Paragon Analytics

Radiochemistry Case Narrative

Tritium

Cordilleran Compliance Services, Inc.

Rulison Area Well Monitoring

PA WO 0811110

1. This report consists of the analytical results and supporting documentation for two water samples received by Paragon on 11/14/2008.
2. These samples were prepared according to procedure PA SOP700R10.
3. The samples were analyzed for the presence of tritium according to procedure PA SOP704R9. The analyses were completed on 11/23/2008.
4. The analysis results for these samples are reported in units of pCi/L. The samples were not filtered prior to analysis.
5. In the analysis of the raw data, "Window 2" is monitored for high-energy beta contamination. Sample 0811110-1 had a "Window 2" count rate slightly above the upper control limit of 41.58 cpm established from calibration on 11/22/2008 through 11/23/2008, at 42.01 cpm. The sample had observed activity at a level below the achieved MDC. Thus, the data quality is believed to be unaffected and the results are submitted without further qualification.
6. 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.

Jean Anderson — 12/9/08
Jean Anderson — Date
Radiochemistry Primary Reviewer

Radiochemistry Final Reviewer — FOR EMILY BITLER — 12/09/08
Radiochemistry Final Reviewer — Date

PARAGON ANALYTICS
Radiochemistry Data Package

Section 1

CHAIN OF CUSTODY

ALS Paragon

Sample Number(s) Cross-Reference Table

Paragon OrderNum: 0811110
Client Name: Cordilleran Compliance Services, Inc.
Client Project Name: Rulison Area Well monitoring
Client Project Number:
Client PO Number:

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
A11-15D	0811110-1		WATER	13-Nov-08	8:40
A11-15B	0811110-2		WATER	13-Nov-08	8:30

Paragon Analytics
A Division of DataChem Laboratories, Inc.

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

Accession Number (LAB ID) 081110

Chain-of-Custody Date 11/13/08 Page 1 of 1

Originator: Retain pink copy!

Project Name/No.: ROULSON AREA WELL MONITORING **Sampler(s):** TPD Turnaround (circle one) **Standard** or **Rush** (Due _____) Dispose: **Date** _____ or **Return to Client**

Report To: JAMES HIX
Phone: (303) 237.2072
Fax: (303) 237 2659
E-mail: jameshix@cordcomp.com
Company: Cordilleran Compliance Services, Inc.
Address: ~~826 2½ Road~~
4690 TABLE MOUNTAIN DR. #200
GOLDEN, CO 80403

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX ~~(only)~~ MTBE SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	RSK	NH_3, NO_x, T-Phos
A11-15D	11/13/08	0840	1	W	HNO_3 HCl, H, 2x	17		X										X			X			X	X		X				X	X	
A11-15B	11/13/08	0830	2	W	"	17		X										X			X			X	X		X				X	X	

* Time Zone: EST CST MST PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

Relinquished By: (1)	Relinquished By: (2)
Signature	Signature
Printed Name T.M. DOBRANSKY	Printed Name
Date 11/13/08 Time 1600	Date Time
Company CORDILLERAN COMPLIANCE	Company

Received By: (1)	Received By: (2)
Signature	Signature
Printed Name JOachim	Printed Name
Date 11/14/08 Time 0930	Date Time
Company PA	Company

Form 202r6.xls (6/16/06)

CONDITION OF SAMPLE UPON RECEIPT FORM **Paragon Analytics**

Client: Cordillieran Workorder No: 0811 110

Project Manager: LS Initials: CB Date: 11-14-08

1.	Does this project require any **special handling** in addition to standard Paragon procedures?		YES	(NO)
2.	Are custody **seals** on **shipping containers** intact?	NONE	(YES)	NO
3.	Are Custody seals on **sample containers** intact?	NONE	(YES)	NO
4.	Is there a **COC (Chain-of-Custody) present** or other representative documents?		(YES)	NO
5.	Are the **COC and bottle labels complete and legible**?		(YES)	NO
6.	Is the **COC in agreement** with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		(YES)	NO
7.	Were **airbills / shipping documents** present and/or removable?	DROP OFF	(YES)	NO
8.	Are **all aqueous samples requiring preservation preserved correctly?** (excluding volatiles)	N/A	YES	(NO)
9.	Are all aqueous **non-preserved samples pH 4-9**?	N/A	(YES)	NO
10.	Is there **sufficient sample** for the requested analyses?		(YES)	NO
11.	Were all samples placed in the **proper containers** for the requested analyses?		(YES)	NO
12.	Are all samples within **holding times** for the requested analyses?		(YES)	NO
13.	Were all sample containers received **intact**? (not broken or leaking, etc.)		(YES)	NO
14.	Are all samples requiring **no** headspace (**VOC, GRO, RSK/MEE, Rx CN/S, radon**) headspace free? **Size of bubble**: √ < green pea ___ > green pea	N/A	YES	(NO)
15.	Do perchlorate LCMS-MS samples **have** headspace? (at least 1/3 of container required)	(N/A)	YES	NO
16.	Were samples checked for and free from the presence of **residual chlorine?** (Applicable when PM has indicated samples are from a chlorinated water source; note if field preservation with sodium thiosulfate was not observed.)	(N/A)	YES	NO
17.	Were the samples **shipped on ice**?		(YES)	NO
18.	Were cooler temperatures **measured at 0.1-6.0°C**? **IR gun used*:** (#2) #4	RAD ONLY	(YES)	NO

Cooler #:	1							
Temperature (°C):	3.4							
No. of custody seals on cooler:	1							
DOT Survey/ Acceptance Information — External µR/hr reading:	14							
Background µR/hr reading:	13							

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? (YES) / NO / NA (If no, see Form 008.)

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

Headspace Bottle # (-1) 1, 2, 3, 6, 7, 9

2 - 1, 2

Slime layer in -1-15 & -1-16 (Organic?)

If applicable, was the client contacted? (YES) / NO / NA Contact: J. Hix Date/Time: ___

Project Manager Signature / Date: 11/12/08

*IR Gun #2: Oakton, SN 29922500201-0066 *IR Gun #4: Oakton, SN 2372220101-0002

CONDITION OF SAMPLE UPON RECEIPT FORM **Paragon Analytics**

Client: Cardiliveran Workorder No: 0811110

Project Manager: LS Initials: AO Date: 11-14-08

Additional Information:

Was the laboratory directed to proceed with the analysis of any samples yielding the presence of residual chlorine? YES / NO / NA

NOTE:

No pH adjustments shall be made without prior consent of Project Manager. After pH adjustments, hold metals and radchem samples ≥ 24 hrs. before analysis.

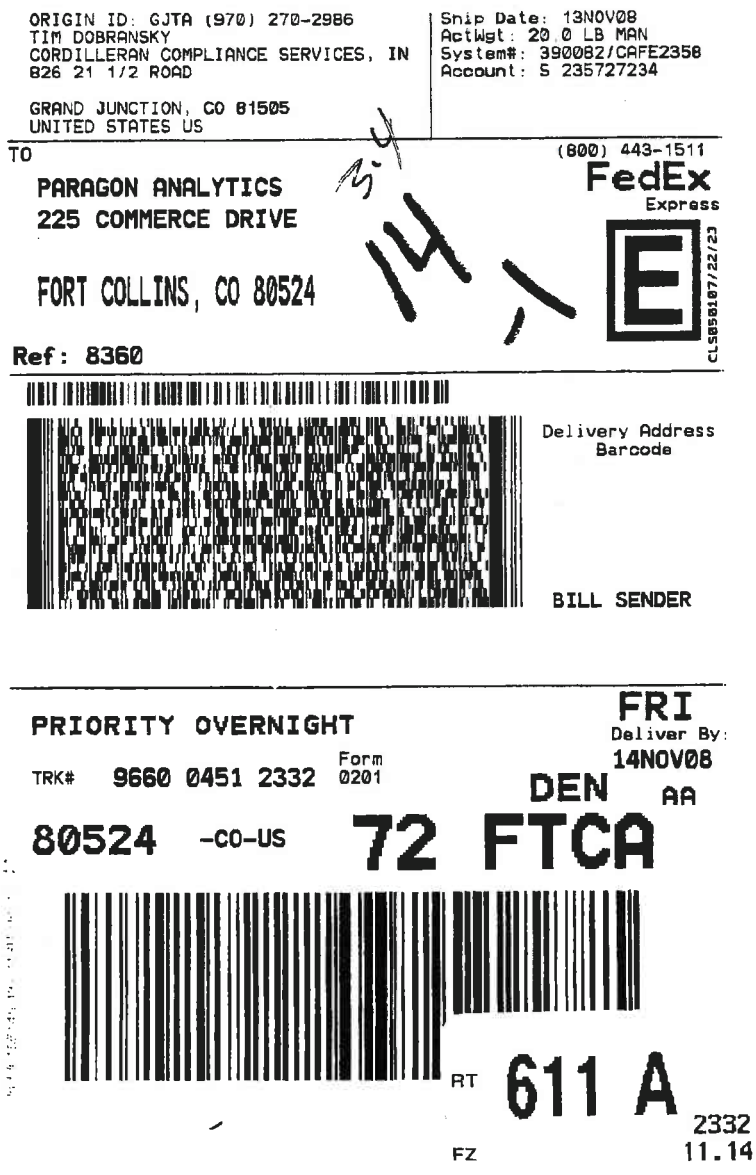
Was the pH of any sample adjusted by the laboratory? **YES** (See Table below) / **NO**

pH Excursion:

Paragon Sample ID	Client Sample ID	Initial pH	Final pH	Reagent Used	Volume Added (mL)	Lot No. of Reagent	Requested Analysis	Initials / Date / Time
-1-12		7	1.6	conc HNO_3	1mL			CW 11/14/08 1030
-1-15		↓	↓	↓	↓			↓
-1-16								
-1-17								
-2-12								
-2-15								
-2-16								
-2-17		↓	↓	↓	↓			↓

