Paragon Analytics
Radiochemistry Case Narrative
Isotopic Polonium

New Horizons
CSMRI / 2135
PA WO 0404241

1. This report consists of the analytical results and supporting documentation for six soil samples received by Paragon on 04/23/04.

2. These samples were prepared according to Paragon Analytics procedures PA SOP773R8 and PA SOP711R1.

3. The samples were analyzed for the presence of Polonium-210 according to Paragon Analytics procedure PA SOP714R8. The analyses were completed on 05/19/04.

4. The isotopic analysis results for these samples are reported on a dry weight basis in units of pCi/gram.

5. Due to the poor availablility of a 'NIST traceable' Polonium-209 tracer solution, the concentration of a dilution of isotopically pure Po-209 received from Oak Ridge National Laboratory was determined by cross calibration against two distinct NIST traceable sources (Po-210 and Pb/Po-210). While the calibration is not formally 'NIST traceable', the Po-209 concentration was calibrated against and is thus referenced to NIST traceable standards.

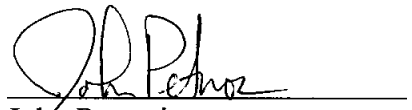
6. Results of this analysis are decay-corrected to the sampling date, based on the 138.4 day half-life of Po-210. This decay correction makes no assumptions as to the equilibrium state of Po-210 with the Pb-210 parent nuclide, which has a half-life of 22.3 years.

7. Paragon Analytics follows the convention outlined in ANSI N42.23 for reporting significant digits in the TPU and MDC results. ANSI N42.23 states that the TPU result should be rounded to two significant digits and that the MDC result should be rounded to the same decimal place as the TPU result. In practice, this could result in an MDC result with a reported value of 0 for samples with significant activity, including the batch laboratory control sample.

8. The requested MDC of 0.1 pCi/gram was not achieved for samples BI17 and H07S (PA ID's 0404241-3 and -11). The reportable Po-210 activity in these samples exceeds their achieved MDC's. These samples are identified with an 'M3' flag on the final reports.

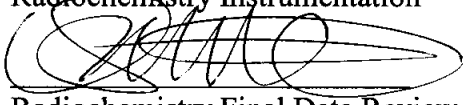
9. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, Paragon Analytics certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.



John Petrovic
Radiochemistry Instrumentation

5/21/04
Date



Radiochemistry Final Data Review

5/21/04
Date

1

PARAGON ANALYTICS
Radiochemistry Data Package

Section 1

SAMPLE RESULTS SUMMARY

Polonium-210 by Alpha Spectroscopy Sample Results Summary

Client Name: New Horizons
Client Project Name: CSMRI
Client Project Number: 2135

Laboratory Name: Paragon Analytics
PAI Work Order: 0404241

Reported on: Friday, May 21, 2004 9:41:39 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	Units	Matrix	Prep Batch	Date Analyzed	Flags
0404241-3	BI17	Sample	Po-210	6.0 +/- 1.2	0.1	pCi/g	SOIL	PL040513-1	5/19/2004	M3
0404241-5	BI37	Sample	Po-210	15.6 +/- 2.7	0.1	pCi/g	SOIL	PL040513-1	5/19/2004	
0404241-7	BI42	Sample	Po-210	0.56 +/- 0.25	0.06	pCi/g	SOIL	PL040513-1	5/19/2004	
0404241-9	H07	Sample	Po-210	98 +/- 15	0	pCi/g	SOIL	PL040513-1	5/19/2004	
0404241-11	H07S	Sample	Po-210	24.3 +/- 4.1	0.1	pCi/g	SOIL	PL040513-1	5/19/2004	M3
0404241-12	BB04	Sample	Po-210	32.2 +/- 5.4	0.1	pCi/g	SOIL	PL040513-1	5/19/2004	

Comments:

Data Package ID: *Po0404241-1*

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

2

PARAGON ANALYTICS

Radiochemistry Data Package

Section 2

QC RESULTS SUMMARY

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Method Blank Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Lab ID: PL040513-1MB

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 13-May-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes

Final Aliquot: 0.250 g
Result Units: pCi/g
File Name: O40511B

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	0.026 +/- 0.093	0.070	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.81	12.8	pCi/g	76.4	20 - 110 %	

Comments:

Qualifiers/Flags:
U - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.
Y2 - Chemical Yield outside default limits.
LT - Result is less than Requested MDC, greater than sample specific MDC.

Abbreviations:
TPU - Total Propagated Uncertainty (see PAI SOP 743)
MDC - Minimum Detectable Concentration (see PAI SOP 709)
BDL - Below Detection Limit

M - Requested MDC not met.
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Laboratory Control Sample(s)

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Lab ID: PL040513-1LCS

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 13-May-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes

Final Aliquot: 0.250 g
Result Units: pCi/g
File Name: O40511L

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13981-52-7	Po-210	32.9 +/- 5.6	0.2	28.4	116	83 - 117	P,M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.81	11.4	pCi/g	67.6	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Duplicate Sample Results (DER)

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BI42
Lab ID: 0404241-7DUP

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 19-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.260 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42417D

CASNO	Analyte	Sample Result +/- 2 s TPU	Duplicate Result +/- 2 s TPU	DER	Control Limit	Lab Qualifiers
13981-52-7	Po-210	0.56 +/- 0.25	0.84 +/- 0.34	0.66	2.13	M3

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
D - DER is greater than Control Limit of 2.13
LT - Result is less than Request MDC, greater than sample specific MDC
M - Requested MDC not met.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

Data Package ID: *PO0404241-1*

PARAGON ANALYTICS
Radiochemistry Data Package

3

Section 3

INDIVIDUAL SAMPLE RESULTS

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BI17
Lab ID: 0404241-3

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 19-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.267 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42413

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	6.0 +/- 1.2	0.1	M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	15.74	12.5	pCi/g	79.4	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BI37
Lab ID: 0404241-5

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 19-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.255 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42415

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	15.6 +/- 2.7	0.1	

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.47	13.2	pCi/g	80.4	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BI42
Lab ID: 0404241-7

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 19-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.255 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42417

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	0.56 +/- 0.25	0.06	

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.48	15.6	pCi/g	94.6	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Duplicate Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BI42
Lab ID: 0404241-7DUP

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 19-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.260 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42417D

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	0.84 +/- 0.34	0.18	M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.19	11.8	pCi/g	73.2	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: H07
Lab ID: 0404241-9

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 22-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.253 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O42419

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	98 +/- 15	0	

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.62	14.2	pCi/g	85.6	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: H07S
Lab ID: 0404241-11

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 22-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.251 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O424111

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	24.3 +/- 4.1	0.1	M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.73	13.9	pCi/g	83.0	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 8

Sample Results

Lab Name: Paragon Analytics
Work Order Number: 0404241
Client Name: New Horizons
ClientProject ID: CSMRI 2135

Field ID: BB04
Lab ID: 0404241-12

Sample Matrix: SOIL
Prep SOP: PAI 711 Rev 5
Date Collected: 16-Apr-04
Date Prepared: 13-May-04
Date Analyzed: 19-May-04

Prep Batch: PL040513-1
QCBatchID: PL040513-1-1
Run ID: PL040513-1A
Count Time: 300 minutes
Report Basis: Dry Weight

Final Aliquot: 0.251 g
Prep Basis: Dry Weight
Moisture(%): NA
Result Units: pCi/g
File Name: O424112

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Lab Qualifier
13981-52-7	Po-210	32.2 +/- 5.4	0.1	

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	16.75	13.8	pCi/g	82.5	20 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *PO0404241-1*

PARAGON ANALYTICS
Radiochemistry Data Package

4

Section 4

RAW DATA

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: Paragon Analytics
PAI Work Order: 0404241

Prep SOP: PAI 711
Analytical SOP: PAI 714

Reported on: Friday, May 21, 2004 9:39:58 AM

Sample ID / QC Type	Nuclide / Type	Sample Date/Time	Prep Batch / QCBatchID	Ingrowth Date /Time	Decay Date/Time	Matrix / %Moist.	Samp Alq / Analy Alq	Inst ID / Det ID	AnRunID / File Name	Count Date/Time	Net Cnts / Bkg Cnts	BaseEff / Bkg(min)	CntDur(min) / Yield	Activity +/- / 2 s TPU	MDC / DecLev	ReportUnits / ReportBasis	DER / RPD	%Spk. Recov / Flags
0404241-3	Po-209	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.534 g	Alpha Spec	PL040513-1A	5/19/2004	696.700	31.36%	300	12.5	0.1	pCi/g	NA	
SMP	Tracer	11:00:00 AM	PL040513-1-1	NA	10:00:00 AM	NA	0.267 g	2	O42413	8:00 AM	1.000	1000	79.4%	2.0	NA	Dry Weight	NA	
0404241-3	Po-210	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.534 g	Alpha Spec	PL040513-1A	5/19/2004	226.700	31.36%	300	6.0	0.1	pCi/g	NA	
SMP	Trg. Analyte	11:00:00 AM	PL040513-1-1	NA	10:00:00 AM	NA	0.267 g	2	O42413	8:00 AM	1.000	1000	79.4%	1.2	NA	Dry Weight	NA	M3
0404241-5	Po-209	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.511 g	Alpha Spec	PL040513-1A	5/19/2004	721.400	32.05%	300	13.2	0.1	pCi/g	NA	
SMP	Tracer	2:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.255 g	3	O42415	8:01 AM	2.000	1000	80.4%	2.1	NA	Dry Weight	NA	
0404241-5	Po-210	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.511 g	Alpha Spec	PL040513-1A	5/19/2004	589.000	32.05%	300	15.6	0.1	pCi/g	NA	
SMP	Trg. Analyte	2:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.255 g	3	O42415	8:01 AM	0.000	1000	80.4%	2.7	NA	Dry Weight	NA	
0404241-7	Po-209	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.51 g	Alpha Spec	PL040513-1A	5/19/2004	813.400	30.72%	300	15.6	0.1	pCi/g	NA	
SMP	Tracer	3:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.255 g	4	O42417	8:01 AM	2.000	1000	94.6%	2.4	NA	Dry Weight	NA	
0404241-7	Po-210	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.51 g	Alpha Spec	PL040513-1A	5/19/2004	24.000	30.72%	300	0.56	0.06	pCi/g	NA	
SMP	Trg. Analyte	3:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.255 g	4	O42417	8:01 AM	0.000	1000	94.6%	0.25	NA	Dry Weight	NA	
0404241-7	Po-209	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.519 g	Alpha Spec	PL040513-1A	5/19/2004	655.200	31.99%	300	11.8	0.2	pCi/g	NA	
DUP	Tracer	3:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.26 g	5	O42417D	8:01 AM	6.000	1000	73.2%	1.9	NA	Dry Weight	NA	
0404241-7	Po-210	4/19/2004	PL040513-1	NA	5/15/2004	SOIL	0.519 g	Alpha Spec	PL040513-1A	5/19/2004	29.400	31.99%	300	0.84	0.18	pCi/g	0.66	
DUP	Trg. Analyte	3:15:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.26 g	5	O42417D	8:01 AM	2.000	1000	73.2%	0.34	NA	Dry Weight	NA	M3
0404241-9	Po-209	4/22/2004	PL040513-1	NA	5/15/2004	SOIL	0.506 g	Alpha Spec	PL040513-1A	5/19/2004	762.500	31.80%	300	14.2	0.2	pCi/g	NA	
SMP	Tracer	1:00:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.253 g	7	O42419	8:02 AM	5.000	1000	85.6%	2.2	NA	Dry Weight	NA	
0404241-9	Po-210	4/22/2004	PL040513-1	NA	5/15/2004	SOIL	0.506 g	Alpha Spec	PL040513-1A	5/19/2004	3919.000	31.80%	300	98	0	pCi/g	NA	
SMP	Trg. Analyte	1:00:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.253 g	7	O42419	8:02 AM	0.000	1000	85.6%	15	NA	Dry Weight	NA	
0404241-11	Po-209	4/22/2004	PL040513-1	NA	5/15/2004	SOIL	0.502 g	Alpha Spec	PL040513-1A	5/19/2004	734.400	31.59%	300	13.9	0.1	pCi/g	NA	
SMP	Tracer	1:05:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.251 g	8	O424111	8:02 AM	2.000	1000	83.0%	2.2	NA	Dry Weight	NA	

Comments:

Data Package ID: *Po0404241-1*

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

+ - Duplicate RPD not within limits.

LT - Result is less than Request MDC, greater than sample specific MDC

* - Aliquot Basis is 'As Recieved' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Recieved'.

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Notes:

1) The Tracer results are not yield corrected (i.e. activity measured not activity added).

2) Where sample time is not available, 12:00 PM (Mountain) is used for decay correction.

