9D1J1810	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-04-0.5 DUP	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	ORIG RESULT	RPD	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	**Work Order:**	D1J18103											
U-235HP	4.90E-02	1.2E-01	1.2E-01	2.14E-01	pCi/g		5.98E-04	195.17%	8/27/99 11:25 a	368.2	g	GER7$1	RICHRC5017
U-238	2.66E-01	8.6E-02	8.6E-02	8.18E-02	pCi/g		4.24E-01	45.83%	8/27/99 11:25 a	368.2	g	GER7$1	RICHRC5017
U-238DHP	1.02E-01	8.7E-01	8.7E-01	1.20E+00	pCi/g		2.31E-01	77.77%	8/27/99 11:25 a	368.2	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

DUPLICATE RESULTS

Date: 9/17/99

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12884	**COLLECTION DATE:**	8/16/99 10:15:00 AM
RPT DB ID/ORIG ID:	D1J3A12R / 9D1J3A10	**REPORT NBR:**	8676	**RECEIVED DATE:**	8/19/99 10:30:00 AM
CLIENT ID:	RW-41-SB-43-0.5 DUP	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	ORIG RESULT	RPD	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	**Work Order:**	D1J3A102											
U-235HP	8.08E-02	1.3E-01	1.3E-01	2.22E-01	pCi/g		3.32E-01	121.75%	8/30/99 08:36 a	346.3	g	GER8$1	RICHRC5017
U-238	1.33E-01	5.1E-02	5.1E-02	9.99E-02	pCi/g		1.62E-01	19.14%	8/30/99 08:36 a	346.3	g	GER8$1	RICHRC5017
U-238DHP	1.00E+01	1.5E+00	1.5E+00	8.83E-01	pCi/g		1.04E+01	3.66%	8/30/99 08:36 a	346.3	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/17/99

BLANK RESULTS

LAB NAME: QUANTERRA, Richland **SDG:** 12884 **ORDER NBR:**

LOT,RPT DB ID: J9H250000-260 D1Q3811X **REPORT NBR:** 8676 **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order: D1Q38101												
U-235HP	-8.43E-03	9.0E-02	9.0E-02	1.54E-01	pCi/g		-0.05	-0.19	8/27/99 03:12 p	348.0	g	GER8$1	RICHRC5017
U-238	1.68E-01	6.2E-02	6.2E-02	9.58E-02	pCi/g		(1.8)	(5.4)	8/27/99 03:12 p	348.0	g	GER8$1	RICHRC5017
U-238DHP	-3.45E-02	2.8E-01	2.8E-01	4.99E-01	pCi/g		-0.07	-0.24	8/27/99 03:12 p	348.0	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/17/99

BLANK RESULTS

LAB NAME: QUANTERRA, Richland **SDG:** 12884 **ORDER NBR:**

LOT,RPT DB ID: J9H250000-265 D1Q3Q11X **REPORT NBR:** 8676 **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order: D1Q3Q101												
U-235HP	7.63E-02	1.0E-01	1.0E-01	1.83E-01	pCi/g		0.42	(1.5)	8/30/99 02:25 p	348.0	g	GER5$1	RICHRC5017
U-238	1.64E-01	6.6E-02	6.6E-02	9.87E-02	pCi/g		(1.7)	(5.)	8/30/99 02:25 p	348.0	g	GER5$1	RICHRC5017
U-238DHP	2.88E-01	3.4E-01	3.4E-01	4.98E-01	pCi/g		0.58	(1.7)	8/30/99 02:25 p	348.0	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/17/99

LABORATORY CONTROL SAMPLE

LAB NAME: QUANTERRA, Richland **SDG:** 12884 **ORDER NBR:**

LOT,RPT DB ID: J9H250000-260 D1Q3812M **REPORT NBR:** 8676 **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	Expected	Expected Uncert	Recovery	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237260	Work Order:	D1Q38102												
CS-137	2.98E-01	9.5E-02	9.5E-02	1.34E-01	pCi/g		3.11E-01	1.4E-02	95.96%	8/27/99 03:16 p	200.01	GRA	GER7$1	RICHRC5017

Number of Results: 1

Comments:

