



facility 755652

facility 755653

project 10243

# Radon-222

## Case Narrative

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### **COGCC**

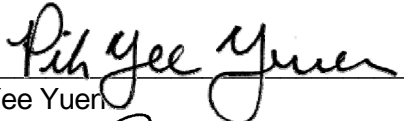
**PW NORM 2017 – 10048**

**Work Order Number: 1706286**

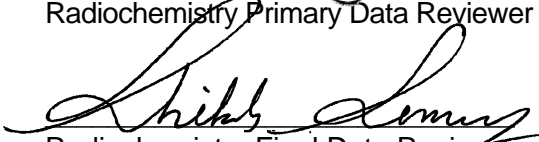
1. This report consists of the analytical results and supporting documentation for two water samples received by ALS on 06/13/2017.
2. These samples were prepared according to the current revision of SOP 799, with procedure modifications outlined in QASS 465528.
3. The samples were analyzed for the presence of  $^{222}\text{Rn}$  according to the current revision of SOP 704. The analyses were completed on 06/15/2017.
4. The analysis results for these samples are reported on an 'As Received' basis in units of pCi/L.
5. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate.
6. The vials for sample 1706286-3 had larger than pea-sized headspace. The vials with the smallest air bubble headspace were used for analysis as per QASS 465528. The presence of headspace may result in a potential bias to the results for samples 1706286-3 and -3REP.
7. 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, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

  
\_\_\_\_\_  
Pik Yee Yuen  
Radiochemistry Primary Data Reviewer

7/24/17  
Date

  
\_\_\_\_\_  
Shih-Li Lomax  
Radiochemistry Final Data Reviewer

7/26/17  
Date

## Section 1

# CHAIN OF CUSTODY

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1706286

**Client Name:** COGCC

**Client Project Name:** PW NORM 2017

**Client Project Number:** 10048

**Client PO Number:** CT 2017-3066

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
755652 Coalview	1706286-1		WATER	13-Jun-17	10:16
755652 Coalview	1706286-2		WATER	13-Jun-17	10:16
755653 Oscar Y	1706286-3		WATER	13-Jun-17	11:36
755653 Oscar Y	1706286-4		WATER	13-Jun-17	11:36



## Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.  
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

**ALSWORKORDER #**

982907

[illegible]



TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

**ALS WORKORDER #**

**Turnaround time for samples received Saturday will be calculated beginning from the next business day.**

[illegible]



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC

Workorder No: 1706286

Project Manager: SS

Initials: JNS

Date: 6/13/17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	<u>NO</u>
2. Are custody seals on shipping containers intact?	<u>NONE</u>	YES	NO
3. Are Custody seals on sample containers intact?	<u>NONE</u>	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		<u>YES</u>	NO
5. Are the COC and bottle labels complete and legible?		<u>YES</u>	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		<u>YES</u>	NO
7. Were airbills / shipping documents present and/or removable?	<u>DROP OFF</u>	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	<u>YES</u>	NO
9. Are all aqueous non-preserved samples pH 4-9?	N/A	<u>YES</u>	NO
10. Is there sufficient sample for the requested analyses?		<u>YES</u>	NO
11. Were all samples placed in the proper containers for the requested analyses?		<u>YES</u>	NO
12. Are all samples within holding times for the requested analyses?		<u>YES</u>	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		<u>YES</u>	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: <u>    </u> < green pea <u>    </u> > green pea	N/A	<u>YES</u>	NO
15. Do any water samples contain sediment? Amount Amount of sediment: <u>    </u> dusting <u>X</u> moderate <u>    </u> heavy	N/A	<u>YES</u>	NO
16. Were the samples shipped on ice?		<u>YES</u>	NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 <u>#4</u>	RAD ONLY	<u>YES</u>	NO
Cooler #:	<u>1</u>	<u>2</u>	<u>3</u>
Temperature (°C):	<u>amb</u>	<u>amb</u>	<u>4</u>
No. of custody seals on cooler:	<u>0</u>	<u>0</u>	<u>0</u>
External µR/hr reading:	<u>1.2</u>		
Background µR/hr reading:	<u>1.0</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)			

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO NA Contact: Philab Date/Time:         

Project Manager Signature / Date: Philab

## Section 2



# **SAMPLE RESULTS SUMMARY**



# Radon-222 by Liquid Scintillation Sample Results Summary

Client Name: COGCC  
Client Project Name: PW NORM 2017  
Client Project Number: 10048  
Laboratory Name: ALS -- Fort Collins  
PAI Work Order: 1706286

Page: 1 of 1  
Reported on: Wednesday, June 21, 2017  
2:57:51 PM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1706286-1	755652 Coalview	Sample	Rn-222	-3E+00 +/- 1.5E+01	2.6E+01	NA	pCi/l	WATER	RN170614-1	6/14/2017	U
1706286-1	755652 Coalview	Replicate	Rn-222	-3E+00 +/- 1.5E+01	2.6E+01	NA	pCi/l	WATER	RN170614-1	6/14/2017	U
1706286-3	755653 Oscar Y	Sample	Rn-222	1E+01 +/- 1.6E+01	2.6E+01	NA	pCi/l	WATER	RN170614-1	6/14/2017	U
1706286-3	755653 Oscar Y	Replicate	Rn-222	-1.4E+01 +/- 1.5E+01	2.7E+01	NA	pCi/l	WATER	RN170614-1	6/14/2017	U

## Comments:

Data Package ID: RN1706286-1

### 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
- MDC - Sample specific Minimum Detectable Concentration
- BDL - Below Detection Limit

## Section 3

# QC RESULTS SUMMARY



# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: RN170614-1MB1MB

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Final Aliquot: 10.0 ml

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	-2E+00 +/- 1.3E+01	2.2E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

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.

DL - Decision Level

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: RN170614-1MB2MB

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Final Aliquot: 10.0 ml

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	-4E+00 +/- 1.4E+01	2.4E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

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.

DL - Decision Level

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: RN170614-1LCS

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 8.85 minutes

Final Aliquot: 10.0 ml

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14859-67-7	Rn-222	2.32E+04 +/- 2.7E+03	1E+02	2.260E+04	102	75 - 125	P,M3

### 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

MDC - Minimum Detectable Concentration

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: RN170614-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 15-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 8.85 minutes

Final Aliquot: 10.0 ml

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14859-67-7	Rn-222	2.31E+04 +/- 2.6E+03	1E+02	2.260E+04	102	75 - 125	P,M3

### 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

MDC - Minimum Detectable Concentration

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID:   
Lab ID: RN170614-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 15-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 8.85 minutes

Final Aliquot: 10.0 ml

Prep Basis: As Received

Moisture(%): NA

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14859-67-7	Rn-222	2.32E+04 +/-	2.7E+03	1E+02	P,M3	2.31E+04 +/-	2.6E+03	1E+02	P,M3	0.0179	2.13

### 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

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: RN1706286-1

## Section 4

# INDIVIDUAL SAMPLE RESULTS





# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755652 Coalview

Lab ID: 1706286-1

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Report Basis: As Received

Final Aliquot: 10.0 ml

Prep Basis: As Received

Moisture(%): NA

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	-3E+00 +/- 1.5E+01	2.6E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755652 Coalview

Lab ID: 1706286-1REP2

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Report Basis: As Received

Final Aliquot: 10.0 ml

Prep Basis: As Received

Moisture(%): NA

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	-3E+00 +/- 1.5E+01	2.6E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755653 Oscar Y

Lab ID: 1706286-3

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Report Basis: As Received

Final Aliquot: 10.0 ml

Prep Basis: As Received

Moisture(%): NA

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	1E+01 +/- 1.6E+01	2.6E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: RN1706286-1

# Radon-222 by Liquid Scintillation

PAI 704 Rev 11

## Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755653 Oscar Y

Lab ID: 1706286-3REP2

Sample Matrix: WATER

Prep SOP: PAI 799 Rev 4

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 14-Jun-17

Prep Batch: RN170614-1

QCBatchID: RN170614-1-1

Run ID: RN170614-1A

Count Time: 70 minutes

Report Basis: As Received

Final Aliquot: 10.0 ml

Prep Basis: As Received

Moisture(%): NA

Result Units: pCi/l

File Name: B65\_19\_061401

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14859-67-7	Rn-222	-1.4E+01 +/- 1.5E+01	2.7E+01	5E+01	NA	U