Abbreviations:

TR- Tracer TA - Target Analyte

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

DER - Duplicate Error Ratio

BDL - Below Detection Limit

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: Paragon Analytics
PAI Work Order: 0404241

Prep SOP: PAI 711
Analytical SOP: PAI 714

Reported on: Friday, May 21, 2004
9:39:58 AM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QCBatchID	Ingrowth Date /Time	Decay Date/Time	Matrix %Moist.	Samp Alq Analy Alq	Inst ID Det ID	AnRunID File Name	Count Date/Time	Net Cnts Bkg Cnts	BaseEff Bkg(min)	CntDur(min) Yield	Activity +/- 2 s TPU	MDC DecLev	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
0404241-11	Po-210	4/22/2004	PL040513-1	NA	5/15/2004	SOIL	0.502 g	Alpha Spec	PL040513-1A	5/19/2004	931.700	31.59%	300	24.3	0.1	pCi/g	NA	
SMP	Trg. Analyte	1:05:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.251 g	8	O424111	8:02 AM	1.000	1000	83.0%	4.1	NA	Dry Weight	NA	M3
0404241-12	Po-209	4/16/2004	PL040513-1	NA	5/15/2004	SOIL	0.502 g	Alpha Spec	PL040513-1A	5/19/2004	662.100	28.66%	300	13.8	0.1	pCi/g	NA	
SMP	Tracer	1:10:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.251 g	49	O424112	8:03 AM	3.000	1000	82.5%	2.2	NA	Dry Weight	NA	
0404241-12	Po-210	4/16/2004	PL040513-1	NA	5/15/2004	SOIL	0.502 g	Alpha Spec	PL040513-1A	5/19/2004	1080.000	28.66%	300	32.2	0.1	pCi/g	NA	
SMP	Trg. Analyte	1:10:00 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.251 g	49	O424112	8:03 AM	0.000	1000	82.5%	5.4	NA	Dry Weight	NA	
PL040513-1	Po-209	5/13/2004	PL040513-1	NA	5/15/2004	SOIL	0.5 g	Alpha Spec	PL040513-1A	5/19/2004	671.800	31.41%	300	12.8	0.1	pCi/g	NA	
MB	Tracer	12:46:37 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.25 g	50	O40511B	8:03 AM	4.000	1000	76.4%	2.0	NA	Dry Weight	NA	
PL040513-1	Po-210	5/13/2004	PL040513-1	NA	5/15/2004	SOIL	0.5 g	Alpha Spec	PL040513-1A	5/19/2004	1.000	31.41%	300	0.026	0.070	pCi/g	NA	
MB	Trg. Analyte	12:46:37 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.25 g	50	O40511B	8:03 AM	0.000	1000	76.4%	0.093	NA	Dry Weight	NA	U
PL040513-1	Po-209	5/13/2004	PL040513-1	NA	5/15/2004	SOIL	0.5 g	Alpha Spec	PL040513-1A	5/19/2004	585.400	30.94%	300	11.4	0.1	pCi/g	NA	
LCS	Tracer	12:46:37 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.25 g	51	O40511L	8:03 AM	2.000	1000	67.6%	1.8	NA	Dry Weight	NA	
PL040513-1	Po-210	5/13/2004	PL040513-1	NA	5/15/2004	SOIL	0.5 g	Alpha Spec	PL040513-1A	5/19/2004	1112.700	30.94%	300	32.9	0.2	pCi/g	NA	116
LCS	Trg. Analyte	12:46:37 PM	PL040513-1-1	NA	10:00:00 AM	NA	0.25 g	51	O40511L	8:03 AM	1.000	1000	67.6%	5.6	NA	Dry Weight	NA	P,M3

Comments:

Data Package ID: *Po0404241-1*

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

+ - Duplicate RPD not within limits.

LT - Result is less than Request MDC, greater than sample specific MDC

* - Aliquot Basis is 'As Recieved' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Recieved'.

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Notes:

1) The Tracer results are not yield corrected (i.e. activity measured not activity added).

2) Where sample time is not available, 12:00 PM (Mountain) is used for decay correction.

Abbreviations:

TR- Tracer TA - Target Analyte

TPU - Total Propagated Uncertainty (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

DER - Duplicate Error Ratio

BDL - Below Detection Limit

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 1:00:58 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-3 PL040513-1
Analysis Type: PO-210

Detector: MCB 1 Input 2
Date/Time of Count: 5/19/04 8:00:46 AM

Sample Volume: 0.534 Total, 0.267 Aliquot.
Live Time: **300.00 Minutes**

Chem. Yield: **79.35%**
Real Time: 300.01 Minutes

Total Eff.: 24.88 %
Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.
Acquisition: 512 Channels

Efficiency: 31.36%
Analysis: Relative Region-Of-Interest

Original: 2,979 + 10.1772 * Chn + -0.00065 * Chn **2.

Spectrum Calibration: 2,979 + 10.2418 * Chn + -0.00065 * Chn **2.

Cal File:

Spectrum File: **C:\USER\ALPHA\ALPHA\O42413.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051802.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	230.44	210	235	6.00	50.00	227.00	0.30	226.70	3.04
Tracer	188.08	168	193	6.00	141.00	697.00	0.30	696.70	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	59.65	5.123	n/a	13.03 %
Tracer	Po-209	4882.00	59.98	15.746	n/a	7.42 %

Totals

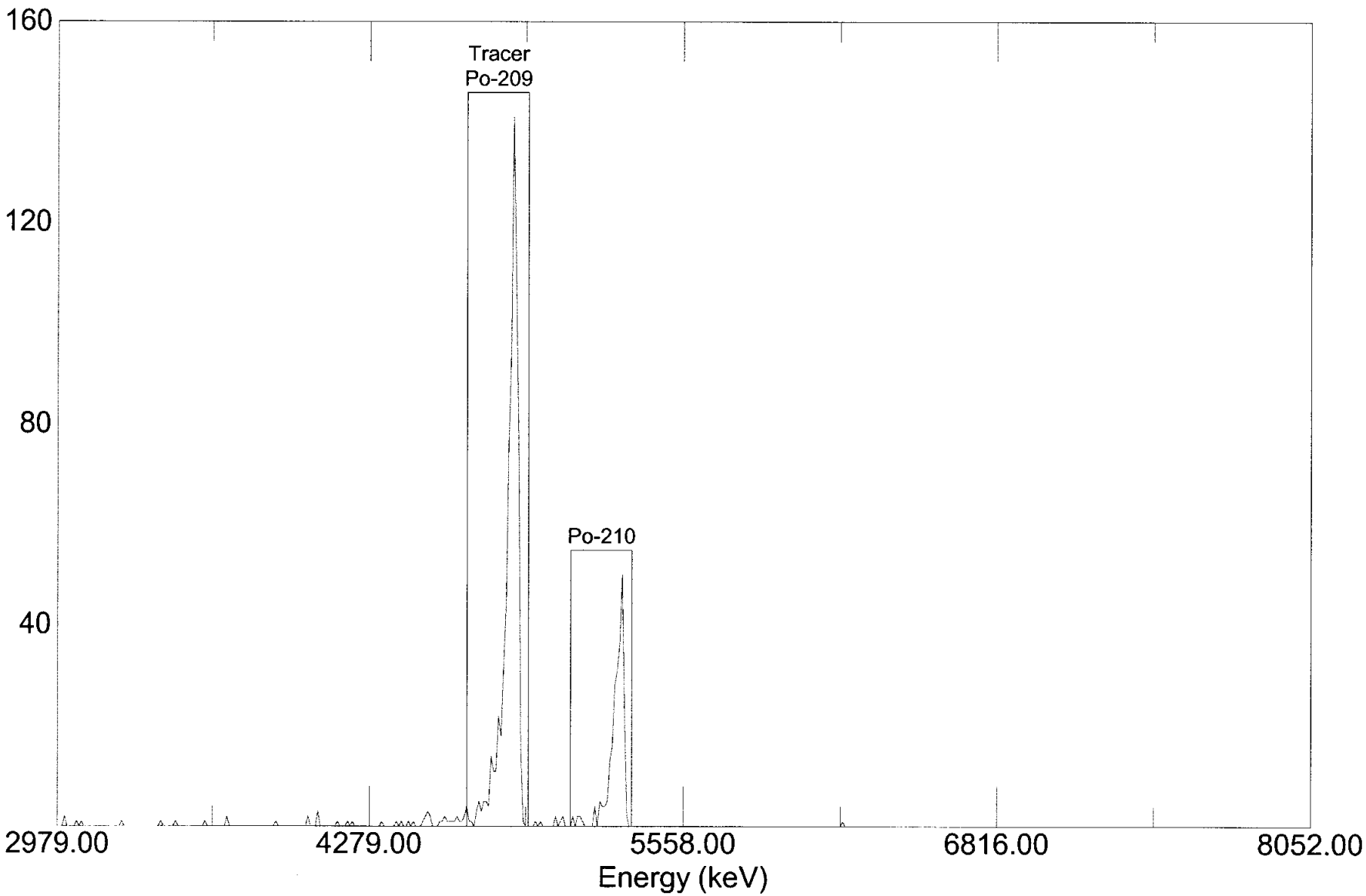
		% Total
Gross Count:	978.00	100.00
Net Area:	973.50	99.54
Background:	4.50	0.46
Composite Fit:	924.00	94.48
Residuals:	54.00	5.52

Analyzed By: Sm

Checked By: SD

000020

O42413 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:00:46 on 19-May-2004
File: C:\USER\ALPHA\ALPHA\O42413.SPC
Sample: 0404241-3 PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #2 MCB 1 Input 2
Type: PO-210

120021

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:43:14 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-5 PL040513-1

Analysis Type: PO-210

Detector: MCB 1 Input 3

Date/Time of Count: 5/19/04 8:01:04 AM

Sample Volume: 0.511 Total, 0.255 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **80.39%**

Real Time: 300.01 Minutes

Total Eff.: 25.77 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 32.05%

Analysis: Relative Region-Of-Interest

Original: 2,947 + 10.5166 * Chn + -0.00140 * Chn **2.

Spectrum Calibration: 2,947 + 10.7509 * Chn + -0.00140 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O42415.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051803.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	225.88	207	232	8.00	88.00	589.00	0.00	589.00	7.62
Tracer	184.37	164	190	6.00	91.00	722.00	0.60	721.40	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	80.95	13.445	n/a	8.08 %
Tracer	Po-209	4882.00	61.41	16.467	n/a	7.29 %

Totals

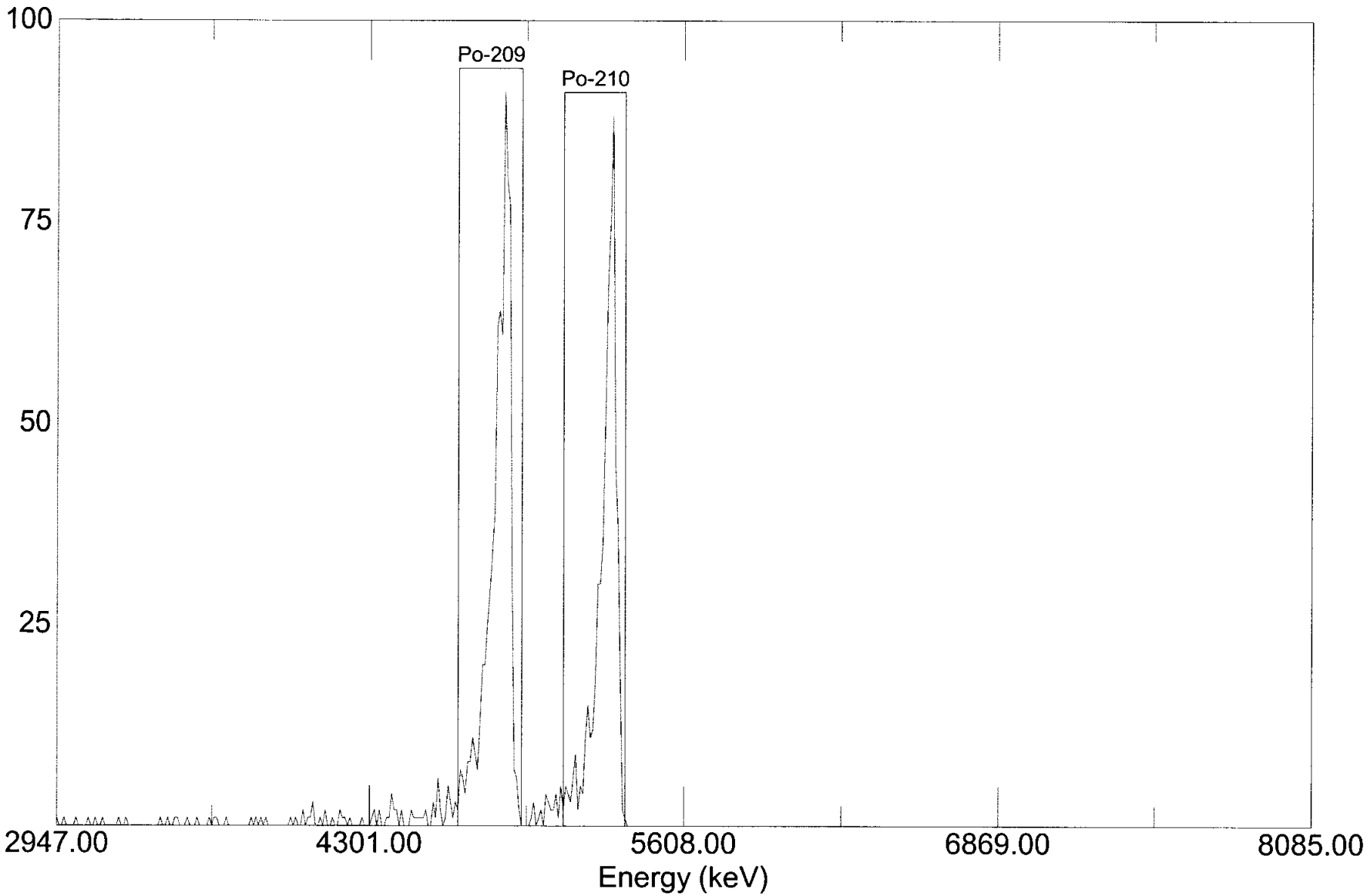
		% Total
Gross Count:	1,431.00	100.00
Net Area:	1,427.40	99.75
Background:	3.60	0.25
Composite Fit:	1,311.00	91.61
Residuals:	120.00	8.39

Analyzed By: _____

Checked By: _____

000022

O42415 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:01:04 on 19-May-2004
File: C:\User\Alpha\ALPHA\O42415.SPC
Sample: 0404241-5 PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #3 MCB 1 Input 3
Type: PO-210

000023

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:45:55 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-7 PL040513-1

Analysis Type: PO-210

Detector: MCB 1 Input 4

Date/Time of Count: 5/19/04 8:01:23 AM

Sample Volume: 0.510 Total, 0.255 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **94.57%**

Real Time: 300.01 Minutes

Total Eff.: 29.05 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 30.72%

Analysis: Relative Region-Of-Interest

Original: 2,944 + 10.6222 * Chn + -0.00170 * Chn **2.