FORM II

Date: 9/17/99

LABORATORY CONTROL SAMPLE

LAB NAME: QUANTERRA, Richland **SDG:** 12884 **ORDER NBR:**

LOT,RPT DB ID: J9H250000-265 D1Q3Q12M **REPORT NBR:** 8676 **MATRIX:** Soil

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	Expected	Expected Uncert	Recovery	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9237265	Work Order:	D1Q3Q102												
CS-137	2.98E-01	1.0E-01	1.0E-01	8.68E-02	pCi/g		3.11E-01	1.4E-02	96.01%	8/30/99 02:26 p	200.01	GRA	GER7$1	RICHRC5017

Number of Results: 1

Comments:

4-01603 (2 Coolers) SW-126884 Due 4-18 Custody No. 12127

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

JAH190178

Page 2 of 3

Project No. 29234

LIMS No.

Base: EGLIN AFB Base ID:

Site Name: IRP SITE NO. RW-41 TEST AREA C-74L

Collected By: B. WENDEL, A. MACBETH, J. SYKES

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	SAMPLE ANALYSIS (SPECIFY PARAMETER LIST AND METHOD): ISOTOPIC URANIUM*								COMMENTS (add preservative information)	FIELD LOT CONTROL NO.: Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
RW-41-SB-01	0.5 X	N1	8/11/99	1030	HA	SO	1	1		D	1	J	0	X	FIELD READING 3.48 KCTS/MIN	NO	O	O	A
RW-41-SB-02	0.5 X	N1	8/11/99	1115	HA	SO	1	1		D	1	J	1	5	4.20 KCTS/MIN	NO	O	O	A
RW-41-SB-03	0.5 X	N1	8/11/99	1145	HA	SO	1	1		D	1	J	1	6	4.03 KCTS/MIN	NO	O	O	A
RW-41-SB-04	0.5 X	N1	8/11/99	1215	HA	SO	1	1		D	1	J	1	8	5.13 KCTS/MIN	NO	O	O	A
RW-41-SB-04	0.5-2 X	N1	8/11/99	1215	HA	SO	1	1		D	1	J	1	A	5.13 KCTS/MIN	NO	O	O	A
RW-41-SB-05	0.5 X	N1	8/11/99	1400	HA	SO	1	1		D	1	J	1	G	3.76 KCTS/MIN	NO	O	O	A
RW-41-SB-09	0.5 X	N1	8/12/99	0950	HA	SO	1	1		D	1	J	1	H	10.52 KCPS/MIN	NO	O	O	A
RW-41-SB-10	0.5 X	N1	8/12/99	1020	HA	SO	1	1		D	1	J	1	M	21.8 KCTS/MIN	NO	O	O	A
RW-41-SB-07	0.5 X	N1	8/12/99	1050	HA	SO	1	1		D	1	J	1	N	102.4 KCTS/MIN	NO	O	O	A
															* & SPECTROSCOPY				

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	Brett Wendel (FT)	Heidelberg	8/12/99	1700
2.		Woodard	8-13-99	1030
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: Fed Ex Airbill #: 810527185450

Analytical Lab: QUANTERRA Location: Richland, OH

Lab Recipient: _____ Date: _____ Time: _____
(Signature)

Additional Remarks:
(Condition Upon Lab Receipt, Etc.) PLS. PO. 1

Rev. 01/97

White - Laboratory; Yellow - RUST; Pink - Project Files

* Valid sample method and matrix codes are on reverse

Custody No. 12127

RUST

Custody Chain and Analytical Request

Page 1 of 3

Project No. 29234

LIMS No.