### 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

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: RN1706286-1

## Section 5

# RAW DATA

5

# Radon-222 by Liquid Scintillation Raw Data Report

Laboratory Name: ALS -- Fort Collins

Prep SOP: PAI 799

Reported on: Thursday, June 15, 2017

PAI Work Order: 1706286

Analytical SOP: PAI 704

10:58:46 AM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QCBatchID	Ingrowth Date /Time	Quench Factor %Lum	Matrix %Moist	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	GrossCPM BkgCPM	BaseEff ProgEff	CndDur(min) Yield	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	Spk. Recov Flags
1706286-1	Rn-222 SMP	6/13/2017 10:16:00 AM	RN170614-1 RN170614-1-1	NA NA	51.7 0.3	WATER NA	10 ml 10 ml	LS6500 21-4	RN170614-1A B65_19_061401	6/14/2017 2:26 PM	5.340 5.510	287.59% NA	70 NA	-3E+00 1.6E+01	2.6E+01	pCi/l As Received	NA NA	U
1706286-1	Rn-222 REP	6/13/2017 10:16:00 AM	RN170614-1 RN170614-1-1	NA NA	55.4 0.22	WATER NA	10 ml 10 ml	LS6500 21-5	RN170614-1A B65_19_061401	6/14/2017 3:38 PM	5.360 5.510	287.59% NA	70 NA	-3E+00 1.5E+01	2.6E+01	pCi/l As Received	NA NA	U
1706286-3	Rn-222 SMP	6/13/2017 11:36:00 AM	RN170614-1 RN170614-1-1	NA NA	51.3 0.43	WATER NA	10 ml 10 ml	LS6500 21-6	RN170614-1A B65_19_061401	6/14/2017 4:49 PM	6.040 5.510	287.59% NA	70 NA	1E+01 1.6E+01	2.6E+01	pCi/l As Received	NA NA	U
1706286-3	Rn-222 REP	6/13/2017 11:36:00 AM	RN170614-1 RN170614-1-1	NA NA	50.8 0.42	WATER NA	10 ml 10 ml	LS6500 21-7	RN170614-1A B65_19_061401	6/14/2017 6:00 PM	4.790 5.510	287.59% NA	70 NA	-1.4E+01 1.5E+01	2.7E+01	pCi/l As Received	NA NA	U
RN170614-1MB1	Rn-222 MB	6/14/2017 9:45:56 AM	RN170614-1 RN170614-1-1	NA NA	45.2 0.1	WATER NA	10 ml 10 ml	LS6500 21-3	RN170614-1A B65_19_061401	6/14/2017 1:15 PM	5.360 5.510	287.59% NA	70 NA	-2E+00 1.3E+01	2.2E+01	pCi/l As Received	NA NA	U
RN170614-1MB2	Rn-222 MB	6/14/2017 9:45:56 AM	RN170614-1 RN170614-1-1	NA NA	43.8 0.05	WATER NA	10 ml 10 ml	LS6500 21-12	RN170614-1A B65_19_061401	6/14/2017 11:57 PM	5.300 5.510	287.59% NA	70 NA	-4E+00 1.4E+01	2.4E+01	pCi/l As Received	NA NA	U
RN170614-1	Rn-222 LCS	6/14/2017 9:45:56 AM	RN170614-1 RN170614-1-1	NA NA	42.9 0	WATER NA	10 ml 10 ml	LS6500 21-2	RN170614-1A B65_19_061401	6/14/2017 1:05 PM	1483.840 5.510	287.59% NA	8.85 NA	2.32E+04 2.7E+03	1E+02	pCi/l As Received	NA NA	102 P, M3
RN170614-1	Rn-222 LCSD	6/14/2017 9:45:56 AM	RN170614-1 RN170614-1-1	NA NA	42 0	WATER NA	10 ml 10 ml	LS6500 13-1	RN170614-1A B65_19_061401	6/15/2017 1:07 AM	1479.550 5.510	287.59% NA	8.85 NA	2.31E+04 2.6E+03	1E+02	pCi/l As Received	0.02 NA	102 P, M3

Comments:

Data Package ID: RN1706286-1

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 Received' while the Report Basis is 'Dry Weight'  
# - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'

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  
MDC - Minimum Detectable Concentration  
DER - Duplicate Error Ratio  
BDL - Below Detection Limit

Date Printed: Wednesday, June 21, 2017

ALS -- Fort Collins

LIMS Version: 6.843

Page 1 of 1

ID=RN 222

14 JUN 2017 11:37

USER:19

COMMENT:LS6500

PRESET TIME : 70.00

DATA CALC : CPM H# : YES SAMPLE REPEATS : 1 PRINTER : EDIT

COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : EDIT

TWO PHASE : NO AQC : NO CYCLE REPEATS : 1 DISK : OFF

SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0

LOW LEVEL : YES HALF LIFE CORRECTION DATE: none

CHAN: 725.0 - 850.0 ✓ %ERROR: 1.75 FACTOR: 1.000000 BKG. SUB: 0

WIDE OPEN WINDOW ✓ %ERROR: 20.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN	H#	WIND1		WIDE		LUMEX %	ELAPSED TIME
				CPM	%ERROR	CPM	%ERROR		
-1	21-1	70.00	44.2	5.46	10.23	48.31	3.44	0.12	71.05
2	21-2	8.85	42.9	1483.84	1.75	2110.51	1.46	0.00	80.54
3	21-3	70.00	45.2	5.36	10.33	47.81	3.46	0.10	151.68
4	21-4	70.00	51.7	5.34	10.34	48.37	3.44	0.30	222.88
5	21-5	70.00	55.4	5.36	10.33	48.03	3.45	0.22	294.06
6	21-6	70.00	51.3	6.04	9.72	48.64	3.43	0.43	365.29
7	21-7	70.00	50.8	4.79	10.93	45.29	3.55	0.42	436.52
8	21-8	70.00	54.8	9.19	7.89	50.63	3.36	0.06	507.63
9	21-9	70.00	56.0	8.37	8.26	50.64	3.36	0.07	578.76
10	21-10	70.00	114.0 ↑	5.70	10.01	46.24	3.52	3.51	650.30
11	21-11	70.00	112.3 ↑	5.67	10.04	46.06	3.52	3.64	721.85
12	21-12	70.00	43.8	5.30	10.38	48.01	3.45	0.05	792.97
13	13-1	8.85	42.0	1479.55	1.75	2086.44	1.47	0.00	802.55
-14	13-2	70.00	44.3	5.56	10.14	46.54	3.50	0.05	873.67

H#  
VCL  
56.8

B65-19-061401

An 6/15/17

JP 6/19/17

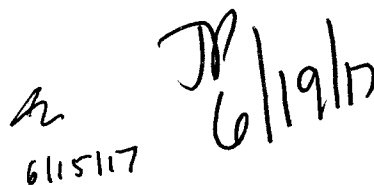
B65\_19\_061401.ASC

```

BSF Version           : 3
Instrument Type        : LS 6000
Data Capture Date     : 14 Jun 2017 11:54:07
User Filename         : C:\...\LS WINCONNECTION\DATA2\USER19\UN061401.BSF
User Number          : 19
User Id               : RN 222
User Comments         : LS6500
Preset Count Time     : 70.00
Calculation Mode      : CPM
H# Selected           : YES
Sample Repeats        : 1
Printer Output Mode   : EDIT
Blank Count           : NO
IC# or SCR Selected   : NO
Replicates            : 1
RS232 Output Mode     : EDIT
Two-Phase Selected    : NO
AQC Choice            : NO
Cycle Repeats         : 1
Data Buffer Output Mode : OFF
Scintillator Choice   : LIQUID
Lumex Selected        : NO
Low Sample Reject Count : 0
Low Level Selection   : YES
Half Life Correction Date : none
Window Limits Window 1 : 725.00
Preset %Error Iso1    : 1.75
Norm Multiplier Iso1  : 1.00000
Background CPM 1      : 0.00
Preset %Error Iso2    : 20.00
Norm Multiplier Iso2  : 1.00000
Background CPM 2      : 0.00