Spectrum Calibration: 2,944 + 10.7279 * Chn + -0.00170 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O42417.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051804.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	228.32	208	233	10.00	5.00	24.00	0.00	24.00	0.28
Tracer	186.18	169	193	6.00	112.00	814.00	0.60	813.40	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	99.52	0.486	n/a	40.01 %
Tracer	Po-209	4882.00	60.57	16.486	n/a	6.87 %

Totals

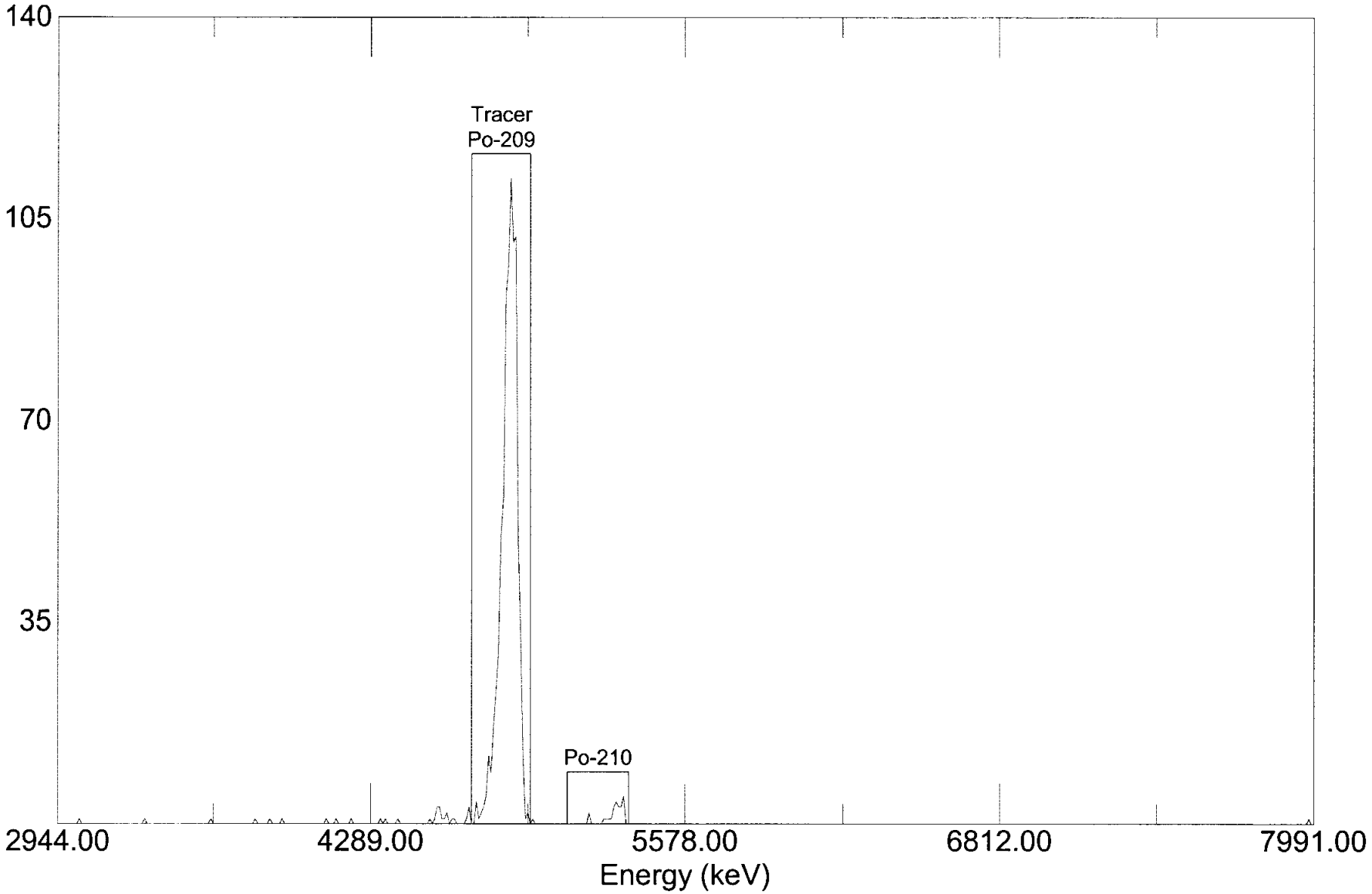
		% Total
Gross Count:	870.00	100.00
Net Area:	865.80	99.52
Background:	4.20	0.48
Composite Fit:	838.00	96.32
Residuals:	32.00	3.68

Analyzed By: _____

Checked By: _____

000024

O42417 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:01:23 on 19-May-2004
File: C:\User\Alpha\ALPHA\O42417.SPC
Sample: 0404241-7 PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #4 MCB 1 Input 4
Type: PO-210

000025

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:45:06 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-7D PL040513-1

Analysis Type: PO-210

Detector: MCB 1 Input 5

Date/Time of Count: 5/19/04 8:01:49 AM

Sample Volume: 0.519 Total, 0.260 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **73.16%**

Real Time: 300.01 Minutes

Total Eff.: 23.41 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 31.99%

Analysis: Relative Region-Of-Interest

Original: 2,965 + 10.3501 * Chn + -0.00110 * Chn **2.

Spectrum Calibration: 2,965 + 10.3699 * Chn + -0.00110 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O42417D.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051805.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	231.25	211	236	2.00	6.00	30.00	0.60	29.40	0.42
Tracer	188.62	168	194	4.00	122.00	657.00	1.80	655.20	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	19.72	0.727	n/a	36.55 %
Tracer	Po-209	4882.00	39.82	16.191	n/a	7.65 %

Totals

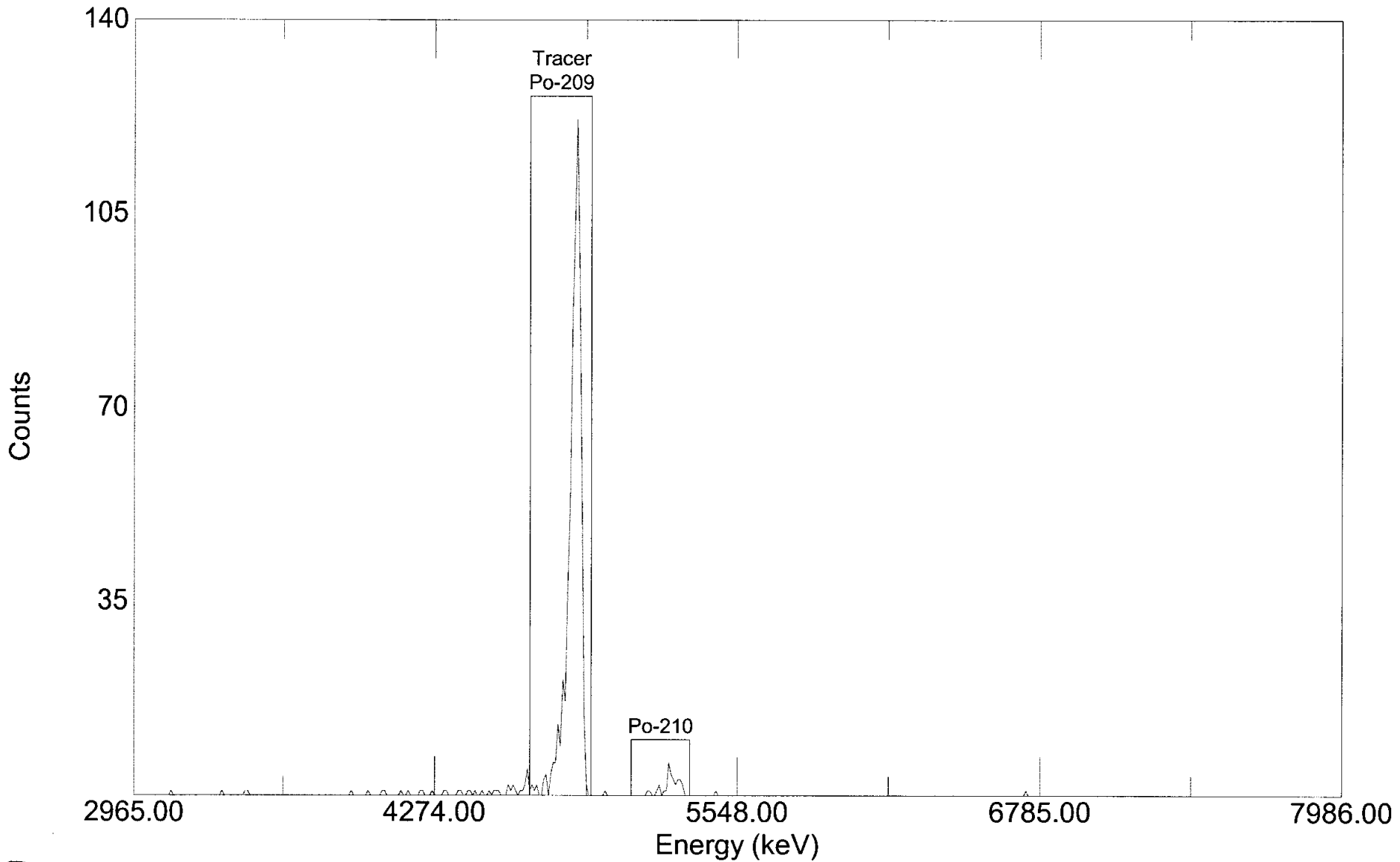
		% Total
Gross Count:	730.00	100.00
Net Area:	724.00	99.18
Background:	6.00	0.82
Composite Fit:	687.00	94.11
Residuals:	43.00	5.89

Analyzed By: _____

Checked By: _____

000026

O42417D AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:01:49 on 19-May-2004
File: C:\User\Alpha\ALPHA\O42417D.SPC
Sample: 0404241-7D PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #5 MCB 1 Input 5
Type: PO-210

000027

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:47:13 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-9 PL040513-1

Analysis Type: PO-210

Detector: MCB 1 Input 7

Date/Time of Count: 5/19/04 8:02:20 AM

Sample Volume: 0.506 Total, 0.253 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **85.62%**

Real Time: 300.01 Minutes

Total Eff.: 27.23 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 31.80%

Analysis: Relative Region-Of-Interest

Original: 2,967 + 10.3929 * Chn + -0.00120 * Chn **2.

Spectrum Calibration: 2,967 + 10.4944 * Chn + -0.00120 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O42419.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051807.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	228.72	210	236	6.00	660.00	3,919.00	0.00	3919.00	47.98
Tracer	186.47	168	193	6.00	127.00	764.00	1.50	762.50	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	59.67	85.422	n/a	3.13 %
Tracer	Po-209	4882.00	60.28	16.620	n/a	7.09 %

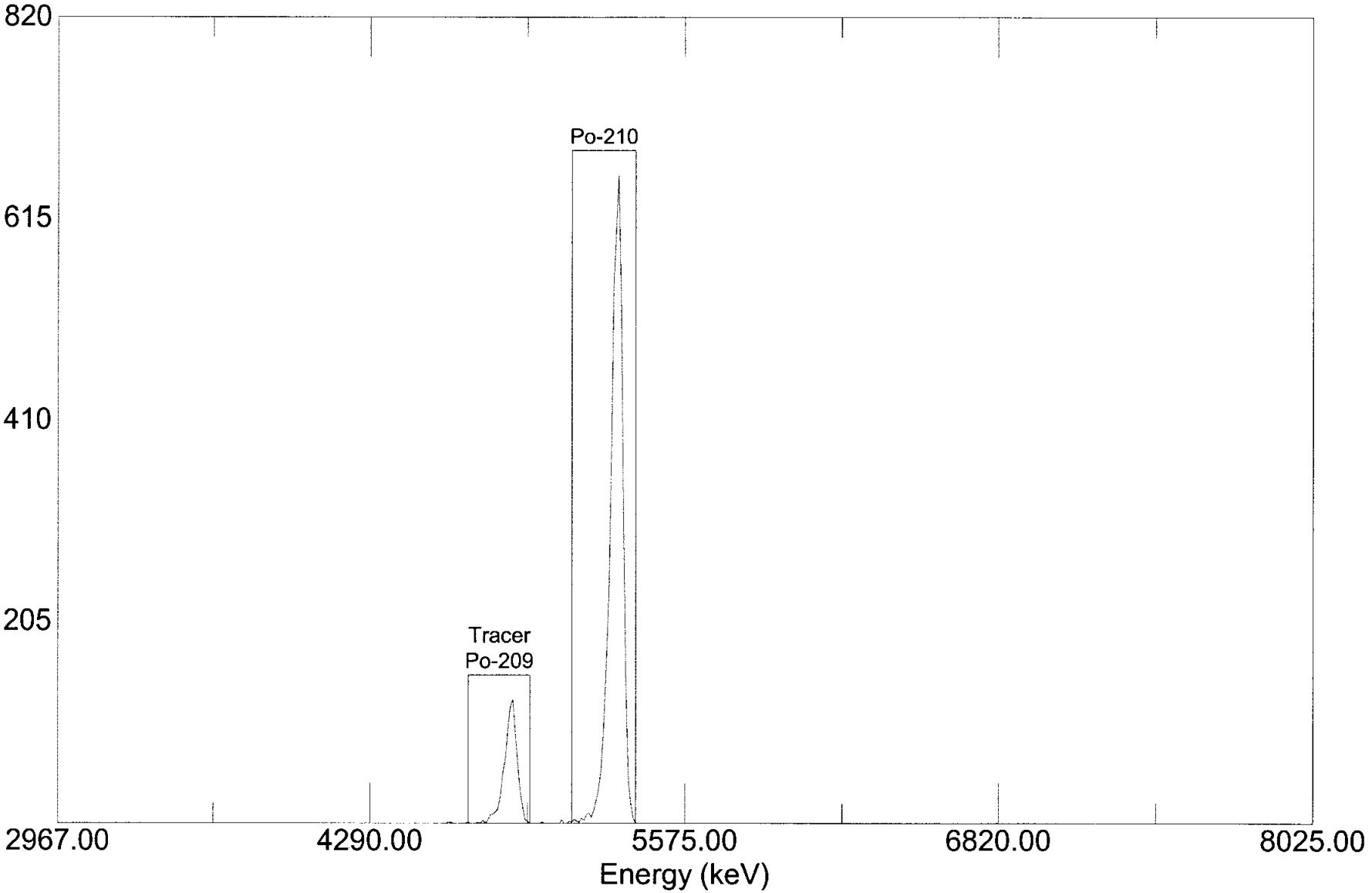
Totals

		% Total
Gross Count:	4,741.00	100.00
Net Area:	4,736.80	99.91
Background:	4.20	0.09
Composite Fit:	4,683.00	98.78
Residuals:	58.00	1.22

Analyzed By: _____

Checked By: _____

O42419 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:02:20 on 19-May-2004
File: C:\User\Alpha\ALPHA\O42419.SPC
Sample: 0404241-9 PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #7 MCB 1 Input 7
Type: PO-210

000029

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:48:43 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-11 PL040513-1
Analysis Type: PO-210

Detector: MCB 1 Input 8
Date/Time of Count: 5/19/04 8:02:41 AM

Sample Volume: 0.503 Total, 0.251 Aliquot.
Live Time: **300.00 Minutes**

Chem. Yield: **83.05%**
Real Time: 300.01 Minutes

Total Eff.: 26.23 %
Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.
Acquisition: 512 Channels

Efficiency: 31.59%
Analysis: Relative Region-Of-Interest

Original: 2,960 + 10.3594 * Chn + -0.00120 * Chn **2.