Rust Environment & Infrastructure

Base: EGLIN AFB Base ID: EGLIN

Site Name: IRP SITE NO. RW-41 TEST AREA C-74C

Collected By: B. WENDEL; A. MACBETH; J. SYKES

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1-4)	SAMPLE ANALYSIS (SPECIFY PARAMETER LIST AND METHOD): ISOTOPIC URANIUM*							COMMENTS (add preservative information) FIELD READING	FIELD LOT CONTROL NO.: Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
RW-41-SB-08	0.5 X	N1	8/12/99	1230	HA	SO	1	1		D	1	J	1	T	8.8 KCTS/MIN	O	O	O	A
RW-41-SB-11	0.5 X	N1	8/12/99	1320	HA	SO	1	1		D	1	J	2	0	13.12 KCTS/MIN	O	O	O	A
RW-41-SB-12	0.5 X	N1	8/12/99	1350	HA	SO	1	1		D	1	J	2	4	9.06 KCTS/MIN	O	O	O	A
RW-41-SB-16	0.5 X	N1	8/12/99	1415	HA	SO	1	1		D	1	J	2	5	71.80 KCTS/MIN	O	O	O	A
RW-41-SB-14	0.5 X	N1	8/12/99	1420	HA	SO	1	1		D	1	J	2	8	108.4 KCTS/MIN	O	O	O	A
RW-41-SB-15	0.5 X	N1	8/12/99	1505	HA	SO	1	1		D	1	J	2	9	583 KCTS/MIN	O	O	O	A
RW-41-SB-13	0.5 X	N1	8/12/99	1520	HA	SO	1	1		D	1	J	2	C	54.7 KCTS/MIN	O	O	O	A
															* (SPECTROSCOPY)				

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	Brett Wendel (ET)	Heidelberg	8/16/99	1700
2.			8-19-99	1030
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: Fed Ex Airbill #: 810 52 71F5450

Analytical Lab: Quanterra Location: Richland, WA

Lab Recipient: _____ (Signature) Date: _____ Time: _____

Additional Remarks:
(Condition Upon Lab Receipt, Etc.) PLS. SEE PG. 1

Custody No. 12127

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

Page 1 of 3

Project No. 27234

LIMS No.

Base: LOCLIN AFB Base ID: LOCLIN

Site Name: IRP SITE NO. RW-41 TEST AREA C-74C

Collected By: A. MACBETH, B. WELDER, S. SYKES

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	SAMPLE ANALYSIS (SPECIFY PARAMETER LIST AND METHOD): ISOTOPIC URANIUM *							COMMENTS (add preservative information) FIELD	FIELD LOT CONTROL NO.: Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
RW-41-SB-19	0.5 X	N1	8/13/99	0920	HA	SO	1	1		D	1	J	2	F	15.75 KCPS/MIN	O	O	O	A
RW-41-SB-18	0.5 X	N1	8/13/99	0955	HA	SO	1	1	1	D	1	J	2	G	75.5 KCPS/MIN	O	O	O	A
RW-41-SB-17	0.5 X	N1	8/13/99	1010	HA	SO	1	1		D	1	J	2	J	115.4 KCPS/MIN	O	O	O	A
RW-41-SB-20	0.5 X	N1	8/13/99	1055	HA	SO	1	1		D	1	J	2	M	9.12 KCPS/MIN	O	O	O	A
RW-41-SB-06	0.5 X	N1	8/11/99	~~1430~~ 1500	HA	SO	1	1		D	1	J	2	T	~~9.38~~ 16.4	O	O	O	A
~~RW-41-SB-36~~	~~0.5~~ App	N1	8/																
															Custody Seal #3 A-314 B-315				
															* γ-SPECTROSCOPY				

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	Brian Welder (ET)		8/16/99	1700
2.		[signature] 4:00 pm	8-1999	1030
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: Fed Ex Airbill #: 810527185450

Analytical Lab: QUANTERRA Location: RICHLAND, WA.

Lab Recipient: _____ (Signature) Date: _____ Time: _____

Additional Remarks:
(Condition Upon Lab Receipt, Etc.) PLS. GRIND ALL SAMPLES TO MAXIMIZE HOMOGENIZATION

Rev. 01/97

White - Laboratory; Yello[w] - RUST; Pink - Project Files

* Valid sam[ple] [m]ethod and matrix codes are on reverse

Custody No. 1[illegible]8

Page 1 of 2

Project No. 25234

LIMS No.

