NRC FORM 314
(06-23-2022)
10 CFR 30.36(j)(1); 40.42(j)(1); 70.38(j)(1); and 72.54(k)(5)(1)(1)

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF DISPOSITION OF MATERIALS

APPROVED BY OMB: NO. 3150-0028 EXPIRES: 03/31/2023

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Licensee Name and Address	License Number	Expiration Date
MRIGlobal 425 Dr. Martin Luther King Jr. Blvd. Kansas City, MO 64110	24-02564-02	June 30, 2026
	Docket Number 030-05083	

A. LICENSE STATUS (Check the appropriate box)

☐ This license has expired. ☐ This license has not yet expired; please terminate it.

B. DISPOSAL OF RADIOACTIVE MATERIAL

(Check the appropriate boxes and complete as necessary. If additional space is needed, provide attachments)

The licensee, or any individual executing this certificate on behalf of the licensee, certifies that:

☐ 1. No radioactive materials have ever been procured or possessed by the licensee.

☑ 2. All activities authorized by this license have ceased, and all radioactive materials procured and/or possessed by the licensee under this license number cited above have been disposed of in the following manner.

☑ a. Transfer of radioactive materials to the licensee listed below:

Moravek Biochemicals, Inc. California License: 2960-30

☑ b. Disposal of radioactive materials:

☐ 1. Directly by the licensee:

☐ 2. By licensed disposal site:

☐ 3. By waste contractor:

Bionomics, Inc. Oak Ridge, TN

☑ c. All radioactive materials have been removed such that any remaining residual radioactivity is within the limits of 10 CFR Part 20, Subpart E, and is ALARA.

C. SURVEYS PERFORMED AND REPORTED

☑ 1. A radiation survey was conducted by the licensee. The survey confirms:

☑ a. the absence of licensed radioactive materials

☑ b. that any remaining residual radioactivity is within the limits of 10 CFR 20, Subpart E, and is ALARA.

☑ 2. A copy of the radiation survey results:

☑ a. is attached; or ☐ b. is not attached (Provide explanation); or ☐ c. was forwarded to the NRC on: Date _____

☐ 3. A radiation survey is not required as only sealed sources were ever possessed under this license, and

☐ a. The results of the latest leak test are attached; and/or ☐ b. No leaking sources have ever been identified.

The person to be contacted regarding the information provided on this form:

Name	Title	Telephone (Include Area Code)	E-mail Address
Brian Wimmer	RSO, Manager-ESH	(816) 326-5076	bwimmer@mriglobal.org

Mail all future correspondence regarding this license to:
Same as above

C. CERTIFYING OFFICIAL

I CERTIFY UNDER PENALTY OF PERJURY THAT THE FOREGOING IS TRUE AND CORRECT

Printed Name and Title	Signature	Date
Brian Wimmer RSO, Manager - ESH		7/11/2022

WARNING: FALSE STATEMENTS IN THIS CERTIFICATE MAY BE SUBJECT TO CIVIL AND/OR CRIMINAL PENALTIES. NRC REGULATIONS REQUIRE THAT SUBMISSIONS TO THE NRC BE COMPLETE AND ACCURATE IN ALL MATERIAL RESPECT. 18 U.S.C. SECTION 1001 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

October 2021 Final Survey – Sample Control 301S

Equipment and Reagents:

Perkin Elmer TriCarb Liquid Scintillation Analyzer, Serial No.: SGLO47201440

Reagents: Ultima Gold Scintillation Cocktail Lot 77-20431, Exp. Date: May 2022

Procedure:

The wipe sampling survey was conducted in accordance with RSP-18, Contamination Surveys Revision 7. The wipe samples were collected using Whatman filter disks in the area listed on this survey form. Areas of approximately 100 cm^2 were wiped with the filter papers, which were placed into labeled scintillation vials. Ten milliliters of scintillation cocktail was added to each vial before being placed on the counter for analysis.

Results:

The results of the analysis of the filter wipes by liquid scintillation are presented below. Contamination levels are in units of disintegrations per minute. The results were not blank corrected.

Area	Description	^{3}H DPM	^{14}C DPM	Notes
Blank	Clean wipe in scintillation liquid.	17	14	
301S	Shelf in -80 freezer	2	24	
301S	Freezer Handle	15	12	
301S	Floor in front of freezer	8	17	
301S	Plastic lock box formerly containing radioisotopes	24	17	

Assay Definition

Assay Description:
Basic dual DPM assay
Assay Type: DPM (Dual)
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\Default\3h_14c_dpm\20211001_1234
Raw Results Path: C:\Packard\Tricarb\Results\Default\3h_14c_dpm\20211001_1234\20211001_1234.results
Assay File Name: C:\Packard\TriCarb\Assays\3h_14c_dpm.lsa

Count Conditions

Nuclide: 3H-14C
  Quench Indicator: tSIE/AEC
  External Std Terminator (sec): 0.5 2s%
  Pre-Count Delay (min): 0.00
Quench Sets:
  Low Energy: 3H-UG
  Mid Energy: 14C-UG
Count Time (min): 1.00
Count Mode: Normal
Assay Count Cycles: 1 Repeat Sample Count: 1
Number of Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL
A	0.0	12.0
B	12.0	156.0
C	0.0	0.0

Count Corrections

Static Controller: On Luminescence Correction: n/a GCT: n/a
Colored Samples: Off Heterogeneity Monitor: n/a PAC: n/a
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75 PAC Strength: n/a
Auxiliary Spectrum: n/a

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	MESSAGES
1	1.00	10	12	17	14	691.50	636.72	
2	1.00	4	20	2	24	644.66	637.25	
3	1.00	9	10	15	12	857.83	630.80	
4	1.00	6	14	8	17	1359.72	591.37	
5	1.00	14	15	24	17	866.89	635.01	

SNC Protocol

Calibration Information
Software Version IC: 5.2
Software Version EC: 5.2
Instrument Model: Tri-Carb 4910TR
Instrument Serial Number: SGLO47201440
3H Chi Square: 18.03 Date Processed: 10/1/2021 2:11:24 PM
14C Chi Square: 15.32 Date Processed: 10/1/2021 2:11:24 PM
3H FOM (1-18.6 keV): 318.86 Date Processed: 10/1/2021 2:11:24 PM
14C FOM (4-156 keV): 573.85 Date Processed: 10/1/2021 2:11:24 PM
3H Efficiency (1-18.6 keV): 62.28 Date Processed: 10/1/2021 2:11:24 PM
14C Efficiency (4-156 keV): 93.19 Date Processed: 10/1/2021 2:11:24 PM
IPA Background Date Processed: 10/1/2021 2:11:24 PM
3H Background CPM (1-18.6 keV): 12.17 Date Processed: 10/1/2021 2:11:24 PM
14C Background CPM (4-156 keV): 15.13 Date Processed: 10/1/2021 2:11:24 PM
3H Calibration DPM: 279500
3H Reference Date: 7/13/2020
14C Calibration DPM: 130400

May 2022 Final Survey – Radioactive Materials Storage Shed (Rad Shed)

Equipment and Reagents:

Perkin Elmer TriCarb Liquid Scintillation Analyzer, Serial No.: SGLO47201440

Reagents: Ultima Gold Scintillation Cocktail Lot 79-22121, Exp. Date: October 2023

Procedure:

On May 5, 2022, a contact survey of the floor area of the rad shed was surveyed using a Ludlum Model 3 survey meter (Serial No. 221315, calibration date 2/23/2022) and a 44-9 probe (Serial No. PR-234247). No readings were detected above background (300 cpm). The wipe sampling survey was conducted in accordance with RSP-18, Contamination Surveys Revision 7. Wipe samples were collected the same day using Whatman filter disks in the area listed on this survey form. Areas of approximately 3720 cm^2 were wiped with the filter papers, which were placed into labeled scintillation vials. Ten milliliters of scintillation cocktail was added to each vial before being placed on the counter for analysis.

Results:

The results of the analysis of the filter wipes by liquid scintillation are presented below (Table 1). Contamination levels are in units of disintegrations per minute. The results were not blank corrected. Areas 37, 38, and 43 were cleaned and re-surveyed with four wipe samples per area. Wipes confirmed cleaning was effective (Table 2). The radioactive materials storage shed has been turned over for general use.

Table 1

Area (see map)	^{3}H DPM	^{14}C DPM	Notes
Blank	21	14	
1	23	21	
2	21	19	
3	15	20	
4	18	23	
5	14	17	
6	16	19	
7	16	21	
8	31	18	
9	18	17	
10	24	21	
11	17	22	
12	20	19	
13	19	18	

Area (see map)	^{3}H DPM	^{14}C DPM	Notes
14	121	20	
15	24	17	
16	14	17	
17	21	16	
18	18	21	
19	17	19	
20	17	20	
21	15	23	
22	14	20	
23	26	14	
24	23	16	
25	22	25	
26	20	20	
27	18	19	
28	24	24	
29	31	24	
30	57	30	
31	57	45	
32	30	29	
33	55	36	
34	55	30	
35	50	34	
36	67	25	
37	104	43	Cleaned and re-wiped
38	103	101	Cleaned and re-wiped
39	24	27	
40	53	34	
41	32	37	
42	89	45	
43	101	56	Cleaned and re-wiped
44	46	29	
45	46	29	
46	31	30	
47	49	41	
48	69	40	
49	77	44	
50	49	35	
51	47	33	
52	26	33	
53	96	47	
54	37	42	

Table 2

Area (see map)	^{3}H DPM	^{14}C DPM	Notes
Blank	21	14	
37A	23	21	
37B	21	19	
37C	15	20	
37D	18	23	
38A	14	17	
38B	16	19	
38C	16	21	
38D	31	18	
43A	18	17	
43B	24	21	
43C	17	22	
43C	20	19	

Map of floor:

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
49	50	51	52	53	54

Door

Assay Definition

Assay Description:

Assay Type: DPM (Dual)
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\BW\5min 3h 14c dpm\20220504_1548
Raw Results Path: C:\Packard\Tricarb\Results\BW\5min 3h 14c dpm\20220504_1548\20220504_1548.results
Assay File Name: C:\Packard\TriCarb\Assays\5min 3h 14c dpm.lsa

Count Conditions

Nuclide: 3H-14C
  Quench Indicator: tSIE/AEC
  External Std Terminator (sec): 0.5 2s%
  Pre-Count Delay (min): 0.00
Quench Sets:
  Low Energy: 3H-UG
  Mid Energy: 14C-UG
Count Time (min): 5.00
Count Mode: Normal
Assay Count Cycles: 1 Repeat Sample Count: 1
Number of Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL
A	0.0	12.0
B	12.0	156.0
C	0.0	0.0

Count Corrections

Static Controller: On Luminescence Correction: n/a GCT: n/a
Colored Samples: Off Heterogeneity Monitor: n/a PAC: n/a
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75 PAC Strength: n/a
Auxiliary Spectrum: n/a

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	MESSAGES
1	5.00	12	12	21	14	902.56	621.21	BK6
2	5.00	9	18	23	21	756.14	317.27	1
3	5.00	10	14	21	17	679.40	393.23	2
4	5.00	7	16	15	20	778.03	317.63	3
5	5.00	8	19	18	23	573.61	340.76	4
6	5.00	7	14	14	17	892.23	389.45	5
7	5.00	8	16	16	19	828.62	399.37	6
8	5.00	8	18	16	21	882.21	386.46	7
9	5.00	13	16	31	18	580.09	346.71	8
10	5.00	8	14	18	17	664.72	341.39	9
11	5.00	10	18	24	21	517.35	343.38	10
12	5.00	8	18	17	22	600.88	351.69	11

13	5.00	9	16	20	19	582.53	343.89	12
14	5.00	9	15	19	18	832.56	355.65	13
15	5.00	6	17	12	20	652.67	322.63	14
16	5.00	11	15	24	17	824.87	421.72	15
17	5.00	7	14	14	17	916.85	398.74	16
18	5.00	9	14	21	16	740.36	378.76	17
19	5.00	9	18	18	21	635.53	384.42	18
20	5.00	8	16	17	19	585.22	361.89	19
21	5.00	8	17	17	20	742.27	381.73	20
22	5.00	9	19	15	23	745.65	418.13	21
23	5.00	8	16	14	20	825.70	423.14	22
24	5.00	10	12	26	14	673.68	324.39	23
25	5.00	10	14	23	16	536.89	344.28	24
26	5.00	10	21	22	25	549.29	330.28	25
27	5.00	9	17	20	20	701.23	360.00	26
28	5.00	9	16	18	19	827.09	397.97	27
29	5.00	11	20	24	24	750.20	375.78	28
30	5.00	10	20	31	24	360.27	253.56	29
31	5.00	11	24	57	30	242.13	163.54	30
32	5.00	16	36	57	45	244.01	202.69	31
33	5.00	8	23	30	29	356.06	179.44	32
34	5.00	16	30	55	36	309.30	218.27	33
35	5.00	11	24	55	30	299.19	166.72	34
36	5.00	14	28	50	34	329.70	218.74	35
37	5.00	16	21	67	25	237.06	210.13	36
38	5.00	30	37	104	43	255.23	244.38	37
39	5.00	36	83	103	101	167.66	248.23	38
40	5.00	9	22	24	27	495.61	265.50	39
41	5.00	15	28	53	34	257.42	214.31	40
42	5.00	12	30	32	37	278.81	241.53	41
43	5.00	21	37	89	45	242.65	191.01	42
44	5.00	21	45	101	56	217.67	167.35	43
45	5.00	16	25	46	29	415.24	283.70	44
46	5.00	14	24	46	29	305.78	245.25	45
47	5.00	9	24	31	30	447.17	211.66	46
48	5.00	17	34	49	41	469.95	251.83	47
49	5.00	20	34	69	40	339.47	236.29	48
50	5.00	20	36	77	44	275.66	208.13	49
51	5.00	17	29	49	35	355.09	262.42	50
52	5.00	12	27	47	33	277.53	199.98	51
53	5.00	9	26	26	33	428.35	229.42	52
54	5.00	27	40	96	47	284.23	229.60	53
55	5.00	15	34	37	42	328.09	283.49	54

SNC Protocol

Calibration Information
Software Version IC: 5.2
Software Version EC: 5.2
Instrument Model: Tri-Carb 4910TR
Instrument Serial Number: SGLO47201440
3H Chi Square: 16.28 Date Processed: 5/4/2022 10:28:58 PM
14C Chi Square: 37.99 Date Processed: 5/4/2022 10:28:58 PM
3H FOM (1-18.6 keV): 302.74 Date Processed: 5/4/2022 10:28:58 PM
14C FOM (4-156 keV): 542.00 Date Processed: 5/4/2022 10:28:58 PM
3H Efficiency (1-18.6 keV): 62.17 Date Processed: 5/4/2022 10:28:58 PM
14C Efficiency (4-156 keV): 93.32 Date Processed: 5/4/2022 10:28:58 PM
IPA Background Date Processed: 5/4/2022 10:28:58 PM
3H Background CPM (1-18.6 keV): 12.77 Date Processed: 5/4/2022 10:28:58 PM
14C Background CPM (4-156 keV): 16.07 Date Processed: 5/4/2022 10:28:58 PM
3H Calibration DPM: 279500
3H Reference Date: 7/13/2020
14C Calibration DPM: 130400

Assay Definition

Assay Description:

Assay Type: DPM (Dual)
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\BW\5min 3h 14c dpm\20220506_1020
Raw Results Path: C:\Packard\Tricarb\Results\BW\5min 3h 14c dpm\20220506_1020\20220506_1020.results
Assay File Name: C:\Packard\TriCarb\Assays\5min 3h 14c dpm.lsa

Count Conditions

Nuclide: 3H-14C
  Quench Indicator: tSIE/AEC
  External Std Terminator (sec): 0.5 2s%
  Pre-Count Delay (min): 0.00
Quench Sets:
  Low Energy: 3H-UG
  Mid Energy: 14C-UG
Count Time (min): 5.00
Count Mode: Normal
Assay Count Cycles: 1 Repeat Sample Count: 1
Number of Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL
A	0.0	12.0
B	12.0	156.0
C	0.0	0.0

Count Corrections

Static Controller: On Luminescence Correction: n/a GCT: n/a
Colored Samples: Off Heterogeneity Monitor: n/a PAC: n/a
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75 PAC Strength: n/a
Auxiliary Spectrum: n/a

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	MESSAGES
1	5.00	4	12	5	14	1022.60	584.13	BKC
2	5.00	10	34	17	41	399.05	325.50	31 A
3	5.00	9	28	15	34	456.52	327.46	D
4	5.00	6	22	8	27	820.75	418.20	C
5	5.00	9	25	15	30	655.17	370.23	D
6	5.00	5	19	5	23	707.65	397.25	38 A
7	5.00	6	22	10	26	777.82	341.62	B
8	5.00	8	25	15	30	617.09	338.21	C
9	5.00	8	25	13	31	676.63	330.98	D
10	5.00	8	26	11	32	602.99	371.16	43 A
11	5.00	8	26	16	31	627.25	315.74	B
12	5.00	8	22	12	27	766.97	460.29	C

13	5.00	9	28	14	34	662.11	391.84	D

SNC Protocol

Calibration Information
Software Version IC: 5.2
Software Version EC: 5.2
Instrument Model: Tri-Carb 4910TR
Instrument Serial Number: SGLO47201440
3H Chi Square: 16.24 Date Processed: 5/6/2022 10:20:18 AM
14C Chi Square: 18.76 Date Processed: 5/6/2022 10:20:18 AM
3H FOM (1-18.6 keV): 302.74 Date Processed: 5/4/2022 10:28:58 PM
14C FOM (4-156 keV): 542.00 Date Processed: 5/4/2022 10:28:58 PM
3H Efficiency (1-18.6 keV): 62.08 Date Processed: 5/6/2022 10:20:18 AM
14C Efficiency (4-156 keV): 93.48 Date Processed: 5/6/2022 10:20:18 AM
IPA Background Date Processed: 5/4/2022 10:28:58 PM
3H Background CPM (1-18.6 keV): 12.77 Date Processed: 5/4/2022 10:28:58 PM
14C Background CPM (4-156 keV): 16.07 Date Processed: 5/4/2022 10:28:58 PM
3H Calibration DPM: 279500
3H Reference Date: 7/13/2020
14C Calibration DPM: 130400

MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

425 Volker Street
Kansas City, MO 64110

USNRC License Number:
24-02564-02

July 2, 2021

Prepared:	Mike Culp	Project Manager	Date:	7-2-21
Approved:	Dave Culp	Field Services Manager	Date:	7-6-21
Approved:	Chris Echterling	Chase Radiation Safety Officer	Date:	7-6-21

Prepared by:

Chase Environmental Group, Inc.
200 Sam Rayburn Parkway
Lenoir City, TN 37771
865-816-6015

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ACRONYMS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
DCGL	Derived Concentration Guideline Level
DCGLw	Derived Concentration Guideline Level – Wilcoxon Rank Sum
DQO	Data Quality Objective
DSV	Default Screening Value
FSS	Final Status Survey
FSSR	Final Status Survey Report
GSF	Gross Square Feet
HEPA	High Efficiency Particulate Air
LBGR	Lower Bound of the Gray Region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MRI	MRIGlobal
NRC	U.S. Nuclear Regulatory Commission
NIST	National Institute of Standards and Technology
QA	Quality Assurance
RSL	Radiosynthesis Laboratory
RWP	Radiation Work Permit
TEDE	Total Effective Dose Equivalent

1.0 INTRODUCTION

MRIGlobal (MRI) permanently ceased licensed activities in the Kimball Building third floor radiosynthesis laboratory (RSL) at the MRI Campus located at 425 Volker Street, Kansas City, MO 66110. The RSL had been used since 2004 to synthesize compounds containing C-14 and H-3 under US Nuclear Regulatory Commission (NRC) license number 24-02564-02. MRI retained Chase Environmental Group (Chase) to decommission the RSL for unrestricted use in support of renovation for non-radioactive uses. Radioactive material use will continue in the building and on campus.

The RSL consists of four laboratories with a total floor area of approximately 1,100 gross square feet (GSF). Exhaust ventilation ducts were directed to the roof directly above where bag-in/bag-out filter units are located. C-14 and H-3 are the only nuclides of concern for decommissioning.

Decommissioning activities were conducted under the Chase Commonwealth of Kentucky radioactive materials license number 201-605-15, utilizing a reciprocal agreement with the NRC, and in accordance with a decommissioning work plan (DWP). The DWP was developed using the guidance provided in NUREG 1757, "*Consolidated NMSS Decommissioning Guidance*"; NRC regulations; and NUREG 1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (MARSSIM). Final status surveys (FSS) were designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with NRC default screening values (DSV). These methods ensured technically defensible data were generated to aid in determining whether or not the site meets the release criteria for unrestricted use specified in NRC regulations.

On-site activities were performed from May 6-25, 2021. All radioactive wastes generated from decommissioning activities were shipped for processing at the Unitech Oak Ridge Service Center, a licensed radioactive waste processing facility in Oak Ridge, TN.

Facility characterization surveys identified extensive contamination within the fume hoods and their associated exhaust ventilation system. Less extensive contamination was identified on other laboratory fixtures, and on the floors and walls. Chase removed all laboratory fixtures, the exhaust ventilation system, and drain system piping to the vertical drainpipes. Chase then remediated contaminated building structures and removed the vinyl sheet flooring. Residual radioactivity was identified on the roof in the area of the exhaust filter housings; Chase removed loose gravel ballast and scanned the roof surface with a gas flow proportional detector until the structural surface investigation level was met, then collected sediment samples of the roof material in the remediated area as well as in each cardinal direction adjacent to the remediated area for C-14 analysis at an external laboratory. The samples results indicate that more remediation is needed on the roof. To

expedite release of the laboratories for renovation, the roof was removed from the scope of this report and will be addressed separately.

This report presents sufficient data to conclude the RSL is suitable for unrestricted release in accordance with NRC requirements. Final status surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. All final status surface activity measurements were a small fraction of the DSVs. Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, **the Total Effective Dose Equivalent (TEDE) to an average member of the critical group is 0.01 mrem/year (0.04% of the release criterion of 25 mrem/yr).**

2.0 FACILITY DESCRIPTION

The MRI Campus is located at 425 Volker Ave, Kansas City, MO 64110. A site satellite photo is presented in Appendix A. Impacted areas within the scope of this report include the Kimball Building third floor RSL consisting of four laboratories totaling approximately 1,100 GSF. The RSL had been used since 2004 to synthesize compounds containing C-14 and H-3 for research and development. A facility floor plan is presented in Appendix B.

RSL floor areas were covered with vinyl sheeting with heat welded seams and integral base coves for spill containment. Walls were painted concrete block with painted drywall patches covering outside windows and former doorways. Suspended ceilings were drop-in drywall panels.

Exhaust ventilation was provided primarily via fume hood exhausts and are directed to the roof where two bag-in/bag-out filter banks were located. Each filter bank was constructed of stainless steel and consisted of a sequence of prefilters, high efficiency particulate air (HEPA) filters, and charcoal filters with dedicated exhaust fans. After filtration, RSL exhaust air was discharged through an adjacent stack. There is no central vacuum system; all vacuum was provided by local pumps dedicated to each hood inside the RSL.

3.0 NUCLIDES OF CONCERN

The nuclides of concern are listed in the table below.

Table 3-1: Radionuclides Used in Dispersible Form

Nuclide	Half-life (years)	Predominant Emission
C-14	5.7E+03	Low Energy Beta
H-3	1.2E+01	Low Energy Beta

4.0 INITIAL RADIOLOGICAL STATUS

Chase characterized impacted areas of the site February 11-12, 2021 under the Chase Commonwealth of Kentucky radioactive materials license number 201-605-15, utilizing a reciprocal agreement with the NRC. The majority of the residual radioactivity was on fume hood internal surfaces, on the internal surfaces of the exhaust ventilation, and on horizontal surfaces such as floors and benchtops. Low levels of detectable residual radioactivity were identified across most RSL floor and benchtop surfaces. Characterization results are described below.

4.1 Building Structures

Fume hood surfaces contained up to 747K dpm/100 cm^2 total surface activity with up to 134K dpm/100 cm^2 removable activity. Chase identified residual detectable activity on most of the vinyl flooring with elevated activity up to 651K dpm/100 cm^2 total surface activity with removable activity up to 413 dpm/100 cm^2. A majority of the vinyl flooring was between 3K and 30K dpm/100 cm^2 total activity. No activity was detected in the interstitial spaces between the suspended and original ceilings.

4.2 Systems

Building systems surveys identified elevated activity inside ventilation ducts and components up to 4.0M dpm/100 cm^2 total surface activity with up to 30K dpm/100 cm^2 removable activity. The average activity in the ductwork from twelve locations was 594K dpm/100 cm^2 total activity and 6K dpm/100 cm^2 removable C-14 activity.