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

Project Manager Signature / Date: 11/17/08


ORIGIN ID: GJTA (970) 270-2986
TIM DOBRANSKY
CORDILLERAN COMPLIANCE SERVICES, IN
826 21 1/2 ROAD
GRAND JUNCTION, CO 81505
UNITED STATES US
Ship Date: 13NOV08
ActWgt: 20.0 LB MAN
System#: 390082/CAFE2358
Account: S 235727234
TO
PARAGON ANALYTICS
225 COMMERCE DRIVE
FORT COLLINS, CO 80524
(800) 443-1511
FedEx
Express
Ref: 8360
Delivery Address Barcode
BILL SENDER
PRIORITY OVERNIGHT
FRI
Deliver By:
14NOV08
TRK# 9660 0451 2332
Form 0201
DEN
AA
80524 -CO-US
72 FTCA
RT
611 A
2332
FZ
11.14

2

PARAGON ANALYTICS
Radiochemistry Data Package

Section 2

SAMPLE RESULTS SUMMARY

Tritium Analysis By Liquid Scintillation Sample Results Summary

Client Name: Cordilleran Compliance Services, Inc.
Client Project Name: Rulison Area Well monitoring
Client Project Number:

Laboratory Name: ALS Paragon
PAI Work Order: 0811110

Reported on: Friday, December 05, 2008 12:18:18 PM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	Units	Matrix	Prep Batch	Date Analyzed	Flags
0811110-1	A11-15D	Sample	H-3	-50 +/- 180	300	pCi/l	WATER	3H081120-1	11/23/2008	U
0811110-2	A11-15B	Sample	H-3	30 +/- 180	300	pCi/l	WATER	3H081120-1	11/22/2008	U

Comments:

Data Package ID: *H30811110-1*

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

3

PARAGON ANALYTICS
Radiochemistry Data Package

Section 3

QC RESULTS SUMMARY

Tritium Analysis By Liquid Scintillation

PAI 704 Rev 9

Method Blank Results

Lab Name: ALS Paragon
Work Order Number: 0811110
Client Name: Cordilleran Compliance Services, Inc.
ClientProject ID: Rulison Area Well monitoring

Lab ID: 3H081120-1MB

Sample Matrix: WATER
Prep SOP: PAI 700 Rev 10
Date Collected: 20-Nov-08
Date Prepared: 20-Nov-08
Date Analyzed: 22-Nov-08

Prep Batch: 3H081120-1
QCBatchID: 3H081120-1-3
Run ID: 3h081120-1x
Count Time: 120 minutes

Final Aliquot: 10.0 ml
Result Units: pCi/l
File Name: Manual Entry

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	Lab Qualifier
10028-17-8	H-3	-130 +/- 180	300	400	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 (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: *H30811110-1*

Tritium Analysis By Liquid Scintillation

PAI 704 Rev 9

Laboratory Control Sample(s)

Lab Name: ALS Paragon
Work Order Number: 0811110
Client Name: Cordilleran Compliance Services, Inc.
ClientProject ID: Rulison Area Well monitoring

Lab ID: 3H081120-1LCS

Sample Matrix: WATER
Prep SOP: PAI 700 Rev 10
Date Collected: 20-Nov-08
Date Prepared: 20-Nov-08
Date Analyzed: 22-Nov-08

Prep Batch: 3H081120-1
QCBatchID: 3H081120-1-3
Run ID: 3h081120-1x
Count Time: 120 minutes

Final Aliquot: 9.90 ml
Result Units: pCi/l
File Name: Manual Entry

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10028-17-8	H-3	12400 +/- 1900	300	13000	94.8	85 - 115	P

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: *H30811110-1*

Tritium Analysis By Liquid Scintillation

PAI 704 Rev 9

Matrix Spike Results

Lab Name: ALS Paragon
Work Order Number: 0811110
Client Name: Cordilleran Compliance Services, Inc.
ClientProject ID: Rulison Area Well monitoring

Field ID: A11-15D
Lab ID: 0811110-1MS

Sample Matrix: WATER
Prep SOP: PAI 700
Date Collected: 13-Nov-08
Date Prepared: 20-Nov-08
Date Analyzed: 23-Nov-08

Prep Batch: 3H081120-1
QCBatchID: 3H081120-1-3
Run ID: 3h081120-1x
Count Time: 120 minutes
Report Basis: Unfiltered

Final Aliquot: 9.90 ml
Prep Basis: Unfiltered
Moisture(%): 100.000
Result Units: pCi/l
File Name: Manual Entry

CASNO	Target Nuclide	Matrix Spike	Sample Results	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
10028-17-8	H-3	12200	-50	300	13000	94.2	85 - 115	P

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

Y2 - Chemical Yield outside default limits.

N - Matrix Spike Recovery outside control limits

P - Matrix Spike 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:

MDC - Minimum Detectable Concentration (see PAI SOP 709)

Data Package ID: *H30811110-1*

PARAGON ANALYTICS
Radiochemistry Data Package

Section 4

INDIVIDUAL SAMPLE RESULTS

Tritium Analysis By Liquid Scintillation

PAI 704 Rev 9

Sample Results

Lab Name: ALS Paragon
Work Order Number: 0811110
Client Name: Cordilleran Compliance Services, Inc.
ClientProject ID: Rulison Area Well monitoring

Field ID: A11-15D
Lab ID: 0811110-1

Sample Matrix: WATER
Prep SOP: PAI 700 Rev 10
Date Collected: 13-Nov-08
Date Prepared: 20-Nov-08
Date Analyzed: 23-Nov-08

Prep Batch: 3H081120-1
QCBatchID: 3H081120-1-3
Run ID: 3h081120-1x
Count Time: 120 minutes
Report Basis: Unfiltered

Final Aliquot: 10.0 ml
Prep Basis: Unfiltered
Moisture(%): 100.000
Result Units: pCi/l
File Name: Manual Entry

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	Lab Qualifier
10028-17-8	H-3	-50 +/- 180	300	400	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 (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *H30811110-1*

Tritium Analysis By Liquid Scintillation

PAI 704 Rev 9

Sample Results

Lab Name: ALS Paragon
Work Order Number: 0811110
Client Name: Cordilleran Compliance Services, Inc.
ClientProject ID: Rulison Area Well monitoring

Field ID: A11-15B
Lab ID: 0811110-2

Sample Matrix: WATER
Prep SOP: PAI 700 Rev 10
Date Collected: 13-Nov-08
Date Prepared: 20-Nov-08
Date Analyzed: 22-Nov-08

Prep Batch: 3H081120-1
QCBatchID: 3H081120-1-3
Run ID: 3h081120-1x
Count Time: 120 minutes
Report Basis: Unfiltered

Final Aliquot: 10.0 ml
Prep Basis: Unfiltered
Moisture(%): 100.000
Result Units: pCi/l
File Name: Manual Entry

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	Lab Qualifier
10028-17-8	H-3	30 +/- 180	300	400	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 (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

BDL - Below Detection Limit

Data Package ID: *H30811110-1*

PARAGON ANALYTICS
Radiochemistry Data Package

Section 5

RAW DATA

Tritium Analysis By Liquid Scintillation Raw Data Report

Laboratory Name: ALS Paragon
PAI Work Order: 0811110

Prep SOP: PAI 700
Analytical SOP: PAI 704

Reported on: Tuesday, November 25, 2008 1:39:01 PM

Sample ID / QC Type	Nuclide Type	Sample Date/Time	Prep Batch / QCBatchID	Ingrowth Date /Time	Quench Factor / %Lum	Matrix / %Moist.	Samp Alq / Analy Alq	Inst ID / Det ID	AnRunID / File Name	Count Date/Time	GrossCPM / BkgCPM	BaseEff / ProgEff	CntDur(min) / Yield	Activity +/- 2 s TPU	MDC / DecLev	ReportUnits / ReportBasis	DER / RPD	%Spk. Recov / Flags
0811110-1	H-3	11/13/2008	3H081120-1	NA	144	WATER	50 ml	ls6500	3h081120-1x	11/23/2008	9.320	20.05%	120	-50	300	pCi/l	NA	
SMP	Trg. Analyte	8:40:00 AM	3H081120-1-3	NA	0.02	100	10 ml	33-11	Manual Entry	3:58 AM	9.540	NA	NA	180	NA	Unfiltered	NA	U
0811110-1	H-3	11/13/2008	3H081120-1	NA	146.8	WATER	50 ml	ls6500	3h081120-1x	11/23/2008	63.410	20.05%	120	12200	300	pCi/l	NA	94.2
MS	Trg. Analyte	8:40:00 AM	3H081120-1-3	NA	0.01	100	9.9 ml	33-12	Manual Entry	6:00 AM	9.540	NA	NA	1900	NA	Unfiltered	NA	P
0811110-2	H-3	11/13/2008	3H081120-1	NA	137.8	WATER	50 ml	ls6500	3h081120-1x	11/22/2008	9.680	20.05%	120	30	300	pCi/l	NA	
SMP	Trg. Analyte	8:30:00 AM	3H081120-1-3	NA	0.02	100	10 ml	37-01	Manual Entry	8:47 AM	9.540	NA	NA	180	NA	Unfiltered	NA	U
3H081120-1	H-3	11/20/2008	3H081120-1	NA	147.5	WATER	50 ml	ls6500	3h081120-1x	11/22/2008	8.980	20.05%	120	-130	300	pCi/l	NA	
MB	Trg. Analyte	10:57:16 AM	3H081120-1-3	NA	0.02	NA	10 ml	37-02	Manual Entry	10:48 AM	9.540	NA	NA	180	NA	Unfiltered	NA	U
3H081120-1	H-3	11/20/2008	3H081120-1	NA	146.9	WATER	50 ml	ls6500	3h081120-1x	11/22/2008	63.980	20.05%	120	12400	300	pCi/l	NA	94.8
LCS	Trg. Analyte	10:57:16 AM	3H081120-1-3	NA	0.01	NA	9.9 ml	37-03	Manual Entry	12:49 PM	9.540	NA	NA	1900	NA	Unfiltered	NA	P

Comments:

Data Package ID: *H30811110-1*

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 (see PAI SOP 743)