Spectrum Calibration: 2,960 + 10.4752 * Chn + -0.00120 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O424111.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051808.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	229.85	210	237	8.00	144.00	932.00	0.30	931.70	11.84
Tracer	187.51	168	193	4.00	111.00	735.00	0.60	734.40	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	79.39	21.228	n/a	6.42 %
Tracer	Po-209	4882.00	40.10	16.733	n/a	7.23 %

Totals

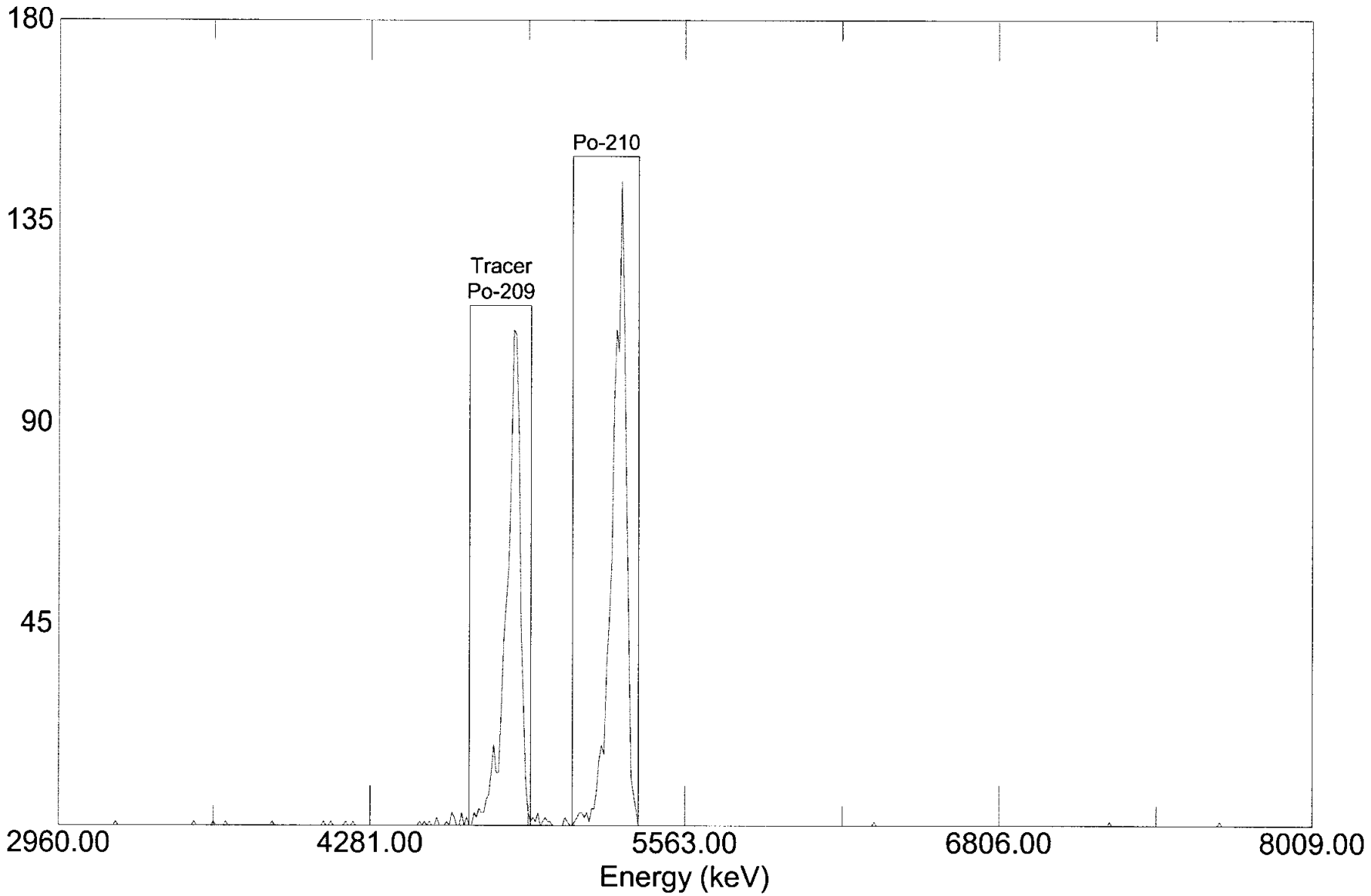
		% Total
Gross Count:	1,709.00	100.00
Net Area:	1,706.30	99.84
Background:	2.70	0.16
Composite Fit:	1,667.00	97.54
Residuals:	42.00	2.46

Analyzed By: SM

Checked By: SD

000030

O424111 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:02:41 on 19-May-2004
File: C:\User\Alpha\ALPHA\O424111.SPC
Sample: 0404241-11 PL040513-1

Real Time: 18000.48 s. Live Time: 18000.00 s.
Detector: #8 MCB 1 Input 8
Type: PO-210

000031

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:49:44 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: 0404241-12 PL040513-1

Analysis Type: PO-210

Detector: MCB 7 Input 1

Date/Time of Count: 5/19/04 8:03:07 AM

Sample Volume: 0.502 Total, 0.251 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **82.51%**

Real Time: 300.00 Minutes

Total Eff.: 23.65 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 28.66%

Analysis: Relative Region-Of-Interest

Original: 2,991 + 10.2326 * Chn + -0.00100 * Chn **2.

Spectrum Calibration: 2,991 + 10.3345 * Chn + -0.00100 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O424112.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051849.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	228.94	209	234	6.00	209.00	1,080.00	0.00	1080.00	15.22
Tracer	186.36	165	191	6.00	117.00	663.00	0.90	662.10	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	59.26	27.332	n/a	5.96 %
Tracer	Po-209	4882.00	59.77	16.756	n/a	7.61 %

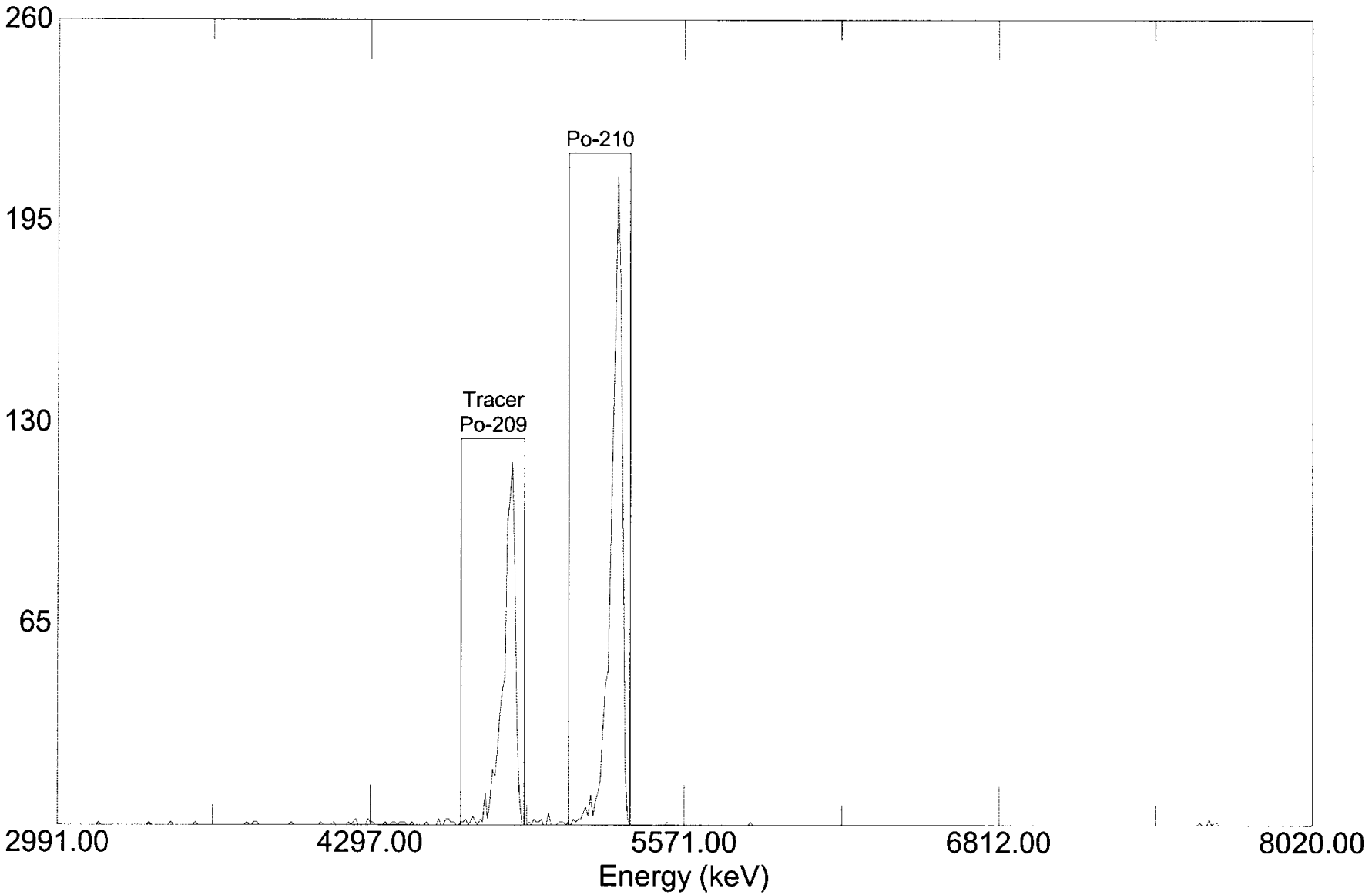
Totals

		% Total
Gross Count:	1,798.00	100.00
Net Area:	1,793.80	99.77
Background:	4.20	0.23
Composite Fit:	1,743.00	96.94
Residuals:	55.00	3.06

Analyzed By: _____

Checked By: _____

O424112 AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:03:07 on 19-May-2004
File: C:\User\Alpha\ALPHA\O424112.SPC
Sample: 0404241-12 PL040513-1

Real Time: 18000.16 s. Live Time: 18000.00 s.
Detector: #49 MCB 7 Input 1
Type: PO-210

000033

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/19/04 4:50:35 PM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: PL040513-1MB PL040513-1

Analysis Type: PO-210

Detector: MCB 7 Input 2

Date/Time of Count: 5/19/04 8:03:38 AM

Sample Volume: 0.500 Total, 0.250 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **76.39%**

Real Time: 300.00 Minutes

Total Eff.: 23.99 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 31.41%

Analysis: Relative Region-Of-Interest

Original: 3,024 + 9.9726 * Chn + -0.00036 * Chn **2.

Spectrum Calibration: 3,024 + 10.0244 * Chn + -0.00036 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O40511B.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051850.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	229.36	209	234	2.00	1.00	1.00	0.00	1.00	0.01
Tracer	186.59	166	192	4.00	84.00	673.00	1.20	671.80	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	19.72	0.025	n/a	196.00 %
Tracer	Po-209	4882.00	39.56	16.816	n/a	7.56 %

Totals

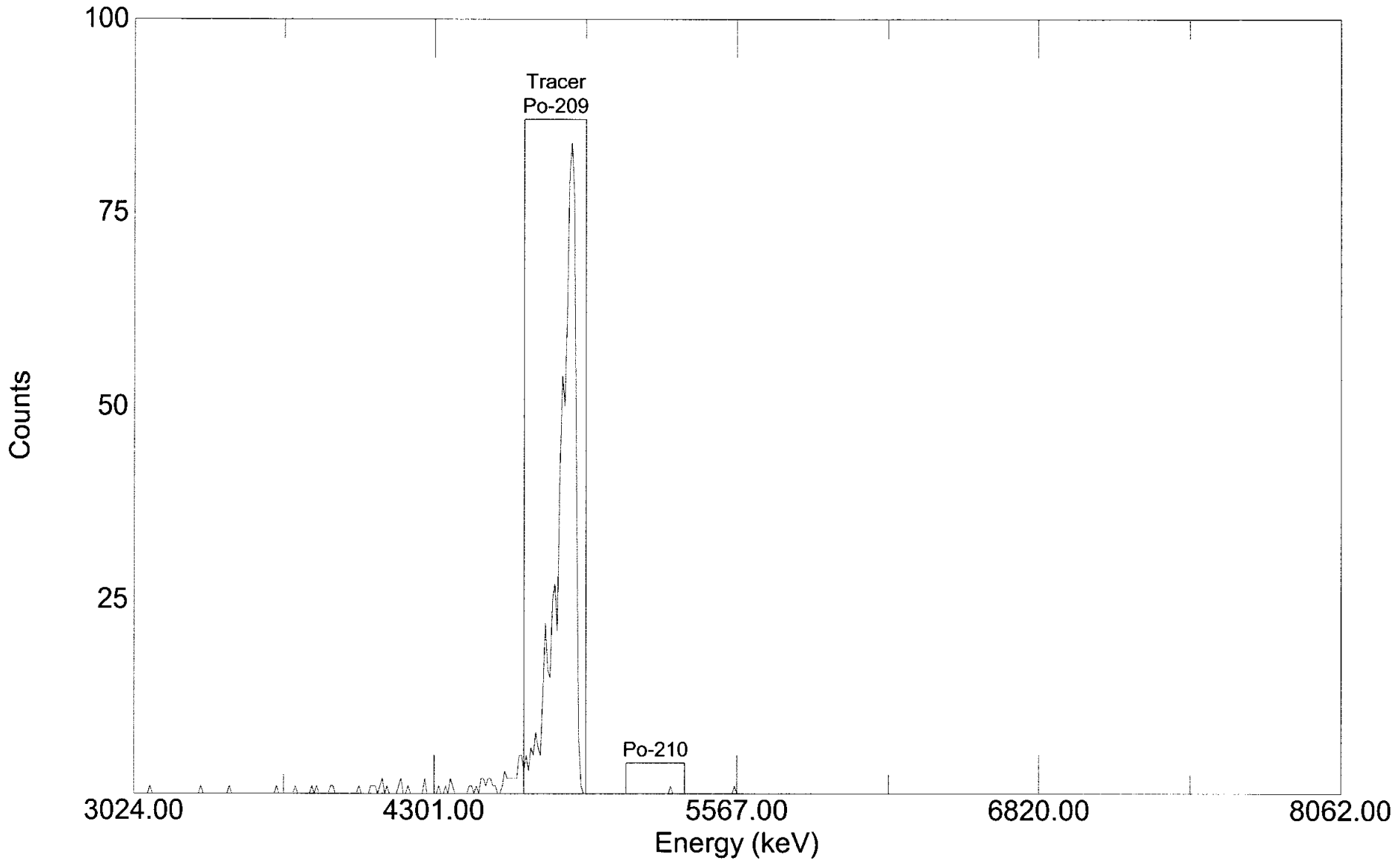
		% Total
Gross Count:	741.00	100.00
Net Area:	735.00	99.19
Background:	6.00	0.81
Composite Fit:	674.00	90.96
Residuals:	67.00	9.04