One sink drain trap had 406 dpm/100 cm^2 removable H-3 activity with all other drain traps less than the investigation level. One vacuum nozzle contained removable activity of 7.3K dpm/100 cm^2.

5.0 UNRESTRICTED RELEASE CRITERIA

The release criteria for unrestricted use are specified in 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use."

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

6.0 DERIVED CONCENTRATION GUIDELINE LEVELS

A Derived Concentration Guideline Level (DCGL) is a radionuclide-specific surface activity concentration that could result in a dose equal to the release criterion. Derived Concentration Guideline Level – Wilcoxon Rank Sum ($DCGL_W$) is the concentration limit if the residual activity is evenly distributed over a large area.

The NRC has published DSVs in NUREG 1757, Volume 1, Appendix B for commonly used radionuclides. The screening values for surfaces under default conditions (generic screening levels) are provided in the table below.

Table 6-1: Default Screening Values for Nuclides of Concern

Nuclide	Half-life (years)	Predominant Emissions	Default Screening Value (dpm/100 cm^2)
C-14	5.7E+03	Low Energy Beta	3.7E+06
H-3	1.2E+01	Low Energy Beta	1.2E+08

The DSV's are the basis for developing the derived concentration guideline levels (DCGL's). An important assumption of the dose model is that removable contamination is <10% of total contamination. Historical survey results as well as characterization survey results confirm that removable contamination levels are very low and meet this assumption. H-3 cannot be accurately detected directly by field instrumentation due to its low energy; therefore, H-3 contamination is evaluated by removable surface activity measurements only.

7.0 INVESTIGATION LEVELS

Investigation levels were used to flag locations that required special attention and further analysis to ensure areas are properly classified and adequate surveys are performed. These locations were marked and received additional investigations to determine the concentration, area, and extent of the contamination. The following investigation levels were used:

- 5,000 dpm/100 cm^2 total beta-gamma surface contamination
- 200 dpm/100 cm^2 removable beta-gamma surface contamination in any LSC channel

8.0 DATA QUALITY OBJECTIVES (DQO)

The Data Quality Objective process as described in MARSSIM is used throughout the design and implementation of final status surveys. The following is a list of the major DQOs for the survey design:

- Static measurements were taken to achieve an MDC_{static} of less than the Investigation Level of 5,000 dpm/100 cm^2.
- Scanning was conducted at a rate to achieve an MDC_{scan} of less than the Investigation Level of 5,000 dpm/100 cm^2.
- Removable contamination measurements were counted to an MDC_{smear} of less than 200 dpm/100 cm^2 in each LSC channel.
- Individual measurements were made to a 95% confidence interval.
- Decision error probability rates were set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternative hypothesis (H_A) are that of NUREG 1505 scenario A:
    - H_0 is that the survey unit does not meet the release criteria
    - H_A is that the survey unit meets the release criteria
- A minimum of 5% duplication of final status surveys was performed for Quality Assurance.
- Characterization and remedial action support surveys were conducted under the same quality assurance criteria as final status surveys such that the data were used as final status survey data to the maximum extent possible.

9.0 PROJECT MANAGEMENT AND ORGANIZATION

Decommissioning activities were performed under Chase Commonwealth of Kentucky radioactive materials license number 201-605-15, and in accordance with the DWP. MRI oversaw decommissioning activities and maintained responsibility for building maintenance, fire, and security functions.

10.0 TRAINING

Chase provided all project personnel with radiation worker training required by the radioactive materials license, as well as training for project-specific programs, plans, and procedures required by the DWP.

11.0 RADIATION SAFETY AND HEALTH PROGRAM

Radiological work was performed according to the Chase radioactive materials license Radiation Safety Program.

12.0 ENVIRONMENTAL MONITORING PROGRAM

Due to the limited scope of the project, a project-specific environmental monitoring program was not required.

13.0 RADIOACTIVE WASTE MANAGEMENT

Radioactive wastes generated during remediation were packaged for transportation into two 20-foot seavan containers. Radioactive wastes were shipped on May 25,

2021 to the Unitech Oak Ridge Service Center for processing and disposal under the provisions of their Tennessee radioactive materials license.

The seavan container was parked near the loading dock and was locked at all times unless waste was being loaded. All remediation wastes were wrapped at the point of generation to prevent the spread of radioactivity during waste loading and transport. Small items were placed into plastic bags. Large items were wrapped in 6-mil plastic sheeting or bags, and then taped. The external surfaces of packaged wastes were surveyed to ensure free from residual radioactivity prior to exiting the restricted area. Waste travel paths and loading area were surveyed after each loading campaign to ensure contamination was not spread from the waste packages. In addition, personnel inspected and certified that the package was in conformance with the applicable Department of Transportation (DOT) and state requirements prior to disposition. A total of 2,106 cubic feet of radioactive waste weighing 10,944 lbs and containing 3.9 mCi was generated during project activities.

14.0 QUALITY ASSURANCE PROGRAM

Project-specific QA requirements were included in the DWP to meet the guidelines of MARSSIM Section 9.

15.0 SURVEY INSTRUMENTATION

15.1 Instrument Calibration

Laboratory and portable field instruments were calibrated within the past year with National Institute of Standards and Technology (NIST) traceable sources, and to radiation emission types and energies that provided detection capabilities similar to the nuclides of concern.

Calibration records for field instruments are provided in Appendix C.

15.2 Functional Checks

Functional checks were performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation were specified by procedure to ensure measurements are statistically valid. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions.

15.3 Datalogging

Structural surface scans and static measurements were performed using datalogging instrumentation. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded. Logged data were downloaded and processed using data management software to perform data analyses and reporting. Reporting includes graphical (4-plot) presentation of scan data as well as summary

statistics functions. The 4-Plot is described in the NIST e-Handbook of Statistical Methods (http://www.itl.nist.gov/div898/handbook/index.htm).

A 4-plot consists of the following:

- A run **sequence plot** presents logged data in chronological order, providing a time history of the survey data.
- A **lag plot** checks whether a data set or time series is random or not. Random data should not exhibit any identifiable structure in the lag plot. Non-random structure in the lag plot indicates that the underlying data are not random.
- A **histogram plot** graphically summarizes the distribution of a univariate data set, showing center (i.e., the location) of the data, spread (i.e., the scale) of the data, skewness of the data, presence of outliers, and presence of multiple modes.
- A **probability plot** is a goodness-of-fit test used to verify the distributional model. The normal probability plot is a graphical technique for assessing whether or not a data set is approximately normally distributed. The data are plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. Departures from this straight line indicate departures from normality.

15.4 Background Determination

Reference background areas or paired background comparisons were not necessary for this survey design. Material and ambient background levels were not significant in comparison to the DCGLs. Ambient background was determined to calculate the actual survey MDCs and associated counting errors.

For total surface activity measurements, ambient background levels were determined by performing a timed count with the probe at waist level in a non-impacted area. Ambient background was subtracted from each total activity gross measurement. Material background, the contribution from naturally-occurring radioactivity in building structural materials, was not accounted for (subtracted) since it was a small fraction of the DCGL.

The liquid scintillation counter (LSC) was set up without automatic background subtraction to report results in gross dpm.

15.5 Efficiency Determination

ISO 7503-1 methods were used for the limiting nuclide (C-14) to determine field concentrations for final status data and calculation of resultant doses from residual radioactivity. MARSSIM protocols for building structures use ISO-7503-1 methodology that takes into account the texture of the surface and the 2π detector

efficiency. Under MARSSIM, the default surface efficiency for beta emitters with maximum energies less than 400 keV is conservatively set at 0.25.

15.6 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and measurement of total and removable contamination were chosen to provide a minimum detectable concentration (MDC) that met the criteria specified in the DQOs. MARSSIM equations relative to building surfaces were modified to convert to units of dpm/100 cm^2. Count times and scanning rates were determined using the following equations:

Static Counting

Static counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E_{tot} \cdot \frac{A}{100\ cm^2}}$$

Where:

MDC_{static}	= minimum detectable concentration level (dpm/100 cm^2)
B_r	= background count rate (cpm)
t_b	= background count time (min)
t_s	= sample count time (min)
E_{tot}	= total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and surface efficiency) (cpm/dpm)
A	= detector probe area (cm^2)

A typical static MDC calculation for C-14 using the Ludlum Model 43-37 gas flow proportional detector is shown below:

$$MDC_{static} = \frac{3 + 3.29\sqrt{(1500)(0.1)\left(1 + \frac{0.1}{0.1}\right)}}{(0.1)(0.075)\left(\frac{584}{100\ cm^2}\right)} = 1{,}370\ dpm/100\ cm^2$$

Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p}\cdot E_{tot}\cdot\frac{A}{100\ cm^2}}$$

Where:

MDC_{scan}	=	minimum detectable concentration (dpm/100 cm^2)
d'	=	desired performance variable (1.38)
b_i	=	background counts during the residence interval (counts)
i	=	residence interval (seconds)
p	=	surveyor efficiency (0.5)
E_{tot}	=	total detector efficiency for radionuclide emission of interest (cpm/dpm)
A	=	detector probe area (cm^2)

A typical MDC_{scan} calculation for the Ludlum 43-37 gas flow proportional detector is shown below (the actual MDC was calculated using instrument-specific parameter values for each measurement):

$$\text{i}=13.3\text{ cm}\cdot\frac{\text{inch}}{2.54\text{ cm}}\cdot\frac{\text{sec}}{20\text{ inch}}=0.262\text{ sec}$$

$$\text{b}_\text{i}=0.262\text{ sec}\cdot\frac{1500\text{ counts}}{\text{minute}}\cdot\frac{\text{minute}}{60\text{ sec}}=6.55\text{ counts}$$

$$\text{MDC}_\text{scan}=\frac{1.38\sqrt{6.55}\left(\frac{60}{0.262}\right)}{\left(\sqrt{0.5}\right)(0.075)\left(\frac{584}{100\text{ cm}^2}\right)}=2{,}612\text{ dpm}/100\text{ cm}^2$$

Smear Counting

Smear counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{smear} = \frac{3+3.29\sqrt{B_r \cdot t_s\left(1+\frac{t_s}{t_b}\right)}}{t_s \cdot E}$$

Where:

MDC_{smear} = minimum detectable concentration level (dpm/smear)
B_r = background count rate (cpm)
t_b = background count time (min)
t_s = sample count time (min)
E = instrument efficiency for radionuclide emission of interest (cpm/dpm)

The liquid scintillation counter was setup to count samples in three channels as described in Section 18.3. The MDC calculations for the C-14 and H-3 LSC Channels are shown below. LSC Channel 3 (open) results were used qualitatively to verify C-14 and H-3 are the only nuclides of concern.

$$^{3}H\ MDC_{smear} = \frac{3+3.29\sqrt{(15)(1)\left(1+\frac{1}{1}\right)}}{(1)(0.6)} = 35 \text{ dpm}$$

$$^{14}C\ MDC_{smear} = \frac{3+3.29\sqrt{(25)(1)\left(1+\frac{1}{1}\right)}}{(1)(0.8)} = 33 \text{ dpm}$$

$$Channel\ 3\ MDC_{smear} = \frac{3+3.29\sqrt{(50)(1)\left(1+\frac{1}{1}\right)}}{(1)(1)} = 36 \text{ cpm}$$

Because the counting efficiency is different for each LSC measurement depending on quench characteristics, and in consideration of the errors associated with wipe counting (i.e., area wiped, wiping pressure, etc.), the *a priori* estimates of smear MDCs calculated above were applied to all removable contamination measurements.

15.7 Uncertainty

The uncertainty for each measurement was calculated using equation 6-15 from MARSSIM:

$$\sigma = 1.96\sqrt{\frac{C_{s+b}}{{T_{s+b}}^2} + \frac{C_b}{{T_b}^2}}$$

Where:

σ	=	Uncertainty
1.96	=	multiplier to achieve a 95% confidence level
C_{s+b}	=	gross sample counts
T_{s+b}	=	sample count time (min.)
C_b	=	gross background counts
T_b	=	background count time (min.)

Uncertainties presented with total surface activity results are additionally corrected for detection efficiency and probe area for presentation in the same units as total surface activity results.

15.8 Instrumentation Specifications

The instrumentation used for decommissioning surveys is summarized in the tables below.

Table 15-1: Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Detector Width	Meter Model	Window Thickness	Typical Efficiency
Ludlum 43-68	Gas Flow Proportional	126 cm^2	8.8 cm	Ludlum 2241-3	0.8 mg/cm^2	7.5% (C-14)
Ludlum 43-37	Gas Flow Proportional	584 cm^2	13.3 cm	Ludlum 2241-3	0.8 mg/cm^2	7.5% (C-14)
LSC	Liquid Scintillation	N/A	N/A	N/A	N/A	60% (H-3) 80% (C-14)

Table 15-2: Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Scan Rate	Count Time	Background (cpm)	MDC (dpm/100 cm^2)
Gross Beta Surface Scans	Ludlum 43-68	5 in/sec	N/A	500	4,297
Gross Beta Surface Scans	Ludlum 43-37	20 in/sec	N/A	1,500	2,612
Gross Beta Total Surface Activity	Ludlum 43-68	N/A	6 sec.	500	3,799
Gross Beta Total Surface Activity	Ludlum 43-37	N/A	6 sec.	1,500	1,370
Removable Activity	LSC	N/A	60 sec.	15 (H-3) 25 (C-14)	35 (H-3) 33 (C-14)

16.0 AREA CLASSIFICATIONS

Based on the results of the historical site assessment and characterization surveys, facility areas were classified as impacted areas or non-impacted areas.

16.1 Non-Impacted Area

Non-impacted areas are areas without residual radioactivity from licensed activities and are not surveyed during final status surveys. The following areas were classified as non-impacted:

- Structural surfaces above a two-meter height (except the RSL).
- Rooms without a history of radioactive materials usage.
- Building exterior surfaces except roof surfaces surrounding the filter housings and exhaust fans
- Surface and subsurface soils of outside grounds.
- Internal surfaces of positively pressurized systems (air, gas, water, etc.)

16.2 Impacted Areas

Impacted areas are those areas that have potential residual radioactivity from licensed activities. Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined as follows:

Class 1 Areas

Areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support classification as Class 2 or Class 3.

The RSL structural surfaces below the drop-in ceiling were classified as Class 1 areas, except for the vestibule.

Class 2 Areas

Areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

The vestibule, adjacent hallway, elevator and gas cylinder storage room surfaces less than a two-meter height were classified as Class 2 areas.

Class 3 Areas

Areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Surfaces above the drop ceiling in areas with a history of radioactive materials usage were classified as Class 3 areas.

17.0 SURVEY UNITS

A survey unit is a geographical area of specified size and shape for which a separate decision is made whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated, and released as a single unit. For the purposes of this project, areas of similar construction and composition were grouped together as survey units and tested individually against the DCGLs and the null hypothesis to show compliance with the release criteria. Survey units were homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small elevated areas of residual radioactivity. Survey units were sized according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for building structures, based on floor area, is Class 1: up to 100 m^2 , Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit.

Survey Unit Numbering Protocol
Each survey unit is assigned a unique number consisting of the building number followed by a dash and a four-digit identifier. The four-digit identifier consists of one digit for the elevation, one digit for the classification, and two digits as a numerical identifier in the event the first 2 digits are the same for two or more survey units using the format below:

Building Number – Elevation/Classification/Numerical Identifier

The default numeric identifier is 01

Buildings:
MRIGlobal Kimball Building = MRI

Elevations:
3 = 3rd Floor

Building systems are not within the scope of MARSSIM survey units; however, the term survey unit is applied to systems for consistent data management. Systems survey units were arranged by building and system type. There are two types of systems – ventilation exhaust and drain. Each system survey unit encompasses all of a certain type within the building.

Systems Components:
DR – Drain
VE – Ventilation Exhaust

Examples:
MRI-3201 is MRIGlobal Kimball Building, third floor, Class 2
MRI-3101 is MRIGlobal Kimball Building, third floor, Class 1
MRI-DR01 is MRIGlobal Kimball Building, drains

Survey unit classifications and designations were determined from the historical site assessment and are listed in the tables below. Survey unit designations are also identified on the building floor plans presented in Appendix B.

Table 17-1: **Building Structural Survey Units**

Survey Unit	Rooms	Approximate Floor Area (ft^2)
MRI-3101	312E	395
MRI-3102	316E	128
MRI-3103	318E	204
MRI-3104	320E	276
MRI-3201	Adjacent Hallway, Vestibule, and Gas Cylinder Storage	907
MRI-3301	312E, 316E, 318E, 320E Above Drop Ceiling	N/A

Table 17-2: Systems Survey Units

Survey Unit	Description
MRI-DR01	Drain System
MRI-VE01	Ventilation Exhaust System

18.0 FINAL STATUS SURVEY DESIGN

Final status surveys were performed using the DQO process to demonstrate that residual radioactivity in each survey unit satisfied the predetermined criteria for release for unrestricted use. Final status surveys were conducted by performing the appropriate combination of scan surveys, total activity measurements and removable activity measurements as discussed further in this section. All final status surveys were performed according to written instructions. Survey data were documented on survey maps and/or associated data information sheets.

18.1 Surface Scans

Scanning was used to identify locations within the survey unit that exceed the investigation level. Scan surveys were conducted by moving the detector probe at a distance of about 1/8 inch from the surface at the prescribed scan rate and listening for an increase in the audible response. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded every second by

datalogging instrumentation. The following table summarizes the minimum percentage of accessible building structural surfaces scanned.

Table 18-1: Scan Survey Coverage

Structure	Class 1	Class 2	Class 3
Floors	100%	80%	N/A
Walls	100%	25%	10%
Other Structures	100%	25%	10%

For surfaces requiring less than 100% coverage, the surfaces scanned were those with the highest potential for residual radioactivity. Floor areas near impacted area entrances and exits received a 100% scan survey. Where elevated activity was identified, the scan frequency around the location was upgraded to bound the area of residual radioactivity.

18.2 Total Surface Activity Measurements

Direct surveys (static measurements) for total surface activity were taken on building surfaces in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey received direct survey measurements. Static measurements were taken in impacted areas at each identified sample location. Scaler count times were determined to achieve the detection sensitivities stated in the DQOs. Field measurements were converted to activity concentrations using the following equation:

$$Activity\ (dpm/100\ cm^2) = \frac{R_{s+b} - R_b}{E_{total} \times \frac{A}{100\ cm^2}}$$

Where:

R_{s+b} = The gross count rate of the measurement in cpm
R_b = The background count rate in cpm
E_{total} = Total Efficiency
A = Area of the detector window (cm^2)

Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples depends on the Relative Shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration). The minimum number of samples is obtained from MARSSIM tables or calculated using equations in Section 5 of MARSSIM.

The actual standard deviation for the survey unit with the highest standard deviation of total surface activity measurements was used. The LBGR was set at one half of

the DCGL. The calculations performed to determine the required numbers of samples are provided below.

Relative Shift

The number of required samples depends on the ratio involving the activity level to be measured relative to the variability in the concentration. This ratio is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta/\sigma_s = \frac{DCGL - LBGR}{\sigma_s}$$

Where:

DCGL = derived concentration guideline level
LBGR = concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S = the highest standard deviation of the residual radioactivity in the survey units

The actual calculation is provided below:

$$\Delta/\sigma_s = \frac{3.7E6 - 1.85E6}{907} = 2{,}040$$

Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by passing a unit that should fail (α decision error) or failing a unit that should pass (β decision error). The decision error rates were set at 0.05 for both α and β errors.

Number of Sample Locations (Sign Test)

The number of direct measurements required for a survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

Where:

N = number of samples needed in the survey unit
$Z_{1-\alpha}$ = percentile represented by the decision error α
$Z_{1-\beta}$ = percentile represented by the decision error β

SignP = estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR
Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include this additional 20%. The following calculations were made to determine this number:

$$N = \frac{(1.645 + 1.645)^2}{4(1.0 - 0.5)^2} = 11$$

$Z_{1-\alpha}$ and $Z_{1-\beta}$ are equal to 1.645 using the error rate of 0.05 from MARSSIM Table 5.2. SignP is equal to 1.0 from MARSSIM Table 5.4. Adding an additional 20% to account for data losses resulted in a value of 14.

Therefore, the determined number of samples per survey unit for the final status surveys is **14**.

Sample Locations

Determination of survey unit sample locations was accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated start location. MARSSIM recommends Class 3 locations be determined by random x and y coordinates, but this survey design provides for Class 3 samples to be obtained on a systematic grid pattern in the same manner as Class 1 and Class 2 survey units. Sample spacing was determined from MARSSIM equation 5-8:

$$\mathrm{L} = \sqrt{\frac{\mathrm{A}}{\mathrm{N}}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

A random starting point was determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid was plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location was plotted at each intersection of the grid. Maps of final status survey locations for all survey units are included in Appendix D.

18.3 Removable Surface Activity Measurements

Removable contamination measurements were collected by wiping an area of approximately 100 cm^2 on structural surfaces, ventilation systems, and drain systems. Removable contamination measurements on drain systems are reported dpm/swab. The smears/swabs were counted to achieve the detection sensitivities

stated in the DQOs. The liquid scintillation counter (LSC) was setup for triple channel counting as follows:

Channel 1 (H-3): 0 – 18.6 keV
Channel 2 (C-14): 18.6 – 156 keV
Channel 3 (open): 0 – 2,000 keV

Channel 3 (open) results were used to verify that H-3 and C-14 are the only nuclides of concern . LSC results are reported in gross dpm/100 cm^2 for H-3 and C-14, and in gross cpm/100 cm^2 for channel 3.

18.4 Surveys of Building Mechanical System Internals

Surveys of various building system components were performed. Survey design for these systems is out of the scope of MARSSIM. For the purposes of identifying potential residual contamination within these systems, a survey protocol was established and is presented in the table below. Total activity measurements were not possible at some drain locations due to geometry. System survey requirements are summarized in the table below.

Table 18-2: System Survey Coverage

System Component	Coverage
Drain Openings/Traps/Roof Drains	100%
Fume Hood Ventilation Exhaust Components	100%

18.5 Quality Assurance Surveys

Quality Assurance surveys consisted of duplicating the final status survey protocol for building structural surfaces at a rate of 5% to include scans, static measurements, and smears.

19.0 SURVEY DOCUMENTATION AND DATA MANAGEMENT

19.1 Survey Packages

Each survey unit was surveyed under a survey package approved by the Project Manager and specifying the survey protocol to be followed. The survey packages contained the following elements to ensure the DQOs were met:

- Survey protocol instructions such as the number of samples, sample spacing, sample locations, areas to be scanned, etc.
- Random number generations to determine survey locations
- Instrumentation to be used
- Scan rates, static count times, and/or minimum sample volumes
- Scaled survey unit maps
- Checklists for the survey technician

19.2 Location Codes

To ensure proper data management and organization, each static and removable activity measurement location was assigned a unique alpha-numeric location code consisting of a sequence of identifiers to indicate specific information about that location, such as the building, survey unit, structural surface, structural material, and a numerically sequenced location number within the survey unit. This system was used so that survey data could be properly entered and organized in the Survey Database. A breakdown of the location code and specific code components are provided in the table below.

Table 19-1: Location Code Description

A unique location code was assigned to each individual survey location to ensure proper data management of the survey results. The following format was used to ensure consistency throughout the final status survey process:

BBB-RRRR-SS-M-LLL

Where:

BBB: = Building code. This field represents the facility. This will be the building number or an assigned area number. (3 characters) e.g.

MRIGlobal = MRI

RRRR: = Survey Unit Number. This is the assigned survey unit number. (4 characters)

SS: = Structural Surface Code. This field represents the structural surface such as floor, wall, ceiling, etc. (2 characters)

F1 = Floor	D1 = Drainpipe	E3 = Hood Ventilation Fan/Component
W1 = Wall	D2 = Floor Drain	
C1 = Ceiling	D3 = Sink Drain	
	D4 = Roof Drains	

M: = Structural Material Code. This field represents the type of structural material on which a particular measurement is taken. (1 character)

M = Miscellaneous
B = Block
V = Vinyl Tile/Sheeting

LLL: = Numerical Identifier. This field represents the survey location number. The field "001" means survey point location number 1. Numerical identifiers are unique within a survey unit. (3-characters)

20.0 DISMANTLEMENT

After removing loose equipment and materials from the laboratories, Chase removed all fume hoods, laboratory fixtures, fume hood ventilation exhausts, and drain traps from the RSL Class 1 areas. Some fixtures required size reduction to fit through structural constraints and inside the elevator for transport to the waste container staged near the loading dock. Fixtures that could not be economically decontaminated were disposed as radioactive waste.