MDC - Minimum Detectable Concentration (see PAI SOP 709)

DER - Duplicate Error Ratio

BDL - Below Detection Limit

ID: H3- 10 ML GEO. 22 NOV 2008 08:47
USER:13 COMMENT:LS6500

PRESET TIME :	120.00						
DATA CALC :	CPM	H# :YES	SAMPLE REPEATS:	1	PRINTER	: STD
COUNT BLANK :	NO	IC# : NO	REPLICATES :	1	RS232	: OFF
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: 100.0 - 320.0 %ERROR: 1.75 FACTOR: 1.000000 BKG. SUB: 0
CHAN: 380.0 - 990.0 %ERROR:20.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN	H#	WIND1 CPM	WIND1 %ERROR	WIND2 CPM	WIND2 %ERROR	LUMEX %	ELAPSED TIME
1	33-1	120.00	147.6	9.50	5.92	39.67	2.90	0.03	121.45
2	33-2	120.00	147.0	9.41	5.95	39.62	2.90	0.04	242.99
3	33-3	120.00	147.6	43.36	2.77	41.03	2.85	0.02	364.53
4	33-4	120.00	149.0	10.11	5.74	40.70	2.86	0.02	486.06
5	33-5	120.00	148.1	34.37	3.11	40.56	2.87	0.02	607.59
6	33-6	120.00	148.6	35.47	3.07	41.72X	2.83	0.02	729.13
7	33-7	120.00	147.8	11.20	5.46	41.09	2.85	0.02	850.66
8	33-8	120.00	147.7	9.67	5.87	40.46	2.87	0.02	972.18
9	33-9	56.80	148.0	229.96	1.75	40.97	4.15	0.00	1030.04
10	33-10	120.00	147.9	91.42	1.91	41.12	2.85	0.01	1151.57
11	33-11	120.00	144.0	9.32	5.98	42.01X	2.82	0.02	1273.10
12	33-12	120.00	146.8	63.41	2.29	39.97	2.89	0.01	1394.62

X ABOVE UCL OF 41.58.

MC
11/25/08

OK
MC
11/23/08

ID: H3— 10 ML GEO. 23 NOV 2008 08:57
USER:13 COMMENT:LS6500

PRESET TIME :	120.00						
DATA CALC :	CPM	H# :	YES	SAMPLE REPEATS:	1	PRINTER	: STD
COUNT BLANK :	NO	IC# :	NO	REPLICATES :	1	RS232	: OFF
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: 100.0 - 320.0 %ERROR: 1.75 FACTOR: 1.000000 BKG. SUB: 0
CHAN: 380.0 - 990.0 %ERROR:20.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN		H#	WIND1 CPM	WIND1 %ERROR	WIND2 CPM	WIND2 %ERROR	LUMEX %	ELAPSED TIME
1	37-1	120.00	137.8		9.68	5.87	38.31	2.95	0.02	121.43
2	37-2	120.00	147.5		8.98	6.09	39.61	2.90	0.02	242.96
3	37-3	120.00	146.9		63.98	2.28	39.58	2.90	0.01	364.49
4	37-4	120.00	147.7		9.46	5.94	39.41	2.91	0.03	486.02

MC 11/24/08

LSC Run Log

Instrument ID: LS 6500

364874

	Date	Sample ID	CountTime (min.)	Rack & Position	Test	User #	Batch ID	Position Check	Initials	Comments
1	11/20/08	3H081103-1MB	180	19 - 7	H3-10mL	5	3H081103-1	MC	MC	NA
2		-1LCS		- 8						
3		-1LCSD		- 9						
4		-1CB3		- 10						
5	11/21/08	DAILY Q.C.	10	1 - 1-4	—		—	MC		
6				-						
7	11/21/08	3H081112-1CB1	70	17 - 1	H3-10mL	5	3H081112-1	MC	MC	RECOUNT; MDC NOT MET
8		08102Z45-4	2.3	- 2						
9		Z74-1	2.55	- 3						
10		2	1.65	- 4						
11		3	2.55	- 5						
12		08110Z4-6	70	- 6						
13		6D		- 7						
14		3H081112-1CB2		- 8						
15		08110Z4-14		- 9						
16		14MS		- 10						
17		053-6		- 11						
18		8		- 12						
19		11		14 - 1						
20		14		- 2						
21		3H081112-1MB		- 3						
22		-1LCS		- 4						
23		-1CB3		- 5						
24	11-22-08	3H081120-1CB1	120	33 - 1	H3-10mL	13	3H081120-1	MC	MC	NA
25		08110Z0-15		- 2						
26		093-4		- 3						
27		7		- 4						
28		4		- 5						
29		9D		- 6						
30		11		- 7						

Reviewed by / Date MC 11/25/08

FORM 762r5.XLS (12/18/2006)

LSC Run Log

Instrument ID: LS 6500

364875

	Date	Sample ID	CountTime (min.)	Rack & Position	Test	User #	Batch ID	Position Check	Initials	Comments
MC 11/23/08	11/22/08	340811Z0-1CBZ	~~56.8~~ 120	33 - 8	H3-10mL	13	340811Z0-1	MC	MC	NA
2	↓	0811093-13	+20 568	↓ - 9	↓	↓	↓	↓	↓	↓
3		↓ 15	120	↓ - 10						
4		0811110-1	↓	↓ - 11						
5		↓ 1MS	↓	↓ - 12	↓	↓	↓	↓	↓	
6	11/23/08	DAILY Q.C.	10	1 - 1-4	—	1	—	MC	↓	
7	↓	0811110-2	120	37 - 1	H3-10mL	13	340811Z0-1	↓	MC	
8		340811Z0-1MB	↓	↓ - 2	↓	↓	↓		↓	
9		↓ -1LCS		↓ - 3						
10		↓ -1CB3	↓	↓ - 4	↓	↓	↓	↓		
11	11/23/08	DAILY Q.C.	10	1 - 1-4	—	1	—	MC	↓	
12				-						
13				-						
14				-						
15				-						
16				-						
17				-						
18				-						
19				-						
20				-		MC				
21				-		11/25/08				
22				-						
23				-						
24				-						
25				-						
26				-						
27				-						
28				-						
29				-						
30				-						

Reviewed by / Date MC 11/25/08

FORM 762r5.XLS (12/18/2006)

PARAGON ANALYTICS
Radiochemistry Data Package

Section 6

QUALITY ASSURANCE SUMMARY REPORTS

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

PARAGON ANALYTICS
Radiochemistry Data Package

Section 7

LABORATORY BENCH SHEETS

Radiochemistry Instrument Worksheet

Paragon Analytics

Prep Batch: 3H081120-1

Prep Procedure: H3 10-mL

Analytical QASS / NCR? (Y) / N 11026

Prep Num	LabID	QC Type	Init Alq	Fin Alq	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
11/27 1	0811010-15	SMP	50	10	ml	pCi/l	L5-6500	33-2	MC							
12/10 1	0811093-4	SMP	50	10	ml	pCi/l		3								
1	0811093-7	SMP	50	10	ml	pCi/l		4								
1	0811093-8	SMP	50	10	ml	pCi/l		5								
1	0811093-9	DUP	50	10	ml	pCi/l		6								
1	0811093-11	SMP	50	10	ml	pCi/l		7								
1	0811093-13	SMP	50	10	ml	pCi/l		9								
1	0811093-15	SMP	50	10	ml	pCi/l		10								
12/8 1	0811110-1	SMP	50	10	ml	pCi/l		11								
1	0811110-1	MS	50	9.901	ml	pCi/l		12								
1	0811110-2	SMP	50	10	ml	pCi/l		37-1								
1	3H081120-1CB1	MB	50	10	ml	pCi/l		33-1								
1	3H081120-1CB2	MB	50	10	ml	pCi/l		8								
1	3H081120-1CB3	MB	50	10	ml	pCi/l		37-4								
1	3H081120-1	MB	50	10	ml	pCi/l		37-2								
1	3H081120-1	LCS	50	9.801	ml	pCi/l		3								

MC 11/25/08

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	648.3610.05	2,694.841	DPM/ml	11/20/08	0.5	ml	ST-002

Reporting Units

LabID:	TstGrpName:	RptUnits:
0811110-1	H3	pCi/l
0811110-2	H3	pCi/l
0811093-4	H3_BJC_STD	pCi/l
0811093-7	H3_BJC_STD	pCi/l
0811093-9	H3_BJC_STD	pCi/l
0811093-11	H3_BJC_STD	pCi/l
0811093-13	H3_BJC_STD	pCi/l
0811093-15	H3_BJC_STD	pCi/l
0811010-15	H3_ITLV	pCi/l

Sample Barcodes

0811010-15 3H081120-1PS1	0811093-4 3H081120-1PS2
0811093-7 3H081120-1PS3	0811093-9 3H081120-1PS4
0811093-9DUP 3H081120-1PS5	0811093-11 3H081120-1PS6
0811093-13 3H081120-1PS7	0811093-15 3H081120-1PS8
0811110-1 3H081120-1PS9	0811110-1MS 3H081120-1PS10
0811110-2 3H081120-1PS11	3H081120-1CB1MB 3H081120-1PS12
3H081120-1CB2MB 3H081120-1PS13	3H081120-1CB3MB 3H081120-1PS14
3H081120-1MB 3H081120-1PS15	3H081120-1LCS 3H081120-1PS16

Radiochemistry Prep Worksheet

Paragon Analytics

Prep Batch: 3H081120-1

Prep Procedure: H3

Reviewed By: gdw GDW **Review Date:** 11/20/2008

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 700 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Gabriel D. Wagner GDW
Prep Date: 11/20/2008
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet: RS-101

