U.S.ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
GAMMA ANALYSES

REPORT OF SAMPLE DELIVERY GROUP #1900153

Project:	Canadian Radium and Uranium 9/19
Analysis method:	Gamma-ray Spectrometry
Report ID:	1900153-GAMMA
Report type:	Original
Date reported:	12/09/2019
Total pages in report:	12

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B9.10556G	RB-190908	NY:MT. KISCO	WATER	09/08/2019	09/10/2019
B9.10557H	RB-190909	NY:MT. KISCO	WATER	09/09/2019	09/10/2019

EXCEPTIONS

1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – No problems were observed.
3. **Sample preparation** – No problems were encountered.
4. **Analysis** – Samples were reanalyzed to include Pb-210 as requested by the client. The results of the reanalyses are reported in this data package.
5. **Holding times** – No holding times were specified.

QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

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ACCREDITATION

NAREL is accredited by the Oregon Environmental Laboratory Accreditation Program (ORELAP) to the TNI standard. NAREL maintains accreditation for all its radiological analyses except the following:

- Analyses of drinking water
- Gross alpha and gross beta of solid matrices, including swipes
- Tritium analysis of solid matrices, including swipes
- Analyses for Ra-226 by method NAREL RA-07-EC
- Analyses for Am-241 by method NAREL ACT-02F
- Curium-244/243

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Project Acceptance Form and/or the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

Velinda Herbert 12/10/19

Velinda Herbert — Date
Quality Assurance Manager, NAREL

Cynthia White 12-10-19

Cynthia White — Date
Director, Center for Environmental Radioanalytical Laboratory Science

If you have questions about the data, please contact Cynthia White ( ).

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GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample, or blank spike
LCX	Laboratory control sample duplicate
MS	Matrix spike
MSD	Matrix spike duplicate (not currently analyzed)
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "*Z* scores." A *Z* score is the number of standard deviations by which the QC result differs from its ideal value. Generally the score is considered acceptable if its absolute value is not greater than 3.

The *Z* score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference. The *Z* score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation of most analyses. An exception is the use of %R in the evaluation of gross alpha matrix spike results. A gross alpha matrix spike result is considered acceptable if either $|Z| \leq 3$ or $60 \leq \%R \leq 110$.

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GENERAL INFORMATION (CONTINUED)

GAMMA ANALYSIS

The reporting format lists the gamma emitters in alphabetical order. The activity, 2-sigma uncertainty, and a sample-specific estimate of the MDC for radionuclides measured by gamma spectroscopy are reported only if the nuclide is detected above background with the exception of client requested nuclides of interest. The activity for each of the requested nuclides is reported whether negative, positive, or zero along with the associated 2-sigma uncertainty and the sample-specific estimate of the MDC.

Due to potential spectral interferences and other possible problems associated with the determination of the activity of certain radionuclides, the activities for ^{212}Bi, ^{212}Pb, ^{208}Tl, ^{210}Pb, ^{214}Bi, ^{214}Pb, ^{234}Th, ^{234m}Pa, ^{226}Ra, ^{231}Th, and ^{235}U are subject to greater uncertainty than other commonly reported radionuclides. It should be noted that this potential uncertainty is not included in the two-sigma expanded uncertainty that is reported with each result. Although in this report we do provide the calculated activities for these radionuclides, we recommend that the results be used only as a qualitative means of indicating the presence of these radionuclides and not as a quantitative measure of their concentration. The results for these nuclides are not used in the evaluation of quality control samples. Furthermore, because of mutual interference between ^{226}Ra and ^{235}U, NAREL's gamma analysis software tends to overestimate the amounts of these nuclides whenever both are present in a sample. Lower estimates for ^{226}Ra activities can be obtained from the reported activities of its decay products, ^{214}Pb and ^{214}Bi, which are likely to be somewhat less than the ^{226}Ra activity because of the potential escape of radon gas.

NAREL's gamma-ray spectrometry software corrects activities and MDCs for decay between collection and analysis, but only up to a limit of twelve half-lives. If the decay time for a sample exceeds twelve half-lives of a radionuclide, that radionuclide is not reported. This software feature may affect results for short-lived radionuclides, such as ^{131}I and ^{140}Ba, when there is a long delay between collection and analysis.