In preparation for dismantlement, energized systems were locked out including hood utilities and ventilation exhaust control valves. The exhaust ventilation system was left running throughout dismantlement activities (until ducting was removed to the inlet of the filter housings) to maintain the laboratories at a negative pressure.

Decontamination and dismantlement were conducted using radiation work permits (RWP) to control the spread of contamination and keep personnel exposures ALARA. Controls were put in place to prevent the spread of contamination during cutting and removal operations, such as the use of HEPA-filtered vacuums. Remedial action surveys were conducted to help determine when an item/area was ready for release surveys. Newly exposed surfaces were characterized as dismantlement occurred.

All fume hood exhaust ducts were removed. Elevated portions of the ducting were removed in manageable sections and carefully lowered to the floor for further size reduction (if necessary), wrapping and movement to the waste container. After removing all contaminated ducting to the filter housings on the roof, the fans were shut down and electrically disconnected. The filter housings and downstream ducting were removed with a crane with the pre-filters, HEPA filters, and charcoal filters installed. The contaminated north fan was removed and disposed, and the south fan was surveyed and left in place for reuse.

Drain traps and piping were removed to the vertical drainpipes that service other parts of the building. Remaining vertical piping was surveyed at the opening in the RSL to verify surface contamination limits were met. One drain line in Lab 312 resulted in residual activity above investigation levels at the connection to the vertical pipe. Because the results were a small fraction of the DCGL and the system services other parts of the building, the vertical piping was not removed.

After dismantling the laboratories and remediating upper surfaces, the seamless vinyl flooring was removed from all the laboratories; however, some backing material and adhesive remains on the floor.

21.0 POST-DISMANTLEMENT CHARACTERIZATION SURVEYS

After removal of contaminated laboratory fixtures and systems, Chase characterized remaining surfaces for residual radioactivity by performing the scanning portion of the final status survey protocol, with judgmental smears and static measurements on areas of highest probability for residual radioactivity. The characterization survey results for the locations of elevated activity and the post-remediation results are presented in Section 22.0.

22.0 SURFACE REMEDIATION

A variety of surface decontamination methods were used including simple wiping, scrubbing, and scouring techniques; paint removal; and aggressive decontamination techniques such as scabbling, scarifying, grinding, etc. Aggressive techniques used HEPA-filtered vacuums to control dust and to minimize the spread of contamination. All remediation activities were conducted to control the spread of contamination and to maintain personnel exposures ALARA.

Remedial action surveys were conducted in support of remediation activities to help determine when an area was ready for a final status survey and to provide updated estimates for final status survey planning. Remedial action surveys served to monitor the effectiveness of decontamination efforts and to ensure that surrounding areas were not cross-contaminated from remediation.

Remedial action surveys consisted of scan surveys and removable contamination measurements. These were conducted following remediation activities to establish the success or failure of decontamination efforts. Results of the survey were the decision basis for continued remediation or conduct of final status surveys. Remedial action surveys were designed to meet the objectives of the final status surveys and, to the extent allowed by MARSSIM, the results of the remedial action surveys were used to supplement the final status survey.

All post remediation total and removable surface activity results on building structural surfaces are below the investigation levels and well below the applicable DCGL. Remediation performed on building surfaces are summarized in the table below.

Table 22-1: Remediated Structural Surfaces

Survey Unit (Room)	Location (Area ft²)	Maximum Activity (dpm/100 cm²)		Remediation Method	Post-Remediation Maximum Activity (dpm/100 cm²)	
		Total	Removable		Total	Removable
MRI-3101 (312E)	312E Side of 312E/316E Door and Adjacent Wall (6)	25,112	13 – ^{3}H 38 – ^{14}C	Scrub/Scour	<MDC	15 – ^{3}H 14 – ^{14}C
MRI-3101 (312E)	East Wall Near End of Removed Benchtop (40)	12,711	42 – ^{3}H 87 – ^{14}C	Scrub/Scour	<MDC	20 – ^{3}H 16 – ^{14}C
MRI-3101 (312E)	West Wall Around Removed Sink (30)	28,729	791 – ^{3}H 1,403 – ^{14}C	Scrub/Scour	<MDC	20 – ^{3}H 16 – ^{14}C
MRI-3102 (316E)	North Wall Near Door to 312E (1)	19,015	33 – ^{3}H 39 – ^{14}C	Hand Scrub/Scour	<MDC	27 – ^{3}H 16 – ^{14}C
MRI-3102 (316E)	316E Side of 312E/316E Door (3)	13,641	35 – ^{3}H 73 – ^{14}C	Hand Scrub/Scour	<MDC	23 – ^{3}H 19 – ^{14}C
MRI-3102 (316E)	North Wall West of Door to 312E (72)	45,470	44 – ^{3}H 99 – ^{14}C	Top Half Scrub/Scour, Bottom Half Scarified	4,960	17 – ^{3}H 23 – ^{14}C
MRI-3102 (316E)	Bottom Half of South and East Wall (27)	157,283	20 – ^{3}H 54 – ^{14}C	Scrub/Scour, Scarified	4,857	17 – ^{3}H 26 – ^{14}C
MRI-3103 (318E)	318E Side of 318E/316E Door (2.5)	28,935	19 – ^{3}H 24 – ^{14}C	Scrub/Scour	<MDC	17 – ^{3}H 18 – ^{14}C
MRI-3104 (320E)	East Wall Near Floor (1)	15,811	21 – ^{3}H 105 – ^{14}C	Scrub/Scour	3,514	26 – ^{3}H 12 – ^{14}C
MRI-3104 (320E)	320E Side of 318E/320E Door (2.5)	159,660	26 – ^{3}H 18 – ^{14}C	Scrub/Scour	<MDC	16 – ^{3}H 12 – ^{14}C

23.0 DATA QUALITY ASSESSMENT (DQA)

The statistical guidance contained in Section 8 of MARSSIM was used to determine if survey units were acceptable for unrestricted release, and whether additional surveys or sample measurements were needed.

23.1 Data Validation

Field data was reviewed by the Project Manager and validated to ensure:

- Completeness of forms
- Proper types of surveys were performed
- The MDCs for measurements met the established data quality objectives
- Independent calculations were performed on a representative sample of data sheets
- Satisfactory instrument calibrations and daily functionality checks were performed as required

Additionally, all final status survey data was entered into the Survey Database. This provided the means to sort survey data, verify activity calculations, and to compute the associated MDC and counting errors. Once data entry for a survey unit was complete, a verification report was printed and compared to original data sheets to ensure correct data entry.

The final status database reports for building structural surfaces and systems are provided in Appendix F and Appendix G, respectively.

23.2 Preliminary Data Review

A preliminary data review was performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data was reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units.

The following preliminary data reviews were performed for each survey unit:

- Calculations of the survey unit mean median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements to ensure a sufficient number of samples was obtained.
- Comparison of survey data with applicable investigation levels.
- Review of graphical outputs.

The actual standard deviation for all survey units were less than the assumed standard deviation used for calculating the number of measurements, therefore an adequate number of samples were collected for each survey unit.

23.3 Review of 4 Plots

No elevated activity was identified by listening to the audible detector response except for the areas of elevated activity that were remediated as described in Section 22.0. Post-remediation scans were conducted, and scan data was corrected to reflect the final condition of the site. 4-Plot graphs indicate that the scan data is approximately normally distributed with slight variability that is likely due to natural radioactivity in some building materials. 4-Plot graphs of the scan results are provided in Appendix E.

23.4 Data Summary Tables

For structural surface locations determined by the MARSSIM systematic grid pattern, the mean, standard deviation, minimum and maximum values and comparisons between survey data and investigation levels are presented for each survey unit in the tables below. Similar tables summarizing systems survey results follow. Building activity reports for each survey unit are included as Appendix F. Reports for building systems surveys are presented in Appendix G.

Table 23-1: Structural Surfaces Total Beta Surface Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)						
3101	14	1,536	3,196	792	103	3,205	5,000	NO
3102	14	2,001	3,196	845	724	3,411	5,000	NO
3103	11	1,184	3,115	792	-207	2,274	5,000	NO
3104	15	1,289	3,115	907	-827	2,688	5,000	NO
3201	14	539	3,196	628	-827	1,654	5,000	NO
3301	15	1,888	3,115	757	207	2,998	5,000	NO

Table 23-2: Building Structural Surfaces Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
3101	14	18	6	6	26	200	NO
3102	14	20	7	9	34	200	NO
3103	11	18	6	8	30	200	NO
3104	15	20	8	7	36	200	NO
3201	14	22	8	11	39	200	NO
3301	15	15	8	5	32	200	NO

Table 23-3: Building Structural Surfaces Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
3101	14	19	8	8	37	200	NO
3102	14	19	6	9	30	200	NO
3103	11	19	6	8	30	200	NO
3104	15	20	5	12	31	200	NO
3201	14	19	10	12	50	200	NO
3301	15	19	4	8	26	200	NO

Table 23-4: Building Structural Surfaces Removable Channel 3 (Open) Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
3101	14	35	8	22	54	200	NO
3102	14	37	5	27	46	200	NO
3103	11	37	7	27	51	200	NO
3104	15	37	7	26	53	200	NO
3201	14	38	11	25	72	200	NO
3301	15	37	4	31	45	200	NO

Table 23-5: Building Systems Total Beta Surface Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)						
DR01	3	23,364	3,292	39,160	755	68,582	5,000	**YES**
VE01	1	2,264	3,072	N/A	2,264	2,264	5,000	NO

Table 23-6: Building Systems Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
DR01	10	60	115	4	385	200	**YES**
VE01	1	52	N/A	52	52	200	NO

Table 23-7: Building Systems Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
DR01	10	54	98	11	331	200	**YES**
VE01	1	53	N/A	53	53	200	NO

Table 23-8: Building Systems Removable Channel 3 (Open) Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
DR01	10	82	140	26	479	200	**YES**
VE01	1	82	N/A	82	82	200	NO

23.5 Determining Compliance for Building Structural Surfaces and Structures

Final status survey results were initially compared to the investigation levels. All locations of elevated activity on building structural surfaces were remediated to below the investigation levels.

All total and removable surface activity results on building structural surfaces were less than the DCGL and an adequate number of samples were obtained, therefore all survey units pass the Sign test. Therefore, the null hypothesis can be rejected and the survey units meet the release criteria and are suitable for release for unrestricted use.

The results of the data quality assessment and calculations of the dose from each structural surface survey unit are presented in the table below.

Table 23-9: Structural Surfaces MARSSIM Grid Location Dose Calculations

Survey Unit (MRI-)	Standard Deviation (dpm/100 cm^2)	# Samples Required	Actual # of Samples	Adequate # of Samples?	Mean (dpm/100 cm^2)	Calculated Annual TEDE [1] (mrem/yr)
3101	792	11	14	YES	1,536	0.01
3102	845	11	14	YES	2,001	0.01
3103	792	11	11	YES	1,184	0.01

[1] The TEDE shown is conservatively calculated by multiplying 25 mrem/yr by the ratio of the mean total surface activity to the C-14 DCGL of 3.7E6 dpm/100 cm^2.

Survey Unit (MRI-)	Standard Deviation (dpm/100 cm^2)	# Samples Required	Actual # of Samples	Adequate # of Samples?	Mean (dpm/100 cm^2)	Calculated Annual TEDE [1] (mrem/yr)
3104	907	11	15	YES	1,289	0.01
3201	628	11	14	YES	539	0.003
3301	757	11	15	YES	1,888	0.01
					Maximum:	**0.01**

23.6 Mechanical System Survey Data Analysis

Building Systems final status survey results were initially compared to the investigation levels. One location in the building drain system was identified above the investigation levels at 68,582 dpm/100 cm^2 total surface activity, 385 dpm/100 cm^2 removable H-3 activity, and 331 dpm/100 cm^2 removable C-14 activity. It should be noted that due to the geometry of the opening, the total surface activity measurement underestimates the level of surface contamination; however, the result is a very small fraction of the DCGL (1.9%), the drain system internals are not accessible except for maintenance and renovation scenarios, and the DCGLs are based on the building occupancy scenario in which a worker spends 2,340 hours per year working within a building that is uniformly contaminated. The conservatism of the dose modeling associated with residual radioactivity within a laboratory drain system offset the underestimation of the total surface activity.

Because the drain system services other parts of the building, and the dose consequence of leaving the drain line in place is a small fraction of the release criteria, the drain line was left in place.

All total and removable surface activity measurement results are less than the applicable DCGL; therefore all systems survey units meet the release criteria and are suitable for release.

24.0 QUALITY ASSURANCE SURVEYS

Quality assurance surveys consisted of re-performing the FSS protocol for building structural surfaces to achieve a minimum of 5% duplication of scans, static measurements and smears. The Project Manager implemented QA surveys by re-performing judgmentally selected survey locations as survey unit QA01 on a per building basis. The locations of QA survey total and removable surface activity measurements are presented in the table below.

Table 24-1: QA Survey Locations

QA Survey Location	FSS Location
MRI-QA01-W1-B-001	MRI-3101-W1-B-005
MRI-QA01-W1-B-002	MRI-3102-W1-B-008
MRI-QA01-F1-M-003	MRI-3103-F1-M-006
MRI-QA01-F1-M-004	MRI-3104-F1-M-013
MRI-QA01-W1-B-005	MRI-3201-W1-B-006
MRI-QA01-W1-B-006	MRI-3301-W1-B-008

The conclusions reached based on QA surveys were the same as those based on the initial surveys. QA survey results are presented in Appendix H and are summarized in the tables below.

Table 24-2: QA Total Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)						
QA01	6	1,258	3,292	1,626	-647	3,390	5,000	NO

Table 24-3: QA Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
QA01	6	19	5	12	25	200	NO

Table 24-4: QA Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
QA01	6	18	3	15	23	200	NO

Table 24-5: QA Removable Channel 3 (Open) Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
MRI-QA01	6	33	4	27	38	200	NO

25.0 ALARA ANALYSIS

Due to the extremely low doses associated with residual radioactivity at the facility, a quantitative ALARA analysis is not required. Default screening values were used to establish DCGLs. NUREG 1757, Volume 2, Appendix N states in part: "For ALARA during decommissioning, all licensees should use typical good-practice efforts such as floor and wall washing, removal of readily removable radioactivity in buildings or in soil areas, and other good housekeeping practices. In addition, licensees should provide a description in the Final Status Survey Report (FSSR) of how these practices were employed to achieve the final activity levels. In light of the conservatism in the building surface and surface soil generic screening levels developed by NRC, NRC staff presumes, absent information to the contrary, that licensees who remediate building surfaces or soil to the generic screening levels do not need to provide analyses to demonstrate that these screening levels are ALARA."

26.0 CONCLUSION

Radiological surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. A sufficient number of samples was taken in the survey unit and all total and removable surface activity results were significantly less than the applicable DCGL, so no further statistical tests are required.

Conclusion: *The null hypothesis is rejected; all survey units pass the statistical tests and are suitable for release for unrestricted use.*

Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, the Total Effective Dose Equivalent (TEDE) to an average member of the critical group is 0.01 mrem/year.

27.0 REFERENCES

- USNRC Regulations
- MRI Global USNRC Radioactive Materials License Number 24-02564-02
- Chase Kentucky License Number 201-605-15
- MRIGlobal Radiosynthesis Laboratory Decommissioning Work Plan, March 4, 2021
- Chase Radiation Safety Manual
- Chase Quality Assurance Program
- NUREG 1757, Volume 1, Revision 2, "Consolidated NMSS Decommissioning Guidance: Decommissioning Process for Materials Licensees," September 2006
- NUREG 1757, Volume 2, Revision 1, "Consolidated NMSS Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria," September 2006
- NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
- NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" Revision 1, August 2020
- ISO-7503-1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters." 1988
- ANSI/HPS N13.12-2013, "Surface and Volumetric Radioactivity Standards for Clearance," May 2013

MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group

Building: MRI	Site Satellite Photo	Page: A.1 of A.1

MRI-3103

MRI-3102

MRI-3101

313S

320S

316E

312E

320E

WALK IN

306E

330E

318E

322E

25

270

301E

26

27

29

30

315E

317E

319E

321E

31

32

331E

311E

331E1

MRI-3201

MRI-3104

Class 1

Class 2

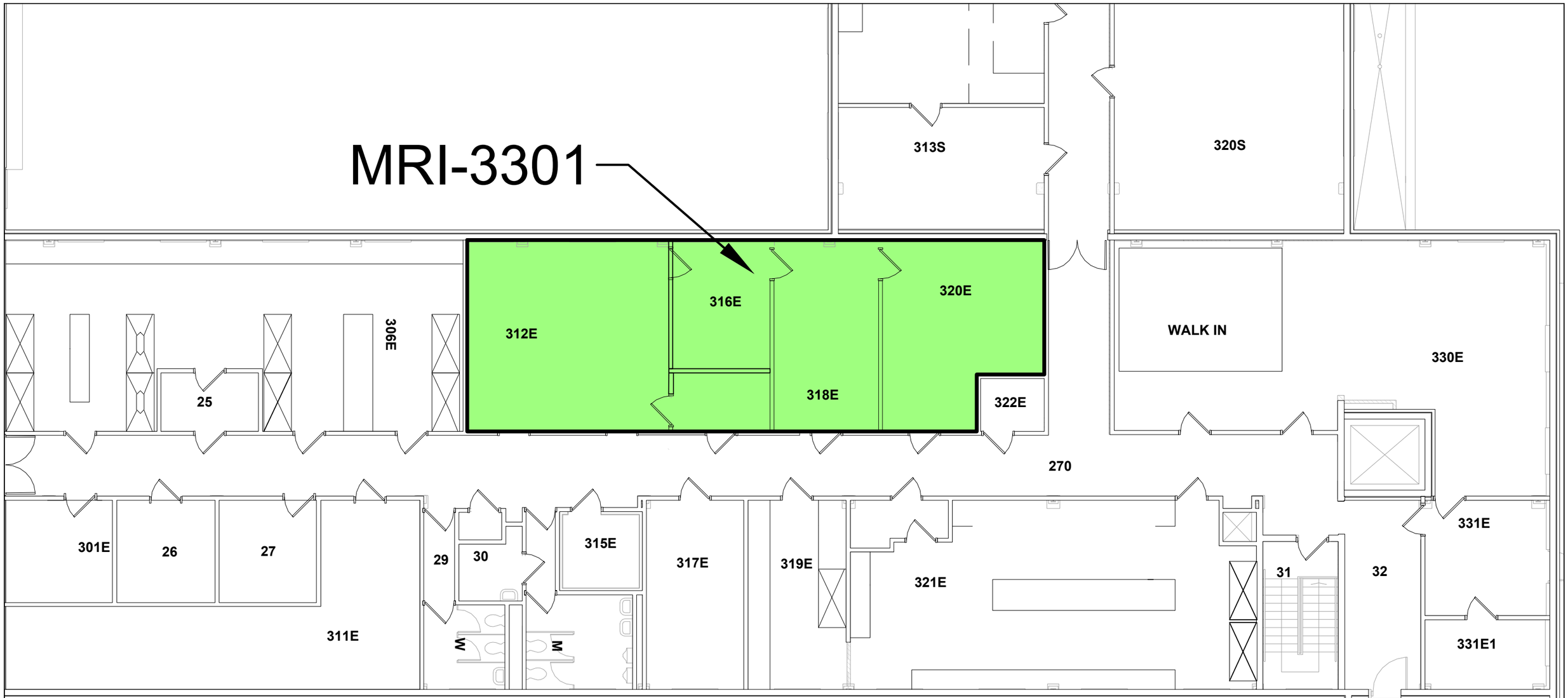
Class 3

NORTH

MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group

Building: MRI	Elevation: 3rd	Page: B.1 of B.2



Class 1

Class 2

Class 3

Note:
MRI-3301 is upper surfaces of RSL.

NORTH

MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group

Building: MRI	Elevation: 3rd	Page: B.2 of B.2

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-406 Rev 3**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 2929,Serial # 160013, Bar Code # ,Property # Chase44

Date: 09/22/20 **Date Last Cal. Expires:** 10/09/20 **Technician:** Jacob Galyon

Temp RelHum: BP: **Reason For Calibration:** Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 **SERIAL #:** 268940 **CAL DUE:** 05/13/21

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA

AS FOUND Instrument Condition: SAT **AS LEFT Instrument Condition:** SAT

AS FOUND Mechanical Zero: 0 **AS LEFT Mechanical Zero:** 0

Scaler Function Check	AS FOUND		AS LEFT		
Beta Channel Window (4-50 mV):	4-50.9	mV	4-50	mV	
Alpha Channel Threshold (175 mV):	179	mV	175	mV	
Alpha Counts w/Pulser @ 10,000 CPM:	10,024	CPM	AF	CPM	% Error: 0.24%
Beta Counts w/Pulser @ 10,000 CPM:	10,024	CPM	AF	CPM	% Error: 0.24%

If AS FOUND data in Scaler Function Check is within 10%, the technician may place AF in AS LEFT section and proceed to High Voltage power supply section.

HIGH VOLTAGE POWER SUPPLY CALIBRATION	AS FOUND		AS LEFT	
Vernier Setting:	3.40		AF	
HV Setpoints:	850	V	AF	V
500 V Reading:	500	V	AF	V
1000 V Reading:	1000	V	AF	V
1500 V Reading:	1490	V	AF	V
Max HV (1500 V +):				

DIGITAL SCALER

AF 250: 250 **% ERR:** 0.00% **AL 250:** AF **% ERR:** 0.00%

AF 2500: 2498 **% ERR:** 0.08% **AL 2500:** AF **% ERR:** 0.08%

AF 25K: 24.97 K **% ERR:** 0.12% **AL 25K:** AF K **% ERR:** 0.12%

AF 250K: 249.7 K **% ERR:** 0.12% **AL 250K:** AF K **% ERR:** 0.12%

☑ **Is the As Found Data Within 20% of the Set Point?**

Comments: **Married as a set with:** **Model:** 43-10-1 **Serial #:** PR167231 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 09/22/21

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 9/24/20

Printed Name: Jacob Galyon

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-414 Rev 4**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-10-1,Serial # PR167231, Bar Code # ,Property # Chase45

Date: 09/22/20 **Date Last Cal. Expires:** 10/09/20 **Technician:** Jacob Galyon

Temp RelHum: BP: CableLength 5 Ft **Reason For Calibration:** Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION **MODEL:** 2929 **SERIAL #:** 160013 **CAL DUE:** 09/22/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	37.33 %
Tc-99:	22.8 %
Th-230:	36.42 %
SrY-90:	39.07 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

HV: Calibration Setpoints 850 V Vernier: 3.40

Threshold Beta: 4 - 50 mV Alpha: 175 mV

Background:	Alpha 2		Beta 45		AF Efficiencies	A-B XTLK
Pu-239:	10481	CPM	321	CPM	36.14%	2.6%
Tc-99:	1	CPM	5601	CPM	19.63%	B-A XTLK
Th-230:	14011	CPM	N/A		34.76%	0.0%
SrY-90:	N/A		3938	CPM	39.84%	

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust, or Plateau

HV: 850 V **Vernier:** 3.40

Background:	Alpha 2		Beta 45		AL Efficiencies	A-B XTLK
Pu-239:	10481	CPM	321	CPM	36.14%	2.6%
Tc-99:	1	CPM	5601	CPM	19.63%	B-A XTLK
Th-230:	14011	CPM	N/A		34.76%	0.0%
SrY-90:	N/A		3938	CPM	39.84%	

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

☑ Is the As Found Data Within 20% of the efficiency from the last cal.?