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0811010-15	SMP		50	10	Unfiltered	0	100	10		
2	1	0811093-4	SMP		50	10	Unfiltered	0	100	10		
3	1	0811093-7	SMP		50	10	Unfiltered	0	100	10		
4	1	0811093-9	SMP		50	10	Unfiltered	0	100	10		
5	1	0811093-9	DUP		50	10	Unfiltered	0	100	10		
6	1	0811093-11	SMP		50	10	Unfiltered	0	100	10		
7	1	0811093-13	SMP		50	10	Unfiltered	0	100	10		
8	1	0811093-15	SMP		50	10	Unfiltered	0	100	10		
9	1	0811110-1	SMP		50	10	Unfiltered	0	100	10		
10	1	0811110-1	MS		50	9.900990	Unfiltered	0	100	10	S1	
11	1	0811110-2	SMP		50	10	Unfiltered	0	100	10		
12	1	3H081120-1CB1	MB		50	10	Unfiltered	0	100	10		
13	1	3H081120-1CB2	MB		50	10	Unfiltered	0	100	10		
14	1	3H081120-1CB3	MB		50	10	Unfiltered	0	100	10		
15	1	3H081120-1	MB		50	10	Unfiltered	0	100	10		
16	1	3H081120-1	LCS		50	9.900990	Unfiltered	0	100	10	S1	

GDW 11-20-08 GDW 11-20-08 GDW 11-20-08 GDW 11-20-08

Comments
UG LLT #97-080701

Spiked By: Gabriel D. Wagner GDW **Date:** 11/20/2008

Witnessed By: Jeff Kujawa **Date:** 11/20/2008

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	848.3610.05	2,894.841	DPM/ml	11/20/08	0.5	ml	ST-002

Paragon Analytics

Radiochemistry Prep Worksheet

Prep Batch: 3H081120-1

Prep Procedure: H3

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 700 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Gabriel D. Wagner GDW
Prep Date: 11/20/2008
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet: RS-101

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0811010-15	SMP		50	10	Unfiltered	0	100	10		
2	1	0811093-4	SMP		50	10	Unfiltered	0	100	10		
3	1	0811093-7	SMP		50	10	Unfiltered	0	100	10		
4	1	0811093-9	SMP		50	10	Unfiltered	0	100	10		
5	1	0811093-9	DUP		50	10	Unfiltered	0	100	10		
6	1	0811093-11	SMP		50	10	Unfiltered	0	100	10		
7	1	0811093-13	SMP		50	10	Unfiltered	0	100	10		
8	1	0811093-15	SMP		50	10	Unfiltered	0	100	10		
9	1	0811110-1	SMP		50	10	Unfiltered	0	100	10		
10	1	0811110-1	MS		50	9.900990	Unfiltered	0	100	10	S1	
11	1	0811110-2	SMP		50	10	Unfiltered	0	100	10		
12	1	3H081120-1	MB		50	10	Unfiltered	0	100	10		
13	1	3H081120-1	LCS		50	9.900990	Unfiltered	0	100	10	S1	

Comments
UG LLT #97-080701

Spiked By: Gabriel D. Wagner GDW **Date:** 11-20-2008
Witnessed By: _____ **Date:** 11/20/08

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	648.3610.05	2,894.841	DPM/ml	11/20/08	0.5	ml	ST-002

Exp. 4/30/09

SAMPLE CONDITION FORM (LIQUID)

ANALYST: GDW

ANALYSIS DATE: 11-20-08 METHOD: 3H

WORK ORDER	SAMPLE ID	SAMPLE CONDITION		
		pH	Color	Remarks
0811010	15	5	Lt. Brown	Lt. sediment
0811093	4	6	clear	none
↓	7	↓	↓	↓
	9			
	11			
	13			
↓	15		↓	↓
0811110	1	6	orangish brown	Strong fuel odor moderate suspended sediment
↓	2	7	↓	↓
				GDW 11-20-08

TRITIUM RUN LOG

358352 Logbook/Page No. SOP 700 Rev 10 Form 1306r1.doc (3/30/2003)

Date	Workorder/ Sample Number	Column ID	Flask ID	Run No.	Comments	Technician's Initials
11-12-08	0811034-14	A	T14	2	3H081112-1	GDW
	-14ms	B	T29			
	0811053-11	C	T20			
	-14	D	T16			
	3H081112-1mb	E	T30			
	-1lcs	F	T17			
	0811053-6	A	T23	3		
	-8	B	T27			
11-20-08	0811010-15	A	T15	1	3H081120-1	GDW
	0811093-4	B	T17			
	-7	C	T14			
	-9	D	T21			
	-9D	E	T30			
	-11	F	T20			
	-13	A	T28	2		
	-15	B	T10			
	0811110-2	C	T23			
	3H081120-1mb	D	T24			
	0811110-1	A	T16	3		
	-1ms	B	T27			
	3H081120-1lcs	C	T6			
11-20-08	~~3H081100 GDW 11-20-08~~ 3H081119-1 MB	N/A	N/A	1	3H081119-1 SOP 754 r5	GDW
	-1lcs					
	6810010-1					

Reviewed by / Date 11/20/08

PARAGON ANALYTICS
Radiochemistry Data Package

Section 8

STANDARDS TRACEABILITY DOCUMENTS

Prepare a working dilution of ~ 4,000 dpm/ml of ^3H, 648.2382.75.

1) Determine density of DI water — bal**

Mass of 100 ml vol. flask	68.2975 g	12
Mass of flask and 100 ml DI H_2O	168.0291 g	1
Net Mass of water	99.7316 g	

4/28/08 JDD $\rho = .9973$ g/ml

2) Transfer Std.

Mass of empty Amber jar (No lid)	257.75 g	26
Mass of Jar + Std transfered	264.58 g	1
* Net Mass of Std. Transferred	6.8506 g	12
↳ from below. JDD 4/28/08		

4) Dilute to Final Vol. w/ DI water

Mass of Std., H_2O, Jar	750.9 g	26
Mass of Jar from above	257.75 g	
Net Mass of new dilution.	493.15 g	

* Standard was transferred by difference from a plastic cup

Mass of Cup and ~10 g of Standard	23.6533 g	12
Mass of Cup and Std. [Not] Transferred	16.8027 g	1

Final Activity Calculation

$$\frac{\left(369{,}530.45 \frac{dpm}{ml}\right)(6.8506\,g)(.9973\,g/ml)}{(.9958\,g/ml)(493.15\,g)} = 5141.07 \frac{dpm}{g} \quad \text{JDD } 4/28/08$$

$$5141.07 \frac{dpm}{ml}$$

Stnd ID: 648.3610.05

MC 7/13/08

Description: H-3
Expiration: 4/30/2009
Activity: 5141.07 dpm/mL
MC 7/13/08
2s Uncertainty: 37.02 dpm/mL
Ref. Date: 9/3/1998
Ref Time: N/A
Prep Date: 4/30/2008 Prep by: JD
Matrix/Comp. DI WATER
Half Life (y): 1.23E+01

Reverification Log		
Analysis Date	Initials	Expiration Date
		MC 7/13/08

Page

Signed 4/28/08 Date

MC 7/13/08 Signed 7/13/08 Date

Prepare a ~~working level dilution (at approximately 2500 DPM/mL)~~ 10 dilution tritium standard using RSO #642 and diluting with DI water.

1) Determine the density of DI water:

Mass of empty 100mL class A volumetric flask	67.1522 g	Bal #13
Mass of flask + water	166.7351 g	↓
Net mass of 100mL H_2O	99.5829 g	

$\rho = .9958$ g/mL

2) Transfer contents of Ampoule SRM 4927F to a ~~40mL VOA vial~~ 500mL glass amber bottle
~~CW 3/17/03~~ CW 3/17/03 bottle

mass of ~~40mL VOA vial~~ bottle w/o lid	255.04g	Bal #26
mass of open ampoule + 50mL beaker	40.9075g	Bal #12
mass of empty ampoule + 50mL beaker	36.0148g	↓
Net mass of Std.	4.8927 g	

3) Dilute Std. with DI water.

mass of bottle w/o lid	255.04 g	Bal #26
mass of bottle, Std, + DI water	757.1 g	↓
Net mass of Std + DI water	502.1g	

4. Final Activity Calculation.

$$\frac{(634.7\ \text{kBq/g})(1000\ \text{Bq/kBq})(60\ \text{DPM/Bq})(4.8927\ \text{g})(.9958\ \text{g/mL})}{502.1\ \text{g}}$$

$= 369,530.45\ \frac{\text{DPM}}{\text{mL}}$

U.S. Department of Commerce
National Institute of Standards and Technology
SRM 4927F
Hydrogen-3
<4 MBq in distilled water

CAUTION RADIOACTIVE

Continued on Page

Read and Understood By

Signed 3/27/03 Date

Signed 3/27/03 Date

National Institute of Standards & Technology

Certificate

PA ID 0648
rec'd 12-04-02

Standard Reference Material 4927F
Hydrogen-3 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive hydrogen-3, as water, 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 beta-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains hydrogen-3 with a total activity of approximately 3.2 MBq. Hydrogen-3 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. There is no detectable external radiation. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains only distilled water. There is no chemical hazard. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

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 September 2008.

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) because of the radioactivity.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, L.R. Karam, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas and M.P. Unterweger of the Radioactivity Group.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by J.W.L. Thomas.

Bert M. Coursey, Chief
Ionizing Radiation Division

Nancy M. Trahey, Chief
Standard Reference Materials Program

Gaithersburg, Maryland 20899
June 1999
Half-life and text revised October 2000

*Notes and references are on pages 5 and 6.

Recommended Procedure for Opening the SRM Ampoule

1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition 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.

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 and 6.

PROPERTIES OF SRM 4927F

Certified values

Solution density	**(0.998 ± 0.002) g·mL^{-1} at 20.0 °C [b]***
Radionuclide	**Hydrogen-3**
Reference time	**1200 EST, 3 September 1998**
Massic activity of the solution [c]	**634.7 kBq·g^{-1}**
Relative expanded uncertainty (k=2)	**0.72% [d] [e]**

Uncertified values

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 mass	Approximately 5.0 g		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L^{-1})	Mass Fraction (g·g^{-1})
	H_2O ^3HHO	55 6×10^{-7}	1.00 1×10^{-8}
Radiological Properties:			
Radionuclidic impurities	None detected [f]		
Half lives used	Hydrogen-3: (4500 ± 8) d [g]		
Calibration method and measuring instrument(s)	4πß gas counting of SRM 4927E using the NIST length-compensated internal gas proportional counters and intercomparison of SRMs 4927E/4927F using two 4πß liquid-scintillation counting systems [h]		

*Notes and references are on pages 5 and 6.