Analyzed By: _____

Checked By: _____

000034

O40511B AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:03:38 on 19-May-2004
Real Time: 18000.18 s. Live Time: 18000.00 s.
File: C:\User\Alpha\ALPHA\O40511B.SPC
Detector: #50 MCB 7 Input 2
Sample: PL040513-1MB PL040513-1
Type: PO-210

000035

Paragon Analytics
Alpha Spectroscopy Analysis

Report Printed:
5/21/04 9:34:06 AM
Para0327.rpt
rev 11/13/03 KVG

Sample Name: PL040513-1LCS PL040513-1

Analysis Type: PO-210

Detector: MCB 7 Input 3

Date/Time of Count: 5/19/04 8:03:58 AM

Sample Volume: 0.500 Total, 0.250 Aliquot.

Live Time: **300.00 Minutes**

Chem. Yield: **67.58%**

Real Time: 300.00 Minutes

Total Eff.: 20.91 %

Dead Time: 0.0 %

Tracer Amount: 18.666 DPM.

Acquisition: 512 Channels

Efficiency: 30.94%

Analysis: Relative Region-Of-Interest

Original: 2,999 + 10.1950 * Chn + -0.00086 * Chn **2.

Spectrum Calibration: 2,999 + 10.2707 * Chn + -0.00086 * Chn **2.

Cal File:

Spectrum File: **C:\User\Alpha\ALPHA\O40511L.SPC**

Background File: **C:\USER\ALPHA\BKGND\B4051851.SPC**

Library File: C:\User\Alpha\ALPHAVIS.ALB

Peaks

Peak	Channel	Start	End	FWHM	Height	Gross Cts	Bkg Cts	Net Area	DPM
1	228.80	212	234	6.00	203.00	1,113.00	0.30	1112.70	17.74
Tracer	186.20	165	192	6.00	82.00	586.00	0.60	585.40	9.33

Analysis Results

Peak	Nuclide	Energy (keV)	Width (keV)	Aliquot pCi	MDA pCi	% Error
1	Po-210	5304.38	59.27	31.963	n/a	5.88 %
Tracer	Po-209	4882.00	59.71	16.816	n/a	8.10 %

Totals

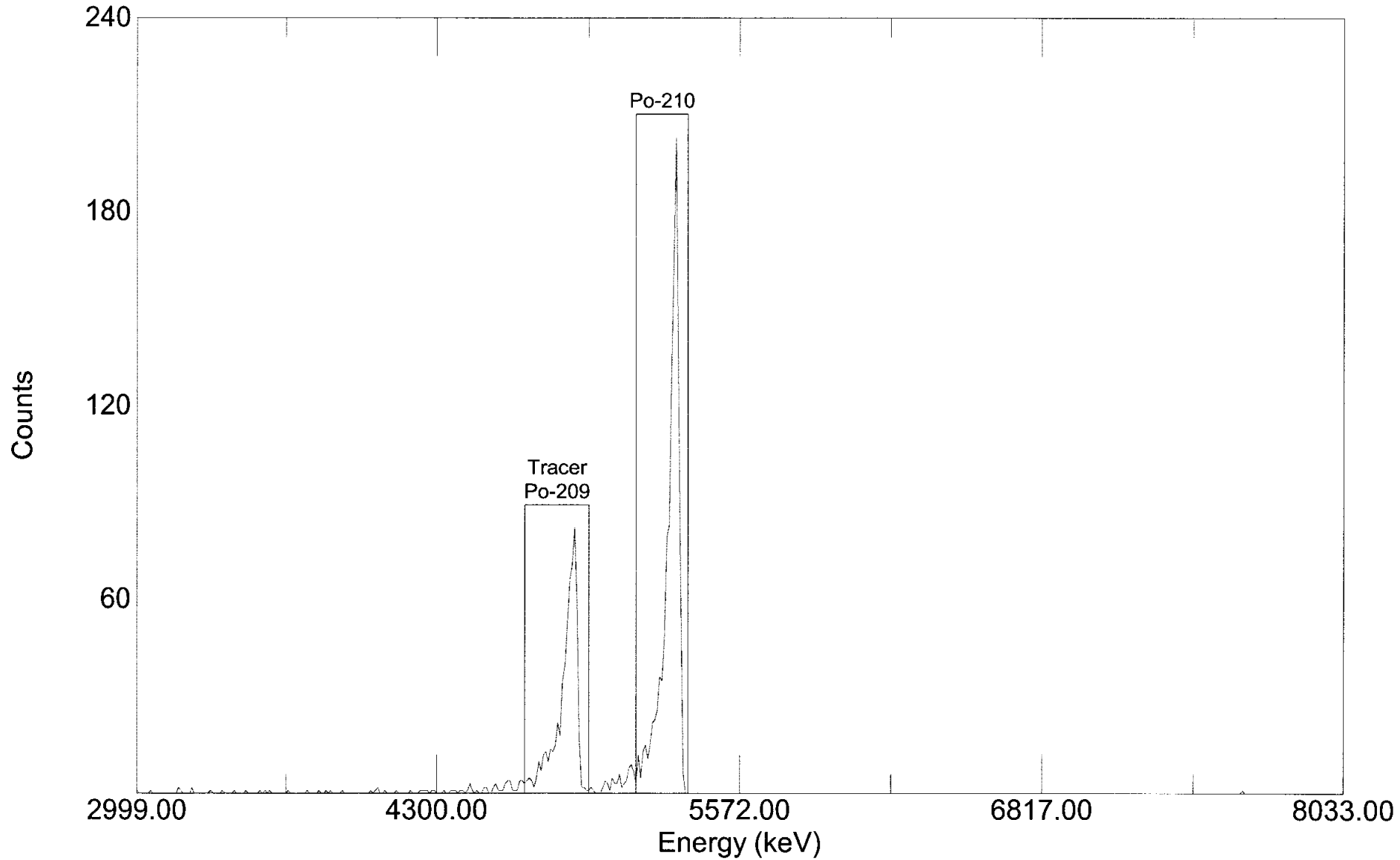
		% Total
Gross Count:	1,842.00	100.00
Net Area:	1,836.30	99.69
Background:	5.70	0.31
Composite Fit:	1,699.00	92.24
Residuals:	143.00	7.76

Analyzed By: JP

Checked By: SD

000036

O40511L AlphaVision Relative Region-Of-Interest (Slope Recalibration)



Acquired: 08:03:58 on 19-May-2004
File: C:\User\Alpha\ALPHA\O40511L.SPC
Sample: PL040513-1LCS PL040513-1

Real Time: 18000.16 s. Live Time: 18000.00 s.
Detector: #51 MCB 7 Input 3
Type: PO-210

Paragon Analytics

FORM 746r6.xls (11/8/2000)

Alpha Spectrometer Instrument Run Log

277729

Date: 5/19/04

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial	File ID/Comm.
9	AS040510-3	AS040510-3LCSD	U/W	300	JP	UR5103LD
10	AS040510-4	C404248-8	Th/W	300	JP	TR42488
11		C404313-1				T43131
12		↓ -2				↓ 2
13		C404314-1				T43141
15		-4				4
16		-5				5
17		-8				8
18		-23				23
19		-24				24
21		AS040510-4MB		420		T5104B
22		LCS		300		L
23	↓	LCSD	↓	↓	↓	LD
24	AS040511-4	C404228-1	U/S	300	JP	U42281
42		-2				2
43		-3				3
44		-4				4
45		-5				5
46		-6				6
47		-7				7
48		-8				8
57		-8D				8D
58		-9				9
59	↓	-10	↓	↓	↓	10

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial	File ID/Comm.
60	AS040511-4	C404228-11	U/S	300	JP	U422811
61		-12				12
62		-13				13
63		-14				14
64	↓	-15	↓	↓	↓	↓ 15
2	PLC4C513-1	C4C4241-3	Pc/S	300	JP	042413
3		-5				5
4		-7				7
5		-7D				7D
7		-9				9
8		-11				11
49		↓ -12				↓ 12
50		PLC4C513-1MB				05131B
51	↓	↓ LCS	↓	↓	↓	↓ L
9	AS040511-4	0404228-16	U/S	300	SM	U422816
10		-17				17
11		-18				18
12		-18D				18D
13		-19				19
15		-20				↓ 20
16		-4MB				U5114B
17	↓	-4LCS	↓	↓	↓	U5114L
18	AS040428-5	0404241-9	U/S	300	SM	UZ42419
19	↓	↓ -12	↓	↓	↓	UZ424112

Notes:
Cont. on page 277730. JP 5/19/04

Reviewed by: JD
Date: 5/19/04

000033

PARAGON ANALYTICS
Radiochemistry Data Package

Section 5

QUALITY ASSURANCE SUMMARY REPORTS

5

No *NON-CONFORMANCE REPORTS* or
QUALITY ASSURANCE SUMMARY SHEETS
are included in this data package.

PARAGON ANALYTICS
Radiochemistry Data Package

Section 6

LABORATORY BENCH SHEETS

6

Radiochemistry Instrument Worksheet

Paragon Analytics

Prep Batch: PL040513-1

Prep Procedure: Po210

Analytical QASS / NCR? Y / (N) NA

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	0404241-3	SMP	0.534	0.267	g	0_42413	2	Sm	_42413			_42413			
1	0404241-5	SMP	0.5106	0.2553	g	_42415	3		_42415			_42415			
1	0404241-7	SMP	0.51	0.255	g	_42417	4		_42417			_42417			
1	0404241-7	DUP	0.5193	0.25965	g	_42417D	5		_42417D			_42417D			
1	0404241-9	SMP	0.5059	0.25295	g	_42419	7		_42419			_42419			
1	0404241-11	SMP	0.5025	0.25125	g	_424111	8		_424111			_424111			
1	0404241-12	SMP	0.5018	0.2509	g	_424112	49		_424112			_424112			
1	PL040513-1	MB	0.5	0.25	g	_40511B	50		_40511B			_40511B			JP 5/21/04
1	PL040513-1	LCS	0.5	0.25	g	_40511L	51		_40511L			_40511L			

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	PO-209	592.1808.81	37.331	DPM/ml	05/13/04	0.5	ml	AW-013

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	059.1572.15	32.153	DPM/ml	05/13/04	1	ml	AW-010
S1	Po-210	059.1572.15	32.153	DPM/ml	05/13/04	1	ml	AW-010

Radiochemistry Prep Worksheet

Paragon Analytics

Prep Batch: PL040513-1

Prep Procedure: Po210

Reviewed By: CRW CW **Review Date:** 5/18/04

Non-Routine Pre-Treatment? Y / (N) **Batch:** N/A **Re-Prep?** Y / (N) **Batch:** N/A **Prep QASS / NCR?** Y / (N) N/A

Prep SOP: PAI 711 **Rev:** 5
Prep SOP: NONE
Matrix Class: solid

Prep Analyst: Chad Wangeline
Prep Date: 5/13/04
Prep Dept: AP

Balance: 23
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq g	Fin Alq g	Prep Basis	Decay Date/Time	Standards	Prep Notes
1	1	0404241-3	SMP		0.534	0.267	Dry Weight	05/15/04 10:00	T1	
2	1	0404241-5	SMP		0.5106	0.2553	Dry Weight	05/15/04 10:00	T1	
3	1	0404241-7	SMP		0.51	0.255	Dry Weight	05/15/04 10:00	T1	
4	1	0404241-7	DUP		0.5193	0.25965	Dry Weight	05/15/04 10:00	T1	
5	1	0404241-9	SMP		0.5059	0.25295	Dry Weight	05/15/04 10:00	T1	
6	1	0404241-11	SMP		0.5025	0.25125	Dry Weight	05/15/04 10:00	T1	
7	1	0404241-12	SMP		0.5018	0.2509	Dry Weight	05/15/04 10:00	T1	
8	1	PL040513-1	MB		0.5	0.25	Dry Weight	05/15/04 10:00	T1	
9	1	PL040513-1	LCS		0.5	0.25	Dry Weight	05/15/04 10:00	S1,T1	

CW 5/18/04

Spiked By: Chad Wangeline **Date:** 5/13/04

Witnessed By: Grace Campagnola **Date:** 5/13/04

Relinquished By: CW
Date: 5/18/04
Received By: SRD
Date: 5/19/04

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	PO-209	592.1808.81	37.331	DPM/ml	05/13/04	0.5	ml	AW-013

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	059.1572.15	32.153	DPM/ml	05/13/04	1	ml	AW-010
S1	Po-210	059.1572.15	32.153	DPM/ml	05/13/04	1	ml	AW-010

Comments
ALL SAMPLES COVERED WITH THIN FILM.