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

#1 L Plastics

Base: EGLIN AFB Base ID: EGLIN

Site Name: IRP SITE NO. RW-41 REST AREA C-74L

Collected By: A. MACBETH, B. WENDEL, D. TILTON

Gamma analysis per [illegible] 8/19/98

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	Isotopic Uranium	Gamma Spectroscopy	Sample Analysis	COMMENTS (add preservative information) (KCTS/MIN) FIDLER READING	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
RW-41-SB-44	0.5 X	N1	8/16/99	0940	HA	SO	1	1		DIJ39	4.53 KCTS/MIN	O	O	O	A
RW-41-SB-43	0.5 X	N1	8/16/99	1015	HA	SO	1	1		D 1 J 3 A	4.91 KCTS/MIN	O	O	O	A
RW-41-SB-43	0.5-2 X	N1	8/16/99	1015	HA	SO	1	1		D 1 J 3 C	4.91 KCTS/MIN	O	O	O	A
RW-41-SB-42	0.5 X	N1	8/16/99	1120	HA	SO	1	1	DIJ3D	Currently still	4.80 KCTS/MIN	O	O	O	A
RW-41-SB-41	0.5 X	N1	8/16/99	1145	HA	SO	1	1	DIJ3E	A-37[illegible]	4.53 KCTS/MIN	O	O	O	A
RW-41-SB-40	0.5 X	N1	8/16/99	1253	HA	SO	1	1	DIJ3F	A-37[illegible]	5.03 KCTS/MIN	O	O	O	A
RW-41-SB-40	0.5-2 X	N1	8/16/99	1253	HA	SO	1	1		D 1 J 3 H	5.03 KCTS/MIN	O	O	O	A
RW-41-SB-39	0.5 X	N1	8/16/99	1350	HA	SO	1	1		D 1 J 3 J	13.14 KCTS/MIN	O	O	O	A
RW-41-SB-39	1.0 X	N1	8/16/99	1355	HA	SO	1	1		D 1 J 3 L	8.01 KCTS/MIN	O	O	O	A
RW-41-SB-39	1.5 X	N1	8/16/99	1400	HA	SO	1	1		D 1 J 3 M	7.88 KCTS/MIN	O	O	O	A

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	[signature] (ET)		8/18/99	1700
2.		Heidelberg 400 [illegible]	8-19-99	1030
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: FEDEX Airbill #: 8105271554[illegible]

Analytical Lab: QUANTERRA Location: RICHLAND, WA

Lab Recipient: ______ (Signature) Date: ______ Time: ______

Additional Remarks: (Condition Upon Lab Receipt, Etc.) PLS. GRIND EACH SAMPLE TO OBTAIN MAXIMUM HOMOGENIZATION

Rev. 01/97 White - Laboratory; Yellow - RUST; Pink - Project Files

* Valid sample method and matrix codes are on reverse

Custody No. 12128

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

Page 2 of 2

Project No. 25234

LIMS No.

Base: EGLIN AFB   Base ID: EGLIN

Site Name: IRP SITE NO. RW-41 TEST AREA C-74C

Collected By: A. MACBETH, D. TILTON

IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	ISOTOPIC & γ SPECTROSCOPY							COMMENTS (add preservative information) FIELD READING (K CTS/MIN)	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
RW-41-SB-38	0.5X	N1	8/16/99	1510	HA	SO	1	1		D	1	J	2	V	20.7	O	O	O	A
RW-41-SB-38	1.0X	N1	8/16/99	1515	HA	SO	1	1	1	D	1	J	2	W	12.7	O	O	O	A
RW-41-SB-38	1.5X	N1	8/16/99	1520	HA	SO	1	1		D	1	J	3	0	75 + DU CHUNK IN SAMPLE	O	O	O	A
RW-41-SB-34	0.5X	N1	8/17/99	1140	HA	SO	1	1		D	1	J	3	2	7.47	O	O	O	A
RW-41-SB-35	0.5X	N1	8/17/99	1315	HA	SO	1	1		D	1	J	3	4	9.87	O	O	O	A
RW-41-SB-36	0.5X	N1	8/17/99	1350	HA	SO	1	1		D	1	J	3	5	7.70	O	O	O	A
RW-41-SB-36	0.5-AX	N1	8/17/99	1350	HA	SO	1	1		D	1	J	3	6	7.70	O	O	O	A
RW-41-SB-37	0.5X	N1	8/17/99	0900	HA	SO	1	1		D	1	J	3	7	8.80	O	O	O	A

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	[signature] (EJ)		8/18/99	1700
2.		Heidelberg / Woodbury	8/19/99	1030
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐   Shipped ☒

Method of Shipment: FEDEX   Airbill #: 8052716546(1)