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Chain of Custody Forms

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USEPA
DateShipped: 9/9/2019
CarrierName: FedEx
AirbillNo: 7761-9080-7836

CHAIN OF CUSTODY RECORD
Canadian Radium & Uranium Corp/NY
Contact Name: Bernard Nwosu
Contact Phone: 908-565-2980

No: 2-090919-0032-0030-0001
Lab: NAREL
Lab Contact: Tonya Hudson
Lab Phone: 343-270-3433

Lab #	Sample #	Location	Matrix	Analyses	Sample Date	Sample Time	Numb Cont	Container	Preservative	Lab QC
	RB-190908	RB-190908	Blank	Alpha Spec (U, Th) & Gamma Spec	9/8/2019	16:00	4	1 L poly	HNO3 pH<2	N BA 10556
	RB-190909	RB-190908	Blank	Alpha Spec (U, Th) & Gamma Spec	9/9/2019	09:00	4	1 L poly	HNO3 pH<2	N BA 10557 H

Special Instructions: Please email results to s.sumbaly@westonsolutions.com and ben.nwosu@westonsolutions.com. Samples to be run for isotopic thorium via NAREL ACT-02FTH, isotopic Uranium via NAREL ACT-02F-U, other gamma isotopes via NAREL GM-01-RA, and Radium-226 and Radium-228 via 21-day ingrowth. 60 day TAT.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
All Samples All Analyses	(Weston)	9/9/19 1600	(Zachary Chambers)	9/10/19 0920	See page 1

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

ANALYSIS SUMMARY

Analysis method: NAREL GAM-01
Title: Gamma-ray Spectrometry

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B9.10556G	RB-190908		12/05/2019	0016871P	0024777Z
B9.10556G	RB-190908	DUP	12/06/2019	0016871P	0024777Z
B9.10557H	RB-190909		12/05/2019	0016871P	0024777Z
LCS-00787197A *		LCS	12/05/2019	0016871P	0024777Z
RBK-00787198B *		RBK	12/06/2019	0016871P	0024777Z

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

SAMPLE ANALYSIS REPORT

Lab sample #:	B9.10556G	Amount analyzed:	3.000e+00 L
Client sample ID:	RB-190908	Preparation batch #:	0016871P
Matrix:	WATER	Assay batch #:	0024777Z
Collected:	2019-09-08 16:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL GAM-01
Dry/wet weight:	N/A	Analyst:	MO
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/04/2019 10:29	1000.0	GE15	MO

ANALYTICAL RESULTS

Analyte		Activity	± 2 σ Uncertainty	DLC	MDC	Unit	Reference Date
Bi212		1.69e+00	1.0e+01	6.7e+00	1.4e+01	PCI/L	09/08/2019 16:00 EDT
Bi214	J	1.53e+00	2.0e+00	1.2e+00	2.4e+00	PCI/L	09/08/2019 16:00 EDT
Cs137		1.69e-01	7.9e-01	5.1e-01	1.0e+00	PCI/L	09/08/2019 16:00 EDT
K40		-1.05e+00	9.8e+00	5.2e+00	1.1e+01	PCI/L	09/08/2019 16:00 EDT
Pb210		-4.11e-01	1.5e+01	1.1e+01	2.2e+01	PCI/L	09/08/2019 16:00 EDT
Pb212		-2.52e-01	1.3e+00	9.1e-01	1.8e+00	PCI/L	09/08/2019 16:00 EDT
Pb214		-5.59e-01	1.9e+00	1.2e+00	2.4e+00	PCI/L	09/08/2019 16:00 EDT
Ra226	J	1.35e+01	1.4e+01	1.0e+01	2.0e+01	PCI/L	09/08/2019 16:00 EDT
Ra228		1.87e+00	2.8e+00	1.7e+00	3.6e+00	PCI/L	09/08/2019 16:00 EDT
Th234		8.47e+00	1.8e+01	1.5e+01	3.0e+01	PCI/L	09/08/2019 16:00 EDT
Tl208		2.07e-01	7.8e-01	5.1e-01	1.0e+00	PCI/L	09/08/2019 16:00 EDT
U235		-2.54e+00	5.7e+00	4.7e+00	9.4e+00	PCI/L	09/08/2019 16:00 EDT

Note: A "J" qualifier indicates a result that may be significantly under or overestimated.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

SAMPLE ANALYSIS REPORT

Lab sample #:	B9.10556G	Amount analyzed:	3.000e+00 L
Client sample ID:	RB-190908	Preparation batch #:	0016871P
Matrix:	WATER	Assay batch #:	0024777Z
Collected:	2019-09-08 16:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL GAM-01
Dry/wet weight:	N/A	Analyst:	MO
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/05/2019 10:42	1000.0	GE16	MO