Reproducibility: Isotope: Sr-90 3935 3889 3839 **Average:** 3887.7 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration and the B-A Xtalk is <1% and the A-B Xtalk is <10%, then the technician may N/A the Plateau Data and go directly to Comments. Geometry = NaI probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU DATA

High Voltage	Source 1: Tc-99 Response (CPM) A ch.	B ch.	Net Eff.	Source 2: Th-230 Response (CPM) A ch.	B ch.	Net Eff.	Background (CPM) A ch.	B ch.	Net A to B Xtalk: <10%	Net B to A Xtalk: <1%
N/A									N/A	
									N/A	
									N/A	
									N/A	
									N/A	
									N/A	

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	71.31%	31.39%	68.34%	56.77%

Comments: **Married as a set with:** **Model:** 2929 **Serial #:** 160013 **Bar Code #:**

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 09/22/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 9/24/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-10-1 **Customer Name :** Chase Environmental
Probe Serial Number : PR167231 **Technician :** Jacob Galyon
Date of Calibration : 9/22/2020

Instruments used during calibration					
Model Number:	2929	Serial Number:	160013	Calibration Due Date:	9/22/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N		Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073	0.0305405	30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 850

Background: 49

C-14 Count: 3735

2π Efficiency: 19.33%
4π Efficiency: 12.06%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2929 **Serial # :** 160013

Date instrument is due for next calibration : 9/22/2021

Performed by : Jacob Galyon Reviewed by : Date : 9/24/20
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments		**Date:**	12/22/2020
Meter Model:	2241-3		**Customer Name:**	Chase
Meter Serial Number:	181288		**Technician:**	Carl Hall
Bar Code Number:			**Reason:**	Due for Cal

M&TE Used					
Instrument Model Number :	500-2	Serial Number:	209797	Cal Due:	5/13/2021

Calibration Data

	As Found Instrument Condition	SAT
Meter		
Threshold	**HV Check 400V - 1500V**	**Pass**

AF	AL
34.5mV	**35mV**

Digital Scaler

Target	As Found	%Error	As Left	%Error
250	250	0.00%	250	0.00%
2,500	2,498	0.08%	2,498	0.08%
25,000	24,983	0.07%	24,983	0.07%
250,000	249,833	0.07%	249,833	0.07%

Rate meter

	AF	% Error	AL	% Error
100	100	0.00%	100	0.00%
250	250	0.00%	250	0.00%
400	400	0.00%	400	0.00%
1,000	1,000	0.00%	1000	0.00%
2,500	2,500	0.00%	2500	0.00%
4,000	4,000	0.00%	4000	0.00%
10,000	10,000	0.00%	10000	0.00%
25,000	25,000	0.00%	25000	0.00%
40,000	40,000	0.00%	40000	0.00%
100,000	100,000	0.00%	100000	0.00%
250,000	250,000	0.00%	250000	0.00%
400,000	400,000	0.00%	400000	0.00%

Alarm	OK
Lamp	OK
Response	OK
Reproducible	OK
Sticker Attached	OK

As Left Instrument Condition	SAT

Probe Settings — Probe 1

Model Number:		44-9	
Serial Number:		RN013604	
	AF		**AL**
HV	893V	**HV**	900V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings — Probe 2

Model Number:		43-5	
Serial Number:		PR089634	
	AF		**AL**
HV	648V	**HV**	650V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings — Probe 3

Model Number:		44-38	
Serial Number:		PR171581	
	AF		**AL**
HV	895V	**HV**	900V
Dead Time	1.20E-04	**Dead Time**	1.20E-04
CC	6.50E+07	**CC**	6.50E+07

Probe Settings — Probe 4

Model Number:		N/A	
Serial Number:		N/A	
	AF		**AL**
HV	N/A	**HV**	N/A
Dead Time	N/A	**Dead Time**	N/A
CC	N/A	**CC**	N/A

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.

Date Instruments are due for Next Calibration: **12/22/2021**

Performed by: _____ **Reviewed by:** _____
Printed Name: Carl Hall **Date Reviewed:** 12/22/20

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Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 44-9,Serial # RN-013604, Bar Code # ,Property # Chase41

Date: 12/22/20 **Date Last Cal. Expires:** 12/05/20 **Technician:** Carl Hall **Reason For Calibration:** Due and Repair

Temp: 77.5 F RelHum: 42 % BP: 29.14 inHG CableLength 5 Ft

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 **SERIAL #** 181288 **CAL DUE:** 12/22/21

MODEL: **SERIAL #** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4050-02	Tc-99	36799 dpm	22,999 cpm	1/20/2020
4052-02	Sr-90	15268 dpm	10,646 cpm	1/20/2020
77173-513	C-14	30557 dpm	19,073 cpm	3/5/2018

Geometry = In contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 13.9 % **Calibration Voltage:** 900 V **Calibration Threshold:** 35 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

AF Background:	40			**AVERAGE**
Tc-99 Count:	5071	4860	5243	5058.0
Sr-90 Count:	4222			

4 π Efficiencies

Tc-99 EFF: 13.64% **Sr-90 EFF:** 27.39%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

AL Background:	40			**AVERAGE**
Tc-99 Count:	5071	4860	5243	5058.0
Sr-90 Count:	4222			

4 π Efficiencies

Tc-99 EFF: 13.64% **Sr-90 EFF:** 27.39%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ **Is the AS FOUND efficiency within 20% of efficiency from last calibration?**
- ☑ **Reproducibility: Are the individual counts within 10% of the average?**
- ☑ **Does the probe meet final acceptance criteria?**
- ☑ **Calibration sticker attached?**

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 181288 **Bar Code #:**

C-14: CPM = 2,937. C-14 Efficiency = 9.48%.

Date Instrument is Due For Next Calibration: 12/22/21

Performed by: _____ **Reviewed by:** _____ **Issue Date:** 12/22/20

Printed Name: Carl Hall

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-408 Rev 4
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-5,Serial # PR089634, Bar Code # ,Property # Chase42

Date: 12/22/20 **Date Last Cal. Expires:** 12/05/20 **Technician:** Carl Hall **Reason For Calibration:** Due for Ca

CableLength 5

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 **SERIAL #:** 181288 **CAL DUE:** 12/22/21

MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
99PU470-0268	Pu-239	14197 dpm	7,188 cpm	1/20/2020
4049-02	Th-230	30198 dpm	15,299 cpm	1/20/2020

Efficiency from Last Calibration: 11.15 % **HV From Last Calibration:** 650 V **Calibration Threshold:** 35 mV

AS FOUND DATA — **1 MINUTE COUNTS (CPM)** — **AS LEFT DATA after repair of HV adjust**

AS FOUND Instrument Condition: SAT

HV: 650 V
Heel: 1633
Center: 1546
Toe: 1554
Background: 0
Uniformity: 3.51 %
Probe Efficiency: Pu-239 **11.11%**

AS LEFT Instrument Condition: SAT

HV: 650 V
Heel: 1633
Center: 1546
Toe: 1554
Background: 0
Uniformity: 3.51 %
Probe Efficiency: Pu-239 **11.11%**

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

☑ **Is the As Found Efficiency Within 20% of the efficiency from the last cal.?**

Reproducibility: **Isotope:** Pu-239 1521 1570 1552 **Average:** 1548 ☑ **Are the individual counts within 10% of the average?**

* If As Found Efficiency (even after repair) is within 10% of the last calibration and uniformity is <10%, the technician may N/A the Plateau Data and proceed to Comments. Geometry = NaI probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU AND SET POINT DATA (CPM)

High Voltage	Source Response	Background
N/A		

HV	HEEL	CENTER	TOE	Background	Uniformity		Efficiency
V					%	Pu-239	
	3228	3152	3170	0		Th-230	10.54%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 181288 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Performed by: _____ **Date Instrument is Due For Next Calibration:** 12/22/21 **Reviewed by:** _____ **Issue Date:** 12/28/20

Printed Name: Carl Hall

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments		**Date:**	12/22/2020
Meter Model:	2241-3		**Customer Name:**	Chase
Meter Serial Number:	181288		**Technician:**	Carl Hall
Probe Model:	44-38		**Reason:**	Due for Cal
Probe Serial Number:	PR171581		**Bar Code Number:**	

M&TE		
Model	**Serial No.**	**Cal Due**
Ludlum 500-2	209797	5/13/2021

N.I.S.T. Source(s)			
Material	**Serial No.**	**Activity**	**Due**
Cs137	KR-4097	130 mCi	2/12/2021
Cs137	0300-GY	400 Cl	2/12/2021
-	-	-	-

Calibration Data

	As Found	As Left		As Found	As Left
High Voltage	895V	900V	**Cal Constant**	6.50E+07	6.50E+07
Threshold	34.5mV	35mV	**Dead Time**	120uSEC	120uSEC

Digital Readings	Exposure Rate	Instrument Reading As Found	Instrument Reading As Left	Percent Error As Found	Percent Error As Left
	0.5 mR/hr	0.515	0.515	3.00%	3.00%
	1 mR/hr	0.97	0.97	-3.00%	-3.00%
	5 mR/hr	5.17	5.17	3.40%	3.40%
	10 mR/hr	10.1	10.1	1.00%	1.00%
	50 mR/hr	54.1	54.1	8.20%	8.20%
	100 mR/hr	102	102	2.00%	2.00%
	500 mR/hr	525	525	5.00%	5.00%

Repair and Service Record

Routine Service:
Check batteries.
Check reset button.
Check fast/slow response.
Check audio.
Check meter zero.
Perform over range test.

Precision

Exposure	Readings	% Dev.
500 mR/hr	517	-0.58%
	528	1.54%
	515	-0.96%

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure or input rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.
*Indicate pulsed scales due to naturally occurring background radiation.

Date Instruments are due for Next Calibration: **12/22/2021**

Performed by: _____
Printed Name: Carl Hall

Reviewed by: _____
Date Reviewed: 12/22/20

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments	**Date:**	3/3/2021
Meter Model:	2241-3	**Customer Name:**	Chase
Meter Serial Number:	181301	**Technician:**	Jacob Galyon
Bar Code Number:		**Reason:**	Due for Cal

M&TE Used					
Instrument Model Number:	500-2	Serial Number:	209797	Cal Due:	5/13/2021

Calibration Data

As Found Instrument Condition		SAT
Meter		
Threshold	**HV Check 400V - 1500V**	**Pass**
AF / **35mV**	**AL** / **35mV**	

Digital Scaler

Target	As Found	%Error	As Left	%Error
250	250	0.00%	250	0.00%
2,500	2,497	0.12%	2,497	0.12%
25,000	24,972	0.11%	24,972	0.11%
250,000	249,678	0.13%	249,678	0.13%

Rate meter

	AF	% Error	AL	% Error
100	100	0.00%	100	0.00%
250	250	0.00%	250	0.00%
400	400	0.00%	400	0.00%
1,000	1,000	0.00%	1000	0.00%
2,500	2,500	0.00%	2500	0.00%
4,000	4,000	0.00%	4000	0.00%
10,000	9,900	1.00%	9900	1.00%
25,000	25,000	0.00%	25000	0.00%
40,000	40,000	0.00%	40000	0.00%
100,000	100,000	0.00%	100000	0.00%
250,000	249,000	0.40%	249000	0.40%
400,000	399,000	0.25%	399000	0.25%

Alarm	OK
Lamp	OK
Response	OK
Reproducible	OK
Sticker Attached	OK

As Left Instrument Condition			SAT
Probe Settings			
Probe 1			
Model Number:		44-9	
Serial Number:		PR171793	
	AF		**AL**
HV	900V	**HV**	900V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings			
Probe 2			
Model Number:		43-5	
Serial Number:		PR089621	
	AF		**AL**
HV	700V	**HV**	700V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings			
Probe 3			
Model Number:		44-6	
Serial Number:		PR140972	
	AF		**AL**
HV	900V	**HV**	900V
Dead Time	9.00E-05	**Dead Time**	9.00E-05
CC	6.55E+07	**CC**	6.55E+07

Probe Settings			
Probe 4			
Model Number:		N/A	
Serial Number:		N/A	
	AF		**AL**
HV	900V	**HV**	900V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.

Date Instruments are due for Next Calibration: 3/3/2022

Performed by: Jacob Galyon
Printed Name: Jacob Galyon

Reviewed by:
Date Reviewed: 3/3/21

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Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 44-9,Serial # PR171793, Bar Code # ,Property # Chase7

Date: 03/03/21 Date Last Cal. Expires: 02/24/21 Technician: Jacob Galyon Reason For Calibration: Due for Calibration

Temp: RelHum: BP: CableLength 5 Ft

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 SERIAL # 181301 CAL DUE: 03/03/22

MODEL: SERIAL # CAL DUE:

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4050-02	Tc-99	36799 dpm	22,999 cpm	1/20/2021
4052-02	Sr-90	14904 dpm	10,392 cpm	1/20/2021

Geometry = in contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 14.43 % Calibration Voltage: 900 V Calibration Threshold: 35 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AF Background:	39			
Tc-99 Count:	5796	5832	5908	5845.3
Sr-90 Count:	4686			

4 π Efficiencies

Tc-99 EFF: 15.78% Sr-90 EFF: 31.18%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AL Background:	39			
Tc-99 Count:	5796	5832	5908	5845.3
Sr-90 Count:	4686			

4 π Efficiencies

Tc-99 EFF: 15.78% Sr-90 EFF: 31.18%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ Is the AS FOUND efficiency within 20% of efficiency from last calibration?
- ☑ Reproducibility: Are the individual counts within 10% of the average?
- ☑ Does the probe meet final acceptance criteria?
- ☑ Calibration sticker attached?

Comments: Married as a set with: Model: 2241-3 Serial #: 181301 Bar Code #:

Date Instrument is Due For Next Calibration: 03/03/22

Performed by: Jacob Galyon Reviewed by: Issue Date: 3/3/21

Printed Name: Jacob Galyon

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-408 Rev 4
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 43-5,Serial # PR089621, Bar Code # ,Property # Chase8

Date: 03/03/21 **Date Last Cal. Expires:** 02/24/21 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Ca

CableLength 5

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 **SERIAL #:** 181301 **CAL DUE:** 03/03/22

MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
99PU470-0268	Pu-239	14196 dpm	7,188 cpm	1/20/2021
4049-02	Th-230	30198 dpm	15,299 cpm	1/20/2021

Efficiency from Last Calibration: 11.01 % **HV From Last Calibration:** 700 V **Calibration Threshold:** 35 mV

AS FOUND DATA

AS FOUND Instrument Condition: SAT

HV: 700 V
Heel: 1653
Center: 1639
Toe: 1630
Background: 0
Uniformity: 0.75 %
Probe Efficiency: Pu-239 **11.56%**

1 MINUTE COUNTS (CPM)

AS LEFT DATA after repair of HV adjust

AS LEFT Instrument Condition: SAT

HV: 700 V
Heel: 1653
Center: 1639
Toe: 1630
Background: 0
Uniformity: 0.75 %
Probe Efficiency: Pu-239 **11.56%**

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

☑ **Is the As Found Efficiency Within 20% of the efficiency from the last cal.?**

Reproducibility: **Isotope:** Pu-239 1495 1541 1585 **Average:** 1540 ☑ **Are the individual counts within 10% of the average?**

* If As Found Efficiency (even after repair) is within 10% of the last calibration and uniformity is <10%, the technician may N/A the Plateau Data and proceed to Comments. Geometry = Nal probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU AND SET POINT DATA (CPM)

High Voltage	Source Response	Background
N/A		

HV	HEEL	CENTER	TOE	Background	Uniformity		Efficiency
700 V	1653	1639	1630	0	0.75 %	Pu-239	11.56%
	2937	3373	3276	0		Th-230	10.58%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 181301 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 03/03/22

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 3/3/21

Printed Name: Jacob Galyon

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments		**Date:**	3/3/2021
Meter Model:	2241-3		**Customer Name:**	Chase
Meter Serial Number:	181301		**Technician:**	Jacob Galyon
Probe Model:	44-6		**Reason:**	Due for Cal
Probe Serial Number:	PR140972		**Bar Code Number:**	

M&TE		
Model	**Serial No.**	**Cal Due**
Ludlum 500-2	209797	5/13/2021
Fluke 87V	92560066	11/3/2022
Fluke 80K-40	82630102	11/2/2022

N.I.S.T. Source(s)			
Material	**Serial No.**	**Activity**	**Cal Due**
Cs137	KR-4097	130 mCi	2/12/2022
Cs137	0300-GY	400 Ci	2/12/2022
-	-	-	-

Calibration Data

	As Found	As Left
High Voltage	900V	900V
Threshold	35mV	35mV
Cal. Constant	9.00E-05	9.00E-05
Dead Time	6.55E+07	6.55E+07

Repair and Service Record

Routine Service:
Check battery.
Check audio and visual alarms.
Perform over range test.
Check alarm reset.

Scale	Exposure	Instrument Reading		Percent Error	
Digital	**Rate**	**As Found**	**As Left**	**As Found**	**As Left**
	0.5 mR/hr	0.521	0.521	4.20%	4.20%
	1 mR/hr	1	1	0.00%	0.00%
	5 mR/hr	5.17	5.17	3.40%	3.40%
	10 mR/hr	9.8	9.8	-2.00%	-2.00%
	50 mR/hr	52.4	52.4	4.80%	4.80%
	100 mR/hr	101	101	1.00%	1.00%
	250 mR/hr	243	243	-2.80%	-2.80%
	400 mR/hr	379	379	-5.25%	-5.25%

Precision

Exposure	Readings	% Dev.
400 mR/hr	381	0.00%
	384	0.79%
	378	-0.79%

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.

Date Instruments are due for Next Calibration: 3/3/2022

Performed by: Jacob Galyon
Printed Name: Jacob Galyon

Reviewed by:
Date Reviewed: 3/5/21

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Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-405 Rev 3**

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Calibration Certificate *7/24/2020*

Calibration Certificate for 3,Serial # 189328, Bar Code # ,Property # Chase68

Date: 07/24/20 **Date Last Cal. Expires:** 08/16/20 **Technician:** Noah Kaye

Location: 999999, **Reason For Calibration:** Due for Calibration

EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 **SERIAL #:** 171700 **CAL DUE:** 05/12/21

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA

Geotropism: SAT **AS FOUND Instrument Condition:** SAT **AS LEFT Instrument Condition:** SAT

HIGH VOLTAGE (+/- 10% tolerance)	AS FOUND HV	AS LEFT HV
500 V:	N/A	AF
1000 V:	N/A	AF
1500 V:	N/A	AF

HV Range 400-1500V: SAT

☐ New Batteries? **Battery Check:** SAT **Alarm:** N/A

AS FOUND Mechanical Zero: 0 **AS LEFT Mechanical Zero:** 0

AS FOUND THRESHOLD: 37.8mV **AS LEFT THRESHOLD:** 37.8mV

AS FOUND HV Reading: 905V **AS LEFT HV Reading:** 900V

RATE METER

SCALE	RATE CPM	AS FOUND	% ERROR	AS LEFT	% ERROR
x.1 or x1	100	100	0.00%	100	0.00%
	250	260	4.00%	250	0.00%
	400	400	0.00%	400	0.00%
x1 or x10	1000	1000	0.00%	1000	0.00%
	2500	2500	0.00%	2500	0.00%
	4000	4000	0.00%	4000	0.00%
x10 or x100	10K	10	0.00%	10	0.00%
	25K	25	0.00%	25	0.00%
	40K	40	0.00%	40	0.00%
x100 or x1000	100K	100	0.00%	100	0.00%
	250K	250	0.00%	250	0.00%
	400K	400	0.00%	400	0.00%

☑ Is the As Found Data Within 20% of the Set Point?

DIGITAL SCALER

AF 250:	N/A	**% ERR:** 0.00%	**AL 250:**	N/A	**% ERR:** 0.00%
AF 2500:	N/A	**% ERR:** 0.00%	**AL 2500:**	N/A	**% ERR:** 0.00%
AF 25K:	N/A K	**% ERR:** 0.00%	**AL 25K:**	N/A K	**% ERR:** 0.00%
AF 100K:	N/A K	**% ERR:** 0.00%	**AL 100K:**	N/A K	**% ERR:** 0.00%

☐ Is the As Found Data Within 20% of the Set Point?

REPRODUCIBILITY

x.1 or x1 Scale:	250	250	250
x1 or x10 Scale:	2500	2500	2500
x10 or x100 Scale:	25 K	25 K	25 K
x100 or x1000 Scale:	250 K	250 K	250 K

☑ Are the Individual Counts Within 10% of the Average?

☑ Fast / Slow Response Switch Functions Properly?

Audio Response: SAT **Audio Divide:** N/A

Push Buttons: SAT **Lamp:** N/A

Scaler/Digital: N/A

Comments: **Married as a set with:** **Model:** 44-9 **Serial #:** PR196097 **Bar Code #:**

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 07/24/21

Performed by: _____ **Reviewed by:** _____ **Date:** 8/3/20

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3
1093 Commerce Park Drive, Suite 300 Oak Ridge, TN 37830
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Calibration Certificate
7/24/2020

Calibration Certificate for 44-9,Serial # PR196097, Bar Code # ,Property # Chase69

Date: 07/24/20 **Date Last Cal. Expires:** 08/16/20 **Technician:** Noah Kaye
Location: 999999, **Reason For Calibration:** Due for Calibration

EQUIPMENT USED DURING CALIBRATION

MODEL: 3 **SERIAL #:** 189328 **CAL DUE:** 07/24/21
MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4073-02	Tc-99	30499 dpm	19,100 cpm	1/20/2020
4065-02	Sr-90	13994 dpm	9,802 cpm	1/20/2020

Geometry = in contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 11.32% **Calibration Voltage:** 900 V **Calibration Threshold:** 37.8 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AF Background:	47			
Tc-99 Count:	3700	3600	3700	3666.7
Sr-90 Count:	3400			

4 π Efficiencies

Tc-99 EFF: 11.87% **Sr-90 EFF:** 23.96%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AL Background:	47			
Tc-99 Count:	3700	3600	3700	3666.7
Sr-90 Count:	3400			

4 π Efficiencies

Tc-99 EFF: 11.87% **Sr-90 EFF:** 23.96%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ **Is the AS FOUND efficiency within 20% of efficiency from last calibration?**
- ☑ **Reproducibility: Are the individual counts within 10% of the average?**
- ☑ **Does the probe meet final acceptance criteria?**
- ☑ **Calibration sticker attached?**

Comments: **Married as a set with:** **Model:** 3 **Serial #:** 189328 **Bar Code #:**

Date Instrument is Due For Next Calibration: 07/24/21

Performed by: _____ **Reviewed by:** _____ **Date:** 8/3/20

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 44-9 **Customer Name :** Chase Environmental
Probe Serial Number : PR196097 **Technician :** Carl Hall
Date of Calibration : 7/24/2020

Instruments used during calibration					
Model Number:	3	Serial Number:	189328	Calibration Due Date:	7/24/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

			Activity(s)			
	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073		30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 900

Background: 47

C-14 Count: 2500

2π Efficiency: 12.86%
4π Efficiency: 8.03%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 3 **Serial # :** 189328
Geometry = flush to surface.

Date instrument is due for next calibration : 7/24/2021

Performed by : Printed Name : Carl Hall
Reviewed by : Date : 8/3/20

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-422 Rev 3**

1093 Commerce Park Drive, Suite 300
Oak Ridge, TN 37830

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Calibration Certificate

6/23/2020

Calibration Certificate for 2241-2,Serial # 211241, Bar Code # ,Property # Chase222

Date: 06/23/20 **Date Last Cal. Expires:** **Technician:** Noah Kaye

Location: 999999, **Reason For Calibration:** Due for Calibration

EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 **SERIAL #:** 171700 **CAL. DUE:** 05/12/21

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA **AS FOUND Instrument Condition:** SAT **AS LEFT Instrument Condition:** **SAT** ☐ **New Batteries?**

DETECTOR 1				DETECTOR 2			
HV Range 400-1500V: SAT				HV Range 400-1500V: SAT			
AF THRESHOLD: 10 mV	AL THRESHOLD: 10 mV	AF THRESHOLD: 10 mV	AL THRESHOLD: 35 mV				
AF HV Reading: 1626 V	AL HV Reading: 1000 V	AF HV Reading: 1518 V	AL HV Reading: 900 V				

SCALER

	AS FOUND	% ERROR	AS LEFT	% ERROR
250:	250	0.00%	AF	0.00%
2500:	2509	0.36%	AF	0.36%
25K:	25	0.00%	AF	0.00%
250K:	250	0.00%	AF	0.00%

☑ **Is the As Found Data Within 20% of the Set Point?**

☑ **Fast / Slow Response Switch Functions Properly?**

Audio Response: SAT **Push Buttons:** SAT **Lamp:** SAT **Digital:** SAT

Comments: **Married as a set with:** **Model:** **Serial #:** **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 06/23/21

Performed by: _____ **Reviewed by:** _____ **Date:** 6/30/20

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3
1093 Commerce Park Drive, Suite 300 Oak Ridge, TN 37830
Calibration Certificate
Page 1 of 1
6/23/2020

Calibration Certificate for 44-9,Serial # PR134348, Bar Code # ,Property # Chase177

Date: 06/23/20 **Date Last Cal. Expires:** 10/10/20 **Technician:** Noah Kaye
Location: 999999, **Reason For Calibration:** Due for Calibration

EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-2 **SERIAL #:** 211241 **CAL DUE:** 06/23/21
MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4073-02	Tc-99	30499 dpm	19,100 cpm	1/20/2020
4065-02	Sr-90	13994 dpm	9,802 cpm	1/20/2020

Geometry = in contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 13.37% **Calibration Voltage:** 900 V **Calibration Threshold:** 35 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AF Background:	47			
Tc-99 Count:	4082	4170	4081	4111.0
Sr-90 Count:	3645			

4 π Efficiencies

Tc-99 EFF: 13.33% **Sr-90 EFF:** 25.71%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AL Background:	47			
Tc-99 Count:	4082	4170	4087	4113.0
Sr-90 Count:	3645			

4 π Efficiencies

Tc-99 EFF: 13.33% **Sr-90 EFF:** 25.71%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ **Is the AS FOUND efficiency within 20% of efficiency from last calibration?**
- ☑ **Reproducibility: Are the individual counts within 10% of the average?**
- ☑ **Does the probe meet final acceptance criteria?**
- ☑ **Calibration sticker attached?**

Comments: **Married as a set with:** **Model:** 2241-2 **Serial #:** 211241 **Bar Code #:**

Date Instrument is Due For Next Calibration: 06/23/21

Performed by: _____ **Reviewed by:** _____ **Date:** 6/30/20

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 44-9 **Customer Name :** Chase Environmental
Probe Serial Number : PR134348 **Technician :** Noah Kaye
Date of Calibration : 6/23/2020

Instruments used during calibration					
Model Number:	2241-2	Serial Number:	211241	Calibration Due Date:	6/23/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073		30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 900

Background: 47

C-14 Count: 2319

2π Efficiency: 11.91%
4π Efficiency: 7.44%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-2 **Serial # :** 211241
Geometry = flush to surface.