Analytical Lab: Quanterra   Location: RICHLAND, WA

Lab Recipient: ______ (Signature)   Date: ______ Time: ______

Additional Remarks: (Condition Upon Lab Receipt, Etc.)   PCS. SEE P. 1

Rev. 01/97   White - Laboratory; Ye... - RUST; Pink - Project Files

* Valid s... method and matrix codes are on reverse

Received 9/99

Analytical Data Package Prepared For

Rust Environment

D.C. NO. RW-41
FILE INDEX NO. COC 12134
FILE NAME: Initial Lab Report
DATE 10/11/99 INT. [illegible]

Radiochemical Analysis By

Quanterra Analytical Services
Richland Laboratory

Report Nbr: 8665

SDG Nbr	ORDER Nbr	CLIENT ID NUMBER	LOT Nbr	WORK ORDER	RPT DB ID	BATCH
12937		RW-41-SB-21-0.5	J9H270247-1	D1TNP102	9D1TNP10	9244327
		RW-41-SB-31-0.5a	J9H270247-10	D1TP5101	9D1TP510	9244327
		RW-41-SB-25-0.5	J9H270247-11	D1TP7101	9D1TP710	9244327
		RW-41-SB-25-0.5a	J9H270247-12	D1TP9101	9D1TP910	9244327
		RW-41-SB-26-0.5	J9H270247-13	D1TPA101	9D1TPA10	9244327
		RW-41-SB-27-0.5	J9H270247-14	D1TPC101	9D1TPC10	9244327
		RW-41-SB-28-0.5	J9H270247-15	D1TPD101	9D1TPD10	9244327
		RW-41-SB-28-0.5a	J9H270247-16	D1TPG101	9D1TPG10	9244327
		RW-41-SB-26-0.5a	J9H270247-17	D1TPK101	9D1TPK10	9244327
		RW-41-SB-29-0.5	J9H270247-18	D1TPP101	9D1TPP10	9244327
		RW-41-SB-22-0.5	J9H270247-2	D1TNQ102	9D1TNQ10	9244327
		RW-41-SB-23-0.5	J9H270247-3	D1TNR102	9D1TNR10	9244327
		RW-41-SB-24-0.5	J9H270247-4	D1TNT102	9D1TNT10	9244327
		RW-41-SB-33-0.5	J9H270247-6	D1TNX101	9D1TNX10	9244327
		RW-41-SB-45-0.5	J9H270247-7	D1TP1101	9D1TP110	9244327
		RW-41-SB-30-0.5	J9H270247-8	D1TP2101	9D1TP210	9244327

Comments:

Report Nbr: 8665

SDG Nbr	ORDER Nbr	CLIENT ID NUMBER	LOT Nbr	WORK ORDER	RPT DB ID	BATCH
12937		RW-41-SB-31-0.5	J9H270247-9	D1TP4101	9D1TP410	9244327

Comments:

Quanterra

CERTIFICATE OF ANALYSIS

Rust International Corporation
Environmental & Infrastructure
15 Brendan Way
Greenville SC 29615

June 29, 1999

Attention Jim Refermat (RUST) and Alec McBeth (EarthTeck)

SDG Number	:	12937
Date Samples Received	:	August 27, 1999
Number of Samples	:	Eighteen (18)
Sample Type	:	Soil
P.O. Number	:	29234/55556
COC No.	:	12134

I. Introduction

On August 27, 1999, eighteen soil samples were received for radiochemical analysis at the Quanterra Richland Laboratory (QRL). Upon receipt the samples were assigned QRL ID number to correspond with the RUST ID number, as listed on the attached pages.

II. Analytical Results/Methodology

The analytical results for this report are presented by laboratory sample ID. Each set of data includes sample identification information analytical results and the appropriate associated statistical errors.

The requested analyses were: **Gamma by HPGE**
Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

II. Quality Control

The analytical results for each analysis performed under SDG 12937 include a minimum of one Laboratory Control Sample (LCS), one method blank and one duplicate. Any exceptions have been noted in the "Comments" section.

IV. Comments

Gamma by HPGE

Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

The sample batch was analyzed with it's own quality control samples and processed for gamma analysis by Quanterra. All samples were analyzed using approximately 350 g of sample. The LCS, batch blank, sample and sample duplicate results are within contractual requirements. As part of Quanterra effort to help clients understand gamma analysis a technical guidance document is included in this report.