ANALYTICAL RESULTS

Analyte		Activity	± 2 σ Uncertainty	DLC	MDC	Unit	Reference Date
Bi212		-2.23e+00	1.1e+01	6.9e+00	1.4e+01	PCI/L	09/08/2019 16:00 EDT
Bi214	J	1.55e+00	2.0e+00	1.2e+00	2.4e+00	PCI/L	09/08/2019 16:00 EDT
Cs137		1.78e-01	7.6e-01	5.0e-01	1.0e+00	PCI/L	09/08/2019 16:00 EDT
K40		7.91e+00	8.7e+00	5.0e+00	1.0e+01	PCI/L	09/08/2019 16:00 EDT
Pb210		-1.34e+01	9.1e+00	1.2e+01	2.4e+01	PCI/L	09/08/2019 16:00 EDT
Pb212		-1.16e+00	2.0e+00	1.1e+00	2.2e+00	PCI/L	09/08/2019 16:00 EDT
Pb214	J	1.57e+00	1.7e+00	1.2e+00	2.4e+00	PCI/L	09/08/2019 16:00 EDT
Ra226		6.06e+00	1.9e+01	1.2e+01	2.4e+01	PCI/L	09/08/2019 16:00 EDT
Ra228		3.89e+00	2.2e+00	1.3e+00	2.7e+00	PCI/L	09/08/2019 16:00 EDT
Th234		8.27e+00	2.2e+01	1.7e+01	3.3e+01	PCI/L	09/08/2019 16:00 EDT
Tl208	J	1.05e+00	6.5e-01	3.9e-01	8.1e-01	PCI/L	09/08/2019 16:00 EDT
U235		-2.80e+00	6.5e+00	5.3e+00	1.1e+01	PCI/L	09/08/2019 16:00 EDT

Note: A "J" qualifier indicates a result that may be significantly under or overestimated.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

SAMPLE ANALYSIS REPORT

Lab sample #:	B9.10557H	Amount analyzed:	3.000e+00 L
Client sample ID:	RB-190909	Preparation batch #:	0016871P
Matrix:	WATER	Assay batch #:	0024777Z
Collected:	2019-09-09 09:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL GAM-01
Dry/wet weight:	N/A	Analyst:	MO
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/04/2019 10:28	1000.0	GE16	MO

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	DLC	MDC	Unit	Reference Date
Bi212	3.52e+00	6.6e+00	5.4e+00	1.1e+01	PCI/L	09/09/2019 09:00 EDT
Bi214	5.22e-01	1.6e+00	1.1e+00	2.2e+00	PCI/L	09/09/2019 09:00 EDT
Cs137	-5.54e-02	5.9e-01	4.9e-01	1.0e+00	PCI/L	09/09/2019 09:00 EDT
K40	3.83e+00	5.7e+00	4.6e+00	9.5e+00	PCI/L	09/09/2019 09:00 EDT
Pb210	-1.46e+00	1.7e+01	1.2e+01	2.3e+01	PCI/L	09/09/2019 09:00 EDT
Pb212	2.23e-01	1.2e+00	1.0e+00	2.1e+00	PCI/L	09/09/2019 09:00 EDT
Pb214	1.01e+00	1.5e+00	1.2e+00	2.4e+00	PCI/L	09/09/2019 09:00 EDT
Ra226	-4.56e+00	2.3e+01	1.1e+01	2.3e+01	PCI/L	09/09/2019 09:00 EDT
Ra228	-1.71e+00	1.1e+01	1.9e+00	3.9e+00	PCI/L	09/09/2019 09:00 EDT
Th234	8.31e+00	1.7e+01	1.4e+01	2.8e+01	PCI/L	09/09/2019 09:00 EDT
Tl208	3.87e-01	6.3e-01	5.1e-01	1.0e+00	PCI/L	09/09/2019 09:00 EDT
U235	7.19e-01	4.4e+00	3.6e+00	7.2e+00	PCI/L	09/09/2019 09:00 EDT

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00787197A	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0016871P
Matrix:	N/A	Assay batch #:	0024777Z
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL GAM-01
Dry/wet weight:	N/A	Analyst:	MO
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/04/2019 10:34	1000.0	GE24	MO

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	DLC	MDC	Unit	Reference Date
Bi207	3.94e+03	4.4e+02	3.5e+01	7.3e+01	PCI	12/15/2010 11:00 CST
Eu155	8.80e+02	1.5e+02	6.9e+01	1.4e+02	PCI	12/15/2010 11:00 CST