Date instrument is due for next calibration : 6/23/2021

Performed by : Noah Kaye Reviewed by : Date : 6/23/20
Printed Name : Noah Kaye

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 253346 **Customer Name :** Chase
Previous due date : 11/20/2020 **P.O Number :**
Date : 2/2/2021 **Technician :** Jacob Galyon
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	**500-2**	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
SAT	SAT

Threshold	
As Found	As Left
4.6	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1675	1675	SAT	SAT
2	1775	1775	SAT	SAT
3	1150	1150	SAT	SAT
4	1275	1275	SAT	SAT

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

Digital Scaler				
Target	**As Found**	**%Error**	**As Left**	**%Error**
250	250	0.04%	250	0.04%
2,500	2,498	0.08%	2,498	0.08%
25,000	24,972	0.11%	24,972	0.11%
250,000	249,732	0.11%	249,732	0.11%

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1675V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR285701
	1775V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR259902
	1150V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR285701
Comments :	**1275V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR259902

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 2/2/2022

Performed by : Jacob Galyon Date: 02/02/21 Reviewed by: Date: 2/2/21
Printed name : Jacob Galyon

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-417 Rev 5**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR259902, Bar Code # Green,Property # Chase104

Date: 02/02/21 **Date Last Cal. Expires:** 11/20/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 253346 **CAL DUE** 02/02/22

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	19.74 %
Tc-99:	24.43 %
Th-230:	17.31 %
SrY-90:	33.10 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1275 V **HV (Beta):** 1775 V **Threshold:** 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Back ground:	4	CPM	775	CPM
Pu-239:	5460	CPM	N/A	18.82%
Tc-99:	N/A		7800	CPM 24.82%
Th-230:	6882	CPM	N/A	17.07%
SrY-90:	N/A		4332	CPM 37.29%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1275 V **HV (Beta):** 1775 V **Threshold:** 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Back ground:	4	CPM	775	CPM
Pu-239:	5460	CPM	N/A	18.82%
Tc-99:	N/A		7800	CPM 24.82%
Th-230:	6882	CPM	N/A	17.07%
SrY-90:	N/A		4332	CPM 37.29%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4383 4221 4272 **Average:** 4292.0 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Pu-239

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.13%	39.69%	33.55%	53.15%

Comments: Married as a set with: **Model:** 2241-3 **Serial #:** 253346 **Bar Code #:** Green

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 02/02/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 2/2/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR259902 **Technician :** Jacob Galyon
Date of Calibration : 2/2/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253346	Calibration Due Date:	2/2/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1775

Background: 775

C-14 Count: 9218

2π Efficiency: 32.57%
4π Efficiency: 12.45%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253346
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 2/2/2022

Performed by : Jacob Galyon Reviewed by : Date : 2/2/21
Printed Name : Jacob Galyon

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-417 Rev 5**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR285701, Bar Code # Green,Property # Chase105

Date: 02/02/21 **Date Last Cal. Expires:** 11/20/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 253346 **CAL DUE** 02/02/22

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	19.05 %
Tc-99:	24.95 %
Th-230:	16.31 %
SrY-90:	38.03 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1150 V **HV (Beta):** 1675 V **Threshold:** 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Background:	1	CPM	190	CPM	
Pu-239:	5507	CPM	N/A		18.99%
Tc-99:	N/A		7127	CPM	24.51%
Th-230:	6745	CPM	N/A		16.74%
SrY-90:	N/A		3937	CPM	38.34%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1150 V **HV (Beta):** 1675 V **Threshold:** 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Background:	1	CPM	190	CPM	
Pu-239:	5507	CPM	N/A		18.99%
Tc-99:	N/A		7127	CPM	24.51%
Th-230:	6745	CPM	N/A		16.74%
SrY-90:	N/A		3937	CPM	38.34%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 3910 3933 3916 **Average:** 3919.7 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.47%	39.19%	32.90%	54.64%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 253346 **Bar Code #:** Green

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 02/02/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 2/2/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR285701 **Technician :** Jacob Galyon
Date of Calibration : 2/2/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253346	Calibration Due Date:	2/2/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1675

Background: 190

C-14 Count: 7822

2π Efficiency: 29.44%
4π Efficiency: 11.26%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253346
Calibrated with plastic standoffs attached while using 5' cable.

Date instrument is due for next calibration : 2/2/2022

Performed by : Jacob Galyon Reviewed by : [signature] Date : 2/2/21
Printed Name : Jacob Galyon
Entered in computer inventory by: _____ Date : _____

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

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Oak Ridge, TN, 37830

Model 2241-3 CALIBRATION FORM

Serial number : 253351 **Customer Name :** Chase
Previous due date : 8/20/2020 **P.O Number :**
Date : 7/30/2020 **Technician :** Jacob Galyon
Reason For Calibration : Due For Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2020
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
4.0	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1675	1675	SAT	SAT
2	1800	1800	SAT	SAT
3	1275	1325	SAT	SAT
4	1350	1350	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	249	0.40%	249	0.40%
2,500	2,497	0.12%	2,497	0.12%
25,000	24,970	0.12%	24,970	0.12%
250,000	249,695	0.12%	249,695	0.12%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:						
	1675V	DET 1	Model:	43-68	Serial Number:	PR216394
	1800V	DET 2	Model:	43-37	Serial Number:	PR178300
	1325V	DET 3	Model:	43-68	Serial Number:	PR216394
Comments :	1350V	DET 4	Model:	43-37	Serial Number:	PR178300

Instrument calibrated per SEC-IS-423
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 7/30/2021

Performed by : Jacob Galyon Date: 07/30/20 Reviewed by: Date: 8/3/20
Printed name : Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
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Calibration Certificate

Calibration Certificate for 43-37,Serial # PR178300, Bar Code # ,Property # Chase107

Date: 07/30/20 **Date Last Cal. Expires:** 08/20/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp 76.5 F RelHum: 40 % BP: 28.93 inHG CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 253351 CAL DUE 07/30/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
Efficiencies from last calibration	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
Pu-239: 19.90 %	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
Tc-99: 23.95 %	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
Th-230: 17.68 %	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020
SrY-90: 36.26 %					

AS FOUND DATA AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1350 V HV (Beta): 1800 V Threshold: 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Background:	5	CPM	1018	CPM
Pu-239:	5450	CPM	N/A	18.78%
Tc-99:	N/A		7691	CPM 23.58%
Th-230:	7066	CPM	N/A	17.52%
SrY-90:	N/A		4281	CPM 33.39%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1350 V HV (Beta): 1800 V Threshold: 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Background:	5	CPM	1018	CPM
Pu-239:	5450	CPM	N/A	18.78%
Tc-99:	N/A		7691	CPM 23.58%
Th-230:	7066	CPM	N/A	17.52%
SrY-90:	N/A		4281	CPM 33.39%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4386 4413 4380 Average: 4393.0 ☑ Are the individual counts within 10% of the average?

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.05%	37.70%	34.45%	47.59%

Comments: Married as a set with: Model: 2241-3 Serial #: 253351 Bar Code #:

Replaced mylar.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 07/30/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 8/3/20

Printed Name: Jacob Galyon

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C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR178300 **Technician :** Jacob Galyon
Date of Calibration : 7/30/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253351	Calibration Due Date:	7/30/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1800

Background: 1018

C-14 Count: 9174

2π Efficiency: 31.47%
4π Efficiency: 12.03%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253351
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 7/30/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon

Reviewed by : Date : 8/3/20

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Calibration Certificate

Calibration Certificate for 43-68,Serial # PR216394, Bar Code # ,Property # Chase108

Date: 07/30/20 Date Last Cal. Expires: 08/20/20 Technician: Jacob Galyon Reason For Calibration: Due for Calibration

Temp 76.8 F RelHum: 40 % BP: 28.9 inHG CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 253351 CAL DUE 08/20/20

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
Efficiencies from last calibration	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
Pu-239: 23.63 %	4072-02	Tc-99	28299 dpm	17,899 cpm	1/20/2020
Tc-99: 27.98 %	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
Th-230: 22.87 %	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020
SrY-90: 38.89 %					

AS FOUND DATA AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1275 V HV (Beta): 1675 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Background:	3	CPM	274	CPM	
Pu-239:	5703	CPM	N/A		19.66%
Tc-99:	N/A		7203	CPM	24.48%
Th-230:	7194	CPM	N/A		17.85%
SrY-90:	N/A		3819	CPM	36.28%

☐ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1325 V HV (Beta): 1675 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Background:	4	CPM	274	CPM	
Pu-239:	6005	CPM	N/A		20.70%
Tc-99:	N/A		7203	CPM	24.48%
Th-230:	7454	CPM	N/A		18.49%
SrY-90:	N/A		3819	CPM	36.28%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 3860 4060 4032 Average: 3984.0 ☐ Are the individual counts within 10% of the average?

If the As Found data (even after repairs) is within 10% of the last calibration, then the As Left data is the same as the As Found data. If the As Found data is not within 10% of the last calibration, then the As Left data is the same as the As Found data.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	40.83%	39.15%	36.35%	51.70%

Comments: Married as a set with: Model: 2241-3 Serial #: 253351 Bar Code #:

Replaced mylar.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 07/30/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 8/3/20

Printed Name: Jacob Galyon

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C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR216394 **Technician :** Jacob Galyon
Date of Calibration : 7/30/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253351	Calibration Due Date:	7/30/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1675

Background: 274

C-14 Count: 8197

2π Efficiency: 30.57%
4π Efficiency: 11.69%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253351
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 7/30/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon

Reviewed by : Date : 8/3/20

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Calibration Certificate

Calibration Certificate for 43-68,Serial # PR289219, Bar Code # Orange,Property # Chase51

Date: 10/14/20 Date Last Cal. Expires: 11/19/20 Technician: Jacob Galyon Reason For Calibration: Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 253356 CAL DUE 10/14/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	18.81 %
Tc-99:	25.15 %
Th-230:	16.38 %
SrY-90:	38.55 %

AS FOUND DATA AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1125 V HV (Beta): 1750 V Threshold: 4 mV

Background:	Alpha		Beta		AF 4 πEfficiencies
	2	CPM	286	CPM	
Pu-239:	5277	CPM	N/A		18.19%
Tc-99:	N/A		7255	CPM	24.63%
Th-230:	6320	CPM	N/A		15.68%
SrY-90:	N/A		4117	CPM	39.20%

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1125 V HV (Beta): 1750 V Threshold: 4 mV

Background:	Alpha		Beta		AL 4 π Efficiencies
	2	CPM	286	CPM	
Pu-239:	5277	CPM	N/A		18.19%
Tc-99:	N/A		7255	CPM	24.63%
Th-230:	6320	CPM	N/A		15.68%
SrY-90:	N/A		4117	CPM	39.20%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4038 4109 4028 Average: 4058.3 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	35.89%	39.38%	30.82%	55.87%

Comments: Married as a set with: Model: 2241-3 Serial #: 253356 Bar Code #: Orange

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 10/14/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 10/14/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

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Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68
Probe Serial Number : PR289219
Date of Calibration : 10/14/2020

Customer Name : Chase Environmental
Technician : Jacob Galyon

Instruments used during calibration

Model Number:	2241-3	Serial Number:	253356	Calibration Due Date:	10/14/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1750

Background: 286

C-14 Count: 8246

2π Efficiency: **30.71%**
4π Efficiency: **11.74%**

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253356
Calibrated with a 5' cable with plastic standoffs attached.

Date instrument is due for next calibration : 10/14/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon

Reviewed by : Date : 10/14/20

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5

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Calibration Certificate

Calibration Certificate for 43-37,Serial # PR281040, Bar Code # Orange,Property # Chase50

Date: 10/14/20 **Date Last Cal. Expires:** 11/19/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 253356 **CAL DUE** 10/14/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
Efficiencies from last calibration	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
Pu-239: 18.98 %	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
Tc-99: 25.64 %	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
Th-230: 17.11 %	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020
SrY-90: 39.93 %					

AS FOUND DATA **AS FOUND Instrument Condition:** SAT

Calibration Setpoints

HV (Alpha): 1275 V HV (Beta): 1875 V Threshold: 4 mV

Background:	Alpha 5 CPM	Beta 914 CPM	AF 4 πEfficiencies
Pu-239:	5312 CPM	N/A	18.30%
Tc-99:	N/A	7965 CPM	24.92%
Th-230:	6125 CPM	N/A	15.19%
SrY-90:	N/A	4504 CPM	36.74%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1275 V HV (Beta): 1875 V Threshold: 4 mV

Background:	Alpha 5 CPM	Beta 914 CPM	AL 4 π Efficiencies
Pu-239:	5312 CPM	N/A	18.30%
Tc-99:	N/A	7965 CPM	24.92%
Th-230:	6125 CPM	N/A	15.19%
SrY-90:	N/A	4504 CPM	36.74%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4673 4706 4584 Average: 4654.3 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	36.11%	39.84%	29.86%	52.36%

Comments: Married as a set with: **Model:** 2241-3 **Serial #:** 253356 **Bar Code #:** Orange

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 10/14/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 10/14/20

Printed Name: Jacob Galyon

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Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase
Probe Serial Number : PR281040 **Technician :** Jacob Galyon
Date of Calibration : 10/14/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253356	Calibration Due Date:	10/14/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1875

Background: 914

C-14 Count: 9068

2π Efficiency: **31.46%**
4π Efficiency: **12.03%**

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253356
Calibrated with plastic standoffs attached while using a 10' cable.

Date instrument is due for next calibration : 10/14/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon
Reviewed by : Date : 10/14/20
Entered in computer inventory by: Date :

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SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 253356 **Customer Name :** Chase
Previous due date : 11/19/2020 **P.O Number :**
Date : 10/14/2020 **Technician :** Jacob Galyon
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
SAT	SAT

Threshold	
As Found	As Left
4.0	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1752	1750	SAT	SAT
2	1877	1875	SAT	SAT
3	1125	1125	SAT	SAT
4	1276	1275	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	250	0.04%	250	0.04%
2,500	2,500	0.00%	2,500	0.00%
25,000	25,004	0.02%	25,004	0.02%
250,000	250,044	0.02%	250,044	0.02%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:						
	1750V	DET 1	Model:	43-68	Serial Number:	PR289219
	1875V	DET 2	Model:	43-37	Serial Number:	PR281040
	1125V	DET 3	Model:	43-68	Serial Number:	PR289219
Comments :	1275V	DET 4	Model:	43-37	Serial Number:	PR281040

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 10/14/2021

Performed by : Date: 10/14/20 Reviewed by: Date: 10/14/20
Printed name : Jacob Galyon

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Suite 200
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Perma-Fix Environmental Services, Inc.
1093 Commerce Park Drive, Suite 300
Oak Ridge, TN, 37830

Model 2241-3 CALIBRATION FORM

Serial number : 253363
Previous due date : 8/20/2020
Date : 7/30/2020

Customer Name : Chase
P.O Number :
Technician : Jacob Galyon
Reason For Calibration : Due For Calibration

INSTRUMENT(S) USED DURING CALIBRATION

Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
4.0	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1700	1700	SAT	SAT
2	1775	1775	SAT	SAT
3	1150	1200	SAT	SAT
4	1275	1275	SAT	SAT

Digital Scaler

Target	As Found	%Error	As Left	%Error
250	250	0.00%	250	0.00%
2,500	2,496	0.16%	2,496	0.16%
25,000	24,960	0.16%	24,960	0.16%
250,000	249,606	0.16%	249,606	0.16%

Reproducability

x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1700V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR190903
	1775V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR265548
	1200V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR190903
Comments :	**1275V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR265548

Instrument calibrated per SEC-IS-423
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 7/30/2021

Performed by: Jacob Galyon Date: 7/30/20 Reviewed by: Date: 8/3/20

Printed name : Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR265548, Bar Code # ,Property # Chase47

Date: 07/30/20 Date Last Cal. Expires: 08/20/20 Technician: Jacob Galyon Reason For Calibration: Due for Calibration

Temp 76.3 F RelHum: 38 % BP: 28.99 inHG CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 253363 CAL DUE 08/20/20

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	19.25 %
Tc-99:	23.97 %
Th-230:	16.95 %
SrY-90:	37.98 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1275 V HV (Beta): 1775 V Threshold: 4 mV

	Alpha		Beta	AF 4 π Efficiencies
Background:	5	CPM	1112	CPM
Pu-239:	5111	CPM	N/A	17.61%
Tc-99:	N/A		7463	CPM 22.44%
Th-230:	6158	CPM	N/A	15.27%
SrY-90:	N/A		4433	CPM 33.98%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1275 V HV (Beta): 1775 V Threshold: 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Background:	5	CPM	1112	CPM
Pu-239:	5111	CPM	N/A	17.61%
Tc-99:	N/A		7463	CPM 22.44%
Th-230:	6158	CPM	N/A	15.27%
SrY-90:	N/A		4433	CPM 33.98%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4443 4398 4410 Average: 4417.0 ☑ Are the individual counts within 10% of the average?

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:

Pu-239	Tc-99	Th-230	SrY-90
34.74%	35.88%	30.02%	48.43%

Comments: Married as a set with: Model: 2241-3 Serial #: 253363 Bar Code #:

Replaced damaged mylar.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 07/30/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 8/3/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR265548 **Technician :** Jacob Galyon
Date of Calibration : 7/30/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253363	Calibration Due Date:	7/30/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1775

Background: 1112

C-14 Count: 8676

2π Efficiency: 29.18%
4π Efficiency: 11.16%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253363
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 7/30/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon

Reviewed by : _____ Date : 8/3/20

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR190903, Bar Code # ,Property # Chase48

Date: 07/30/20 Date Last Cal. Expires: 08/20/20 Technician: Jacob Galyon Reason For Calibration: Due for Calibration

Temp 75 F RelHum: 40 % BP: 28.99 inHG CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 253363 CAL DUE 08/20/20

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration
Pu-239: 23.32 %
Tc-99: 27.30 %
Th-230: 21.72 %
SrY-90: 39.89 %

AS FOUND DATA AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1150 V HV (Beta): 1700 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Background:	3	CPM	306	CPM	
Pu-239:	5490	CPM	N/A		18.93%
Tc-99:	N/A		7104	CPM	24.02%
Th-230:	6651	CPM	N/A		16.50%
SrY-90:	N/A		3909	CPM	36.87%

☐ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1200 V HV (Beta): 1700 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Background:	3	CPM	306	CPM	
Pu-239:	5679	CPM	N/A		19.58%
Tc-99:	N/A		7104	CPM	24.02%
Th-230:	6981	CPM	N/A		17.42%
SrY-90:	N/A		3909	CPM	36.87%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 3901 3898 3830 Average: 3876.3 ☐ Are the individual counts within 10% of the average?

If no AS Found or as left data, the instrument is out of calibration, the ...

PLATEAU DATA

Alpha Source: Pu-239

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	38.62%	38.41%	34.04%	52.54%

Comments: Married as a set with: Model: 2241-3 Serial #: 253363 Bar Code #:

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 07/30/21

All Instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 8/13/20
Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR190903 **Technician :** Jacob Galyon
Date of Calibration : 7/30/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	253363	Calibration Due Date:	7/30/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1700

Background: 306

C-14 Count: 8070

2π Efficiency: **29.95%**
4π Efficiency: **11.45%**

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 253363
Calibrated with plastic standoffs attached

Date instrument is due for next calibration : 7/30/2021

Performed by : Jacob Galyon
Printed Name : Jacob Galyon

Reviewed by : [signature] Date : 8/3/20

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 267161 **Customer Name :** Chase
Previous due date : 11/19/2020 **P.O Number :**
Date : 12/17/2020 **Technician :** Jacob Galyon
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	**500-2**	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
4.6	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1700	1700	SAT	SAT
2	1825	1825	SAT	SAT
3	1175	1175	SAT	SAT
4	1375	1375	SAT	SAT

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

Digital Scaler				
Target	**As Found**	**%Error**	**As Left**	**%Error**
250	249	0.40%	249	0.40%
2,500	2,496	0.16%	2,496	0.16%
25,000	24,960	0.16%	24,960	0.16%
250,000	249,605	0.16%	249,605	0.16%

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1700V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR289347
	1825V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR148503
	1175V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR289347
Comments :	**1375V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR148503

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Date: Reviewed by: Date: 12/31/20
Printed name : Jacob Galyon

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-417 Rev 5**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR289347, Bar Code # Purple,Property # Chase99

Date: 12/17/20 **Date Last Cal. Expires:** 11/19/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 267161 **CAL DUE** 11/19/20

Efficiencies from last calibration

Pu-239:	18.87 %
Tc-99:	24.82 %
Th-230:	16.68 %
SrY-90:	37.34 %

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1175 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	4	CPM	204	CPM	
Pu-239:	6333	CPM	N/A		21.83%
Tc-99:	N/A		7979	CPM	27.47%
Th-230:	8651	CPM	N/A		21.46%
SrY-90:	N/A		4206	CPM	40.95%

☑ **Is the As Found Data within 20% of the efficiency from the last cal.?**

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1175 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	4	CPM	204	CPM	
Pu-239:	6333	CPM	N/A		21.83%
Tc-99:	N/A		7979	CPM	27.47%
Th-230:	8651	CPM	N/A		21.46%
SrY-90:	N/A		4206	CPM	40.95%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4243 4259 4310 **Average:** 4270.7 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	43.07%	43.93%	42.18%	58.36%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 267161 **Bar Code #:** Purple

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 12/17/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 12/31/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR289347 **Technician :** Jacob Galyon
Date of Calibration : 12/17/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/17/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Activity(s)					
	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1700

Background: 204

C-14 Count: 7830

2π Efficiency: 29.42%
4π Efficiency: 11.25%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161
Calibrated with plastic standoffs attached while using 5' cable.

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Reviewed by : Date : 12/31/20
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

Safety and Ecology Corporation **SEC PROCEDURE #** **SEC-IS-417 Rev 5**

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR148503, Bar Code # Purple,Property # Chase100

Date: 12/17/20 **Date Last Cal. Expires:** 11/19/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 267161 **CAL DUE** 12/17/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	23.64 %
Tc-99:	28.76 %
Th-230:	22.78 %
SrY-90:	40.22 %

AS FOUND DATA

AS FOUND Instrument Condition: UNSA

Calibration Setpoints

HV (Alpha): 1375 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Back ground:	4	CPM	835	CPM
Pu-239:	5715	CPM	N/A	19.70%
Tc-99:	N/A		7976	CPM 25.23%
Th-230:	6976	CPM	N/A	17.30%
SrY-90:	N/A		4776	CPM 40.33%

☑ **Is the As Found Data within 20% of the efficiency from the last cal.?**

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1375 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Back ground:	4	CPM	835	CPM
Pu-239:	5715	CPM	N/A	19.70%
Tc-99:	N/A		7976	CPM 25.23%
Th-230:	6976	CPM	N/A	17.30%
SrY-90:	N/A		4776	CPM 40.33%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4607 4900 4671 **Average:** 4726.0 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	38.86%	40.35%	34.01%	57.47%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 267161 **Bar Code #:** Purple

Replaced damaged mylar.

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 12/17/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 12/31/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR148503 **Technician :** Jacob Galyon
Date of Calibration : 12/17/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/17/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Activity(s)					
	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1825

Background: 835

C-14 Count: 9348

2π Efficiency: 32.84%
4π Efficiency: 12.56%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161
Calibrated with a 10' cable.