```

Sam	Rack	Time	H#	CPM	Iso1	%Err1	CPM	Iso2	%Err2	LumEx	ElTime
1	21-1	70.00	44.2		5.46	10.23		48.31	3.44	0.12	71.05
2	21-2	8.85	42.9	1483.84		1.75	2110.51		1.46	0.00	80.54
3	21-3	70.00	45.2		5.36	10.33		47.81	3.46	0.10	151.68
4	21-4	70.00	51.7		5.34	10.34		48.37	3.44	0.30	222.88
5	21-5	70.00	55.4		5.36	10.33		48.03	3.45	0.22	294.06
6	21-6	70.00	51.3		6.04	9.72		48.64	3.43	0.43	365.29
7	21-7	70.00	50.8		4.79	10.93		45.29	3.55	0.42	436.52
8	21-8	70.00	54.8		9.19	7.89		50.63	3.36	0.06	507.63
9	21-9	70.00	56.0		8.37	8.26		50.64	3.36	0.07	578.76
10	21-10	70.00	114.0		5.70	10.01		46.24	3.52	3.51	650.30
11	21-11	70.00	112.3		5.67	10.04		46.06	3.52	3.64	721.85
12	21-12	70.00	43.8		5.30	10.38		48.01	3.45	0.05	792.97
13	13-1	8.85	42.0	1479.55		1.75	2086.44		1.47	0.00	802.55
14	13-2	70.00	44.3		5.56	10.14		46.54	3.50	0.05	873.67


  
 6/15/17



ALS

LS6500

Instrument ID:

Date	Sample ID	CountTime (min.)	Rack & Position	Test	User #	Batch ID	Position Check	Initials	Comments
6/10/17	1705601-2SDUP	156	26 - 7	WSSM	13	3H170606-1	42	42	nd
	-26		- 8						
	-27		- 9						
	-28		- 10						
	-29		- 11						
	3H170605-1CB2		- 12						
	1705601-30		13 - 1						
	-31		- 2						
	-32		- 3						
	-33		- 4						
	-34		- 5						
	-35		- 6						
	-36		- 7						
	-37		- 8						
	3H170605-1CB1-105	54.65	- 9						
	-106-5 MB	64.85	- 10						
	-106-3		- 11						
6/12/17	Daily OVC	10	1,3 - 1-3,1-2		1,3		42	42	
6/14/17	Daily DC	10	1,3 - 1-3,1-2		1,3		42	42	
	RN170614-1CB1-105	70	2,1 - 1	RN222	19	RN170614-1	42	42	
	-1MB1-LS	8.88	- 2						
	-1MB1	70	- 3						
	17060249-1		- 4						
	-1REP		- 5						
	-2		- 6						
	-2REP		- 7						
	1706286-1		- 8						
	-1REP		- 9						
	-3		- 10						
	-3REP		- 11						

Analyst / Date 42 6/15/17

FORM 7627.XLS (12/3/2015)

Instrument ID:

LS6500

ALS

Date	Sample ID	CountTime (min.)	Rack & Position	Test	User #	Batch ID	Position Check	Initials	Comments
6/15/17	RN170614-1 M02	7.0	2.1 - 12	RN222	1.1	RN170614-1	OK	OK	NA
	↓	8.85	1.3 - 1	↓	↓	↓	↓	↓	↓
6/15/17	Daily QC	7.0	↓ - 2	↓	↓	↓	↓	↓	↓
6/15/17	3H170613-1CB1	10	1.3 - 1-3, 1-2	—	1.3	—	OK	OK	NA
	↓	3.0	12 - 1	H30MS	6.0	3H170613-1	OK	OK	NA
	1706048-1	↓	2	↓	↓	↓	↓	↓	↓
	2	↓	3	↓	↓	↓	↓	↓	↓
	3	↓	4	↓	↓	↓	↓	↓	↓
	4	↓	5	↓	↓	↓	↓	↓	↓
	5	↓	6	↓	↓	↓	↓	↓	↓
	5 DVD	↓	7	↓	↓	↓	↓	↓	↓
	6	↓	8	↓	↓	↓	↓	↓	↓
	7	↓	9	↓	↓	↓	↓	↓	↓
	8	↓	10	↓	↓	↓	↓	↓	↓
	8 MS	↓	11	↓	↓	↓	↓	↓	↓
	9	↓	12	↓	↓	↓	↓	↓	↓
	10	↓	33 - 1	↓	↓	↓	↓	↓	↓
	3H170613-1CB2	↓	2	↓	↓	↓	↓	↓	↓
	1706048-11	↓	3	↓	↓	↓	↓	↓	↓
	12	↓	4	↓	↓	↓	↓	↓	↓
	13	↓	5	↓	↓	↓	↓	↓	↓
	14	↓	6	↓	↓	↓	↓	↓	↓
	15	↓	7	↓	↓	↓	↓	↓	↓
	16	↓	8	↓	↓	↓	↓	↓	↓
	17	↓	9	↓	↓	↓	↓	↓	↓
	18	↓	10	↓	↓	↓	↓	↓	↓
	19	↓	11	↓	↓	↓	↓	↓	↓
	20	↓	12	↓	↓	↓	↓	↓	↓
6/15/17	RN170615-1CB1	7.0	57 - 2	RN222	1.1	RN170615-1	OK	OK	NA
↓	↓	8.70	↓ - 2	↓	↓	↓	↓	↓	↓
	1706048-1	↓	2	↓	↓	↓	↓	↓	↓

Analyst / Date Ar 6/16/17

FORM 76217.XLS (12/3/2015)

Note: Each page is copied as completed and included with the workorder/run documentation; reviewed subsequently

468293



## Section 6

# QUALITY ASSURANCE SUMMARY REPORTS

**6**

Generic RN Headspace

ALS

# QUALITY ASSURANCE SUMMARY SHEET

ALS W.O. # / BATCH

TEST

METHOD

SOP/REV (PREP)

SOP/REV (ANAL)

Briefly document any QA or other problems or deviations associated with the analysis of samples. Problems could result from: log-in, color, odor, dilution, consistency, scheduling, equipment, or instrumentation, or may include documentation of minor deviations necessary due to unique DQO's or sample characteristics.

JKB 11/9/16

JKB 11/9/16

JKB 11/9/16

The samples listed below had air bubbles in the sample container. Per PM instruction, the two VOAs with the smallest air bubble headspace were used for analysis.

JKB 9/1/0/11

JKB 11/9/16

TECHNICIAN/ANALYST

DEPARTMENT MANAGER

DATE

DATE

FORM 302r6.doc (4/22/04)

465528

## Section 7

# LABORATORY BENCH SHEETS



Prep Procedure: Rn222 20 min. 6.75.

Rn222

**L**

70 m. c. i.

Analytical QASS / NCR? (Y) N















453768

[illegible]

### Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Ra-226	916.4095.69	1/4/17	100.335	DPM/ml	06/14/17	5	ml	RS-032
S1	Rn-222	916.4095.69	↓	100.335	DPM/ml	06/14/17	5	ml	RS-032

## Sample Barcodes

1706286-1 RN170614-1PS1		1706286-1REP RN170614-1PS2		1706286-3 RN170614-1PS3	
1706286-3REP RN170614-1PS4		1706299-1 RN170614-1PS5		1706299-1REP RN170614-1PS6	
1706299-2 RN170614-1PS7		1706299-2REP RN170614-1PS8		RN170614-1CB1MB RN170614-1PS9	
RN170614-1CB2MB RN170614-1PS10		RN170614-1MB1MB RN170614-1PS11		RN170614-1MB2MB RN170614-1PS12	
RN170614-1LCS RN170614-1PS13		RN170614-1LCS RN170614-1PS14			

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: RN170614-1

Reporting Units

LabID:	TstGrpName:	RptUnits:
1706299-1	Rn222	pCi/l
1706286-1	Rn222	pCi/l
1706299-2	Rn222	pCi/l
1706286-3	Rn222	pCi/l



# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN170614-1

Prep Procedure: Rn222

Reviewed By: *ars* Review Date: 6/14/2017

Non-Routine Pre-Treatment? Y / ☒ Batch: *NA* Re-Prep? Y / ☒ Prep QASS / NCR? ☒ / N *465528*