Radiochemistry Prep Worksheet

Paragon Analytics

Prep Batch: PL040513-1

Prep Procedure: Po210

Prep Batch Not Validated!!!

Reviewed By: **Review Date:**

Non-Routine Pre-Treatment? Y / N **Batch:** _____ **Re-Prep? Y / N** **Batch:** _____ **Prep QASS / NCR? Y / N** _____

Prep SOP: PAI 711 **Rev:** 5
Prep SOP: NONE
Matrix Class: solid

Prep Analyst: Chad Wangeline CW
Prep Date: 5/13/04
Prep Dept: AP

Balance:
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq g	Fin Alq g	Prep Basis	Decay Date/Time	Prep Notes
1	1	0404241-3	SMP		0.534	0.267	Dry Weight	2/15/04 1000	T1
2	1	0404241-5	SMP		0.5106	0.2553	Dry Weight		T1
3	1	0404241-7	SMP		0.51	0.255	Dry Weight		T1
4	1	0404241-7	DUP		0.5193	0.25965	"		T1
5	1	0404241-9	SMP		0.5059	0.25295	Dry Weight		T1
6	1	0404241-11	SMP		0.5025	0.25125	Dry Weight		T1
7	1	0404241-12	SMP		0.5018	0.2509	Dry Weight		T1
8	1	PL040513-1	MB		0.5	0.25			T1
9	1	PL040513-1	LCS		0.5	0.25			T1, S1

Spiked By: CW **Date:** 5/13/04
Witnessed By: [illegible] **Date:** 5/13/04

Relinquished By: _____
Date: _____
Received By: _____
Date: _____

T1 Po-209 592.1808.81 0.5 Aw013
exp 2/10/05

S1 Pb-210 059.1572.15 1.0000 Aw010
exp 11/7/04

Comments

SAMPLE CONDITION FORM (SOLIDS)

ANALYST: CW

ANALYSIS DATE: 5/13/01 METHOD: Po-210

WORK ORDER	SAMPLE ID	SAMPLE CONDITION		
		Dry/Wet	TEXTURE	Remarks
0404241	3	Dry	Ground	None
	5			
	7			
	9			
	11			
	12			

5/13/01

CW

4/28/04 W.O. # 04-04-241 (PO^{ISO}, Th^{ISO}, U^{ISO}, Pb 210L)

in oven - 4/27 @ 1100
out oven - 4/28 @ 1100

S.O.P. - 721 - R10
balance # 15, oven # 1
5 balls, shake 15 min.

Sample #	sample / can / balls (g)	can / balls (g)	ground sample (g)	TYPE sample
04-04-241-3	126.6	96.4	30.2	SOIL
-5	126.5	96.3	30.2	
-7	126.8	96.4	30.4	
-9	127.0	96.9	30.1	
-11	127.1	96.7	30.4	
-12	125.7	96.5	29.2	

C.O. - 4/28/04

Continued on Page

Read and Understood By

Carson P. O'Dell 4/28/04
Signed Date

Signed 4/29/04
Date

PARAGON ANALYTICS
Radiochemistry Data Package

Section 7

STANDARDS TRACEABILITY DOCUMENTS

7

Po 209 Spiking Soultion

1.) Determine density of 2.0 N HCl

Mass of 100 ml volumetric flask	56.4602 g	Bal 12
Mass of flask + HCl	159.5771 g	↓
Net mass of HCl	103.1169 g	

$\rho = 1.031$ g/ml

2) Transfer contents of RSO# 592 ampoule to a 1l wide-mouth poly bottle.

Mass of 1l bottle (w/o lid)	72.2002 g	Bal 12
Mass of ampoule (opened + 50 ml beaker)	367.0628 g	Bal 12
Mass of ampoule, beaker w/o std	32.0264 g	↓
Net mass of std transferred	5.0364 g	

3) Add 2N HCl to final dilution

Mass of 1l bottle (from above)	72.2002 g	Bal 12
Mass of bottle + std + 2N HCl	737.5 g	Bal 26
Net Mass of Std.	665.3 g.	

4) Final Activity Calculation:

$$\frac{(85.42\ Bq/g)(60\ dpm/Bq)(5.0364\ g)(1.031\ g/ml)}{(665.3\ g)} = 40.00\ dpm/ml$$

RG 12/6/01

Stnd ID: **592.1808.81**

RG 12/6/01

Description:	**Po-209**
Activity:	**40.00 dpm/ml**
Uncertainty:	**0.168 dpm/ml**
Ref. Date:	**3/15/94**
Ref Time:	**na**
Prep Date:	**11/15/01** Prep by: **DCB**
Expiration:	**11/15/02**
Matrix/Comp.	**2.0N HCl**
Half Life (y):	**1.02E+02**

RG 12/6/01

RG 12/6/01

Verified RG 12/6/01

Standard Reverified on 11-17-02.

Expires: 11-17-03

RG 12/6/01

Standard Reverified on 2-10-04.

Expires: 2-10-05

RG 2/17/04

Continued on Page

Read and Understood By

Signed _____ Date 11/15/01

Signed _____ Date 12/6/01

National Institute of Standards & Technology

Certificate

PA ID 0592
Recd 9-25-01

Standard Reference Material 4326
Polonium-209 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive polonium-209 chloride and hydrochloric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of alpha-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains polonium-209 with a total activity of approximately 500 Bq. Polonium-209 decays by alpha-particle emission. None of the alpha particles escape from the SRM ampoule. During the decay process X-rays and gamma rays with energies from 10 to 900 keV are also emitted. Most of these photons escape from the SRM ampoule but their intensities are so small that they do not represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains hydrochloric acid (HCl) with a concentration of 2 moles per liter of water. The solution is corrosive and represents a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2. The ampoule should be opened only by persons qualified to handle both radioactive material and strong acid solution.

Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least June 2004. Refer to reference [5] for details on the long-term stability of polonium solution standards.

The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) both because of the radioactivity and because of the strong acid.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M.R. Hutchinson, Group Leader. The overall technical direction and physical measurements leading to certification were provided by R. Collé of the Radioactivity Group and Z. Lin, Guest Researcher.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by N.M. Trahey.

Gaithersburg, Maryland 20899
January 1995 (Text only revised November 1997)

Thomas E. Gills, Chief
Standard Reference Materials Program

*Notes and references are on pages 5 to 7.

000049

Liquid-Scintillation Counting Warning

Polonium-209 decays primarily by alpha-particle emission. One of the principal alpha-particle transitions feeds a low-energy, **delayed**, isomeric state in the lead-205 daughter. Liquid-scintillation measurements of polonium-209 activity can include some of the activity of this isomeric state. Refer to reference [6] for further information about the effect of this isomeric transition on routine liquid-scintillation counting of polonium-209.

Recommended Procedure for Opening the SRM Ampoule

1) If the SRM solution is to be diluted, it is recommended that the diluting solution have an acid concentration comparable to that of the SRM solution.

2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it. Work in a fume hood. In addition to the radioactive material, the solution contains strong acid and is corrosive.

3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.

4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.

5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.

6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.

7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.

8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. NEVER PIPETTE BY MOUTH.

9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss.

See also reference [4]*.

*Notes and references are on pages 5 to 7.

PROPERTIES OF SRM 4326
(Certified values are shown in bold type)

Source identification number	NIST SRM 4326		
Physical Properties:			
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule		
Ampoule specifications	Body outside diameter Wall Thickness Barium content Lead-oxide content Other heavy elements	(16.5 ± 0.5) mm (0.60 ± 0.04) mm Less than 2.5% Less than 0.02% Trace quantities	
Solution density	**(1.031 ± 0.004) g·mL^{-1} at 22 °C** [b]*		
Solution mass	**(5.160 ± 0.003) g** [b]		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L^{-1})	Mass Fraction (g·g^{-1})
	H_2O HCl HNO_3 $PoCl_4$	53 2 <3 × 10^{-3} 7 × 10^{-10}	0.93 0.07 <2 × 10^{-4} 2 × 10^{-10}
Radiological Properties:			
Radionuclide	**Polonium-209**		
Reference time	**1200 EST, 15 March 1994**		
Massic alpha-particle-emission rate of the solution [c]	**85.42 α·s^{-1}·g^{-1}** (Polonium-209 only) [d]		
Relative expanded uncertainty (k=2)	**0.42%** [e]		
Alpha-particle-emitting impurities	**Polonium-208: (0.106 ± 0.017) α·s^{-1}·g^{-1}** [b, f]		
Photon-emitting impurities	None detected [g]		
Half lives used	Polonium-209: (102 ± 5) a [h] Polonium-208: (2.898 ± 0.002) a [h]		
Measuring instruments	Two 4πα liquid-scintillation counting systems, 2πα gas-flow proportional counter, and silicon surface-barrier detector		

*Notes and references are on pages 5 to 7.

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ALPHA-PARTICLE-EMISSION RATE [e]*

Input Quantity x_i, the source of uncertainty (and individual uncertainty components where appropriate)	Method Used To Evaluate $u(x_i)$, the standard uncertainty of x_i (A) denotes evaluation by statistical methods (B) denotes evaluation by other methods	Relative Uncertainty Of Input Quantity, $u(x_i)/x_i$, (%) [i]	Relative Sensitivity Factor, $\lvert \partial y/\partial x_i \rvert \cdot (x_i/y)$ [j]	Relative Uncertainty Of Output Quantity, $u_i(y)/y$, (%) [k]
Massic liquid-scintillation count rate, corrected for background and decay	Standard deviation for repeated measurements. Six degrees of freedom. (A)	0.06	1.0	0.06
Background variability	Multiple comparisons (A) [7]	0.20	0.02 [m]	0.004
Liquid-scintillator quench corrections	Multiple comparisons (A) [7]	0.12	1.0	0.12
Liquid-scintillation-cocktail stability	Multiple comparisons (A) [7]	0.7	0.007	0.005
Gravimetric measurements	Estimated (B)	0.05	1.0	0.05
Half life of Po-208 Half life of Po-209	Standard uncertainty of the half life (A)	0.07 [n] 4.9 [n]	0.0003 [p] 0.004 [p]	0.00002 0.02
Extrapolation of alpha-particle-count-rate-versus-energy to zero energy	Estimated (B) [7]	0.06	1.0	0.06
Live-time [q]	Estimated (B) [7]	0.04	1.0	0.04
Alpha-particle detection efficiency of scintillator	Estimated (B) [7]	0.10	1.0	0.10
Correction for non-alpha-particle decay modes	Estimated (B) [7]	0.06	1.0	0.06
Alpha-particle-emitting impurities	Estimated (B) [r] Limit of detection (B) [s]	8.1 100.	0.001 0.0006	0.01 0.06
Photon-emitting impurities	Limit of detection (B) [s]	100.	0.0002	0.02
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.21
Coverage Factor, k				x 2
Relative Expanded Uncertainty of the Output Quantity, U/y, (%)				0.42

*Notes and references are on pages 5 to 7.

NOTES

[a] The Sievert is the SI unit for dose equivalent. See reference [1]. One μSv is equal to 0.1 mrem.

Distance from Ampoule (cm):	1	30	100
Approximate Dose Rate (μSv/h):	<0.1	-	-

[b] The stated uncertainty is two times the standard uncertainty.

[c] **Massic alpha-particle-emission rate** is the preferred name for the quantity alpha-particle-emission rate divided by the total mass of the sample. **Massic activity** is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].

[d] The polonium-209 massic activity of the solution is 85.83 $Bq \cdot g^{-1}$, assuming an alpha-particle branching ratio of (0.9952 ± 0.0004) $\alpha \cdot s^{-1} \cdot Bq^{-1}$ [h].

[e] The reported value, y, of massic alpha-particle-emission rate (alpha-particle-emission rate per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as $y = f(x_1, x_2, x_3, \ldots x_n)$, where f is a mathematical function derived from the assumed model of the measurement process.

The value, x_i, used for each input quantity i has a **standard uncertainty**, $u(x_i)$, that generates a corresponding uncertainty in y, $u_i(y) \equiv |\partial y/\partial x_i| \cdot u(x_i)$, called a **component of combined standard uncertainty** of y.

The **combined standard uncertainty** of y, $u_c(y)$, is the positive square root of the sum of the squares of the components of combined standard uncertainty.

The combined standard uncertainty is multiplied by a **coverage factor** of $k = 2$ to obtain U, the **expanded uncertainty** of y.

Since it can be assumed that the possible estimated values of the massic alpha-particle-emission rate are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic alpha-particle-emission rate is believed to lie in the interval $y \pm U$ with a level of confidence of approximately 95 percent.

For further information on the expression of uncertainties, see references [2] and [3]. See reference [7] for further information on uncertainties related to this calibration.

[f] Estimated limits of detection for alpha-particle-emitting impurities are:
0.002 $\alpha \cdot s^{-1} \cdot g^{-1}$ for energies less than 3.5 MeV,
0.05 $\alpha \cdot s^{-1} \cdot g^{-1}$ for energies between 3.5 and 4.2 MeV, and
0.0002 $\alpha \cdot s^{-1} \cdot g^{-1}$ for energies greater than 5.18 MeV.

[g] Estimated limits of detection for photon-emitting impurities are:
2×10^{-4} $\gamma \cdot s^{-1} \cdot g^{-1}$ for energies between 15 and 68 keV,
2×10^{-4} $\gamma \cdot s^{-1} \cdot g^{-1}$ for energies between 81 and 256 keV,
6×10^{-5} $\gamma \cdot s^{-1} \cdot g^{-1}$ for energies between 266 and 892 keV, and
4×10^{-6} $\gamma \cdot s^{-1} \cdot g^{-1}$ for energies between 900 and 3300 keV,
provided that the photons are separated in energy by 4 keV or more from photons emitted in the decay of polonium-209. See reference [7] for further information about the impurity analyses.

[h] The stated uncertainty is the standard uncertainty. See reference [8].

[i] Relative standard uncertainty of the input quantity x_i.