I certify that this Certificate of Analysis is in compliance with the SOW, both technically and for completeness, for other than the conditions detailed above. The Laboratory Manager or a designee, as verified by the following signature has authorized release of the data contained in this hard copy data package.

Reviewed and approved:

Toni Lynn Lauricella
Project Manager

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Matrix Spike and Matrix Spike Duplicate Analyses – Gamma Spectroscopy

Customers should be made aware of the limitations of ordering MS/MSDs on some matrices. Also customers should be advised that with some preparation and analysis methods it may not be technically correct to request a matrix spike. In applications and methods where the homogeneity of the spiked sample creates potential calibration differences with the standard, it is not technically advisable to spike the matrix and an alternative approach should be pursued to demonstrate precision and accuracy.

Discussion

Soil analyses by gamma spectroscopy is a situation where it is not advisable to spike the matrix for the analysis. Soil by nature of its variable and complex chemical constituency, offers the greatest challenge when MS/MSDs are requested. The primary challenge is the laboratory's ability to produce homogeneous spiked soil material since a liquid spike cannot be uniformly distributed in the soil matrix. This is inherent to the granular matrix and the absorption properties of liquid on/in porous materials. Best attempts at producing matrix spikes and matrix spike duplicates have proven to be less than adequate due to homogeneity and absorption issues.

With a destructive preparatory method, used for analysis such as strontium, the homogeneity issue may not present much of a complication. Destructive methods typically totally dissolve, leach, digest, or chemically breakdown the constituents and remove the isotope of interest from both the sample and the spike that was added. However, with nondestructive preparation methods or a method where an entire aliquot may not be used, homogeneity of the matrix spike is essential. Spatial and geometrical differences between the soil sample, the matrix spike, and the sources used to calibrate the detectors have significant impact on the percent recoveries and the relative percent differences between recoveries.

Gamma spectroscopy of soil is one such analysis where the spiked material in the soil must match or approximate the distribution of the spiked material in the standard. Additionally, the constituents of the soil can impact or mask one's ability to detect or quantify an added spike. Activity levels, as well as the energies of the isotopes in a soil, influence the spectral features such as Compton continuum and summation effects. These geometric effects can limit a laboratory's ability to detect an added spike. In addition the activity level of other isotopes and the geometry can create interfering lines which can affect the spike recovery.

Area of Interest: Gamma Spectroscopy
Document No.: 99002-RO
Authored By: Brian Crandall
Reviewed By: Matt Lardy and Jackie Waddell
Date Reviewed: 08/19/99

Recommendations

Matrix spikes (MS) and matrix spike duplicates (MSD) may not be valid or required for all matrices and methods. Quanterra Richland has attempted matrix spike and matrix spike duplicates for soil samples analyzed by gamma spectroscopy even though this may not be technically advisable for this matrix and analysis method. It is our belief that an incorrect perception of precision and accuracy may be developed due to the limitations and interferences that are associated with the matrix. It is the recommendation of Quanterra to use the gamma lines of naturally occurring radionuclides, such as ^{40}K, ^{214}Pb (after equilibrium with ^{226}Ra is achieved), ^{232}Th(in equilibrium with ^{228}Ra and ^{228}Ac), or ^{238}U (in equilibrium with ^{234}Th) to measure precision and/or accuracy (indicators of quality control) on replicate samples for gamma spectroscopy. This will more accurately portray the quality of the laboratory and method rather than gauge Quanterra's ability to create a homogeneously spiked soil material.

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Reporting Naturally Occurring Radionuclides (Often called naturally occurring radioactive materials, NORM):

Discussion

Many long-lived naturally occurring radionuclides do not emit gammas with energies in the most efficient range of germanium detectors. In addition, gammas that are emitted often have abundances that are so low that their measurement is precluded on a practical basis. Examples of these radionuclides are Ra-226, Ra-228, Th-228, Th-230, and Th-232, U-234, U-235 and U-238. These radionuclides exist in what are called decay chains. For example, U-238, U-234, Th-230 and Ra-226 are in a decay chain with U-238 as the precursor. These radionuclides decay to progeny with energetic gammas, but many progeny have a very short half-life (seconds, minutes and hours). These progeny then are used to estimate the concentrations of their parent(s). Quanterra Richland's nuclide library for Gamma Spectroscopy includes many of the predominant natural naturally occurring radionuclides and their progeny.