Prep SOP: PAI 799 Rev: 4

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Andrew R. Steger *ars*

Prep Date: 6/14/2017

Prep Dept: RS

Balance: NA

Balance: NA

Cocktail: Mineral Oil

Cocktail Pipet: RS035

Aliquot Pipet: RS035

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1706286-1	SMP	<i>NA</i>	10	10	As Received	<i>NA</i>	Sampled on 6/13/17 10:16
2	2	1706286-1	REP		10	10	As Received		Sampled on 6/13/17 10:16
3	1	1706286-3	SMP		10	10	As Received		Sampled on 6/13/17 11:36
4	2	1706286-3	REP		10	10	As Received		Sampled on 6/13/17 11:36
5	1	1706299-1	SMP		10	10	As Received		Sampled on 6/13/17 10:00
6	2	1706299-1	REP		10	10	As Received		Sampled on 6/13/17 10:00
7	1	1706299-2	SMP		10	10	As Received		Sampled on 6/13/17 12:00
8	2	1706299-2	REP		10	10	As Received		Sampled on 6/13/17 12:00
9	1	RN170614-1CB1 MB			10	10	As Received		<i>as 6/14/17</i>
10	1	RN170614-1CB2 MB			10	10	As Received		
11	1	RN170614-1MB1 MB			10	10	As Received		
12	1	RN170614-1MB2 MB			10	10	As Received		
13	1	RN170614-1 LCS			10	10	As Received	S1	
14	1	RN170614-1 LCSD			10	10	As Received	S1	

Comments

Spiked By: Rebecca L. Merola Date: 12/14/2017

Witnessed By: Andrew R. Steger Date: 12/14/2017

## Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Ra-226	916.4095.69	<i>1/4/17</i>	100.335	DPM/ml	06/14/17	5	ml	RS-032
S1	Rn-222	916.4095.69	<i>↓</i>	100.335	DPM/ml	06/14/17	5	ml	RS-032

# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN170614-1

Test: Radon

**Prep Batch Not Validated!!!**

Review Date:

Reviewed By:

Non-Routine Pre-Treatment? Y / N Batch: \_\_\_\_\_

Re-Prep? Y / N Batch: \_\_\_\_\_

QASS / NCR? Y / N \_\_\_\_\_

Prep SOP: PAI 799 4

Prep Analyst: Andrew R. Steger

Balance: N/A

Cocktail: Mineral Oil

Matrix: liquid

Prep Date: 6/14/2017

Balance: N/A

Cocktail Pipet: RSO35

Prep Dept: RS

Aliquot Pipet: RSO35

Prep Num	Lab ID	QC Type	Dish No	Init Alq	Fin Alq	Units	Prep Basis	Standards Info	R	P	Prep Notes
1	1706299-1	SMP		10	10	mL	As Received		21	4	Sampled 6/13/17 10:00
2	1706299-1	REP								5	
1	1706299-2	SMP								6	Sampled 6/13/17 12:00
2	1706299-2	REP								7	
1	1706286-1	SMP								8	Sampled 6/13/17 10:16
2	1706286-1	REP								9	
1	1706286-3	SMP								10	
2	1706286-3	REP								11	Sampled 6/13/17 11:36
1	RN170614-1C81	MB							21	1	
1	RN170614-1C82	MB							13	2	
1	RN170614-1M81	MB							21	3	
1	RN170614-1M82	MB							↓	-12	
1	RN170614-1	LCS						S <sub>1</sub>	21	2	
1	RN170614-1	LCS0						S <sub>1</sub>	13	1	

## Tracer/Carrier Info

Nuclide	Soln ID	Conc	Alq/Units	Pipet ID

## Spike Info

Nuclide	Soln ID	Conc	Alq/Units	Pipet ID
Rn-226	916-109569	100.338	5mL	RS032
Rn-222				

Spiked By: Rebecca L. Merola

Date: 12/14/15

Witnessed By: Andrew R. Steger

Date: 12/14/16

Sample Condition Form (Liquid)				
Analyst: Andrew Steger				
Analysis Date: 6/14/17			Method: Prep	
Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)				
Work Order	Sample ID	pH	Color	Remarks
1706299	1	~6	clear	None
↓	2	↓	↓	Pea sized headspace on all bottles
1706286	1	↓	light tan	oily
↓	3	↓	yellow	slightly larger than pea sized headspace for bottles #4 and #5
<div style="position: relative; width: 100%; height: 100%;"> <div style="position: absolute; top: 0; left: 0; width: 100%; height: 100%; border-left: 2px solid black; border-bottom: 2px solid black; transform: rotate(45deg);"></div> <div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%);"> as of 6/14/17 </div> </div>				

## Section 8

# **STANDARDS TRACEABILITY DOCUMENTS**



916.4095.69

Ra226 working std

Prepare a working dilution of 916.3610.76

12/18/14

1. Density of 0.1M HCl, lot # 0000092116

Mass of 100mL vol. flask:

68.3000g

Balance # 12

Mass of flask &amp; 100mL acid:

168.0372g

Balance# 12

Net Mass:

99.7372g

Density:

0.9974g/mL

2. Mass of 916.3610.76 transferred:

Mass of open empty nalgene:

74.1631g

Balance# 12

Mass of nalgene &amp; standard:

77.5202g

Balance# 12

Net mass of standard transferred:

3.3571g

Balance# NA

3. Dilute to final volume:

Mass of nalgene, standard, &amp; diluent:

1077.5g

Balance# 26

Mass of empty nalgene (from above):

74.1631g

Balance# 12

Net mass of new dilution:

1003.3369g

Balance# NA

4. Final activity calculation:

$$30,156.00 \text{ dpm/g} (0.9974 \text{ g/mL}) \left( \frac{3.3571 \text{ g}}{1003.3369 \text{ g}} \right) = 100.64 \text{ dpm/mL}$$

12/18/14

JP 11/9/15

Std ID: 916.4095.69

Description: Ra-226

Expiration: 1/6/2016

Activity: 100.64 dpm/mL

2s Uncertainty: 4.93 dpm/mL

Ref. Date: 7/1/2010

Ref Time: N/A

Prep Date: 12/8/2014 Prep by: TE

Matrix/Comp. 0.1M HCl

Half Life (y): 1.60E+03

Reverification Log		
Analysis Date	Initials	Expiration Date
1/4/2016	JP	1/04/2017

JP 11/9/15

Continued on Page

1 Clint

Signed

12/8/14

Date

Read and Understood By

JP

Signed

01/09/2015

Date

Prepare a intermediate dilution of Rn-226			
O.M. HCl diluent lot # H45A12			
Density of diluent			
Mass of 100 ml Vol Flask	68.7982g	12	
Flask + Acid	168.0565g	1	
Net	99.2583g		
$\rho = 0.9976 \frac{g}{ml}$			
Mass of parent transference			
Mass of Open Full Ampule + Reaker	38.2022g	12	
Mass of Open Empty Ampule + Reaker	33.2251g	1	
Net	4.9771g		
Dilute to final Vol./Mass			
Mass of Open Empty 40 ml Vol. Vial	21.397g	12	
Mass of Vial, Stop, + diluent	57.9016g	1	
Net	36.5045g		

Activity, Calc.

7/27/10

$$\frac{(1860 \text{ D. Rn}) (10 \text{ dpm})}{(1 \text{ Rn})} \cdot \frac{4.9771 \text{ g}}{36.5045 \text{ g}} = \frac{30.156 \text{ dpm}}{30.156 \text{ dpm}}$$

7/27/10

Continued on Page \_\_\_\_\_

Read and Understood By



Signed

9/27/10

Date



Signed

9/27/10

Date



**Eckert & Ziegler**  
Analytics

mc  
7-6-10  
R50#  
9/6

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticinc.com

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82563-307

Ra-226 5 mL Liquid in Flame Sealed Vial

**Customer:** ALS Laboratory Group / Fort Collins  
**P.O. No.:** 73625 08-10-10, Rem 1

This standard radionuclide source was prepared gravimetrically from a master solution calibrated by Eckert & Ziegler Analytics, using a germanium gamma spectrometer system. Radionuclide purity and calibration were checked with a germanium gamma spectrometer system. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.13, Revision 1, February, 1979, and compliance with ANSI N42.22-1998, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, %			Reference Date (12:00 PM EST)
			U <sub>A</sub>	U <sub>B</sub>	U	
Ra-226	5.844E+08	1.860E+04	0.8	2.4	4.8	07/01/2010

\*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1287, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

**Comments:**

Impurities:  $\gamma$ -impurities <0.1%. 6.08176 g 0.1M HCl solution with approximately 30  $\mu$ g/g Ba carrier.