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1900153

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00787198B	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0016871P
Matrix:	N/A	Assay batch #:	0024777Z
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL GAM-01
Dry/wet weight:	N/A	Analyst:	MO
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/05/2019 10:40	1000.0	GE15	MO

ANALYTICAL RESULTS

Analyte		Activity	± 2 σ Uncertainty	DLC	MDC	Unit	Reference Date
Bi212		6.92e+00	2.9e+01	1.9e+01	3.8e+01	PCI	11/05/2019 06:00 CST
Bi214		-3.75e+00	6.2e+00	3.7e+00	7.6e+00	PCI	11/05/2019 06:00 CST
Cs137		4.55e-02	2.3e+00	1.5e+00	3.0e+00	PCI	11/05/2019 06:00 CST
K40		-1.86e+01	2.7e+01	1.9e+01	4.0e+01	PCI	11/05/2019 06:00 CST
Pb210		-2.10e+01	3.9e+01	2.9e+01	5.8e+01	PCI	11/05/2019 06:00 CST
Pb212		8.99e-01	3.4e+00	2.4e+00	4.8e+00	PCI	11/05/2019 06:00 CST
Pb214		-4.44e-01	5.6e+00	3.4e+00	6.9e+00	PCI	11/05/2019 06:00 CST
Ra226	J	3.26e+01	3.8e+01	2.6e+01	5.3e+01	PCI	11/05/2019 06:00 CST
Ra228		4.40e+00	8.1e+00	4.9e+00	1.0e+01	PCI	11/05/2019 06:00 CST
Th234		3.14e+00	3.9e+01	2.9e+01	5.9e+01	PCI	11/05/2019 06:00 CST
Tl208	J	3.87e+00	2.4e+00	1.3e+00	2.7e+00	PCI	11/05/2019 06:00 CST
U235		-6.68e+00	1.4e+01	1.2e+01	2.3e+01	PCI	11/05/2019 06:00 CST

Note: A "J" qualifier indicates a result that may be significantly under or overestimated.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1900153

PREPARATION BATCH SUMMARY

Preparation batch #: 0016871P
Analysis method: NAREL GAM-01
Preparation procedure: N/A

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B9.10556G	RB-190908	00787194X		N/A		MO
B9.10556G	RB-190908	00787196Z	DUP	N/A		MO
B9.10557H	RB-190909	00787195Y		N/A		MO
LCS-00787197A *		00787197A	LCS	N/A		MO
RBK-00787198B *		00787198B	RBK	N/A		MO

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0016871P

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B9.10556G	00787196Z	DUP	BI212		-1446.5	-0.52	PASS
B9.10556G	00787196Z	DUP	BI214		1.6	0.02	PASS-J
B9.10556G	00787196Z	DUP	CS137		4.8	0.02	PASS
B9.10556G	00787196Z	DUP	K40		261.3	1.37	PASS
B9.10556G	00787196Z	DUP	PB210		-188.1	-1.48	PASS
B9.10556G	00787196Z	DUP	PB212		-128.6	-0.77	PASS
B9.10556G	00787196Z	DUP	PB214		421.2	1.66	PASS-J
B9.10556G	00787196Z	DUP	RA226		76.1	-0.63	PASS-J
B9.10556G	00787196Z	DUP	RA228		70.4	1.12	PASS
B9.10556G	00787196Z	DUP	TH234		2.4	-0.01	PASS
B9.10556G	00787196Z	DUP	TL208		134.1	1.66	PASS-J
B9.10556G	00787196Z	DUP	U235		-9.8	-0.06	PASS
LCS-00787197A	00787197A	LCS	BI207	99.8		-0.04	PASS
LCS-00787197A	00787197A	LCS	EU155	102.6		0.30	PASS
RBK-00787198B	00787198B	RBK	BI212				PASS
RBK-00787198B	00787198B	RBK	BI214				PASS
RBK-00787198B	00787198B	RBK	CS137				PASS
RBK-00787198B	00787198B	RBK	K40				PASS
RBK-00787198B	00787198B	RBK	PB210				PASS
RBK-00787198B	00787198B	RBK	PB212				PASS
RBK-00787198B	00787198B	RBK	PB214				PASS
RBK-00787198B	00787198B	RBK	RA226				PASS-J
RBK-00787198B	00787198B	RBK	RA228				PASS
RBK-00787198B	00787198B	RBK	TH234				PASS
RBK-00787198B	00787198B	RBK	TL208				HIGH-J
RBK-00787198B	00787198B	RBK	U235				PASS

Note: Results qualified with -J may be significantly under or over-estimated and are not evaluated for QC purposes.

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