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Reviewed by : Date : 12/31/20
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

Perma-Fix Environmental Services
1093 Commerce Park Dr, Suite 300
Oak Ridge, TN 37830

Model 2241-3 CALIBRATION FORM

Serial number : 338016 **Customer Name :** Chase
Previous due date : 2/24/2021 **P.O Number :**
Date : 2/4/2021 **Technician : Jacob Galyon**
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
SAT	SAT

Threshold	
As Found	As Left
4.0	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1775	1775	SAT	SAT
2	1825	1825	SAT	SAT
3	1175	1175	SAT	SAT
4	1325	1325	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	250	0.04%	250	0.04%
2,500	2,500	0.00%	2,500	0.00%
25,000	25,003	0.01%	25,003	0.01%
250,000	250,040	0.02%	250,040	0.02%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1775V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR149790
	1825V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR128616
	1175V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR149790
Comments :	**1325V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR128616

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 2/4/2022

Performed by: Jacob Galyon Date: 02/04/21 Reviewed by: Date: 2/4/21
Printed name : Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR149790, Bar Code # Pink,Property # Chase194

Date: 02/04/21 **Date Last Cal. Expires:** 02/24/21 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 338016 **CAL DUE** 02/24/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	19.68 %
Tc-99:	25.51 %
Th-230:	17.70 %
SrY-90:	41.09 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1175 V HV (Beta): 1775 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	4	CPM	242	CPM	
Pu-239:	5568	CPM	N/A		19.19%
Tc-99:	N/A		7625	CPM	26.09%
Th-230:	7142	CPM	N/A		17.71%
SrY-90:	N/A		4062	CPM	40.05%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1175 V HV (Beta): 1775 V Threshold: 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Back ground:	4	CPM	242	CPM
Pu-239:	5568	CPM	N/A	19.19%
Tc-99:	N/A		7625	CPM 26.09%
Th-230:	7142	CPM	N/A	17.71%
SrY-90:	N/A		4062	CPM 40.05%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4335 4107 4109 Average: 4183.7 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.86%	41.71%	34.82%	57.07%

Comments: Married as a set with: Model: 2241-3 Serial #: 338016 Bar Code #: Pink

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 02/04/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon Reviewed by: Issue Date: 2/4/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR149790 **Technician :** Jacob Galyon
Date of Calibration : 2/4/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	338016	Calibration Due Date:	2/4/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Activity(s)					
	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1775

Background: 242

C-14 Count: 8617

2π Efficiency: 32.31%
4π Efficiency: 12.35%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 338016
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 2/4/2022

Performed by : Jacob Galyon Reviewed by : Date : 2/4/21
Printed Name : Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR128616, Bar Code # Pink,Property # Chase193

Date: 02/04/21 **Date Last Cal. Expires:** 02/24/21 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 338016 **CAL DUE** 02/24/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	19.62 %
Tc-99:	24.06 %
Th-230:	17.48 %
SrY-90:	38.26 %

AS FOUND DATA

AS FOUND Instrument Condition: UNSA

Calibration Setpoints

HV (Alpha): 1325 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Back ground:	5	CPM	743	CPM
Pu-239:	5585	CPM	N/A	19.25%
Tc-99:	N/A		7864	CPM 25.16%
Th-230:	6976	CPM	N/A	17.30%
SrY-90:	N/A		4690	CPM 41.38%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1325 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Back ground:	5	CPM	743	CPM
Pu-239:	5585	CPM	N/A	19.25%
Tc-99:	N/A		7864	CPM 25.16%
Th-230:	6976	CPM	N/A	17.30%
SrY-90:	N/A		4690	CPM 41.38%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4605 4674 4734 **Average:** 4671.0 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.97%	40.23%	34.01%	58.97%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 338016 **Bar Code #:** Pink

Replaced mylar.

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 02/04/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 2/4/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR128616 **Technician :** Jacob Galyon
Date of Calibration : 2/4/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	338016	Calibration Due Date:	2/4/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1825

Background: 743

C-14 Count: 8983

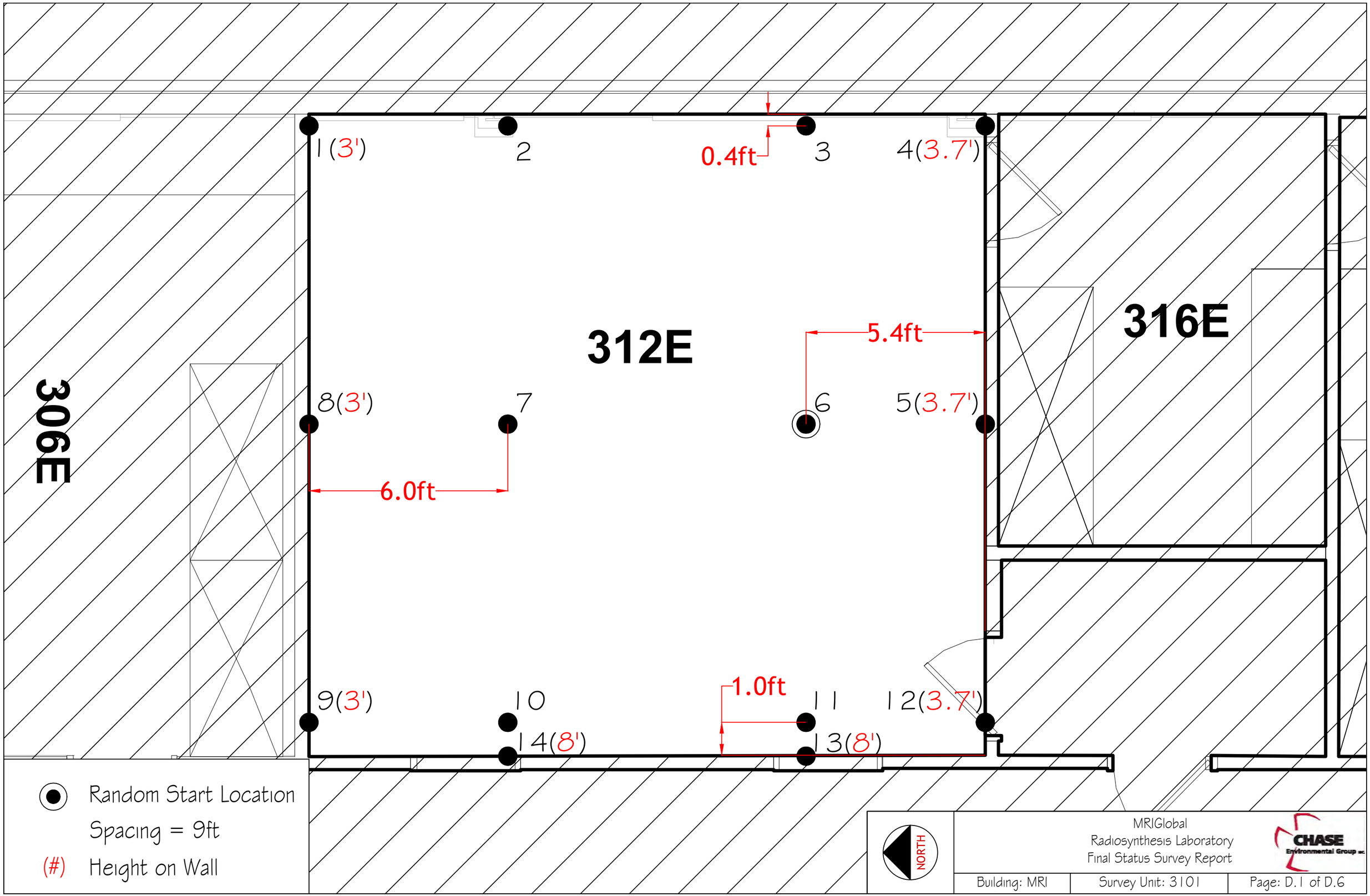
2π Efficiency: 31.79%
4π Efficiency: 12.15%

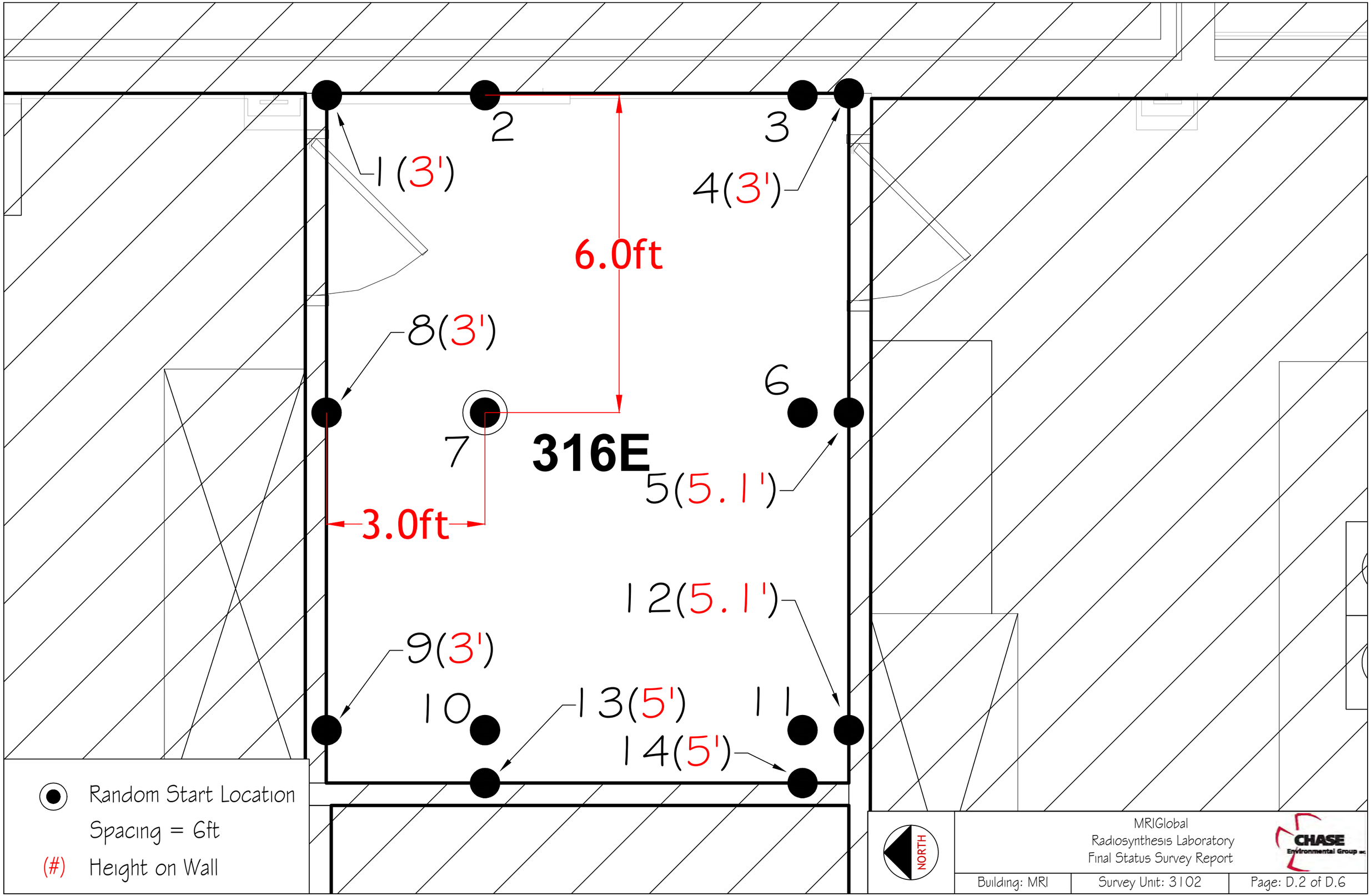
Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 338016
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 2/4/2022 .

Performed by : Jacob Galyon Reviewed by : _____ Date : 2/4/21
Printed Name : Jacob Galyon

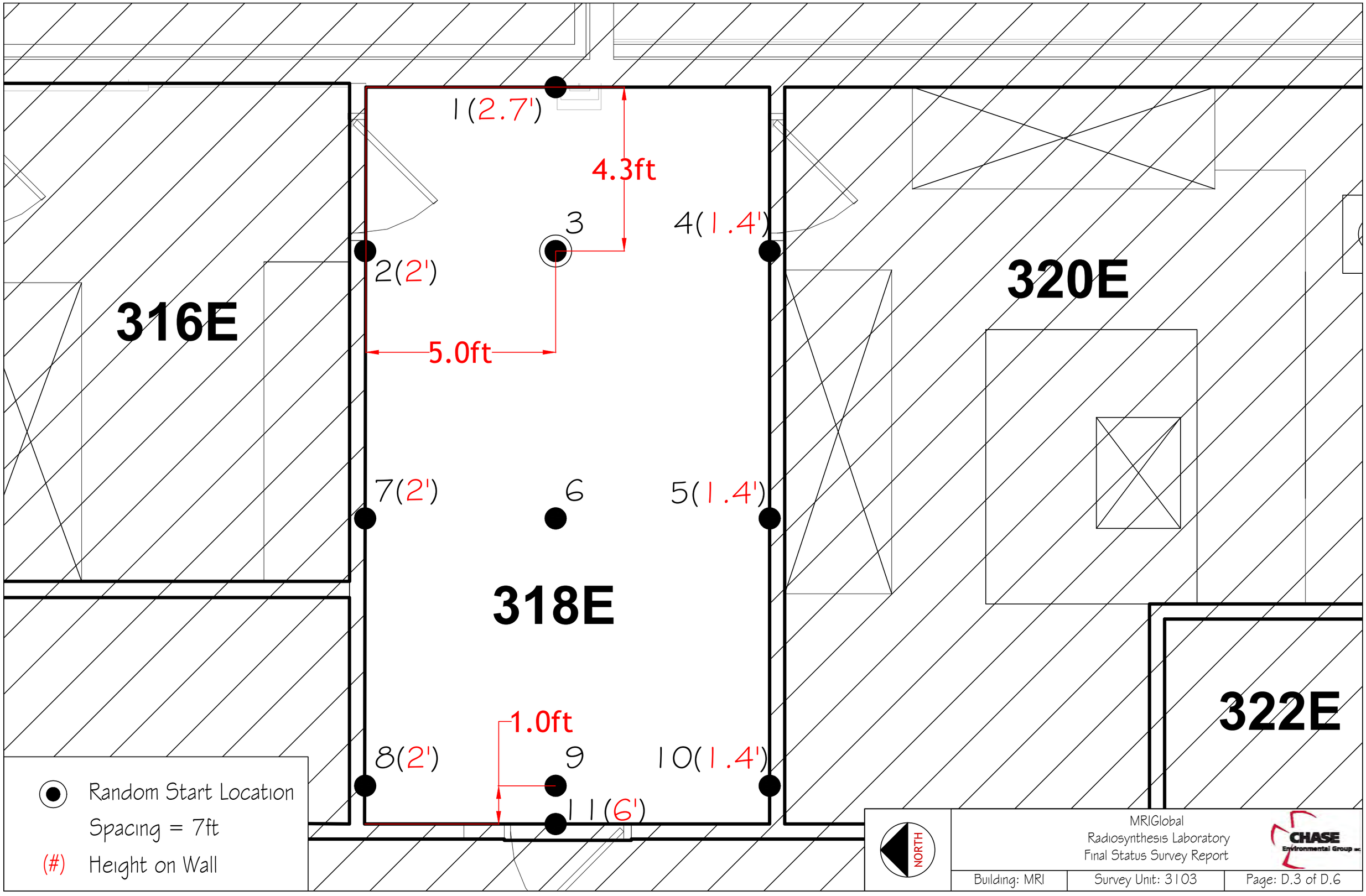

1 (3')
2
0.4ft
3
4(3.7')
312E
316E
306E
5.4ft
8(3')
7
6
5(3.7')
6.0ft
9(3')
10
1.0ft
11
12(3.7')
14(8')
13(8')
Random Start Location
Spacing = 9ft
(#) Height on Wall
NORTH
MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report
CHASE Environmental Group
Building: MRI
Survey Unit: 3101
Page: D.1 of D.6



MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

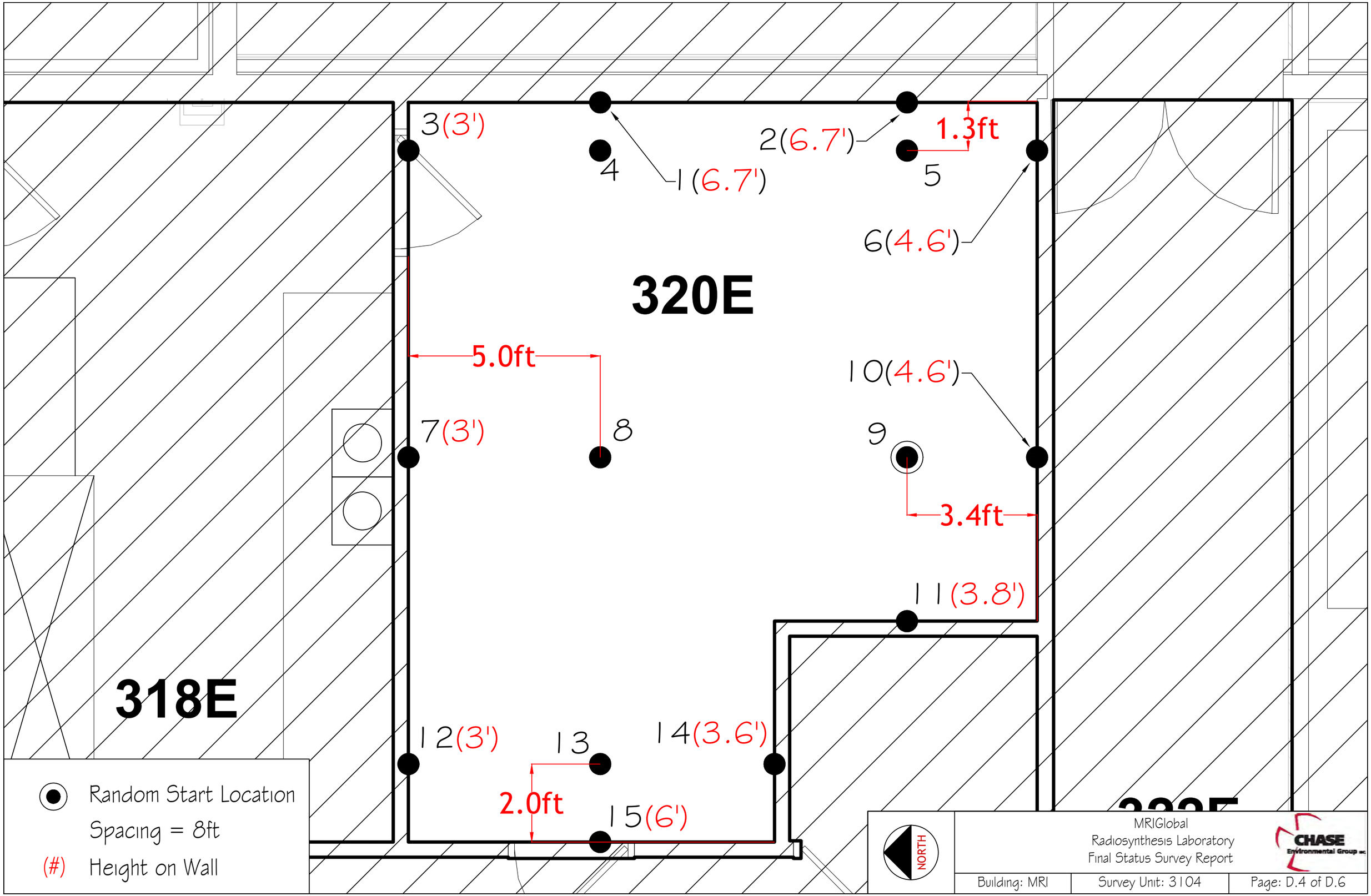
CHASE Environmental Group

Building: MRI	Survey Unit: 3102	Page: D.2 of D.6

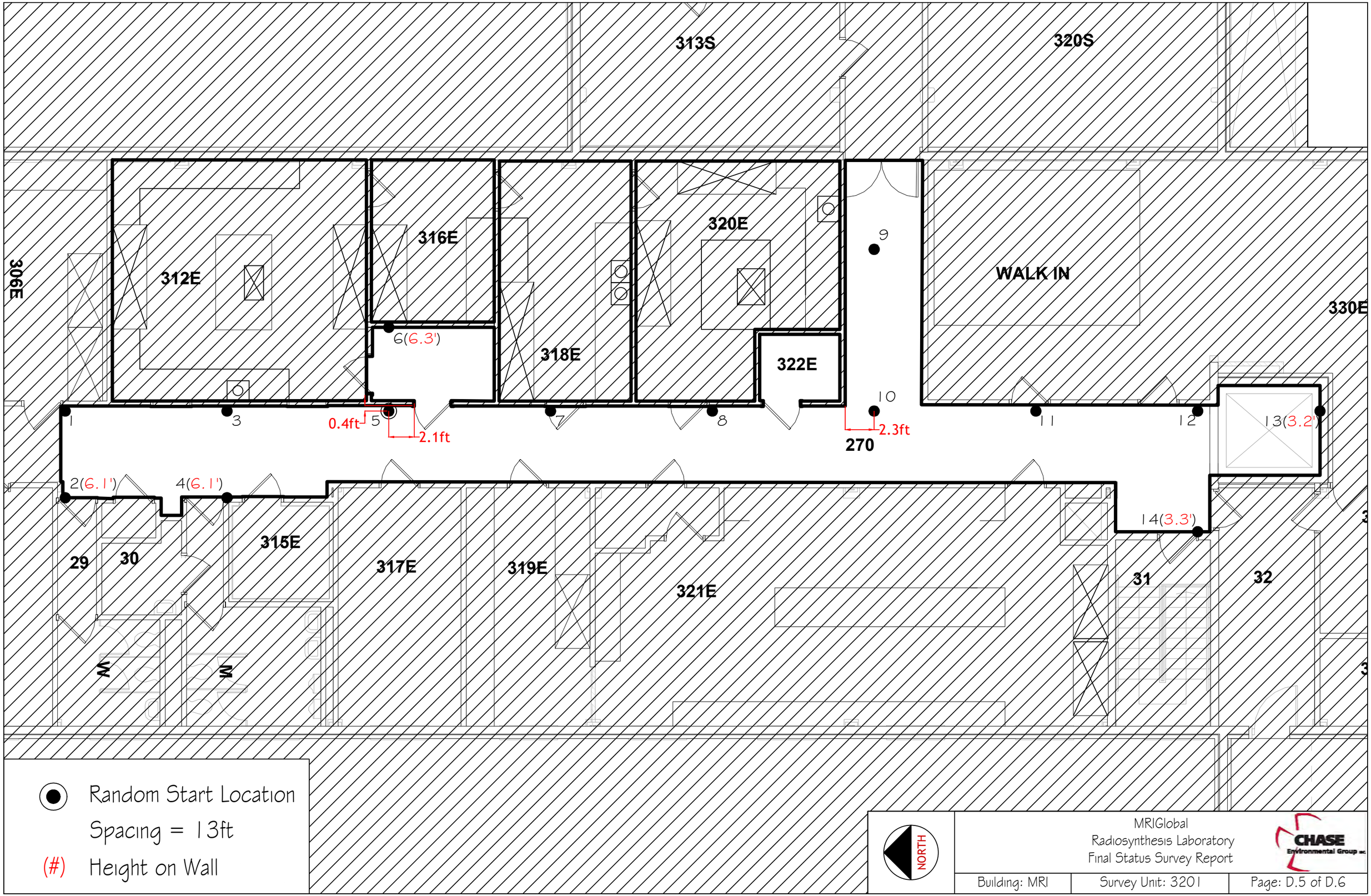


MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group



3(3')
4
1(6.7')
2(6.7')
1.3ft
5
6(4.6')
320E
5.0ft
10(4.6')
7(3')
8
9
3.4ft
11(3.8')
318E
12(3')
13
14(3.6')
2.0ft
15(6')
Random Start Location
Spacing = 8ft
(#) Height on Wall
NORTH
MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report
CHASE Environmental Group
Building: MRI
Survey Unit: 3104
Page: D.4 of D.6


313S
320S
316E
320E
312E
306E
WALK IN
330E
318E
322E
9
10
6(6.3')
0.4ft
2.1ft
2.3ft
270
1
3
5
7
8
11
12
13(3.2')
2(6.1')
4(6.1')
14(3.3')
315E
317E
319E
321E
29
30
31
32
Random Start Location
Spacing = 13ft
(#) Height on Wall
NORTH
MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report
CHASE Environmental Group
Building: MRI
Survey Unit: 3201
Page: D.5 of D.6

313S

4(C)

5(C)

6(1.6)

5.3ft

7(C)

1.2ft

8(2.3)

9(C)

10(2.3)

13(C)

1.9ft

14(C)

3.5ft

312E

316E

318E

320E

9.4ft

3(C)

2(C)

1(1.6)

3.0ft

1.9ft

12(2.3)

11(C)

15(C)