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

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 count rate of SRM 4927E, corrected for background and decay [h]	Standard deviation of the mean for 23 sets of gas counting measurements (A)	0.18	1.0	0.18
Gram-mole measurements	Estimated (B)	0.20	1.0	0.20
Live-time [p]	Estimated (B)	0.10	1.0	0.10
Extrapolation of count-rate-versus-energy to zero energy	Estimated (B)	0.20	1.0	0.20
Half life of H-3	Standard uncertainty of the half life (A)	0.18 [m]	0.009 [n]	0.002
Liquid-scintillation intercomparison of SRM 4927F and SRM 4927E	Standard deviation of the mean for 7 sets of liquid-scintillation measurements (A)	0.06	1.0	0.06
Radionuclidic impurities	Limit of detection (B) [q]	100.	0.0005	0.05
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.36
Coverage Factor, k				x 2
Relative Expanded Uncertainty of the Output Quantity, U/y, (%)				0.72

*Notes and references are on pages 5 and 6.

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 (Not detectable)

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

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

[d] The reported value, y, of massic activity (activity 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, $u_i(y) = |\partial y/\partial x_i| \cdot u(x_i)$, 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 activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity 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].

[e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the massic response is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).

[f] The estimated limit of detection for radionuclidic impurities is 300 $Bq \cdot g^{-1}$.

[g] The stated uncertainty is the standard uncertainty. See reference [5].

[h] Extensive gas-counting measurements were made on the SRM 4927E solution during 1998 and 1999. The SRM 4927F solution was intercompared with the SRM 4927E solution using liquid-scintillation counting.

[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] 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.

[n] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$

[p] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.

[q] 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 H-3)}·{(Bq of impurity)/(Bq of H-3)}. 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] L.L. Lucas and M.P. Unterweger, *Comprehensive Review and Critical Evaluation of the Half-Life of Tritium*, J. Res. Natl. Inst. Stand. Technol. **105**, 541-549 (2000).

PARAGON ANALYTICS
Radiochemistry Data Package

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

Liquid Scintillation Counter

Instrumentation Calibration

Initial Efficiency Calibration
Standards Traceability

LS6500 10mL geometry Tritium Background Determination

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 (10 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 on 9/2/08 LNT

							Individual Reagent Blanks			Average of Reagent Blanks		
COUNT DATE	#	Sample ID	Count Duration (m)	Count Rate (CPM)	Total Cts.	Mean	LCL	UCL	Pass ?	LCL	UCL	Pass ?
11/22/2008	37	3H081120-1CB1	120	9.50	1140.00		8.23	10.77	PASS			
11/22/2008	38	3H081120-1CB2	120	9.67	1160.40		8.23	10.77	PASS			
11/23/2008	39	3H081120-1CB3	120	9.46	1135.20	9.54	8.23	10.77	PASS	8.23	10.77	PASS

Tritium "Window 2" Control Limits (LS 6500)

The background count rate is determined from the average of the reagent blanks for the batch. Window 2 control limits are established using the average count rate from the three reagent blanks associated with each prep batch +/- 3X the estimated poisson uncertainty.

Updated 9/2/08 LNT

COUNT DATE	Sample ID	Count Duration (min.)	**Average count Duration (min.)**	Count Rate (CPM)	Batch Average Reagent Blank	**Lower Control Limit**	**Upper Control Limit**	**PASS/ FAIL**
11/22/2008	3H081120-1CB1	120		39.67				
11/22/2008	3H081120-1CB2	120		40.46				
11/23/2008	3H081120-1CB3	120	**120**	39.41	39.85	**38.12**	**41.58**	
	0811093-13	57		40.97		**37.33**	**42.36**	**PASS**

10-mL Tritium Efficiency Calibration LS6500

10 mL sample + 10 mL Ultima Gold LLT
8/27/2008
LS6500

Standard used: 699.2613.19

94000.71	dpm/ml as of	9/3/1998
1/2 life =	1.23E+01	yrs.
current activity =	53558.31	dpm/ml
volume =	0.1961	ml
Average Spike Activity =	10501.61	dpm

Sample ID	WIND1 cpm	WIND2 cpm	%LUMEX	H #	
0723514-10LCS	2156.23	44.10	0.00	143.8	
0723514-11LCS	2096.00	47.36	0.00	144.8	
0723514-12LCS	2093.28	39.52	0.00	144.6	
0723514-07MB	9.43	42.44	0.02	144.8	
0723514-08MB	9.77	40.97	0.01	143.8	
0723514-09MB	9.43	41.48	0.01	144.2	
average LCS=	2115.17	41.63	0.01	144.3	averages
average bkg=	9.54				
net cpm=	2105.63	**WIND2 cpm**	**%LUMEX**	**H #**	
/known dpm=	10501.61	**44.13**	**5.00**	**159.3**	**UCL**
		39.13	**0.00**	**129.3**	**LCL**
efficiency=	**0.2005**	See Tech. Mgr.	See Tech. Mgr.	Std. Addition	**Corrective Action**

Instrument Technician: Lindsay Tearman 8/29/08
Signature & Date

Supervisory Review: [signature] 9/3/08
Signature & Date

^{3}H Efficiency Calibration Verification / Method Blank Verification 8/27/08

Calibration Source Check

LS 6500
Analysis Date: 8/27/2008
Nuclide: ^{3}H
Half Life: 1.23E+01 yrs

Calibration Check Source:

Spike Standard: 648.3020.69
Reference Date : 9/3/1998
Spiked DPM/mL : 4011.21 dpm/mL
Spike Volume : 0.5 mL
Spiked into : 50.0 mL
Current Spk. Act. : 10.74 pCi/mL

CONTROL LIMITS: 85%-115%

Calibration Check Source Count

Sample ID	Position	Prep Date	Cnt. Dur.	Anal. Vol.	GrsCPM	BkgCPM	Efficiency	Activity	Units	Chem. Yield	LCS Recovery:	Pass/Fail
0723516-10LCS	57-10	11/28/2007	75	9.90099	54.75	9.54	0.2005	10.70	pCi/mL	100%	99.6%	PASS
0723516-11LCS	57-11	11/28/2007	75	9.90099	54.53	9.54	0.2005	10.65	pCi/mL	100%	99.2%	PASS
0723516-12LCS	57-12	11/28/2007	75	9.90099	54.84	9.54	0.2005	10.72	pCi/mL	100%	99.8%	PASS

Method Blank Check Count

Sample ID	Rack	Prep Date	Cnt. Dur.	Anal. Vol.	GrsCPM	BkgCPM	Efficiency	Chem. Yield	k (denom.)	activity	MDC	Pass/Fail	Units	2s CU	1σ IU 0.056	1σ PU 0.051	2σ TPU
															2σ IU	2σ PU	
0723516-07MB	57-7	11/28/2007	75	10	9.17	9.54	0.2005	100%	4.268	-0.0875	0.39	PASS	pCi/mL	0.234	-0.00980	-0.00892	0.234
0723516-08MB	57-8	11/28/2007	75	10	9.44	9.54	0.2005	100%	4.268	-0.0242	0.40	PASS	pCi/mL	0.236	-0.00271	-0.00247	0.236
0723516-09MB	57-9	11/28/2007	75	10	10.01	9.54	0.2005	100%	4.268	0.1094	0.41	PASS	pCi/mL	0.239	0.01225	0.01115	0.240

ID=H3— 10 ML GEO. 27 AUG 2008 11:59
USER:13 COMMENT:LS6500

PRESET TIME :	75.00								
DATA CALC :	CPM	H#	:YES	SAMPLE REPEATS:	1	PRINTER	: STD
COUNT BLANK :	NO	IC#	: NO	REPLICATES :	1	RS232	: OFF
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: 100.0 - 320.0 %ERROR: 1.75 FACTOR: 1.000000 BKG. SUB: 0
CHAN: 380.0 - 990.0 %ERROR:20.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN	H#	WIND1 CPM	WIND1 %ERROR	WIND2 CPM	WIND2 %ERROR	LUMEX %	ELAPSED TIME
1	57-1	75.00	144.8	9.43	7.52	42.44	3.54	0.02	76.08
2	57-2	75.00	143.8	9.77	7.39	40.97	3.61	0.01	152.26
3	57-3	75.00	144.2	9.43	7.52	41.48	3.59	0.01	228.42
4	57-4	6.10	143.8	2156.23	1.74	44.10	12.19	0.00	235.17
5	57-5	6.25	144.8	2096.00	1.75	47.36	11.62	0.00	242.11
6	57-6	6.25	144.6	2093.28	1.75	39.52	12.73	0.00	249.02
7	57-7	75.00	144.7	9.17	7.62	41.17	3.60	0.02	325.20
8	57-8	75.00	144.6	9.44	7.52	41.17	3.60	0.01	401.38
9	57-9	75.00	145.0	10.01	7.30	41.83	3.57	0.01	477.56
10	57-10	75.00	145.6	54.75	3.12	41.84	3.57	0.01	553.74
11	57-11	75.00	145.0	54.53	3.13	40.64	3.62	0.01	629.94
12	57-12	75.00	144.2	54.84	3.12	41.89	3.57	0.01	706.12