Source Prepared by: W. Mao  
W. Mao, Radiochemist

QA Approved: J. D. McCorvey  
J. D. McCorvey, QA Manager Alternate

Date: 6/30/10

ANA Form 005 Rev. 10

Single Isotope Certificate, Rev 1 9/28/2008



**Corporate Office**  
24937 Avenue Tibbitts Valencia, California 91355

**Laboratory**  
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

## Section 9

# **ADDITIONAL SUPPORTING DOCUMENTATION**



## **Liquid Scintillation Counter**

### **Instrumentation Calibration**

### **Initial Efficiency Calibration Standards Traceability**

# Rn-222 Background Determination LS6500

Interim control limits are established from the initial calibration for the geometry of interest. Limits are  $\pm 3$  standard deviations from the initial unquenched calibration blank data. Once enough historical data is acquired, new historical limits are set as follows: Control limits for reagent blanks are established from 30 individual historical data points (15 batches). Limits are  $\pm 3$  standard deviations from 30 individual historical data points. Individual reagent blanks and the average of reagent blanks from each batch are in control if the Count Rate (CPM) is within the established control limits.

## CURRENTLY UNDER INTERIM LIMITS

UPDATED 02/10/2017 JP

COUNT DATE	#	Sample ID	Count Duration (m)	Count Rate (CPM)	Total Cts.	Mean	Individual Reagent Blanks			Average of Reagent Blanks		
							LCL	UCL	Pass ?	LCL	UCL	Pass ?
6/14/2017	27	RN170614-1CB1	70	5.46	382.2		4.85	6.35	PASS			
6/15/2017	28	RN170614-1CB2	70	5.56	389.2	5.51	4.85	6.35	PASS	4.85	6.35	PASS

# Radon-222 Efficiency Calibration

10ml Sample + 10ml Mineral Oil Cocktail

Beckman LS6500

Date of Calibration : 2/2/2017

Preparation Date : 1/9/2017

LUMEX Correction: OFF

Known Activity of Rn-222 (Ra-226) Standard 907.3610.53

Activity = 1025.87 2/24/2010  
 Ra-226 1/2 life = 1.60E+03 yrs.  
 Current Activity = 1022.79 dpm/mL  
 Spiked = 5.00 mL  
 Spike Activity = 5113.95 dpm  
 Days Ingrowth = 24.00 days  
 Rn-222 1/2 Life = 3.832 days  
 Minimum Ingrowth Factor = 0.987

(725-850)			
Sample ID	WIND1 CPM	LUMEX %	H#
RN170109-1MB1	6.03	0.01	41.4
RN170109-1MB2	5.73	0.01	40.8
RN170109-1MB3	5.60	0.01	40.5
1713007-1	14637.78	0.00	42.6
1713007-2	14880.00	0.00	43.0
1713007-3	14621.11	0.00	42.7
Average LCS=	14712.96	0.01	41.8
Average BKG=	5.79		
Net CPM=	14707.18		
/Known DPM=	5113.95		
Calibration Factor (CF)= 2.8759		LUMEX%	H#
		5.00	56.8
		0.00	26.8
		See Tech Mgr.	See Tech Mgr.
		See Tech Mgr.	Corr. Action

\*\*WIND 2 is not evaluated for higher energy contamination for this test.

Previous Eff  $\Rightarrow$  2.6436  $\left| \frac{2.8759}{2.6436} - 1 \right| \cdot 100 = 8.79\%$  Difference

Instrument Technician :

Signature & Date

Supervisory Review :

Signature & Date

OK, new set of calibration vials, ICVs in control limits. JP 2/22/17

## 222Rn Efficiency Calibration Verification / Method Blank Verification

### Calibration Source Check

LS6500

Analysis Date: 2/2/2017  
Nuclide: Rn222/Ra226  
Half Life: 1.60E+03 yr.

### Calibration Check Source:

Spike Standard: 916.4095.69  
Reference Date : 7/1/2010  
Spiked DPM : 100.64 dpm/mL  
Spike Volume : 5.0 mL  
Spiked into : 10 mL  
Current Spk. Act. : 22.60 pCi/mL

Acceptance Criteria: 75%-125%

### Calibration Check Source Count

Sample ID	Rack	Pos	Prep Date	Cut. Dur.	Anal. Vol.	GrscPM	BkgCPM	Efficiency	Activity	Units	Chem. Yield	LCS Recovery:	Pass/Fail
1624003-1	27	4	12/14/2016	8.80	10	1487.27	5.46	2.8759	23.21	pCi/mL	100%	102.7%	PASS
1624003-2	27	5	12/14/2016	8.70	10	1502.18	5.46	2.8759	23.44	pCi/mL	100%	103.7%	PASS
1624003-3	27	6	12/14/2016	8.65	10	1516.19	5.46	2.8759	23.66	pCi/mL	100%	104.7%	PASS
1624003-4	27	7	12/14/2016	8.75	10	1502.29	5.46	2.8759	23.45	pCi/mL	100%	103.7%	PASS

### Method Blank Check Count

Sample ID	Rack	Pos	Prep Date	Cut. Dur.	Anal. Vol.	GrscPM	BkgCPM	Efficiency	Chem. Yield	k (denom.)	activity	MDC	Pass/Fail	Units	2s CU	1σ IU	1σ PU's	2s TPU
RN161214-1MB1	27	8	12/14/2016	120	10	5.16	5.46	2.8759	100%	63.841	-0.0047	0.02	PASS	pCi/mL	0.009	-0.00053	-0.00030	0.009
RN161214-1MB2	27	9	12/14/2016	120	10	5.22	5.46	2.8759	100%	63.841	-0.0038	0.02	PASS	pCi/mL	0.009	-0.00042	-0.00024	0.009
RN161214-1MB3	27	2	12/14/2016	120	10	5.53	5.46	2.8759	100%	63.841	0.0011	0.02	PASS	pCi/mL	0.009	0.00012	0.00021	0.009
RN161214-1MB4	27	3	12/14/2016	120	10	5.74	5.46	2.8759	100%	63.841	0.0044	0.02	PASS	pCi/mL	0.010	0.00049	0.00086	0.010

OK 28 2/22/17

ID=RN 222

2 FEB 2017 14:21

USER:19

COMMENT:LS6500

PRESET TIME : 120.00

DATA CALC : CPM H# : YES SAMPLE REPEATS: .1 PRINTER : EDIT

COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : EDIT

TWO PHASE : NO AQC : NO CYCLE REPEATS : 1 DISK : OFF

SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0

LOW LEVEL : YES HALF LIFE CORRECTION DATE: none

CHAN: 725.0 - 850.0 ✓ %ERROR: 1.75 FACTOR: 1.000000 BKG. SUB: 0

WIDE OPEN WINDOW %ERROR: 20.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN	H#	WIND1		WIDE		LUMEX %	ELAPSED TIME
				CPM	%ERROR	CPM	%ERROR		
1	48-1	0.90	42.6	14637.78	1.74	20406.67	1.48	0.00	1.39
2	48-2	0.90	43.0	14880.00	1.73	20648.89	1.47	0.00	2.88
3	48-3	0.90	42.7	14621.11	1.74	20164.45	1.48	0.00	4.36
4	48-4	120.00	41.4	6.03	7.43	51.42	2.55	0.01	125.81
5	48-5	120.00	40.8	5.73	7.62	49.56	2.59	0.01	247.26
6	48-6	120.00	40.5	5.60	7.72	49.64	2.59	0.01	368.69
MISSING SAMPLE									
13	27-1	120.00	41.8	5.25	7.97	48.16	2.63	0.01	490.33
14	27-2	120.00	41.0	5.53	7.76	48.42	2.62	0.01	611.76
15	27-3	120.00	41.2	5.74	7.62	47.94	2.64	0.01	733.21
16	27-4	8.80	43.4	1487.27	1.75	2103.86	1.47	0.00	742.65
17	27-5	8.70	42.2	1502.18	1.75	2131.49	1.47	0.00	751.99
18	27-6	8.65	42.1	1516.19	1.75	2171.56	1.46	0.00	761.29
19	27-7	8.75	41.0	1502.29	1.74	2156.91	1.46	0.00	770.67
20	27-8	120.00	40.1	5.16	8.04	46.52	2.68	0.01	892.13
21	27-9	120.00	42.7	5.22	7.99	46.07	2.69	0.01	1013.58
22	27-10	120.00	40.8	5.66	7.68	48.12	2.63	0.01	1135.05