The issue is further complicated by the fact that a radon radionuclide is also part of the decay progeny. Radon usually precedes the short-lived progeny so that in the sample treatment because of its nature the radon is usually removed. The radon and its progeny will grow back in (ingrowth) from decay of the parent, but it takes a minimum of 10 days to accomplish this. This works well for soil samples, to a lesser extent for other solid samples and not at all for water samples. An example of this is Ra-226 and its progeny Rn-222, Po-218, Pb-214 and Bi-214.

In other cases the progeny is not preceded by radon, but care must be taken that equilibrium between progeny and parent has been established before counting. Two examples of this are Ra-228 and its progeny Ac-228 and Th-232 and its progeny Ra-228.

Listed in the tables below are examples of long-lived naturally occurring radionuclides with their short-lived progeny. The short-lived radionuclides are used to determine the concentrations of their long-lived precursor.

Area of Interest: Gamma Spectroscopy
Document No.: 99001-R0
Authored By: Matt Lardy
Reviewed By: Jackie Waddell and Brian Crandall
Date Reviewed: 08/16/99

A. Thorium-234 and Uranium-238

U-238 DA represents the U-238 concentration and is reported using the lines from Pb-214 and Bi-214 as shown in the table below.

U-238 DHP represents the U-238 concentration and is reported using Th-234 with its key line at 63.28 keV and the 92.59 keV line as the secondary line. See the table below.

Th-234 may be reported as TH-234DA. TH-234DA is determined from the 1001 and 766 keV lines of its progeny, Pa-234m. See the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Th-234DA	Pa-234m	766.41
	Pa-234m	1001.03*
U-238DHP	Th-234	63.28*
	Th-234	92.59**
U-238DA	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Bi-214	609.31
		* keyline
		** The activity and abundances of the two peaks at 92.3 and 92.8 keV are summed.

Quanterra Richland's preparation methods are designed to ensure that the progeny are in near equilibrium with their respective parent nuclides For calculation purposes the half-life of U-238 is used for reporting Th-234DA. Likewise, the half-lives of Th-234, Pa-234m, Pb-214 and Bi-214 are 24.1 days, 1.17 minutes, 27 minutes and 19.9 minutes respectively. It is not reasonable to use the individual half-lives for decay correction since their production is limited by the decay of the long lived precursor parent. In these cases the half-life of the parent is used for calculation purposes.

B. Actinium-228, Radium-228 and Thorium-232

Ac-228, Ra-228 and Th-232 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Ac-228	Ac-228	209.28
	Ac-228	270.23
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	969.11
Ra-228DA	Ac-228	209.28
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	964.6
	Ac-228	969.11
Th-232DA	Pb-212	238.63
	Ac-228	338.32*
	Ac-228	583.14
	Ac-228	911.07
	Ac-228	964.60
	Ac-228	969.11
		* keyline

Note that there is very little flexibility for distinguishing between these three analytes. Quanterra Richland's preparation methods are designed to ensure near equilibrium exists and for calculation purposes the progeny are assumed to be in equilibrium with their parent. For calculation purposes Ac-228 is given a half-life of Th-232 when reported individually since the half-life of Ac-228 is 6.15 hours.

C. Bismuth-214, Lead-214 and Radium-226

Bi-214, Pb-214 and Ra-226 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below:

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Bi-214	Bi-214	609.32*
	Bi-214	768.36
	Bi-214	1120.29
	Bi-214	1764.49
Pb-214	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Pb-214	785.91
Ra-226DA	Ra-226	186.21
	Pb-214	214.98
	Pb-214	295.22
	Pb-214	351.92
	Bi-214	609.32*
	Bi-214	1120.28
	Bi-214	1238.11
	Bi-214	1764.49
		* keyline

Quanterra Richland's preparation methods are designed to ensure that near equilibrium exists between parent and progeny. A period of ~ 10 days or more should elapse between sample preparation (drying and grinding) and counting as to allow a sufficient period for the ingrowth of Ra-226 progeny. For calculation purposes equilibrium with Ra-226 and its progeny Bi-214 and Pb-214 is assumed. The half-life of Ra-226 is used when the Ra-226 result is calculated. When Bi-214 and Pb-214 are reported separately the half-life of U-238 is used.