[j] The relative change in the output quantity y divided by the relative change in the input quantity x_i. If $|\partial y/\partial x_i| \cdot (x_i/y) = 1.0$, then a 1% change in x_i results in a 1% change in y. If $|\partial y/\partial x_i| \cdot (x_i/y) = 0.05$, then a 1% change in x_i results in a 0.05% change in y.

[k] Relative component of combined standard uncertainty of output quantity y, rounded to two significant figures or less. The relative component of combined standard uncertainty of y is given by $u_i(y)/y \equiv |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$. The numerical values of $u(x_i)/x_i$, $|\partial y/\partial x_i| \cdot (x_i/y)$, and $u_i(y)/y$, all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.

[m] $|\partial y/\partial x_i| \cdot (x_i/y)$ = (average background count rate)/(average net sample count rate).

[n] The relative standard uncertainty of $\lambda \cdot t$ is determined by the relative standard uncertainty of λ (i.e., of the half life). The relative standard uncertainty of t is negligible.

[p] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t| \cdot$ {(response per Bq of impurity)/(response per Bq of Po-209)}$\cdot${(Bq of impurity)/(Bq of Po-209)}.

[q] The live time is determined by counting the pulses from a gated oscillator.

[r] The standard uncertainty given is for the detected Po-208 impurity. $|\partial y/\partial x_i| \cdot (x_i/y)$ = {(response per Bq of impurity)/(response per Bq of Po-209)}$\cdot${(Bq of impurity)/(Bq of Po-209)}.

[s] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e. $u(x_i)/x_i$ = 100%. $|\partial y/\partial x_i| \cdot (x_i/y)$ = {(response per Bq of impurity)/(response per Bq of Po-209)}$\cdot${(Bq of impurity)/(Bq of Po-209)}. Thus $u_i(y)/y$ is the relative change in y if the impurity were present with a massic activity equal to the estimated limit of detection.

REFERENCES

[1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.

[2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900. (Listed under ISO miscellaneous publications as "ISO Guide to the Expression 1993".)

[3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.

[4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.

[5] R. Collé, Long-term Stability of Carrier-Free Polonium Solution Standards, *Radioactivity and Radiochemistry*, **4** (1993) 18.

[6] R. Collé, Z. Lin, J.M.R. Hutchinson, and F.J. Schima, A Delayed Isomeric State in ^{205}Pb and Its Implications for $4\pi\alpha$ Liquid-Scintillation Spectrometry of ^{209}Po, *Appl. Radiat. Isot.*, **45** (1994) 1165.

[7] R. Collé, Z. Lin, F.J. Schima, P.A. Hodge, J.W.L. Thomas, J.M.R. Hutchinson, and B.M. Coursey, Preparation and Calibration of Carrier-free ^{209}Po Solution Standards, *J. Res. NIST*, **100** (1995) 1.

[8] Evaluated Nuclear Structure Data File (ENSDF), July 1994.

8/26/98 Pb-210 standard S-053 is diluted in 1N HCl.

1 ml (1.0654 g) of S-053 was diluted with 1N HCl to total mass of 1018.0 g (1034.6 ml).

$$\text{Expected Activity} = \frac{1.015\,\mu Ci}{52.7402\,g}(1.0654\,g)(1034.6\,ml)^{-1} = 19.82\ pCi/ml$$

Balance 12

Bottle Tare: 79.2 g

Bottle Full: 1097.2 g

1018.0 g

Density 1N HCl: 1.0163 g/ml

Matrix 1N HCl (Baker Lot M 13040)

Label for previous page — 10/6/98

Stnd ID: 066.1572.14
Description: Polonium-209 Tracer Solution
Activity: 20.4 dpm/mL
Uncertainty: 1.4 dpm/mL
Ref. Date: 9/22/98
Ref Time: n/a
Prep Date 8/25/98 Prep by: WC
Expiration 8/25/01
Matrix/Comp. 1 M HCl
... correct with each use

Not verified 10/6/98

Verified 2/8/99 DCB

Stnd ID: 059.1572.15
Description: Pb-210 working level spiking solution
Activity: 19.820 pCi/ml
Uncertainty: 0.991 pCi/ml
Ref. Date: 4/1/93
Ref Time: na
Prep Date 8/26/98 Prep by: WC
Expiration 8/26/03
Matrix/Comp. 0.1N HCl
Half Life (y): 2.23E+01

DCB 2/8/99

Reverified 11/14/03.
New expiration date 11/7/04.
SD 11/14/03

Continued on Page

Read and Understood By

Signed: Wade Cairns Date: 8/26/98 Signed: DCB Date: 2/8/99

PROJECT Pb 210 ~~working~~ stock (4-20-93) standard S#053 Continued From Page _____

R50 # 00059
Pb-210 std in 2.0 M HNO_3
Activity = 1,015 ± µCi in 52.74020 grams

opened ampule 4-20-93 @ 4:00 pm
transfered to plastic bottle (125 ml size)

Purchased from analytics, inc, s/n 45939-307 qty

THP 5/8/95

Continued on Page

Read and Understood By

Signed _____ Date 4-20-93

Signed _____ Date 4-26-93

R367-043

Notebook No. 367 43

PROJECT Pb carrier solution Continued From Page

prepared same as p. 3 of this logbook

1.600 g of reagent grade $Pb(NO_3)_2$ dissolved in 1000 mL of DI H_2O

∴ 1.0 mL = 1.0 mg Pb

balance used = No. 14

Continued on Page

Read and Understood By

Robert Thomas 9-5-95

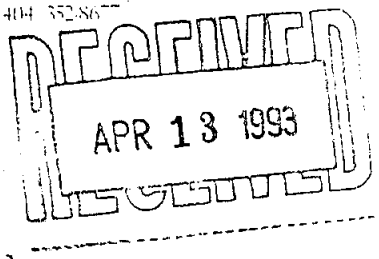
000058

ANALYTICS

Analytics, Inc.
3380 Seaboard Industrial Boulevard
Atlanta, Georgia 30318
404 352-8677

Rec: 4/13/93

Std. 059



CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

45939-307

Pb-210 50 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master liquid radionuclide solution source. The master source was calibrated by liquid scintillation counting.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

Source prepared by: E. W. Belvin
E. W. Belvin, Production Manager

ISOTOPE:	Pb-210
ACTIVITY (dps):	3.754 E+04
HALF-LIFE:	22.3 years
CALIBRATION DATE:	April 1, 1993 12:00 EST
TOTAL ERROR:	5.0%
SYSTEMATIC ERROR:	2.6%
RANDOM ERROR:	2.4%

52.74020 grams of solution in 2M HNO_3 containing 0.5 μg Pb and 0.5 μg Bi per mL.

P O NUMBER 31805, Item 1

Q A APPROVED D. M. Markey 4-12-93

PARAGON ANALYTICS
Radiochemistry Data Package

Section 8

CHAIN OF CUSTODY

Paragon Analytics

Sample Number(s) Cross-Reference Table

Paragon OrderNum: 0404241
Client Name: New Horizons
Client Project Name: CSMRI
Client Project Number: 2135
Client PO Number:

Client Sample	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
BB04	0404241-1		SOIL	16-Apr-04	13:10
BI17	0404241-2		SOIL	19-Apr-04	11:00
BI17	0404241-3		SOIL	19-Apr-04	11:00
BI37	0404241-4		SOIL	19-Apr-04	14:15
BI37	0404241-5		SOIL	19-Apr-04	14:15
BI42	0404241-6		SOIL	19-Apr-04	15:15
BI42	0404241-7		SOIL	19-Apr-04	15:15
H07	0404241-8		SOIL	22-Apr-04	13:00
H07	0404241-9		SOIL	22-Apr-04	13:00
H07S	0404241-10		SOIL	22-Apr-04	13:05
H07S	0404241-11		SOIL	22-Apr-04	13:05
BB04	0404241-12		SOIL	16-Apr-04	13:10
H07	0404241-13		LEACHAT	22-Apr-04	13:00
H07S	0404241-14		LEACHAT	22-Apr-04	13:05

Paragon Analytics, Inc.

225 Commerce Drive Fort Collins, CO 80524
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Chain-of-Custody

Accession Number (LAB ID) 0404241
Date 4/23/04 Page 1 of 1

Project Name / No.: CSHRT / 2135 Sampler(s): * see comments (circle one) Turnaround: (Standard or Rush) (Due ______) Dispose or Return to Client

Report To: Sally Cuffin
Phone: 303 995 3590
Fax: 303-973-8906 (call first)
Company: NHEC
Address: 21 Dawn Heath Drive
Littleton, CO 80127

circle method or specify under comments

Sample ID	Date	Time *	Lab ID	Matrix	No. of Containers	VOCs SW8260B E624 E524.2 OLMO__	BTEX (only) SW8021B	SVOCs SW8270C E625 E525 OLMO__	OC Pesticides SW8081A E608 E508 OLMO__	PCBs SW8082 E608 E508 OLMO__	OP Pesticides SW8141A E614	Herbicides SW8151A E615	TCLP Organics SW1311 8260B 8270C 8081A 8151A	(TCLP Metals) SW 1311 6010B 7471	Total Metals SW6010B 7470 7471 E200 ILMO__	Dissolved Metals SW6010B 7470 E200 ILMO__	Reactive CN / S SW846 Chapter 7	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions ** SW9056 E300.0	pH SW9040B 9045C	Oil & Grease SW9071A E413.2	TPH GRO DRO SW8015B (both)	TOX SW9020B	Gross Alpha / Beta SW9310 E900.0	Actinides by PAI SOP (circle) Pu / U / Am / Th / Cm	Total Uranium by KPA D5174-91	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 SW9315 E903.0 Radium 228 SW9320 E904.0	Strontium 89 D5811-95 Strontium 90 D5811-95	Gamma Isotopes ** E901.1	Gamma spec library + Ra-226, 228	Isotopic Th, U, Pb-210, Po-210
BB04	4/16/04	1310	1	S	1																											→	→ **
BI17	4/19/04	1100	2/3	S	2																											1	1
BI37	↓	1415	4/5	S	2																											1	1
BI42	↓	1515	6/7	S	2																											1	1
H07	4/22/04	1300	8/9	S	2									★																		1	1
H075	↓	1305	10/11	S	2									★																		1	1

Comments:

★ Drew Pfizer
Efrain Oquita
~~Greg~~ George Tripp

** Rush gamma screen - then do alpha spec for Isotopic Th, U, Pb-210, Po-210

★ Perform TCLP metals - arsenic ~~barium~~ barium, cadmium, chromium, lead, selenium, silver, ~~nickel~~ vanadium, zinc, mercury, molybdenum - use alpha spec container

Form 202r4.xls (1/3/01)

Relinquished By: (1)	Relinquished By: (2)
Signature [signature]	Signature
Printed Name Sally M. Cuffin	Printed Name
Date 4/23/04 Time 11:00	Date Time
Company NHEC	Company

Received By: (1)	Received By: (2)
Signature [signature]	Signature
Printed Name Amy Wolf	Printed Name
Date 4/23/04 Time 1530	Date Time
Company Paragon Analytics	Company

Time Zone (circle one): EST CST MST PST

** Indicate specific analytes under comments.

Distribution: white / yellow (Paragon); pink retained by originator.

00062

Paragon Analytics, Inc. -- Fort Collins, Colorado

CONDITION OF SAMPLE UPON RECEIPT FORM

CLIENT: New Horizons WORKORDER NO: 0404241

PROJECT MANAGER: Deb Fazio INITIALS: DW DATE: 4/23/04

1. Does this project require any special handling in addition to standard Paragon procedures?		Yes	(No)
IS PRE-SCREENING REQUIRED? (radiochemistry, DOE, etc.)		Yes	(No)
2. Are custody seals on shipping containers intact? How many custody seals are provided? _____	(N/A)	Yes	No
3. Are the custody seals on sample containers intact?	(N/A)	Yes	No
4. Is there a Chain-of-Custody (COC) or other representative documents, letters, or shipping memos?		(Yes)	No
5. Is the COC complete? Relinquished: Yes ✓ No ___ Analyses Requested: Yes ✓ No ___	N/A	(Yes)	No
6. Is the COC in agreement with the samples received? No. of Samples: Yes ✓ No ___ Sample ID's: Yes ✓ No ___ Matrix: Yes ✓ No ___ No. of Containers: Yes ✓ No ___	N/A	(Yes)	No
7. Were COC (if applicable) and sample labels legible?		(Yes)	No
8. Were airbills present and/or removable?	(N/A)	Yes	No
9. Are all aqueous samples requiring chemical preservation preserved correctly (excluding volatile organics)?	(N/A)	Yes	No
Are all aqueous **non-preserved** samples at the correct pH?		Yes	No
10. Is there enough sample for requested analyses? If so, were samples placed in the proper containers?		(Yes)	No
11. Are all samples within holding times for the requested analyses?		(Yes)	No
12. Were all sample containers received intact? (not broken or leaking, etc.)		(Yes)	No
13. Are samples requiring no headspace (volatiles, reactive cyanide/sulfide, radon), headspace free? **Size of bubble: ___ < green pea; ___ > green pea** (List sample IDs and affected containers on Page 2)	(N/A)	Yes	No
14. Were samples checked for and free from the presence of residual chlorine?	(N/A)	Yes	No
15. Were the sample(s) shipped on ice?	(N/A)	Yes	No
16. Were cooler temperatures measured at 0.1 - 6 °C ? **IR Gun Used*: 1 2**	(N/A)	Yes	No
17. Were all samples cooled that should have been cooled?	(N/A)	Yes	No

Cooler #'s 1

Temperature Ambient (cool out) ° C

Project Manager Signature / Date: Debbie Fazio 4/26/04

A NO RESPONSE TO ANY QUESTION EXCEPT # 1 REQUIRES THE COMPLETION OF PAGE 2 OF THIS FORM

* IR Gun #1 (original): Raytek, SN SC-PM3/T29403
IR Gun #2 (newer): Oakton, SN 2SCIR1201