✓

✓

✓

✓

B65-19-020202

AZ  
2/6/17

JP 2/22/17

```

BSF Version          : 3
Instrument Type       : LS 6000
Data Capture Date    : 02 Feb 2017 13:39:06
User Filename        : C:\...\LS WINCONNECTION\DATA2\USER19\UN020202.BSF
User Number         : 19
User Id             : RN 222
User Comments        : LS6500
Preset Count Time    : 120.00
Calculation Mode     : CPM
H# Selected         : YES
Sample Repeats       : 1
Printer Output Mode   : EDIT
Blank Count          : NO
IC# or SCR Selected  : NO
Replicates           : 1
RS232 Output Mode    : EDIT
Two-Phase Selected   : NO
AQC Choice           : NO
Cycle Repeats        : 1
Data Buffer Output Mode : OFF
Scintillator Choice  : LIQUID
Lumex Selected       : NO
Low Sample Reject Count : 0
Low Level Selection   : YES
Half Life Correction Date : none
Window Limits Window 1 : 725.00
Preset %Error Iso1    : 1.75
Norm Multiplier Iso1 : 1.00000
Background CPM 1     : 0.00
Preset %Error Iso2    : 20.00
Norm Multiplier Iso2 : 1.00000
Background CPM 2     : 0.00

```

Sam	Rack	Time	H#	CPM	Iso1	%Err1	CPM	Iso2	%Err2	LumEx	ElTime
1	48-1	0.90	42.6	14637.78	1.74		20406.67	1.48	0.00	1.39	
2	48-2	0.90	43.0	14880.00	1.73		20648.89	1.47	0.00	2.88	
3	48-3	0.90	42.7	14621.11	1.74		20164.45	1.48	0.00	4.36	
4	48-4	120.00	41.4	6.03	7.43		51.42	2.55	0.01	125.81	
5	48-5	120.00	40.8	5.73	7.62		49.56	2.59	0.01	247.26	
6	48-6	120.00	40.5	5.60	7.72		49.64	2.59	0.01	368.69	
13	27-1	120.00	41.8	5.25	7.97		48.16	2.63	0.01	490.33	
14	27-2	120.00	41.0	5.53	7.76		48.42	2.62	0.01	611.76	
15	27-3	120.00	41.2	5.74	7.62		47.94	2.64	0.01	733.21	
16	27-4	8.80	43.4	1487.27	1.75		2103.86	1.47	0.00	742.65	
17	27-5	8.70	42.2	1502.18	1.75		2131.49	1.47	0.00	751.99	
18	27-6	8.65	42.1	1516.19	1.75		2171.56	1.46	0.00	761.29	
19	27-7	8.75	41.0	1502.29	1.74		2156.91	1.46	0.00	770.67	
20	27-8	120.00	40.1	5.16	8.04		46.52	2.68	0.01	892.13	
21	27-9	120.00	42.7	5.22	7.99		46.07	2.69	0.01	1013.58	
22	27-10	120.00	40.8	5.66	7.68		48.12	2.63	0.01	1135.05	

JP 2/2/17

12  
2/6/17



# Radiochemistry Instrument Worksheet

Prep Batch: RN170109-1

ALS -- Fort Collins

Prep Procedure: Rn222 Eff. Cal

Analytical QASS / NCR? Y *NA*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
1	1713007-1	SMP	10	10	ml	pCi/l	LS6500	4B-1	<i>MC</i>							
1	1713007-2	SMP	10	10	ml	pCi/l		-2								
1	1713007-3	SMP	10	10	ml	pCi/l		-3								
1	17170109-1MB	MB	10	10	ml	pCi/l		-4								
1	17170109-1MB	MB	10	10	ml	pCi/l		-5								
1	17170109-1MB	MB	10	10	ml	pCi/l		-6								

*BB 2/6/17*

Spike Solution Information									
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Ra-226	907.3610.53		1,022.820	DPM/ml	01/09/17	5	ml	RS-032
S1	Rn-222	907.3610.53		1,022.820	DPM/ml	01/09/17	5	ml	RS-032

## Sample Barcodes

1713007-1 RN170109-1PS1		1713007-2 RN170109-1PS2	
17170109-1MB1MB RN170109-1PS4		17170109-1MB2MB RN170109-1PS5	

## Reporting Units

LabID	TstGrpName	RptUnits
1713007-1	Rn222	pCi/l
1713007-2	Rn222	pCi/l
1713007-3	Rn222	pCi/l



# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN170109-1

Prep Procedure: Rn222

Reviewed By: *rlm* Review Date: 1/9/2017

Non-Routine Pre-Treatment? Y ☒ N

Batch: *NA*

Re-Prep? Y ☒ N

Batch: *NA*

Prep QASS / NCR? Y ☒ N

Prep SOP: PAI 799 Rev: 4

Prep Analyst: Rebecca L. Merola

Balance:

Cocktail: 137-16041

Prep SOP: NONE

Prep Date: 1/9/2017

Cocktail Pipet:

Matrix Class: liquid

Prep Dept: RS

Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1713007-1	SMP	<i>NA</i>	10	10	Unfiltered	S1	<i>1/9/12</i>
2	1	1713007-2	SMP		10	10	Unfiltered	S1	
3	1	1713007-3	SMP		10	10	Unfiltered	S1	
4	1	RN170109-1MB1	MB		10	10	Unfiltered		
5	1	RN170109-1MB2	MB		10	10	Unfiltered		
6	1	RN170109-1MB3	MB		10	10	Unfiltered		

Comments

Spiked By: Rebecca L. Merola

Date: 1/9/2017

Witnessed By: Macey S. Hall

Date: 1/9/2017

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Ra-226	907.3610.53		1,022.820	DPM/ml	RS-032
S1	Rn-222	907.3610.53		1,022.820	DPM/ml	RS-032

Reagent Solution IDs\*

137-16041 J26A03

\*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN170109-1

**Prep Batch Not Validated!!!**

Prep Procedure: Rn222

Reviewed By:

Review Date:

Non-Routine Pre-Treatment? Y / N

Re-Prep? Y / N

Prep QASS / NCR? Y / N

Prep SOP: PAI 799 Rev: 4

Prep Analyst: Rebecca L. Merola

Balance:

Cocktail:  
Cocktail Pipet:  
Aliquot Pipet:

Prep Date: 1/9/2017

Prep Dept: RS

Prep SOP: NONE

Matrix Class: liquid

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1713007-1	SMP		10	10	Unfiltered	S1	
2	1	1713007-2	SMP		10	10	Unfiltered	S1	
3	1	1713007-3	SMP		10	10	Unfiltered	S1	
4	1	RN170109-1MB1	MB		10	10	Unfiltered		
5	1	RN170109-1MB2	MB		10	10	Unfiltered		
6	1	RN170109-1MB3	MB		10	10	Unfiltered		

Comments

Spiked By: MSH Date: 1/9/17

Witnessed By: MSH Date: 1/9/17

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Ra-226	907.3610.53	12/29/17	1,022.820	DPM/ml	RS-032
S1	Rn-222	907.3610.53	↓	1,022.820	DPM/ml	RS-032

Reagent Solution IDs\*

137-16041 J26A03

\*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

ALS -- Fort Collins

Supersedes: NA

# Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: RN161214-1

Prep Procedure: Rn222 ICB + ICB

Analytical QASS / NCR? Y N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
1	1624003-1	SMP	10	10	ml	pCi/l	156500	27-4	<u>16</u>							
1	1624003-2	SMP	10	10	ml	pCi/l		-5								
1	1624003-3	SMP	10	10	ml	pCi/l		-6								
1	1624003-4	SMP	10	10	ml	pCi/l		-7								
1	N161214-1-1MB1 MB		10	10	ml	pCi/l		-2								
1	N161214-1-1MB4 MB		10	10	ml	pCi/l		-3								
1	N161214-1-1CB1 MB		10	10	ml	pCi/l		-1								
1	N161214-1-1CB2 MB		10	10	ml	pCi/l		-10								
1	N161214-1-1MB1 MB		10	10	ml	pCi/l		-8								
1	N161214-1-1MB2 MB		10	10	ml	pCi/l		-9								

## Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Ra-226	916.4095.69		100.357	DPM/ml	12/14/16	5	ml	RS-032
S1	Rn-222	916.4095.69		100.357	DPM/ml	12/14/16	5	ml	RS-032

## Sample Barcodes

1624003-1 RN161214-1PS1		1624003-2 RN161214-1PS2		1624003-3 RN161214-1PS3	
1624003-4 RN161214-1PS4		RN161214-1-1MB3MB RN161214-1PS5		RN161214-1-1MB4MB RN161214-1PS6	
RN161214-1-1CB1MB RN161214-1PS7		RN161214-1-1CB2MB RN161214-1PS8		RN161214-1-1MB1MB RN161214-1PS9	
RN161214-1-1MB2MB RN161214-1PS10					