JS 8/28/08

LSC Run Log

Instrument ID: LS 6500

364841

	Date	Sample ID	CountTime (min.)	Rack & Position	Test	User #	Batch ID	Position Check	Initials	Comments
1	8/27/08	0723514-07 MB	75	57 - 1	H3-10mL	13	3H071126-1	JS	JS	H-3 10mL S.P. Calib.
2		-08 MB		-2						
3		-09 MB	↓	-3						
4		-10 LCS	6.10	-4						
5		-11 LCS	6.25	-5						
6		-12 LCS	↓	-6						
7		0723516-07MB	75	-7			3H071128-1			
8		-08MB		-8						
9		-09MB		-9						
10		-10 LCS		-10						
11		-11 LCS		-11						
12	↓	-12 LCS	↓	↓ -12	↓	↓	↓	↓	↓	↓
13	8/28/08	3H080817-1CB1	40	30 - 1	H3-10mL	11	3H080817-1	JS	JS	N/A
14		0808081-1		-2						
15		-2		-3						
16		-3		-4						
17		-4		-5						
18		-5		-6						
19		-6		-7						
20		-7		-8						
21		-8		-9						
22		-9		-10						
23		-10		-11						
24		-10D		↓ -12						
25		-10MS		31 - 1						
26		3H080817-1CB2		-2						
27		0808081-11		-3						
28		-12		-4						
29		-13		-5						
30	↓	-14	↓	↓ -6	↓	↓	↓	↓	↓	↓

Reviewed by / Date JS 8/29/08

FORM 7627-5.XLS (12/18/2006)

Radiochemistry Instrument Worksheet

Paragon Analytics

Prep Batch: 3H071126-1

Prep Procedure: H3 – 5mL (10mL) Single Point Calibration

Analytical QASS / NCR? Y (N) N/A

Prep Num	LabID	QC Type	Init Alq	Fin Alq	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	0723514-01	MB	50	5	ml										
1	0723514-02	MB	50	5	ml										
1	0723514-03	MB	50	5	ml										
1	0723514-04	LCS	50	4.901961	ml										
1	0723514-05	LCS	50	4.901961	ml										
1	0723514-06	LCS	50	4.901961	ml										
1	0723514-07	MB	50	10	ml										
1	0723514-08	MB	50	10	ml										
1	0723514-09	MB	50	10	ml										
1	0723514-10	LCS	50	9.803922	ml										
1	0723514-11	LCS	50	9.803922	ml										
1	0723514-12	LCS	50	9.803922	ml										

JS 8/27/08

LS6500 57-1 JS

-2
-3
-4
-5
-6

JS 8/28/08

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	699.2613.19	55,943.587	DPM/ml	11/26/07	1	ml	RS-006

Sample Barcodes

0723514-01MB 3H071126-1PS1	0723514-02MB 3H071126-1PS2
0723514-03MB 3H071126-1PS3	0723514-04LCS 3H071126-1PS4
0723514-05LCS 3H071126-1PS5	0723514-06LCS 3H071126-1PS6
0723514-07MB 3H071126-1PS7	0723514-08MB 3H071126-1PS8
0723514-09MB 3H071126-1PS9	0723514-10LCS 3H071126-1PS10
0723514-11LCS 3H071126-1PS11	0723514-12LCS 3H071126-1PS12

Paragon Analytics

Radiochemistry Prep Worksheet

Prep Batch: 3H071126-1

Prep Procedure: H3

Reviewed By: JRK Review Date: 11/28/2007

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

Prep SOP: PAI 700 Rev: 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeff Kujawa
Prep Date: 11/26/2007
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0723514-01	MB		50	5	Unfiltered	0	100	5		
2	1	0723514-02	MB		50	5	Unfiltered	0	100	5		
3	1	0723514-03	MB		50	5	Unfiltered	0	100	5		
4	1	0723514-04	LCS		50	4.901961	Unfiltered	0	100	5	S1	
5	1	0723514-05	LCS		50	4.901961	Unfiltered	0	100	5	S1	
6	1	0723514-06	LCS		50	4.901961	Unfiltered	0	100	5	S1	
7	1	0723514-07	MB		50	10	Unfiltered	0	100	10		
8	1	0723514-08	MB		50	10	Unfiltered	0	100	10		
9	1	0723514-09	MB		50	10	Unfiltered	0	100	10		
10	1	0723514-10	LCS		50	9.803922	Unfiltered	0	100	10	S1	
11	1	0723514-11	LCS		50	9.803922	Unfiltered	0	100	10	S1	
12	1	0723514-12	LCS		50	9.803922	Unfiltered	0	100	10	S1	

Spiked By: Jeff Kujawa Date: 11/26/2007

Witnessed By: Derek B. Caduff Date: 11/26/2007

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	699.2613.19	55,943.587	DPM/ml	11/26/07	1	ml	RS-006

Comments
UG LLT LOT# 97-070701.

Paragon Analytics

Radiochemistry Prep Worksheet

Prep Batch: 3H071126-1

Prep Procedure: H3

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 700 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeff Kujawa
Prep Date: 11/26/2007
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0723514-01	MB		50	5	Unfiltered	0	100	5		
2	1	0723514-02	MB		50	5	Unfiltered	0	100	5		
3	1	0723514-03	MB		50	5	Unfiltered	0	100	5		
4	1	0723514-04	LCS		50	4.901961	Unfiltered	0	100	5	S1	
5	1	0723514-05	LCS		50	4.901961	Unfiltered	0	100	5	S1	
6	1	0723514-06	LCS		50	4.901961	Unfiltered	0	100	5	S1	
7	1	0723514-07	MB		50	10	Unfiltered	0	100	10		
8	1	0723514-08	MB		50	10	Unfiltered	0	100	10		
9	1	0723514-09	MB		50	10	Unfiltered	0	100	10		
10	1	0723514-10	LCS		50	9.803922	Unfiltered	0	100	10	S1	
11	1	0723514-11	LCS		50	9.803922	Unfiltered	0	100	10	S1	
12	1	0723514-12	LCS		50	9.803922	Unfiltered	0	100	10	S1	

Spiked By: **Date:** 11/26/07
Witnessed By: **Date:** 11/26/07

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	699.2613.19	55,943.587	DPM/ml	11/26/07	1	ml	RS-006

exp: 8/13/08

Comments
S1 UG LLT LOT# 97-070701.

TRITIUM RUN LOG

319185 Logbook/Page No. SOP 700 Rev 10 Form 1306r1.doc (3/30/2003)

Date	Workorder/ Sample Number	Column ID	Flask ID	Run No.	Comments	Technician's Initials
11/20/07	0711002S-1D	N/A	N/A	9	Batch 3H071114-2 SOP 754 R5	EMF
11/26/07	0723514-1, 7	A	T2	2	Batch 3H071126-1	JLG
	-2, 8	A	T7	1		
	-3, 9	B	T8			
	-4, 10	C	T11			
	-5, 11	D	102			
	-6, 12	F	600			
11/27/07	0723516-1, 7	A	102	1	Batch 3H071127-1	JLG
	-2, 8	B	600			
	-3, 9	C	T2			
	-4, 10	D	T7			
	-5, 11	E	T8			
	-6, 12	F	T11			

JLG 11/28/07

Reviewed by / Date JLG 11/28/07

Radiochemistry Instrument Worksheet

Paragon Analytics

Prep Batch: 3H071128-1

Prep Procedure: H3- ICB, ICV's (5, 10ml) 5.P. Calibration)

Analytical QASS / NCR? Y / (N) / N/A

Prep Num	LabID	QC Type	Init Alq	Fin Alq	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	0723516-01	MB	50	5	ml										
1	0723516-02	MB	50	5	ml										
1	0723516-03	MB	50	5	ml										
1	0723516-04	LCS	50	4.950495	ml										
1	0723516-05	LCS	50	4.950495	ml										
1	0723516-06	LCS	50	4.950495	ml										
1	0723516-07	MB	50	10	ml										
1	0723516-08	MB	50	10	ml										
1	0723516-09	MB	50	10	ml										
1	0723516-10	LCS	50	9.900990	ml										
1	0723516-11	LCS	50	9.900990	ml										
1	0723516-12	LCS	50	9.900990	ml										

LS6500 57-7 JS 8/27/08

-8
-9
-10
-11
-12

JS 8/28/08

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
*S1	H-3	648.3020.69	2,386.637	DPM/ml	11/28/07	0.5	ml	RS-003

Sample Barcodes

0723516-01MB
3H071128-1PS1

0723516-02MB
3H071128-1PS2

0723516-03MB
3H071128-1PS3

0723516-04LCS
3H071128-1PS4

0723516-05LCS
3H071128-1PS5

0723516-06LCS
3H071128-1PS6

0723516-07MB
3H071128-1PS7

0723516-08MB
3H071128-1PS8

0723516-09MB
3H071128-1PS9

0723516-10LCS
3H071128-1PS10

0723516-11LCS
3H071128-1PS11

0723516-12LCS
3H071128-1PS12

Radiochemistry Prep Worksheet

Paragon Analytics

Prep Batch: 3H071128-1

Prep Procedure: H3

Reviewed By: JRK **Review Date:** 11/28/2007

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

Prep SOP: PAI 700 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeff Kujawa
Prep Date: 11/28/2007
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0723516-01	MB		50	5	Unfiltered	0	100	5		
2	1	0723516-02	MB		50	5	Unfiltered	0	100	5		
3	1	0723516-03	MB		50	5	Unfiltered	0	100	5		
4	1	0723516-04	LCS		50	4.950495	Unfiltered	0	100	5	S1	
5	1	0723516-05	LCS		50	4.950495	Unfiltered	0	100	5	S1	
6	1	0723516-06	LCS		50	4.950495	Unfiltered	0	100	5	S1	
7	1	0723516-07	MB		50	10	Unfiltered	0	100	10		
8	1	0723516-08	MB		50	10	Unfiltered	0	100	10		
9	1	0723516-09	MB		50	10	Unfiltered	0	100	10		
10	1	0723516-10	LCS		50	9.900990	Unfiltered	0	100	10	S1	
11	1	0723516-11	LCS		50	9.900990	Unfiltered	0	100	10	S1	
12	1	0723516-12	LCS		50	9.900990	Unfiltered	0	100	10	S1	

Spiked By: Jeff Kujawa **Date:** 11/28/2007

Witnessed By: Gabriel D. Wagner **Date:** 11/28/2007

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	648.3020.69	2,386.637	DPM/ml	11/28/07	0.5	ml	RS-003

Comments
UG LLT LOT# 97-070701.