322E

270

Random Start Location

Spacing = 11ft

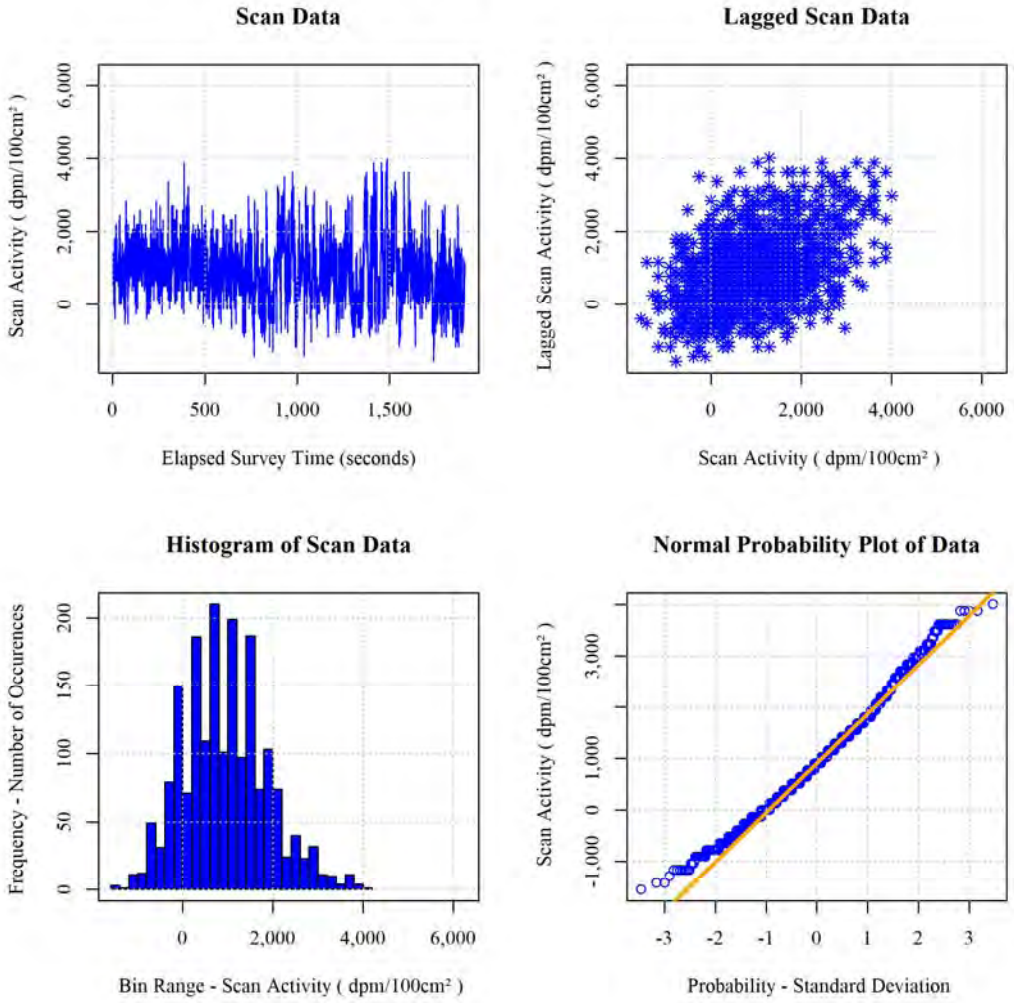
(#) Height Down Wall From Ceiling

NORTH

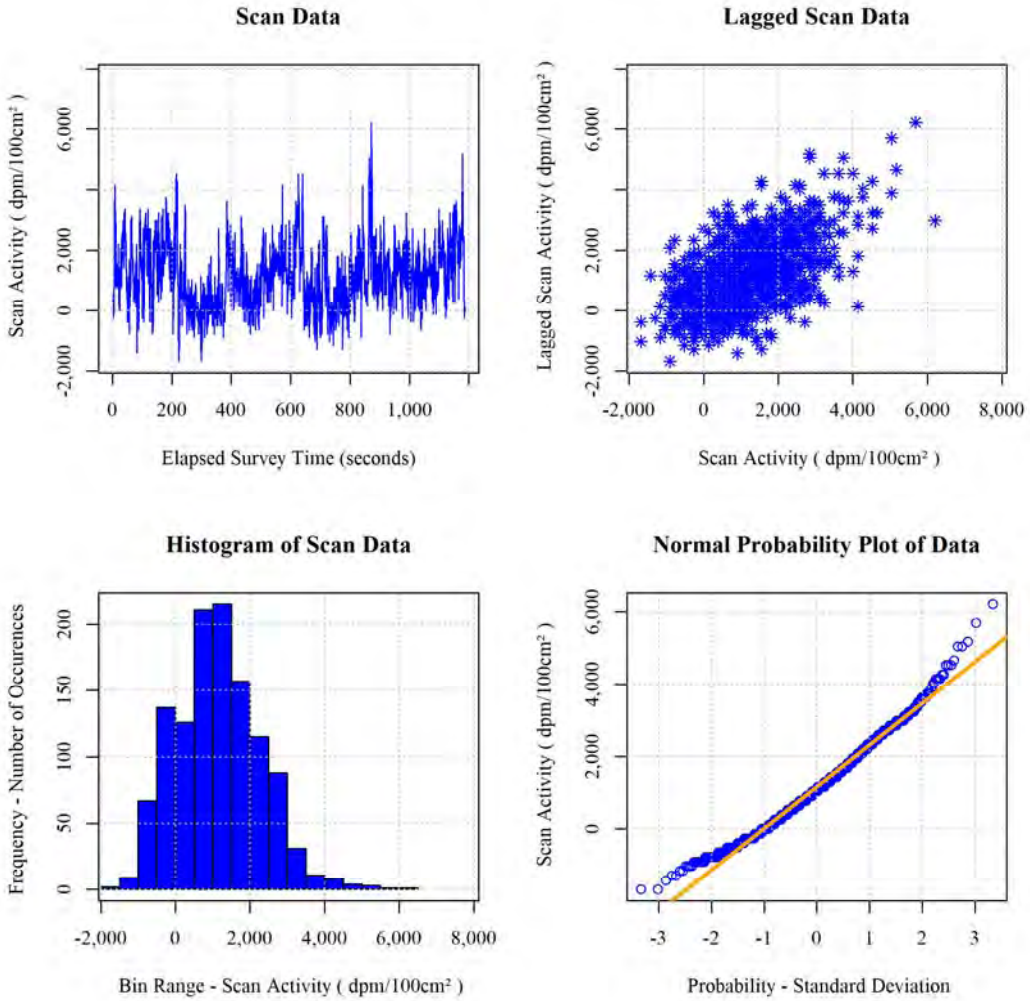
MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group

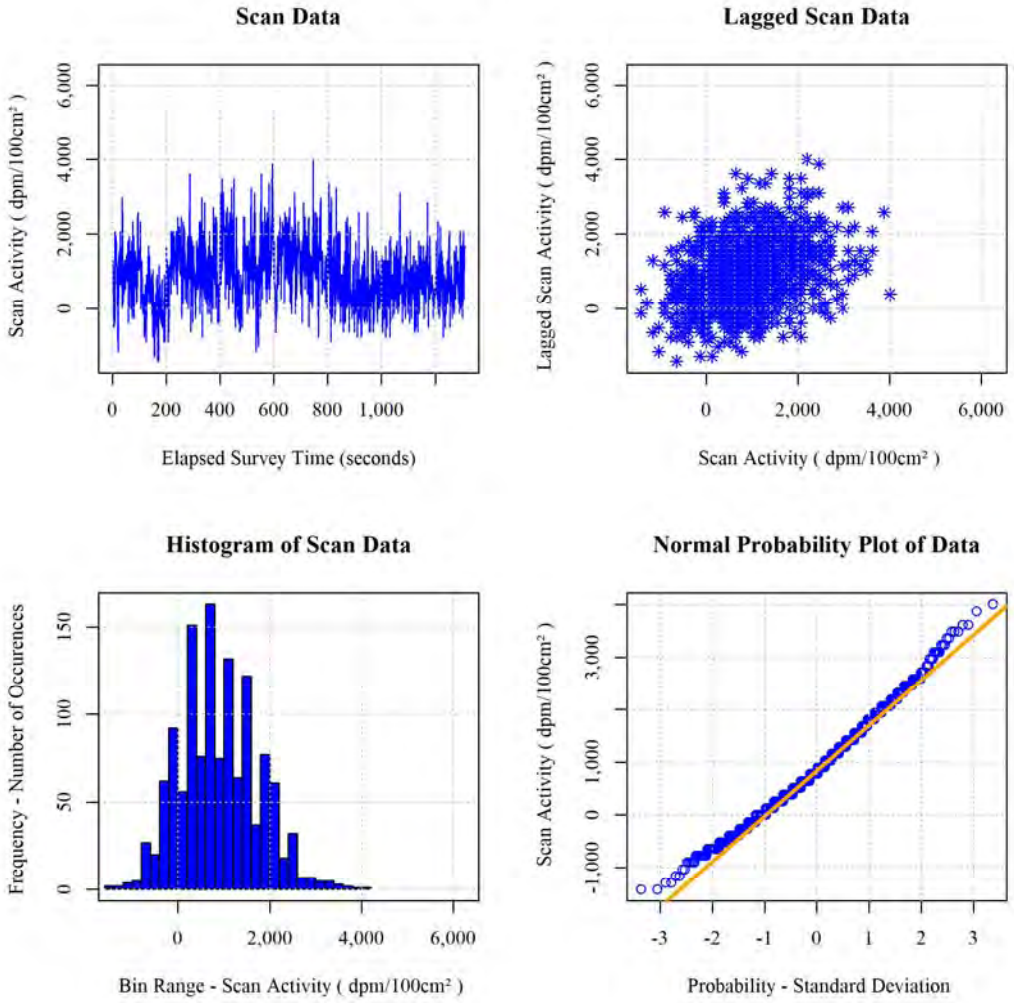
Survey Unit: MRI-3101 Probe: PR128616_Beta (43-37)



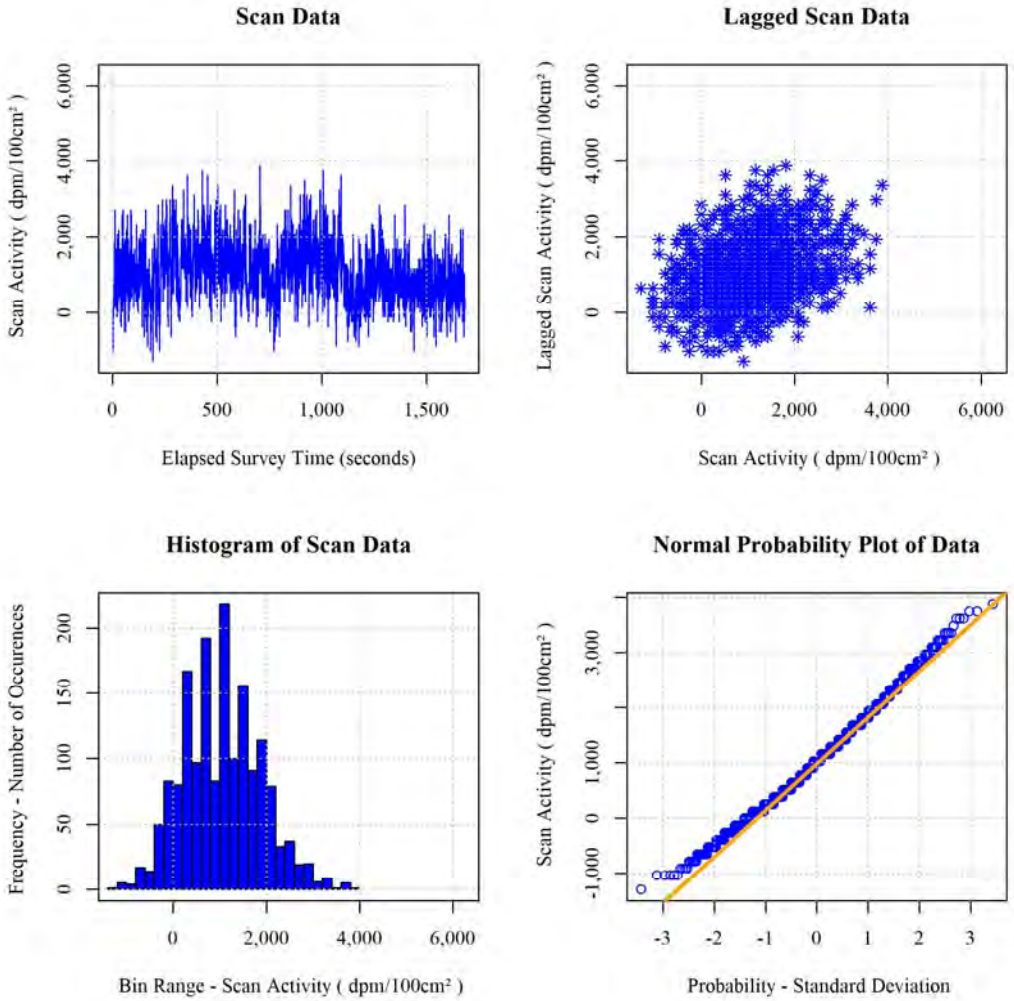
Survey Unit: MRI-3102 Probe: PR128616_Beta (43-37)



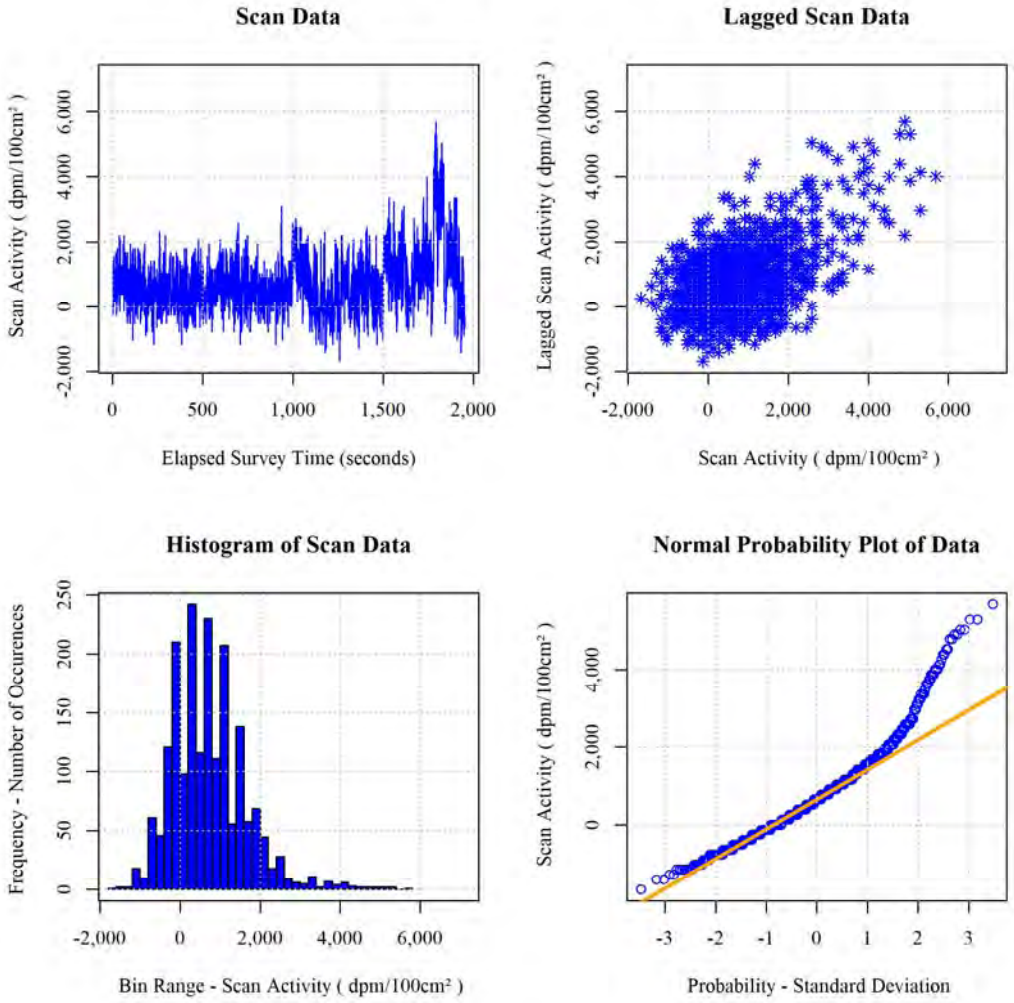
Survey Unit: MRI-3103 Probe: PR128616_Beta (43-37)



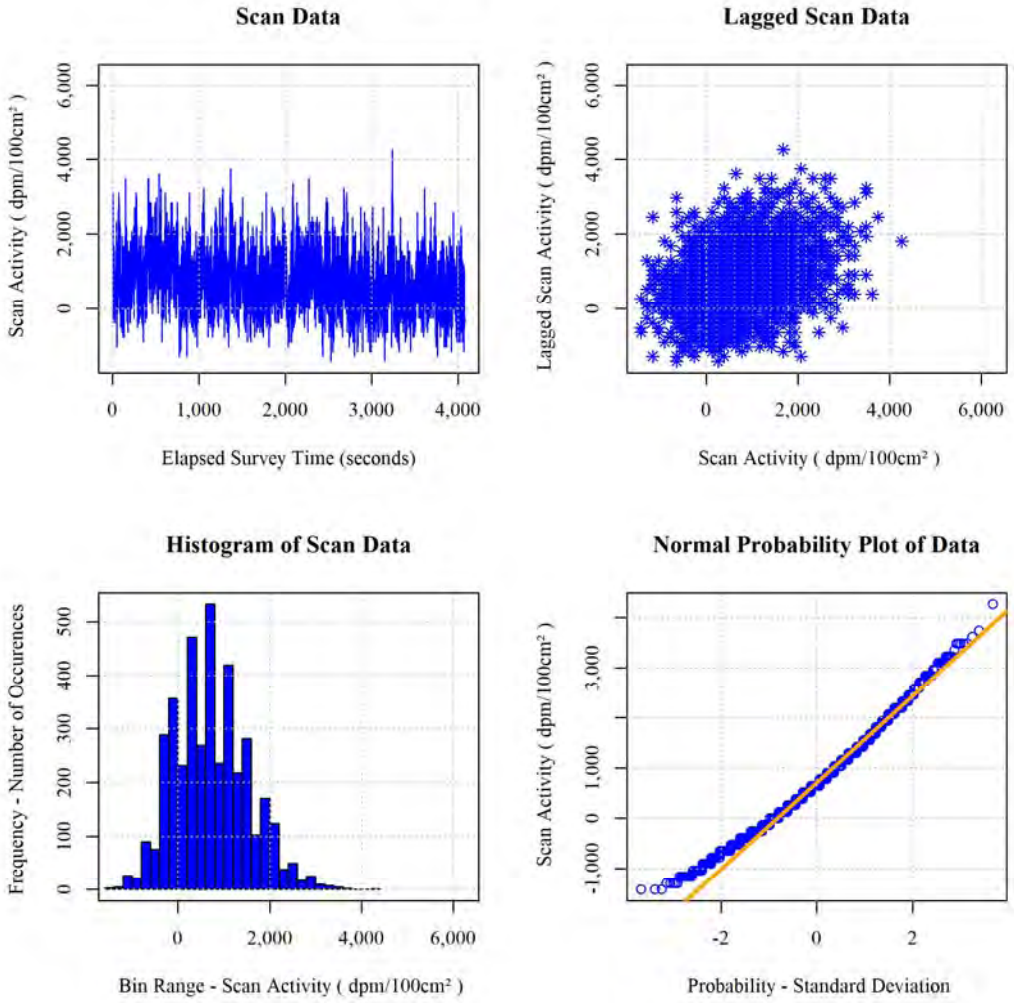
Survey Unit: MRI-3104 Probe: PR128616_Beta (43-37)



Survey Unit: MRI-3201 Probe: PR128616_Beta (43-37)



Survey Unit: MRI-3301 Probe: PR128616_Beta (43-37)



Survey Results

Building: MRI Survey Unit: 3101 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-3101-W1-B-001	2,067 +/- 1,943	3,196	20	35	18	33	35	46
MRI-3101-F1-M-002	1,861 +/- 1,922	3,196	11	35	14	33	32	46
MRI-3101-F1-M-003	2,067 +/- 1,943	3,196	6	35	19	33	30	46
MRI-3101-W1-M-004	827 +/- 1,812	3,196	23	35	**37**	33	**54**	46
MRI-3101-W1-B-005	103 +/- 1,731	3,196	13	35	8	33	22	46
MRI-3101-F1-M-006	1,240 +/- 1,857	3,196	25	35	11	33	34	46
MRI-3101-F1-M-007	827 +/- 1,812	3,196	18	35	11	33	27	46
MRI-3101-W1-B-008	2,274 +/- 1,964	3,196	19	35	15	33	30	46
MRI-3101-W1-B-009	2,067 +/- 1,943	3,196	16	35	22	33	31	46
MRI-3101-F1-M-010	1,137 +/- 1,846	3,196	26	35	22	33	**47**	46
MRI-3101-F1-M-011	1,137 +/- 1,846	3,196	23	35	24	33	40	46
MRI-3101-W1-B-012	930 +/- 1,824	3,196	19	35	15	33	29	46
MRI-3101-W1-B-013	**3,205** +/- 2,056	3,196	15	35	24	33	36	46
MRI-3101-W1-B-014	1,757 +/- 1,911	3,196	12	35	27	33	41	46

Static Count	14	**Sample Count**	14	14	14
Average	1,536		18	19	35
Minimum	103		6	8	22
Maximum	3,205		26	37	54
Standard Deviation	792		6	8	8

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: 3102 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-3102-W1-M-001	1,034 +/- 1,835	3,196	25	35	15	33	32	46
MRI-3102-F1-M-002	724 +/- 1,801	3,196	12	35	16	33	27	46
MRI-3102-F1-M-003	1,964 +/- 1,933	3,196	34	35	15	33	38	46
MRI-3102-W1-B-004	1,344 +/- 1,868	3,196	23	35	9	33	32	46
MRI-3102-W1-B-005	2,481 +/- 1,985	3,196	24	35	16	33	36	46
MRI-3102-F1-M-006	2,378 +/- 1,975	3,196	9	35	17	33	33	46
MRI-3102-F1-M-007	2,067 +/- 1,943	3,196	17	35	15	33	34	46
MRI-3102-W1-B-008	**3,411** +/- 2,076	3,196	22	35	19	33	42	46
MRI-3102-W1-B-009	**3,308** +/- 2,066	3,196	13	35	19	33	34	46
MRI-3102-F1-M-010	1,240 +/- 1,857	3,196	19	35	23	33	38	46
MRI-3102-F1-M-011	1,447 +/- 1,879	3,196	18	35	20	33	44	46
MRI-3102-W1-B-012	2,998 +/- 2,036	3,196	13	35	29	33	39	46
MRI-3102-W1-B-013	2,171 +/- 1,954	3,196	23	35	29	33	**46**	46
MRI-3102-W1-B-014	1,447 +/- 1,879	3,196	23	35	30	33	40	46

Static Count	14	**Sample Count**	14	14	14
Average	2,001		20	19	37
Minimum	724		9	9	27
Maximum	3,411		34	30	46
Standard Deviation	845		7	6	5

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: 3103 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-3103-W1-B-001	1,757 +/- 1,868	3,115	21	35	30	33	**51**	46
MRI-3103-W1-B-002	1,137 +/- 1,801	3,115	12	35	24	33	35	46
MRI-3103-F1-M-003	827 +/- 1,766	3,115	16	35	13	33	30	46
MRI-3103-W1-B-004	2,067 +/- 1,901	3,115	11	35	19	33	35	46
MRI-3103-W1-B-005	827 +/- 1,766	3,115	13	35	24	33	41	46
MRI-3103-F1-M-006	1,034 +/- 1,789	3,115	19	35	21	33	41	46
MRI-3103-W1-B-007	2,274 +/- 1,922	3,115	22	35	12	33	27	46
MRI-3103-W1-B-008	2,067 +/- 1,901	3,115	30	35	16	33	41	46
MRI-3103-F1-M-009	207 +/- 1,695	3,115	24	35	23	33	41	46
MRI-3103-W1-B-010	1,034 +/- 1,789	3,115	18	35	8	33	31	46
MRI-3103-W1-M-011	-207 +/- 1,646	3,115	8	35	22	33	32	46

Static Count	11	**Sample Count**	11	11	11
Average	1,184		18	19	37
Minimum	-207		8	8	27
Maximum	2,274		30	30	51
Standard Deviation	792		6	6	7