000063

PARAGON ANALYTICS
Radiochemistry Data Package

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

9

Calibration Data Summary

Laboratory Name: Paragon Analytics
PAI Work Order: 0404241

Prep SOP: PAI 711
Analytical SOP: PAI 714

Reported on: Friday, May 21, 2004
9:39:58 AM

Lab Sample ID Spectrum Analysis Date	QC Type	Batch ID Analysis Run	Test Name	Detector Id	Eff Spectrum Bkg Spectrum Egy Spectrum	Eff Date Bkg Date Egy Date	**RESULTS** %Efficiency Bkg CPM Energy keV	FLAGS Efficiency Background Energy	**LCL** %Efficiency Bkg CPM Energy keV	**LWL** %Efficiency Bkg CPM Energy keV	**UWL** %Efficiency Bkg CPM Energy keV	**UCL** %Efficiency Bkg CPM Energy keV
0404241-3	SMP	PL040513-1	Po210	2	C4051802	5/18/2004	31.36	Pass	30.08	30.62	32.61	33.24
O42413		PL040513-1A			B4051802	5/19/2004	0.0150	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051802	5/18/2004	5541.5	Pass	5500.0	5510.0	5590.0	5600.0
0404241-5	SMP	PL040513-1	Po210	3	C4051803	5/18/2004	32.05	Pass	30.42	30.96	33.08	33.62
O42415		PL040513-1A			B4051803	5/19/2004	0.0120	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051803	5/18/2004	5547.9	Pass	5492.4	5502.4	5582.4	5592.4
0404241-7	SMP	PL040513-1	Po210	4	C4051804	5/18/2004	30.72	Pass	28.41	28.91	30.80	31.40
O42417		PL040513-1A			B4051804	5/19/2004	0.0140	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051804	5/18/2004	5551.4	Pass	5514.9	5525.3	5566.7	5577.1
0404241-7	DUP	PL040513-1	Po210	5	C4051805	5/18/2004	31.99	Warning	29.40	29.93	31.97	32.50
O42417D		PL040513-1A			B4051805	5/19/2004	0.0200	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051805	5/18/2004	5542.7	Pass	5490.9	5504.9	5580.9	5590.9
0404241-9	SMP	PL040513-1	Po210	7	C4051807	5/18/2004	31.80	Pass	30.43	30.97	32.99	33.63
O42419		PL040513-1A			B4051807	5/19/2004	0.0140	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051807	5/18/2004	5548.8	Pass	5497.0	5507.0	5587.0	5597.0
0404241-11	SMP	PL040513-1	Po210	8	C4051808	5/18/2004	31.59	Pass	29.87	30.40	32.48	33.01
O424111		PL040513-1A			B4051808	5/19/2004	0.0090	Warning	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051808	5/18/2004	5533.4	Pass	5507.4	5517.4	5597.4	5607.4
0404241-12	SMP	PL040513-1	Po210	49	C4051849	5/18/2004	28.66	Pass	27.23	27.71	29.61	30.10
O424112		PL040513-1A			B4051849	5/19/2004	0.0140	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051849	5/18/2004	5544.8	Pass	5495.0	5504.0	5585.0	5595.0
PL040513-1	MB	PL040513-1	Po210	50	C4051850	5/18/2004	31.41	Pass	29.12	29.64	31.57	32.18
O40511B		PL040513-1A			B4051850	5/19/2004	0.0200	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051850	5/18/2004	5553.5	Pass	5496.0	5506.0	5586.0	5596.0
PL040513-1	LCS	PL040513-1	Po210	51	C4051851	5/18/2004	30.94	Pass	29.23	29.75	31.69	32.31
O40511L		PL040513-1A			B4051851	5/19/2004	0.0190	Pass	0.0000	0.0100	0.1000	0.1500
5/19/2004					C4051851	5/18/2004	5553.0	Pass	5493.3	5503.3	5583.3	5593.3

Data Package ID: *Po0404241-1*

Abbreviations:

Eff - Efficiency	Bkg - Background	LCL - Lower Control Limit	UWL - Upper Warning Limit	
Egy - Energy	CPM - Counts per Minute	LWL - Lower Warning Limit	UCL - Upper Control Limit	CI - The Analysis Date exceeds the Calibration Date by more than 7 days.

Alpha Spectroscopy

Quality Control Data

Weekly Background, Energy, and Efficiency Calibrations

Alpha Spec Calibration Source Re-Certification

R:\INSTVALPHA\CLCRT304.XLS

Primary Certified Source
Source PAI ID 190 was recalibrated by Isotope Products Laboratories on 03-01-2003 and recieved by PAI on 03-04-2003.

Source ID: 92MIX223027; PAI ID 190 (Labled #9)
Total Activity: 3754 dpm
Ref. Date: 3/1/03
Count Date: 3/22/04

U-234 Activity:	79.06%	=	2967.90 dpm (decay corrected)
Am-241 Activity:	19.20%	=	719.56 dpm (decay corrected)
Combined Activity:		=	3687.46 dpm (decay corrected)

Detector 13 Efficiency Determination

Source Serial #	PAI ID	Seqential #	Count Date	Am-241 net cts	U-234 net cts	count dur (s)	Combined cpm	Known dpm	detector efficiency
92MIX223027	190	97-19-103-09	3/22/04	7824.65	32919.75	2100	1164.126	3687.46	31.57%

Sources 1 through 8 activity determination

Source Serial #	PAI ID	Seqential #	Count Date	Am-241 net cts	U-234 net cts	count dur (s)	detector efficiency	Am-241 dpm	U-234 dpm	combined dpm
92MIX2203026	182	97-19-103-01	3/22/04	13674.65	81078.76	2100	31.57%	1237.59	7337.81	8575.40
92MIX2203028	183	97-19-103-02	3/22/04	15497.65	153089.76	2100	31.57%	1402.57	13854.97	15257.54
92MIX2203024	184	97-19-103-03	3/22/04	72039.65	74346.76	2100	31.57%	6519.75	6728.55	13248.30
92MIX2203021	185	97-19-103-04	3/22/04	22309.65	63564.76	2100	31.57%	2019.07	5752.75	7771.83
92MIX2203025	186	97-19-103-05	3/22/04	102504.65	126055.76	2100	31.57%	9276.90	11408.33	20685.23
92MIX2203022	187	97-19-103-06	3/22/04	77656.69	83352.76	2100	31.57%	7028.11	7543.61	14571.72
92MIX2203023	188	97-19-103-07	3/22/04	46378.65	70580.76	2100	31.57%	4197.37	6387.72	10585.09
92MIX2203029	189	97-19-103-08	3/22/04	34881.65	219992.76	2100	31.57%	3156.87	19909.84	23066.71

Detector 13 Efficiency Verification

Source Serial #	PAI ID	Seqential #	Count Date	Am-241 net cts	U-234 net cts	count dur (s)	Combined cpm	Known dpm	detector efficiency	% difference from 1st count
92MIX223027	190	97-19-103-09	3/22/04	7546.69	32241.76	2100	1136.813	3687.46	30.83%	2.35%

Sources 1 through 8 activity re-verification

Source Serial #	PAI ID	Seqential #	Combined Observed dpm	Combined Certified dpm*	Percent Difference %	Within 5% of Certified value Yes/No
92MIX2203026	182	97-19-103-01	8575.40	8730.07	1.77%	Yes
92MIX2203028	183	97-19-103-02	15257.54	15767.93	3.24%	Yes
92MIX2203024	184	97-19-103-03	13248.30	13517.34	1.99%	Yes
92MIX2203021	185	97-19-103-04	7771.83	8130.72	4.41%	Yes
92MIX2203025	186	97-19-103-05	20685.23	20951.92	1.27%	Yes
92MIX2203022	187	97-19-103-06	14571.72	15242.25	4.40%	Yes
92MIX2203023	188	97-19-103-07	10585.09	10755.77	1.59%	Yes
92MIX2203029	189	97-19-103-08	23066.71	23263.22	0.84%	Yes

*Sources 185,186,187, & 188 decay corrected to 04/01/03.
*Sources 182,183,184, & 189 decay corrected to 05/01/03.

OK - RG
EXP 3/22/05

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

α-1

PAI 187
recalibrate 4-15-03

CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A:	U-234
Radionuclide B:	U-235
Radionuclide C:	Am-241
Half Life (U-234):	(2.454 ± 0.006)E+05 years
Half Life (U-235):	(7.037 ± 0.011)E+08 years
Half Life (Am-241):	432.17 ± 0.66 years

Customer:	PARAGON ANALYTICS, INC.
P.O. No.:	EW040203/R2193
Catalog No.:	MISC-STD
Reference Date:	1-May-03 12:00 PST
Source No.:	92MIX2203026

Contained Radioactivity:

U-234:	3.354 nCi	(124.1 Bq)	
U-235:	0.06566 nCi	(2.429 Bq)	
Am-241:	0.5793 nCi	(21.43 Bq)	
Total Activity:	3.999 nCi	(148.0 Bq)	

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Mar 1998.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.7%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4483 α/min in 2π on 11 Apr 03.

Quality Control

15-May-03
Date Signed

IPL Ref. No.: 987-7

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

α 2
PAI 483
Recalibrated 4-15-05

CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): (2.454 ± 0.006)E+05 years
Half Life (U-235): (7.037 ± 0.011)E+08 years
Half Life (Am-241): 432.17 ± 0.66 years

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203028

Contained Radioactivity:

U-234:	6.467	nCi (239.3 Bq)	Am-241:	0.6366	nCi (23.55 Bq)
U-235:	0.1135	nCi (4.200 Bq)	Total Activity:	7.217	nCi (267.1 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.7%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 8091 α/min in 2π on 11 Apr 03.

Quality Control

15-Apr-05
Date Signed

IPL Ref. No.: 987-7

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

α3

PAT I.D 184
recalibrated 4-1503

CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): (2.454 ± 0.006)E+05 years
Half Life (U-235): (7.037 ± 0.011)E+08 years
Half Life (Am-241): 432.17 ± 0.66 years

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203024

Contained Radioactivity:

U-234:	3.227	nCi (119.4 Bq)	Am-241:	2.866	nCi (106.0 Bq)
U-235:	0.05205	nCi (1.926 Bq)	Total Activity:	6.145	nCi (227.3 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.6%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 6889 α/min in 2π on 11 Apr 03.

Quality Control

15-APR-03
Date Signed

IPL Ref. No.: 987-7

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

α 4

PAI I.D. CC 1455
(rec'd from recalibrate 3-25-03)

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide A:	U-234	Customer:	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	P.O. No.:	EW030603/R2155
Radionuclide C:	Am-241	Catalog No.:	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	Reference Date:	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	Source No.:	92MIX2203021
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	2.731	nCi	(101.0 Bq)	Am-241:	0.9325	nCi	(34.50 Bq)
U-235:	0.03416	nCi	(1.264 Bq)	Total Activity:	3.698	nCi	(136.8 Bq)

Physical description:

- A. Capsule type: Disk (22 mm OD X 0.79 mm THK)
- B. Nature of active deposit: Electrodeposited and diffusion bonded oxides
- C. Active Diameter: 19 mm
- D. Backing: Stainless steel
- E. Cover: None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8%
B. Type B (systematic) uncertainty:	± 3.1%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.2%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4145 α/min in 2π on 18 Mar 03.

[signature]
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

x 5

#AI I.D 0C-186
spec. libration received 3-28-03

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide A:	U-234	Customer:	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	P.O. No.:	EW030603/R2155
Radionuclide C:	Am-241	Catalog No.:	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	Reference Date:	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	Source No.:	92MIX2203025
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	5.486	nCi	(203.0 Bq)	Am-241:	3.958	nCi	(146.4 Bq)
U-235:	0.09221	nCi	(3.412 Bq)	Total Activity:	9.536	nCi	(352.8 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8%
B. Type B (systematic) uncertainty:	± 3.1%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.2%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 10690 α/min in 2π on 18 Mar 03.

Daniel ... Dalson
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

α6

#AII Ø, CC 187 / rec'd for recalibrate 3-25-03

Isotope Products Laboratories

An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide A:	U-234	Customer:	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	P.O. No.:	EW030603/R2155
Radionuclide C:	Am-241	Catalog No.:	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	Reference Date:	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	Source No.:	92MIX2203022
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	3.592 nCi (132.9 Bq)	Am-241:	3.279 nCi (121.3 Bq)
U-235:	0.08556 nCi (3.166 Bq)	Total Activity:	6.957 nCi (257.4 Bq)

Physical description:

A. Capsule type: Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit: Electrodeposited and diffusion bonded oxides
C. Active Diameter: 19 mm
D. Backing: Stainless steel
E. Cover: None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty: ± 0.8%
B. Type B (systematic) uncertainty: ± 3.1%
C. Uncertainty in aliquot weighing: ± 0.0%
D. Total uncertainty at the 99% confidence level: ± 3.2%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 7799 α/min in 2π on 18 Mar 03.

[signature]
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

α 7

PA IP 188
Recd for recalibration
3-28-03

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOURCE

Radionuclide A:	U-234	Customer:	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	P.O. No.:	EW030603/R2155
Radionuclide C:	Am-241	Catalog No.:	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	Reference Date:	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	Source No.:	92MIX2203023
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	2.895	nCi	(107.1 Bq)	Am-241:	1.953	nCi	(72.26 Bq)
U-235:	0.02502	nCi	(0.9257 Bq)	Total Activity:	4.873	nCi	(180.3 Bq)

Physical description:

A. Capsule type: Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit: Electrodeposited and diffusion bonded oxides
C. Active Diameter: 19 mm
D. Backing: Stainless steel
E. Cover: None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8%
B. Type B (systematic) uncertainty:	± 3.1%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.2%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 5463 α/min in 2π on 18 Mar 03.

[signature] Quality Control

19-Mar-03 Date Signed

IPL Ref. No.: 987-2

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

x8

PAI, IO 189
recd 4-2-03
recalibrated 4-15-03

CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): (2.454 ± 0.006)E+05 years
Half Life (U-235): (7.037 ± 0.011)E+08 years
Half Life (Am-241): 432.17 ± 0.66 years

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203029

Contained Radioactivity:

U-234:	9.048	nCi	(334.8 Bq)
U-235:	0.1771	nCi	(6.553 Bq)
Am-241:	1.433	nCi	(53.02 Bq)
Total Activity:	10.66	nCi	(394.4 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:
This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Mar 1998.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.5%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.0%

Notes:
- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 11950 α/min in 2π on 11 Apr 03.

Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7