Paragon Analytics

Radiochemistry Prep Worksheet

Prep Batch: 3H071128-1

Prep Procedure: H3

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 700 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeff Kujawa JK
Prep Date: 11/28/2007
Prep Dept: RS

Balance:
Balance:

Cocktail: UG LLT
Cocktail Pipet: T-002
Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Water Added(ml)	Moisture(%)	Analysis Vol.(ml)	Standards	Prep Notes
1	1	0723516-01	MB		50	5	Unfiltered	0	100	5		
2	1	0723516-02	MB		50	5	Unfiltered	0	100	5		
3	1	0723516-03	MB		50	5	Unfiltered	0	100	5		
4	1	0723516-04	LCS		50	4.950495	Unfiltered	0	100	5	S1	
5	1	0723516-05	LCS		50	4.950495	Unfiltered	0	100	5	S1	
6	1	0723516-06	LCS		50	4.950495	Unfiltered	0	100	5	S1	
7	1	0723516-07	MB		50	10	Unfiltered	0	100	10		
8	1	0723516-08	MB		50	10	Unfiltered	0	100	10		
9	1	0723516-09	MB		50	10	Unfiltered	0	100	10		
10	1	0723516-10	LCS		50	9.900990	Unfiltered	0	100	10	S1	
11	1	0723516-11	LCS		50	9.900990	Unfiltered	0	100	10	S1	
12	1	0723516-12	LCS		50	9.900990	Unfiltered	0	100	10	S1	

Spiked By: JK **Date:** 11/28/07
Witnessed By: GDW **Date:** 11/28/07

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	H-3	648.3020.69	2,386.637	DPM/ml	11/28/07	0.5	ml	~~ST-002~~ PS-003 JK 11/28/07

exp. 8/13/08

Comments
UG LLT LOT# 97-070701.

TRITIUM RUN LOG

319185 Logbook/Page No. SOP 700 Rev 10 Form 1306r1.doc (3/30/2003)

Date	Workorder/ Sample Number	Column ID	Flask ID	Run No.	Comments	Technician's Initials
11/20/07	0711002S-1D	N/A	N/A	9	Batch 3H071114-2 SOP 754 Rev 5	EMF
11/26/07	0723514-1, 7	A	T2	2	Batch 3H071126-1	JLG
	-2, 8	A	T7	1		
	-3, 9	B	T8			
	-4, 10	C	T11			
	-5, 11	D	102			
	-6, 12	F	600			
11/25/07	0723516-1, 7	A	102	1	Batch 3H071128-1	JLG
	-2, 8	B	600			
	-3, 9	C	T2			
	-4, 10	D	T7			
	-5 11	E	T8			
	-6, 12	F	T11			

JLG 11/25/07

Reviewed by / Date JLG 11/28/07

PROJECT 699.2613.19 3H

Continued From Page

Prepare a working dilution of approx 90,000 DPM/mL by diluting Std 699.2613.18 with DI water

1) See Density on page 18 of logbook 2613

2) Transfer Std 699.2613.18 to a 125 mL Amber glass bottle

Mass of bottle w/o lid	94.7389 g	Bal #12
Mass of bottle + Std	96.6778 g	
Net mass of Std	1.9389 g	

3) Add DI water to final Dilution

Mass of bottle w/o lid from above	94.7389 g	Bal #12
Mass of bottle, Std, + DI water	192.4076 g	
Net mass of Std + DI water	97.6687 g	

4) Final Activity Calculation

$$\frac{(6.34 \text{ kBq/g})(4.8157 \text{ g})(1000 \text{ dpm/Bq})(1000 \text{ Bq/kBq})(0.9958 \text{ g/mL})(1.9389 \text{ g})}{(38.5765 \text{ g})(\text{of } 97.6687 \text{ g})} = 91,000.71 \text{ DPM/mL}$$

Reverification Log

Analysis Date	Initials	Expiration Date
9/24/06	RG	9/24/07
8/1/08	BLS	8/1/08

Stnd ID: 699.2613.19
Description: ^{3}H
Expiration: 7/28/04
Activity: 94000.71 dpm/mL
2s Uncertainty: 676.81 dpm/mL
Ref. Date: 9/3/98
Ref Time: N/A
Prep Date: 7/28/03 Prep by: JRK
Matrix/Comp. DI Water
Half Life (y): 1.23E+01

* NCR for ICPT work SD 8/1/03

Signed 7/28/03 Date

Stnd ID: 699.2613.19
Description: 3H
Expiration: 8/11/05
Activity: 94000.71 dpm/mL
2s Uncertainty: 676.81 dpm/mL
Ref. Date: 9/3/98
Ref Time: N/A
Prep Date: 7/29/04 Prep by: JLK
Matrix/Comp. DI Water
Half Life (y): 1.23E+01
Requires NCR for ICPT work.

Stnd ID: 699.2613.19
Description: 3H
Expiration: 7/30/05
Activity: 94000.71 dpm/mL
2s Uncertainty: 676.81 dpm/mL
Ref. Date: 9/3/98
Ref Time: N/A
Prep Date: 7/29/04 Prep by: JLK
Matrix/Comp. DI Water
Half Life (y): 1.23E+01

Read and understood

Signed 8/1/03 Date

18 PROJECT 699.2613.18 34 Notebook No. 2613

Continued From Page

Prepare a 1° dilution of Ampoule 699 by diluting with DI water.

1.) Determine the density of DI water

Mass of empty class A 100mL volumetric flask	107.7956 g
Mass of flask + 100 mL of DI water	107.3755 g
Net mass of DI water	99.5799 g

$\rho = 0.9958\ g/mL$

2) Transfer contents of ampoule 699 into a 40 mL Amber glass VOA vial

Mass of VOA vile w/o lid	24.3883g
Mass of opened ampoule before transfer	40.8438g
Mass of opened ampoule after transfer	36.0281 g
Net mass of std transferred	4.8157 g

3) Add DI water to final dilution

Mass of VOA vile w/o lid, std from above	24.3883g
Mass of VOA vile, std, + DI water	62.9648g
Net mass of std + DI water	38.5765 g

4) Final Activity Calculation

$$\left(634.7\ \frac{kBq}{g}\right)\left(4.8157\ g\right)\left(\frac{1000\ Bq}{1\ kBq}\right)\left(\frac{0.9958\ g}{mL}\right)$$

$$38.5765\ g$$

$$= 4,733,412.57\ \frac{Bq}{mL}$$

U.S. Department of Commerce
National Institute of Standards and Technology
SRM 4927F
Hydrogen-3
<4 MBq in distilled water
CAUTION
RADIOACTIVE

Continued on Page

Read and Understood By

Signed	7/29/03	Signed	7/31/03
	Date		Date

National Institute of Standards & Technology

Certificate

PAF, ID 0699
recd 5-09-03

Standard Reference Material 4927F
Hydrogen-3 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive hydrogen-3, as water, 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 beta-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains hydrogen-3 with a total activity of approximately 3.2 MBq. Hydrogen-3 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. There is no detectable external radiation. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains only distilled water. There is no chemical hazard. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

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 September 2008.

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) because of the radioactivity.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, L.R. Karam, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas and M.P. Unterweger of the Radioactivity Group.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by J.W.L. Thomas.

Bert M. Coursey, Chief
Ionizing Radiation Division

Nancy M. Trahey, Chief
Standard Reference Materials Program

Gaithersburg, Maryland 20899
June 1999
Half-life and text revised October 2000

*Notes and references are on pages 5 and 6.

Recommended Procedure for Opening the SRM Ampoule

1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition 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.

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 and 6.

PROPERTIES OF SRM 4927F

Certified values

Solution density	**(0.998 ± 0.002) g·mL^{-1} at 20.0 °C [b]***
Radionuclide	**Hydrogen-3**
Reference time	**1200 EST, 3 September 1998**
Massic activity of the solution [c]	**634.7 kBq·g^{-1}**
Relative expanded uncertainty (k=2)	**0.72% [d] [e]**

Uncertified values

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 mass	Approximately 5.0 g		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L^{-1})	Mass Fraction (g·g^{-1})
	H_2O ^3HHO	55 6×10^{-7}	1.00 1×10^{-8}
Radiological Properties:			
Radionuclidic impurities	None detected [f]		
Half lives used	Hydrogen-3: (4500 ± 8) d [g]		
Calibration method and measuring instrument(s)	4πβ gas counting of SRM 4927E using the NIST length-compensated internal gas proportional counters and intercomparison of SRMs 4927E/4927F using two 4πβ liquid-scintillation counting systems [h]		

*Notes and references are on pages 5 and 6.

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

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 count rate of SRM 4927E, corrected for background and decay [h]	Standard deviation of the mean for 23 sets of gas counting measurements (A)	0.18	1.0	0.18
Gram-mole measurements	Estimated (B)	0.20	1.0	0.20
Live-time [p]	Estimated (B)	0.10	1.0	0.10
Extrapolation of count-rate-versus-energy to zero energy	Estimated (B)	0.20	1.0	0.20
Half life of H-3	Standard uncertainty of the half life (A)	0.18 [m]	0.009 [n]	0.002
Liquid-scintillation intercomparison of SRM 4927F and SRM 4927E	Standard deviation of the mean for 7 sets of liquid-scintillation measurements (A)	0.06	1.0	0.06
Radionuclidic impurities	Limit of detection (B) [q]	100.	0.0005	0.05
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.36
Coverage Factor, k				x 2
Relative Expanded Uncertainty of the Output Quantity, U/y, (%)				0.72

*Notes and references are on pages 5 and 6.

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 (Not detectable)		

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

[c] Massic activity is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].

[d] The reported value, y, of massic activity (activity 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 activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity 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].

[e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the massic response is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).

[f] The estimated limit of detection for radionuclidic impurities is 300 Bq·g^{-1}.

[g] The stated uncertainty is the standard uncertainty. See reference [5].

[h] Extensive gas-counting measurements were made on the SRM 4927E solution during 1998 and 1999. The SRM 4927F solution was intercompared with the SRM 4927E solution using liquid-scintillation counting.

[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 $u_i(y)/y = |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$. 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] 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.

[n] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$

[p] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.