## Reporting Units

LabID	TstGrpName	RptUnits
1624003-1	Rn222	pCi/l
1624003-2	Rn222	pCi/l
1624003-3	Rn222	pCi/l
1624003-4	Rn222	pCi/l

# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN161214-1

Prep Procedure: Rn222

Reviewed By: rlm *h* Review Date: 1/9/2017

Non-Routine Pre-Treatment? Y ☒ N

Batch: NA

Re-Prep? Y ☒ N

Prep QASS / NCR? Y ☒ N

Prep SOP: PAI 799 Rev: 4

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 12/14/2016

Prep Dept: RS

Balance:

Balance:

Cocktail: 137-16041

Cocktail Pipet: RS401

Aliquot Pipet: RS032

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1624003-1	SMP	<i>MB</i>	10	10	Unfiltered	S1	<i>119117</i>
2	1	1624003-2	SMP		10	10	Unfiltered	S1	
3	1	1624003-3	SMP		10	10	Unfiltered	S1	
4	1	1624003-4	SMP		10	10	Unfiltered	S1	
5	1	1N161214-1-1MB	MB		10	10	Unfiltered		
6	1	1N161214-1-1MB	MB		10	10	Unfiltered		
7	1	RN161214-1CB1	MB		10	10	Unfiltered		
8	1	RN161214-1CB2	MB		10	10	Unfiltered		
9	1	RN161214-1MB1	MB		10	10	Unfiltered		
10	1	RN161214-1MB2	MB		10	10	Unfiltered		

Comments

Spiked By: Rebecca L. Merola Date: 12/14/2016

Witnessed By: Andrew R. Steger Date: 12/14/2016

Spike Solution Information							
Soln #	Nuclide	SolnID	Exo Date	Prep Conc	Units	Prep Date	Aliquot Units
S1	Ra-226	916.4095.69		100.357	DPM/ml	12/14/16	5 ml
S1	Rn-222	916.4095.69		100.357	DPM/ml	12/14/16	5 ml

Reagent Solution IDs\*

137-13071 J26A03

\*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

# Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: RN161214-1

**Prep Batch Not Validated!!!**

Prep Procedure: Rn222

Reviewed By: \_\_\_\_\_ Review Date: \_\_\_\_\_

Non-Routine Pre-Treatment? Y / N Batch: \_\_\_\_\_

Prep QASS / NCR? Y / N \_\_\_\_\_

Prep SOP: PAI 799 Rev: 4

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 12/14/2016

Prep Dept: RS

Balance:

Balance:

Cocktail: 137-16041

Cocktail Pipet: RS401

Aliquot Pipet: RS032

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1624003-1	SMP		10	10		S1	
2	1	1624003-2	SMP		10	10		S1	
3	1	1624003-3	SMP		10	10		S1	
4	1	1624003-4	SMP		10	10		S1	
5	1	1N161214-1-1MB	MB		10	10			
6	1	1N161214-1-1MB	MB		10	10			
7	1	1N161214-1-1CB1	MB		10	10			
8	1	1N161214-1-1CB2	MB		10	10			
9	1	1N161214-1-1MB1	MB		10	10			
10	1	1N161214-1-1MB2	MB		10	10			

Comments

Spiked By: Dr Date: 12/14/16

Witnessed By: John R. Hays Date: 12/14/16

Spike Solution Information						
Soln #	Nuclide	SolnID	Exo Date	Prep Conc	Units	Pipet ID
S1	Ra-226	916.4095.69	1/4/17	100.357	DPM/ml	RS-032
S1	Rn-222	916.4095.69		100.357	DPM/ml	RS-032

Reagent Solution IDs\*

137-13071 J26A03

\*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

# Rn-222 Background Determination LS6500

Interim control limits are established from the initial calibration for the geometry of interest. Limits are +/- 3 standard deviations from the initial unquenched calibration blank data. Once enough historical data is acquired, new historical limits are set as follows: Control limits for reagent blanks are established from 30 individual historical data points (15 batches). Limits are +/- 3 standard deviations from 30 individual historical data points. Individual reagent blanks and the average of reagent blanks from each batch are in control if the Count Rate (CPM) is within the established control limits.

## CURRENTLY UNDER HISTORICAL LIMITS UPDATED 6/25/14 MH

COUNT DATE	#	Sample ID	Count Duration (m)	Count Rate (CPM)	Total Cts.	Mean	Individual Reagent Blanks			Average of Reagent Blanks		
							LCL	UCL	Pass ?	LCL	UCL	Pass ?
2/2/2017	247	RN161214-1CB1	120	5.25	630.0	5.46	4.44	6.47	PASS	4.44	6.47	PASS
2/3/2017	248	RN161214-1CB2	120	5.66	679.2	5.46	4.44	6.47	PASS	4.44	6.47	PASS

*Handwritten signature*  
2/6/17

# **DAILY INSTRUMENT PERFORMANCE CHECKS - LS6500 (LL OFF, LUMEX OFF)**

Daily IPCs consist of the following standards;

Efficiency Check -

**Eckert&Ziegler Tritium Standard**

**Eckert&Ziegler C-14 Standard**

Lot H92218

Lot 92228

101700.00 dpm

102420.00 dpm

3/4/2013 REF

3/4/2013 REF

3/4/2018 EXP

3/4/2018 EXP

## **Historic Control Limits**

as of 09/14/16 LC

Decay Corrected Tritium

Carbon-14

**UCL (3 sigma)**

61531.57

79032.10

**UWL (2 sigma)**

61328.60

78892.00

**Mean Value**

60922.70

78611.80

**LWL (2 sigma)**

60516.80

78331.60

**LCL (3 sigma)**

60313.83

78191.50

Decay Corrected

<u>Obs</u>	<u>Date</u>	<u>H-3 CPM</u>	<u>H-CPM</u>	<u>PASS?</u>	<u>C-14 CPM</u>	<u>PASS?</u>
106	2/2/2017	48622.60	60656.88	OK	78613.1	OK
107	2/3/2017	48487.00	60497.07	LWL	78695.8	OK

*RV*  
*2/6/17*

**DAILY CHECK LL ON <sup>99</sup>Tc SOURCE- LS6500**

<sup>99</sup> Tc standard		SPIKE	
836.3020.70		KNOWN ACTIVITY AS OF 2/26/07	
3/2/2016	REF	58000.38	dpm/g
3/7/2017	EXP	58000.38	dpm

Historic Control Limits as of 9/14/16 LC

	<u>blank</u>	<u>Blank Quench #</u>	<u>spike</u>
UCL (3 sigma)	18.30	57.00	11983.40
UWL (2 sigma)	17.00	55.90	11700.60
Mean Value	14.50	53.50	11135.00
LWL (2 sigma)	11.90	51.20	10569.30
LCL (3 sigma)	10.64	50.10	10286.50

Obs #	Date	Blank C.R.	Pass ?	Quench #	Pass	Spiked C.R.	Pass ?
106	2/2/2017	14.5	OK	54.9	OK	10576.3	OK
107	2/3/2017	14.6	OK	55	OK	10505.1	LWL

*OK*  
*2/6/17*



Prepare a Calibration Source of ~1000 dpm/ml  
of Ra-226 from RSD # 907.

Density of 0.1 M HCl diluent lot # H42 A01  
Mass of Volumetric flask 68.2976 g  
Mass of flask + Acid 168.0675 g  
Net mass 100 ml's diluent 99.7699 g  
 $\rho = 0.9977 \text{ g/mL}$

Mass of Parent transferred  
Mass of source (open) 37.7436 g  
Mass of empty vial 32.7493 g  
Net mass transferred 5.0043 g

Dilute to final vol  
Mass of Nalgene, Parent, & Diluent 1151.5 g  
Net mass of empty Nalgene 74.7890 g  
Final Mass = 1076.711 g

Activity Calculation

$$\left(18.75 \times 10^4 \text{ Bq}\right) \left(\frac{60 \text{ dpm}}{1 \text{ Bq}}\right) \left(\frac{5.0043 \text{ g}}{5.08515 \text{ g}}\right) \left(\frac{0.9977 \text{ g/mL}}{1076.711 \text{ g}}\right) = 1025.87 \frac{\text{dpm}}{\text{mL}}$$

Std ID: 907.3610.53

Description: Ra-226

Expiration: 3/10/2011

Activity: 1025.87 dpm/mL

2s Uncertainty: 50.27 dpm/mL

Ref. Date: 2/24/2010

Ref Time: N/A

Prep Date: 3/5/2010 Prep by: JD

Matrix/Comp. 0.1M HCl

Half Life (y): 1.60E+03

Reverification Log		
Analysis Date	Initials	Expiration Date
5/3/2011	RG	5/3/2012
9/23/11	RG	9/23/12
1/25/13	JP	1/25/14

\*RG 4/30/11

RG 4/6/10

Continued on Page

Read and Understood By

Signature

Date

Signature

Date



**Eckert & Ziegler**  
Analytics

REC  
2-26-2010

RSO#  
907

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analytiscinc.com

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

81680A-307

8 mL Liquid in Flame Sealed Vial

**Customer:** ALS Lab/Fort Collins, CO  
**P.O. No.:** 73828 02-04-10, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution calibrated by Eckert & Ziegler Analytics, using a germanium gamma spectrometer system. Radionuclide purity and calibration were checked with a germanium gamma spectrometer system. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.18, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, %			Reference Date (12:00 PM EST)
			u <sub>A</sub>	u <sub>B</sub>	U	
Ra-226	8.844E+08	1.875E+04	0.8	2.4	4.9	02/24/2010

\*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

**Comments:**

Impurities:  $\gamma$ -impurities < 0.1 %. 8.08518 grams in 0.1M HCl solution with approximately 30  $\mu$ g/g Ba carrier.