[q] 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 H-3)}·{(Bq of impurity)/(Bq of H-3)}. 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] L.L. Lucas and M.P. Unterweger, *Comprehensive Review and Critical Evaluation of the Half-Life of Tritium*, J. Res. Natl. Inst. Stand. Technol. 105, 541-549 (2000).

Prepare a working level dilution of approx. 400 dpm/mL from 648.2382.75 diluting with DI water.

(1) Determine the density of water
Mass of empty 100mL class A volumetric flask: 68.5644g
Mass of flask + 100mL DI water: 168.2311g
Net mass of water: 99.6667g
ρ = 0.997 g/mL
Bal 12

(2) ~~Mass~~ Transfer standard to 500mL Amber bottle. AB 3/8/07
mass of standard in 100mL poly cup: 12.8145g
mass of poly cup after transfer: 7.4323g
Net mass of standard transferred: 5.3822g
Bal 12

(3) Dilute with DI water
Mass of Amber bottle (500mL): 262.87g
Mass of bottle + standard + DI water: 759.30g
Net mass of standard + DI water: 496.43g
Bal 26

(4) Final activity calculation
* Note: Density of 648.2382.75 is 0.9958 g/mL AB 3/8/07

$$\frac{(369530.45\ \text{dpm/mL})(5.3822\ \text{g})(0.997\ \text{g/mL})}{(0.9958\ \text{g/mL})(496.43\ \text{g})} = 4011.21\ \text{dpm/mL}$$

RG 3/20/07

Stnd ID: 648.3020.69

Description: H-3
Expiration: 3/12/2008
Activity: 4011.21 dpm/mL
2s Uncertainty: 28.88 dpm/mL
Ref. Date: 9/3/1998
Ref Time: N/A
Prep Date: 3/8/2007 Prep by: AB
Matrix/Comp. DI H2O
Half Life (y): 1.23E+01

RG 3/20/07

Reverification Log		
Analysis Date	Initials	Expiration Date
8/13/07	VLB	8/13/08
2/29/08	MEC	2/25/09

RG 3/20/07

Continued on Page

Read and Understood By

Signed	Date	Signed	Date
A Baldwin	3/8/07	Renee Gallegos	3/20/07

PROJECT 648.2382.75 3H Notebook No. 2382 75

Continued From Page

Prepare a 10 dilution dilution (of approximately 2000 pCi/mL)
from standard using RSO #644
and diluting with DI water.

1) Determine the density of DI water:

Mass of empty 100 mL class A volumetric flask	67.1522 g	Bal #13
Mass of flask + water	166.7351 g	
Net mass of 100 mL H_2O	99.5829 g	
	$\rho = .9958$ g/mL	

2) Transfer contents of ampoule SRM 4927F to a
~~400 mL~~ 500 mL glass amber bottle

mass of ~~400 mL~~ bottle w/o lid	255.04 g	Bal #26
mass of open ampoule + 50 mL beaker	40.9075 g	Bal #13
mass of empty ampoule + 50 mL beaker	36.0148 g	
Net mass of Std.	4.8927 g	

3) Dilute Std. with DI water

mass of bottle w/o lid	255.04 g	Bal #26
mass of bottle, Std. + DI water	757.1 g	
Net mass of Std. + DI water	502.1 g	

4. Final Activity Calculation:

$$\frac{(654.7\ kBq/g)(1000\ Bq/kBq)(60\ dpm/Bq)(4.8927\ g)(.9958\ g/mL)}{502.1\ g} = 369,530.45\ \frac{dpm}{mL}$$

U.S. Department of Commerce
National Institute of Standards and Technology
SRM 4927F
Hydrogen-3
~654 kBq in distilled water

CAUTION
RADIOACTIVE

Continued on Page

Read and Understood By

Signed [signature] 3/27/03 Date

Signed Renee Mallory 3/27/03 Date

National Institute of Standards & Technology

Certificate

PATD C.648
ICE-C 17-BV-C

Standard Reference Material 4927F
Hydrogen-3 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive hydrogen-3, as water, 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 beta-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains hydrogen-3 with a total activity of approximately 3.2 MBq. Hydrogen-3 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. There is no detectable external radiation. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains only distilled water. There is no chemical hazard. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

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 September 2008.

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) because of the radioactivity.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, L.R. Karam, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas and M.P. Unterweger of the Radioactivity Group.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by J.W.L. Thomas.

Bert M. Coursey, Chief
Ionizing Radiation Division

Nancy M. Trahey, Chief
Standard Reference Materials Program

Gaithersburg, Maryland 20899
June 1999
Half-life and text revised October 2000

*Notes and references are on pages 5 and 6.

Recommended Procedure for Opening the SRM Ampoule

1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition 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.

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 and 6.

PROPERTIES OF SRM 4927F

Certified values

Solution density	(0.998 ± 0.002) g·mL^{-1} at 20.0 °C [b]*
Radionuclide	Hydrogen-3
Reference time	1200 EST, 3 September 1998
Massic activity of the solution [c]	634.7 kBq·g^{-1}
Relative expanded uncertainty (k=2)	0.72% [d] [e]

Uncertified values

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 mass	Approximately 5.0 g		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L^{-1})	Mass Fraction (g·g^{-1})
	H_2O ^3HHO	55 6×10^{-7}	1.00 1×10^{-8}
Radiological Properties:			
Radionuclidic impurities	None detected [f]		
Half lives used	Hydrogen-3: (4500 ± 8) d [g]		
Calibration method and measuring instrument(s)	4πβ gas counting of SRM 4927E using the NIST length-compensated internal gas proportional counters and intercomparison of SRMs 4927E/4927F using two 4πβ liquid-scintillation counting systems [h]		

*Notes and references are on pages 5 and 6.

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

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 count rate of SRM 4927E, corrected for background and decay [h]	Standard deviation of the mean for 23 sets of gas counting measurements (A)	0.18	1.0	0.18
Gram-mole measurements	Estimated (B)	0.20	1.0	0.20
Live-time [p]	Estimated (B)	0.10	1.0	0.10
Extrapolation of count-rate-versus-energy to zero energy	Estimated (B)	0.20	1.0	0.20
Half life of H-3	Standard uncertainty of the half life (A)	0.18 [m]	0.009 [n]	0.002
Liquid-scintillation intercomparison of SRM 4927F and SRM 4927E	Standard deviation of the mean for 7 sets of liquid-scintillation measurements (A)	0.06	1.0	0.06
Radionuclidic impurities	Limit of detection (B) [q]	100.	0.0005	0.05
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.36
Coverage Factor, k				x 2
Relative Expanded Uncertainty of the Output Quantity, U/y, (%)				0.72

*Notes and references are on pages 5 and 6.

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 (Not detectable)		

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

[c] Massic activity is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].

[d] The reported value, y, of massic activity (activity 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, $u_i(y) = |\partial y/\partial x_i| \cdot u(x_i)$, 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 activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity 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].

[e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the massic response is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).

[f] The estimated limit of detection for radionuclidic impurities is 300 $Bq \cdot g^{-1}$.

[g] The stated uncertainty is the standard uncertainty. See reference [5].

[h] Extensive gas-counting measurements were made on the SRM 4927E solution during 1998 and 1999. The SRM 4927F solution was intercompared with the SRM 4927E solution using liquid-scintillation counting.

[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 $u_i(y)/y = |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$. 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] 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.

[n] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$

[p] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.

[q] 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 H-3)} · {(Bq of impurity)/(Bq of H-3)}. 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] L.L. Lucas and M.P. Unterweger, *Comprehensive Review and Critical Evaluation of the Half-Life of Tritium*, J. Res. Natl. Inst. Stand. Technol. **105**, 541-549 (2000).

DAILY INSTRUMENT PERFORMANCE CHECKS - LS6500

Daily IPCs consist of the following standards;

Efficiency Check

Beckman Tritium Standard	Beckman C-14 Standard	PAI Reagent Blank (10-mL DI Water + 10 mL UG LLT
Lot HNP0509	Lot CNP3311	7/24/2008
105800 dpm	101000 dpm	
10/29/2003 REF	10/29/2003 REF	
10/29/2008 EXP	10/29/2008 EXP	

Interim Control Limits 8/19/2008

	Decay Corrected Tritium	Carbon-14	Reagent Blank	Quench Factor
UCL	49552.49	67094.79	19.79	149.5
Mean Value	47192.85	63899.80	17.00	142.4
LCL	44833.20	60704.81	12.21	135.3

Obs	Date	H-3 CPM	Decay Corrected H-CPM		C-14 CPM		Reagent H-3 Bkg CPM		Quench H#	
11	8/27/2008	35487.0	46608.01	OK	65240.7	OK	15.20	OK	144.5	OK
12	8/28/2008	36390.3	47801.78	OK	65118.3	OK	13.80	OK	146.3	OK

Liquid Scintillation Counter

Quality Control Data

Daily Instrument Performance Checks

DAILY INSTRUMENT PERFORMANCE CHECKS - LS6500

Daily IPCs consist of the following standards;

Efficiency Check

Beckman Tritium Standard	Beckman C-14 Standard	PAI Reagent Blank (10-mL DI Water + 10 mL UG LLT)	
Lot HPE0410	Lot CPE2711	7/24/2008	ref
104700 dpm	100,100 dpm	7/24/2009	exp
3/19/2008 REF	3/19/2008 REF		
3/19/2013 EXP	3/19/2013 EXP		

Interim Control Limits 10/20/2008

	Decay Corrected Tritium	Carbon-14	Reagent Blank	Quench Factor
UCL	55138.40	69099.80	19.79	153.0
Mean Value	52512.76	65809.34	16.00	145.7
LCL	49887.12	62518.87	12.21	138.4

Obs	Date	H-3 CPM	Decay Corrected H-CPM		C-14 CPM		Reagent H-3 Bkg CPM		Quench H#	
35	11/21/08	50292.1	52248.91	OK	64131	OK	13.80	OK	149.9	OK
36	11/23/08	48996.3	50918.43	OK	63184.2	OK	15.40	OK	151	OK