Source Prepared by: \_\_\_\_\_

W. Mao, Radiochemist

QA Approved: \_\_\_\_\_

J. D. McCorvey, QA Manager Alternate

Date: \_\_\_\_\_

2/24/10



Single Isotope Certificate, Rev 1 9/28/2009

Corporate Office

24937 Avenue Tibblitts Valencia, California 91355

Laboratory

1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Prepare a working dilution of 916.3610.76

1. Density of 0.1M HCl, lot # 0600092116

Mass of 100mL vol. flask:

Mass of flask & 100mL acid:

Net Mass:

Density:

68.3000g

168.0372g

99.7372g

0.9974g/mL

Balance # 12

Balance# 12

2. Mass of 916.3610.76 transferred:

Mass of open empty nalgene:

Mass of nalgene & standard:

Net mass of standard transferred:

74.1631g

77.5202g

3.3571g

Balance# 12

Balance# 12

Balance# NA

3. Dilute to final volume:

Mass of nalgene, standard, & diluent:

Mass of empty nalgene (from above):

Net mass of new dilution:

1077.5g

74.1631g

1003.3369g

Balance# 26

Balance# 12

Balance# NA

4. Final activity calculation:

$$30,156.00 \text{ dpm/g} (0.9974 \text{ g/mL}) \left( \frac{3.3571 \text{ g}}{1003.3369 \text{ g}} \right) = 100.64 \text{ dpm/mL}$$

Std ID: 916.4095.69

Description: Ra-226

Expiration: 1/6/2016

Activity: 100.64 dpm/mL

2s Uncertainty: 4.93 dpm/mL

Ref. Date: 7/1/2010

Ref Time: N/A

Prep Date: 12/8/2014 Prep by: TE

Matrix/Comp. 0.1M HCl

Half Life (y): 1.60E+03

#### Reverification Log

Analysis Date	Initials	Expiration Date

Analysis Date	Initials	Expiration Date

(continued on Page

Read and Understood By

01/09/2015

Date

Prepare a intermediate dilution of 250  $\mu$ g/L  
 0.1 M HCl diluent lot # H45A12  
 Density of diluent  
 Mass of 100 ml Vol Flask 68.2982 g 12  
 Flask + Acid 168.0565 g 2  
 Net 99.7583 g  
 $\rho = 0.9976 \frac{g}{ml}$

Mass of parent transferred  
 Mass of Open Full Ampule + Receptor 38.2082 g 12  
 Mass of Open Empty Ampule + Receptor 33.2251 g 6  
 Net 4.9831 g

Dilute to final Vol./Mass  
 Mass of Open Empty 40 ml Vol Vial 2.397 g 12  
 Mass of Vial, Std. + diluent 57.9016 g 1  
 Net 36.5045 g

Activity, Calc.

Jan 9/27/10

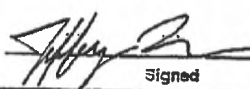
$\frac{(1860 \text{ D. } Bq)(20 \text{ } \mu\text{g})}{(1 Bq)} \cdot \frac{4.9831 \text{ g}}{5.05176 \text{ g}} \cdot \frac{1}{36.5045 \text{ g}} = \frac{30.156 \text{ dpm}}{36.5045 \text{ g}}$   
 Jan 9/27/10

Continued on Page \_\_\_\_\_

Read and Understood By

  
 Signed

9/27/10  
 Date

  
 Signed

9/27/10  
 Date



Eckert & Ziegler

Analytics

mc  
7-6-10  
R50#  
9/16

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticsinc.com

# CERTIFICATE OF CALIBRATION

## Standard Radionuclide Source

82583-307

Ra-226 5 mL Liquid in Flame Sealed Vial

Customer: ALS Laboratory Group / Fort Collins  
P.O. No.: 73625 06-10-10, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution calibrated by Eckert & Ziegler Analytics, using a germanium gamma spectrometer system. Radionuclide purity and calibration were checked with a germanium gamma spectrometer system. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.18, Revision 1, February, 1979, and compliance with ANSI N42.22-1998, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, %			Reference Date (12:00 PM EST)
			u <sub>1</sub>	u <sub>2</sub>	U	
Ra-226	5.844E+08	1.860E+04	0.5	2.4	4.9	07/01/2010

\*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1287, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

### Comments:

Impurities:  $\gamma$ -impurities <0.1%. 6.08178 g 0.1M HCl solution with approximately 30  $\mu$ g/g Ba carrier.

Source Prepared by:

W. Mao, Radiochemist

QA Approved:

J. D. McCorvey, QA Manager Alternate

Date:

6/30/10

ASA Form 005 Rev. 100

Single Isotope Certificate, Rev 1 9/28/2008

Corporate Office

24937 Avenue Tibbitts Valencia, California 91355



Laboratory

1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

**Liquid Scintillation Counter**

**Quality Control Data**

**Daily Instrument Performance Checks**

# DAILY INSTRUMENT PERFORMANCE CHECKS - LS6500 (LL OFF, LUMEX OFF)

Daily IPCs consist of the following standards;

Efficiency Check -

**Eckert&Ziegler Tritium Standard**

**Eckert&Ziegler C-14 Standard**

Lot H92218

Lot 92228

101700.00 dpm

102420.00 dpm

3/4/2013 REF

3/4/2013 REF

3/4/2018 EXP

3/4/2018 EXP

## Historic Control Limits

as of 03/23/17 JP

Decay Corrected Tritium

Carbon-14

**UCL (3 sigma)**

60874.14

78955.90

**UWL (2 sigma)**

60748.60

78843.70

**Mean Value**

60497.50

78619.40

**LWL (2 sigma)**

60246.40

78395.20

**LCL (3 sigma)**

60120.82

78283.02

## Decay Corrected

<u>Obs</u>	<u>Date</u>	<u>H-3 CPM</u>	<u>H-CPM</u>	<u>PASS?</u>	<u>C-14 CPM</u>	<u>PASS?</u>
53	6/14/2017	47252.60	60162.63	LWL	78623.2	OK
54	6/15/2017	47185.60	60086.61	LOW	78635.9	OK
55	6/16/2017	47287.10	60225.17	LWL	78690.2	OK

# DAILY CHECK LL ON <sup>99</sup>Tc SOURCE- LS6500

<sup>99</sup> Tc standard		SPIKE	
836.3020.70	KNOWN ACTIVITY AS OF 2/26/07		
3/6/2017	REF	58000.38	dpm/g
3/6/2018	EXP	58000.38	dpm

Historic Control Limits as of 9/14/16 LC

	<u>blank</u>	<u>Blank Quench #</u>	<u>spike</u>
UCL (3 sigma)	19.25	60.35	11876.50
UWL (2 sigma)	17.88	59.18	11596.22
Mean Value	15.25	56.64	11035.70
LWL (2 sigma)	12.52	54.21	10475.01
LCL (3 sigma)	11.19	53.04	10194.74

Obs #	Date	Blank C.R.	Pass ?	Quench #	Pass	Spiked C.R.	Pass ?
53	6/14/2017	14.9	OK	54.9	OK	10855.3	OK
54	6/15/2017	15.8	OK	54.3	OK	10788.1	OK
55	6/16/2017	15.4	OK	54.5	OK	10972.7	OK