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: 3104 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-3104-W1-B-001	620 +/- 1,743	3,115	31	35	14	33	37	46
MRI-3104-W1-B-002	-827 +/- 1,569	3,115	14	35	16	33	31	46
MRI-3104-W1-B-003	930 +/- 1,778	3,115	17	35	29	33	**47**	46
MRI-3104-F1-M-004	1,964 +/- 1,890	3,115	15	35	12	33	26	46
MRI-3104-F1-M-005	2,067 +/- 1,901	3,115	19	35	20	33	36	46
MRI-3104-W1-B-006	1,447 +/- 1,835	3,115	24	35	18	33	36	46
MRI-3104-W1-B-007	1,551 +/- 1,846	3,115	13	35	19	33	30	46
MRI-3104-F1-M-008	1,137 +/- 1,801	3,115	23	35	22	33	42	46
MRI-3104-F1-M-009	827 +/- 1,766	3,115	7	35	19	33	28	46
MRI-3104-W1-B-010	2,688 +/- 1,964	3,115	25	35	31	33	**53**	46
MRI-3104-W1-B-011	1,964 +/- 1,890	3,115	24	35	19	33	35	46
MRI-3104-W1-B-012	2,481 +/- 1,943	3,115	9	35	23	33	38	46
MRI-3104-F1-M-013	207 +/- 1,695	3,115	24	35	18	33	34	46
MRI-3104-W1-B-014	1,240 +/- 1,812	3,115	**36**	35	17	33	41	46
MRI-3104-W1-M-015	1,034 +/- 1,789	3,115	25	35	19	33	38	46

Static Count	15	**Sample Count**	15	15	15
Average	1,289		20	20	37
Minimum	-827		7	12	26
Maximum	2,688		36	31	53
Standard Deviation	907		8	5	7

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: 3201 Survey Type: Structural Class: 2

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-3201-F1-V-001	0 +/- 1,719	3,196	15	35	23	33	45	46
MRI-3201-W1-B-002	-827 +/- 1,621	3,196	13	35	15	33	25	46
MRI-3201-F1-V-003	620 +/- 1,789	3,196	19	35	24	33	41	46
MRI-3201-W1-B-004	827 +/- 1,812	3,196	18	35	12	33	29	46
MRI-3201-F1-V-005	930 +/- 1,824	3,196	11	35	19	33	33	46
MRI-3201-W1-B-006	1,654 +/- 1,901	3,196	29	35	14	33	33	46
MRI-3201-F1-V-007	-103 +/- 1,707	3,196	30	35	15	33	39	46
MRI-3201-F1-V-008	827 +/- 1,812	3,196	32	35	15	33	36	46
MRI-3201-F1-V-009	103 +/- 1,731	3,196	13	35	14	33	34	46
MRI-3201-F1-V-010	1,344 +/- 1,868	3,196	17	35	18	33	32	46
MRI-3201-F1-V-011	827 +/- 1,812	3,196	28	35	**50**	33	**72**	46
MRI-3201-F1-V-012	413 +/- 1,766	3,196	**39**	35	13	33	42	46
MRI-3201-W1-M-013	620 +/- 1,789	3,196	22	35	18	33	31	46
MRI-3201-W1-M-014	310 +/- 1,755	3,196	20	35	16	33	34	46

Static Count	14	**Sample Count**	14	14	14
Average	539		22	19	38
Minimum	-827		11	12	25
Maximum	1,654		39	50	72
Standard Deviation	628		8	10	11

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: 3301 Survey Type: Structural Class: 3

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-3301-W1-B-001	2,171 +/- 1,911	3,115	32	35	19	33	43	46
MRI-3301-C1-M-002	207 +/- 1,695	3,115	18	35	22	33	37	46
MRI-3301-C1-M-003	2,274 +/- 1,922	3,115	28	35	8	33	33	46
MRI-3301-C1-M-004	1,757 +/- 1,868	3,115	15	35	19	33	37	46
MRI-3301-C1-M-005	1,240 +/- 1,812	3,115	8	35	26	33	43	46
MRI-3301-W1-B-006	1,757 +/- 1,868	3,115	9	35	18	33	31	46
MRI-3301-C1-M-007	1,551 +/- 1,846	3,115	10	35	22	33	33	46
MRI-3301-W1-B-008	2,998 +/- 1,995	3,115	18	35	18	33	33	46
MRI-3301-C1-M-009	2,171 +/- 1,911	3,115	12	35	19	33	45	46
MRI-3301-W1-B-010	2,274 +/- 1,922	3,115	5	35	22	33	36	46
MRI-3301-C1-M-011	1,654 +/- 1,857	3,115	15	35	19	33	33	46
MRI-3301-W1-B-012	1,240 +/- 1,812	3,115	25	35	20	33	41	46
MRI-3301-C1-M-013	2,998 +/- 1,995	3,115	14	35	16	33	34	46
MRI-3301-C1-M-014	1,240 +/- 1,812	3,115	13	35	15	33	34	46
MRI-3301-C1-M-015	2,791 +/- 1,975	3,115	7	35	22	33	35	46

Static Count	15	**Sample Count**	15	15	15
Average	1,888		15	19	37
Minimum	207		5	8	31
Maximum	2,998		32	26	45
Standard Deviation	757		8	4	4

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: VE01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-VE01-E3-M-001	2,264 +/- 1,902	3,072	**52**	35	**53**	33	**82**	46
Static Count	1	**Sample Count**	1		1		1	
Average	2,264		52		53		82	
Minimum	2,264		52		53		82	
Maximum	2,264		52		53		82	
Standard Deviation								

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: DR01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-DR01-D1-M-001	**68,582** +/- 5,616	3,292	**385**	35	**331**	33	**479**	46
MRI-DR01-D2-M-002	+/-		29	35	30	33	**48**	46
MRI-DR01-D1-M-003	755 +/- 1,855	3,292	28	35	11	33	26	46
MRI-DR01-D2-M-004	+/-		**52**	35	14	33	43	46
MRI-DR01-D1-M-005	755 +/- 1,855	3,292	19	35	24	33	35	46
MRI-DR01-D4-M-006	+/-		**36**	35	15	33	41	46
MRI-DR01-D2-M-007	+/-		12	35	25	33	35	46
MRI-DR01-D2-M-008	+/-		4	35	26	33	33	46
MRI-DR01-D3-M-009	+/-		18	35	28	33	40	46
MRI-DR01-D3-M-010	+/-		14	35	31	33	41	46

Static Count	3	**Sample Count**	10	10	10
Average	23,364		60	54	82
Minimum	755		4	11	26
Maximum	68,582		385	331	479
Standard Deviation	39,160		115	98	140

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: QA01 Survey Type: QA Class: QA

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-QA01-W1-B-001	1,294 +/- 1,914	3,292	17	35	15	33	31	46
MRI-QA01-W1-B-002	**3,990** +/- 2,186	3,292	25	35	17	33	35	46
MRI-QA01-F1-M-003	0 +/- 1,768	3,292	19	35	23	33	38	46
MRI-QA01-F1-M-004	-647 +/- 1,691	3,292	24	35	18	33	33	46
MRI-QA01-W1-B-005	1,941 +/- 1,983	3,292	12	35	20	33	32	46
MRI-QA01-W1-B-006	970 +/- 1,879	3,292	15	35	15	33	27	46

Static Count	6	**Sample Count**	6	6	6
Average	1,258		19	18	33
Minimum	-647		12	15	27
Maximum	3,990		25	23	38
Standard Deviation	1,626		5	3	4

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 =0-2,000 keV
Static measurements not performed inside all drain openings due to small geometry.

MRIGlobal Kimball Building Roof and Drain System Remediation Final Status Survey Report

425 Volker Street
Kansas City, MO 64110

USNRC License Number:
24-02564-02

November 22, 2021

Prepared:	Mike Culp	Project Manager	Date:	11-22-21
Approved:	Dave Culp	Field Services Manager	Date:	11-24-21

Prepared by:

Chase Environmental Group, Inc.
200 Sam Rayburn Parkway
Lenoir City, TN 37771
865-816-6015

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ACRONYMS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
DCGL	Derived Concentration Guideline Level
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum
DOT	Department of Transportation
DQA	Data Quality Assessment
DQO	Data Quality Objective
DSV	Default Screening Value
DWP	Decommissioning Work Plan
FSS	Final Status Survey
FSSR	Final Status Survey Report
H_0	Null Hypothesis
H_A	Alternate Hypothesis
HEPA	High Efficiency Particulate Air
LBGR	Lower Bound of the Gray Region
LSC	Liquid Scintillation Counting or Counter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MRI	MRIGlobal
NRC	U.S. Nuclear Regulatory Commission
NIST	National Institute of Standards and Technology
QA	Quality Assurance
RSL	Radiosynthesis Laboratory
RWP	Radiation Work Permit
TEDE	Total Effective Dose Equivalent
WCS	Waste Control Specialists

1.0 INTRODUCTION

MRIGlobal (MRI) permanently ceased licensed activities in the Kimball Building third floor radiosynthesis laboratory (RSL) at the MRI Campus located at 425 Volker Street, Kansas City, MO 66110. The RSL had been used since 2004 to synthesize compounds containing C-14 and H-3 under US Nuclear Regulatory Commission (NRC) license number 24-02564-02. MRI retained Chase Environmental Group (Chase) to decommission the RSL for unrestricted use in support of renovation for non-radioactive uses. Radioactive material use will continue in the building and on campus.

Chase remediated the RSL from May 6-25, 2021 under the Chase Commonwealth of Kentucky radioactive materials license number 201-605-15, utilizing a reciprocal agreement with the NRC, and in accordance with a decommissioning work plan (DWP). The DWP was developed using the guidance provided in NUREG 1757, "*Consolidated NMSS Decommissioning Guidance*"; NRC regulations; and NUREG 1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (MARSSIM). Final status surveys (FSS) were designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with NRC default screening values (DSV). Details of the RSL remediation and survey are presented in the *"MRIGlobal Radiosynthesis Laboratory Final Status Survey Report"* dated July 2, 2021.

During decommissioning of the RSL, residual radioactivity was identified in the roof ballast sediment in the area of the exhaust filter housings up to 1,230 pCi/g C-14 and within the drain system riser servicing Room 312E at 68,582 dpm/100 cm^2 total surface activity. To expedite release of the laboratories for renovation, the roof and drain riser were removed from the scope of the RSL final status survey report (FSSR) and were addressed separately under Addendum 1 to the DWP and this report; the scope of this FSSR is limited to the areas included in the DWP Addendum 1.

Chase remediated roof structures and the RSL Room 312E drain riser from October 22-24, 2021. All radioactive wastes generated from roof and drain riser remediation were shipped for disposal at the Waste Control Specialists site in Andrews, TX on October 25, 2021.

This report presents sufficient data to conclude the Kimball Building roof and the Room 312E drain system riser are suitable for unrestricted release in accordance with NRC requirements. Final status surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. All final status surface activity measurements were a small fraction of the DSVs. Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.4, **the Total Effective**

Dose Equivalent (TEDE) to an average member of the critical group is 0.01 mrem/year (0.04% of the release criterion of 25 mrem/yr).

2.0 FACILITY DESCRIPTION

The MRI Campus is located at 425 Volker Ave, Kansas City, MO 64110. A site satellite photo is presented in Appendix A. Impacted areas within the scope of this report include the Kimball Building roof and Laboratory 312E drain riser.

The RSL exhaust ventilation ducts were directed to the roof directly above where bag-in/bag-out filter units were located. The roof is constructed of a membrane covered with less than one inch of pea gravel ballast interbedded with a layer of sediment. A floor plan showing the roof footprint is presented in Appendix B.

The drain riser consisted of cast iron piping on the west side of Room 312E that extended from the first floor to the roof where it vented. The sink drain on the west side of lab connected to the riser at a tee connection. The riser extended through the floor where another tee connection was located in the overhead of the second floor. Another tee connection downstream directed flow to the first floor via various fittings and eventually to the sanitary sewer system. Branch lines servicing drains from other areas were attached to the riser.

3.0 NUCLIDES OF CONCERN

The nuclides of concern are listed in the table below.

Table 3-1: Radionuclides Used in Dispersible Form

Nuclide	Half-life (years)	Predominant Emission
C-14	5.7E+03	Low Energy Beta
H-3	1.2E+01	Low Energy Beta

4.0 INITIAL RADIOLOGICAL STATUS

4.1 Building Structures (Roof Surface)

During synthesis lab decommissioning performed in May of 2021, residual radioactivity was identified on the roof surface in the area where the synthesis lab exhaust filter housings were located. Chase remediated the roof surface by removing the ballast in areas where radioactivity was detectable on a gas flow proportional counter. The underlying roof surfaces were at a very small fraction of the structural surfaces DCGLs. Chase then collected sediment samples in the surrounding area for comparison to the NRC default screening value for surface soils (12 pCi/g C-14). Use of the soil screening value for comparison is extremely conservative because it is based on a resident farmer scenario for soil contamination versus a scenario of sediment within roof ballast with minimal occupancy and

limited exposure pathways. Sediment sample results ranged from 63 to 1,230 pCi/g C-14. Subsequently, Chase mobilized to the site in July of 2021 to collect 30 additional samples to identify the extent and magnitude of residual radioactivity in the roof sediment. Results ranged from non-detectable to 186 pCi/g C-14. These results indicated approximately 5,195 ft^2 of the roof gravel and sediment required removal and disposal as radioactive waste. The impacted area was conservatively determined by bounding the area with sediment sample results less than the C-14 DSV for surface soils.

4.2 System (Room 312 Drain Riser)

As part of decommissioning activities in the radiosynthesis laboratory, drain traps and piping were removed to the vertical risers that service other parts of the building. Remaining vertical piping was surveyed at the opening to verify surface contamination limits were met. One drain line in Lab 312 contained residual activity above investigation levels (68,582 dpm/100 cm^2 total surface activity, 385 dpm/100 cm^2 removable H-3 activity, and 331 dpm/100 cm^2 removable C-14 activity) at the connection to the vertical riser.

5.0 UNRESTRICTED RELEASE CRITERIA

The release criteria for unrestricted use are specified in 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use."

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

6.0 DERIVED CONCENTRATION GUIDELINE LEVELS

A Derived Concentration Guideline Level (DCGL) is a radionuclide-specific surface activity concentration that could result in a dose equal to the release criterion. Derived Concentration Guideline Level – Wilcoxon Rank Sum (DCGLw) is the concentration limit if the residual activity is evenly distributed over a large area.

The NRC has published DSVs in NUREG 1757, Volume 1, Appendix B for commonly used radionuclides. The screening values for surfaces under default conditions (generic screening levels) are provided in the table below.

Table 6-1: Default Screening Values for Nuclides of Concern

Nuclide	Half-life (years)	Predominant Emissions	Default Screening Value (dpm/100 cm^2)
C-14	5.7E+03	Low Energy Beta	3.7E+06
H-3	1.2E+01	Low Energy Beta	1.2E+08

The DSV's are the basis for developing the derived concentration guideline levels (DCGL's). An important assumption of the dose model is that removable contamination is <10% of total contamination. Historical survey results as well as characterization survey results confirm that removable contamination levels are very low and meet this assumption. H-3 cannot be accurately detected directly by field instrumentation due to its low energy; therefore, H-3 contamination is evaluated by removable surface activity measurements only.

7.0 INVESTIGATION LEVELS

Investigation levels were used to flag locations that required special attention and further analysis to ensure areas are properly classified and adequate surveys are performed. These locations were marked and received additional investigations to determine the concentration, area, and extent of the contamination. The following investigation levels were used:

- 5,000 dpm/100 cm^2 total beta-gamma surface contamination
- 200 dpm/100 cm^2 removable beta-gamma surface contamination in any LSC channel

8.0 DATA QUALITY OBJECTIVES (DQO)

The Data Quality Objective process as described in MARSSIM is used throughout the design and implementation of final status surveys. The following is a list of the major DQOs for the survey design:

- Static measurements were taken to achieve an MDC_{static} of less than the Investigation Level of 5,000 dpm/100 cm^2.
- Scanning was conducted at a rate to achieve an MDC_{scan} of less than the Investigation Level of 5,000 dpm/100 cm^2.
- Removable contamination measurements were counted to an MDC_{smear} of less than 200 dpm/100 cm^2 in each LSC channel.
- Individual measurements were made to a 95% confidence interval.
- Decision error probability rates were set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternative hypothesis (H_A) are that of NUREG 1505 scenario A:
    - H_0 is that the survey unit does not meet the release criteria

- H_A is that the survey unit meets the release criteria

- A minimum of 5% duplication of final status surveys was performed for Quality Assurance.
- Characterization and remedial action support surveys were conducted under the same quality assurance criteria as final status surveys such that the data were used as final status survey data to the maximum extent possible.

9.0 PROJECT MANAGEMENT AND ORGANIZATION

Decommissioning activities were performed under Chase Commonwealth of Kentucky radioactive materials license number 201-605-15, and in accordance with the DWP and DWP Addendum 1. MRI oversaw decommissioning activities and maintained responsibility for building maintenance, fire, and security functions.

10.0 TRAINING

Chase provided all project personnel with radiation worker training required by the radioactive materials license, as well as training for project-specific programs, plans, and procedures required by the DWP.

11.0 RADIATION SAFETY AND HEALTH PROGRAM

Radiological work was performed according to the Chase radioactive materials license Radiation Safety Program.

12.0 ENVIRONMENTAL MONITORING PROGRAM

Due to the limited scope of the project, a project-specific environmental monitoring program was not required; however, effluent air samples were collected during roof work. The highest effluent air sample result was less than the MDC of 1.3E-12 µCi/ml (<0.05% of the most limiting C-14 effluent concentration listed in 10 CFR 20 Appendix B, Table 2 of 3E-9 µCi/ml).

13.0 RADIOACTIVE WASTE MANAGEMENT

Radioactive wastes generated during remediation were packaged for transportation into (3) 3.5 cubic yard bags and (3) 1 cubic yard bags. Radioactive wastes were shipped on October 25, 2021 to the Waste Control Specialists (WCS) Subtitle C disposal site in Andrews, TX.

In addition, personnel inspected and certified that the packages were in conformance with the applicable US Department of Transportation (DOT) and State requirements prior to disposition. A total of 330 cubic feet of radioactive waste weighing approximately 31,500 lbs and containing 1.6 mCi was generated during project activities.

14.0 QUALITY ASSURANCE PROGRAM

Project-specific QA requirements were included in the DWP to meet the guidelines of MARSSIM Section 9.

15.0 SURVEY INSTRUMENTATION

15.1 Instrument Calibration

Laboratory and portable field instruments were calibrated within the past year with National Institute of Standards and Technology (NIST) traceable sources, and to radiation emission types and energies that provided detection capabilities similar to the nuclides of concern.

Calibration records for field instruments are provided in Appendix C.

15.2 Functional Checks

Functional checks were performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation were specified by procedure to ensure measurements are statistically valid. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions.

15.3 Datalogging

Structural surface scans and static measurements were performed using datalogging instrumentation. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded. Logged data were downloaded and processed using data management software to perform data analyses and reporting. Reporting includes graphical (4-plot) presentation of scan data as well as summary statistics functions. The 4-Plot is described in the NIST e-Handbook of Statistical Methods
(http://www.itl.nist.gov/div898/handbook/index.htm).

A 4-plot consists of the following:

- A run **sequence plot** presents logged data in chronological order, providing a time history of the survey data.
- A **lag plot** checks whether a data set or time series is random or not. Random data should not exhibit any identifiable structure in the lag plot. Non-random structure in the lag plot indicates that the underlying data are not random.
- A **histogram plot** graphically summarizes the distribution of a univariate data set, showing center (i.e., the location) of the data, spread (i.e., the scale) of the data, skewness of the data, presence of outliers, and presence of multiple modes.

- A **probability plot** is a goodness-of-fit test used to verify the distributional model. The normal probability plot is a graphical technique for assessing whether or not a data set is approximately normally distributed. The data are plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. Departures from this straight line indicate departures from normality.

15.4 Background Determination

Reference background areas or paired background comparisons were not necessary for this survey design. Material and ambient background levels were not significant in comparison to the DCGLs. Ambient background was determined to calculate the actual survey MDCs and associated counting errors.

For total surface activity measurements, ambient background levels were determined by performing a timed count with the probe at waist level in a non-impacted area. Ambient background was subtracted from each total activity gross measurement. Material background, the contribution from naturally-occurring radioactivity in building structural materials, was not accounted for (subtracted) since it was a small fraction of the DCGL.

The liquid scintillation counter (LSC) was set up without automatic background subtraction to report results in gross dpm.

15.5 Efficiency Determination

ISO 7503-1 methods were used for the limiting nuclide (C-14) to determine field concentrations for final status data and calculation of resultant doses from residual radioactivity. MARSSIM protocols for building structures use ISO-7503-1 methodology that takes into account the texture of the surface and the 2π detector efficiency. Under MARSSIM, the default surface efficiency for beta emitters with maximum energies less than 400 keV is conservatively set at 0.25.

15.6 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and measurement of total and removable contamination were chosen to provide a minimum detectable concentration (MDC) that met the criteria specified in the DQOs. MARSSIM equations relative to building surfaces were modified to convert to units of dpm/100 cm^2. Count times and scanning rates were determined using the following equations:

Static Counting

Static counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E_{tot} \cdot \frac{A}{100\ cm^2}}$$

Where:

MDC_{static} = minimum detectable concentration level (dpm/100 cm^2)
B_r = background count rate (cpm)
t_b = background count time (min)
t_s = sample count time (min)
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and surface efficiency) (cpm/dpm)
A = detector probe area (cm^2)

A typical static MDC calculation for C-14 using the Ludlum Model 43-37 gas flow proportional detector is shown below:

$$MDC_{static} = \frac{3 + 3.29\sqrt{(1500)(0.1)\left(1 + \frac{0.1}{0.1}\right)}}{(0.1)(0.075)\left(\frac{584}{100\ cm^2}\right)} = 1{,}370 \text{ dpm/100 cm}^2$$

Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100\ cm^2}}$$

Where:

MDC_{scan} = minimum detectable concentration (dpm/100 cm^2)
d' = desired performance variable (1.38)
b_i = background counts during the residence interval (counts)
i = residence interval (seconds)
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (cpm/dpm)
A = detector probe area (cm^2)

A typical MDC_{scan} calculation for the Ludlum 43-37 gas flow proportional detector is shown below (the actual MDC was calculated using instrument-specific parameter values for each measurement):

$$i = 13.3 \text{ cm} \cdot \frac{\text{inch}}{2.54 \text{ cm}} \cdot \frac{\text{sec}}{20 \text{ inch}} = 0.262 \text{ sec}$$

$$b_i = 0.262 \text{ sec} \cdot \frac{1500 \text{ counts}}{\text{minute}} \cdot \frac{\text{minute}}{60 \text{ sec}} = 6.55 \text{ counts}$$

$$MDC_{scan} = \frac{1.38\sqrt{6.55}\left(\frac{60}{0.262}\right)}{\left(\sqrt{0.5}\right)(0.075)\left(\frac{584}{100 \text{ cm}^2}\right)} = 2{,}612 \text{ dpm}/100 \text{ cm}^2$$

Smear Counting

Smear counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{smear} = \frac{3 + 3.29\sqrt{B_r \cdot t_s\left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E}$$

Where:

MDC_{smear} = minimum detectable concentration level (dpm/smear)
B_r = background count rate (cpm)
t_b = background count time (min)
t_s = sample count time (min)
E = instrument efficiency for radionuclide emission of interest (cpm/dpm)

The liquid scintillation counter was setup to count samples in three channels as described in Section 18.3. The MDC calculations for the C-14 and H-3 LSC Channels are shown below. LSC Channel 3 (open) results were used qualitatively to verify C-14 and H-3 are the only nuclides of concern.

$$^{3}H\ MDC_{smear} = \frac{3+3.29\sqrt{(15)(1)\left(1+\frac{1}{1}\right)}}{(1)(0.6)} = 35 \text{ dpm}$$

$$^{14}C\ MDC_{smear} = \frac{3+3.29\sqrt{(25)(1)\left(1+\frac{1}{1}\right)}}{(1)(0.8)} = 33 \text{ dpm}$$

$$Channel\ 3\ MDC_{smear} = \frac{3+3.29\sqrt{(50)(1)\left(1+\frac{1}{1}\right)}}{(1)(1)} = 36 \text{ cpm}$$

Because the counting efficiency is different for each LSC measurement depending on quench characteristics, and in consideration of the errors associated with wipe counting (i.e., area wiped, wiping pressure, etc.), the *a priori* estimates of smear MDCs calculated above were applied to all removable contamination measurements.

15.7 Uncertainty

The uncertainty for each measurement was calculated using equation 6-15 from MARSSIM:

$$\sigma = 1.96\sqrt{\frac{C_{s+b}}{{T_{s+b}}^2} + \frac{C_b}{{T_b}^2}}$$

Where:

σ	=	Uncertainty
1.96	=	multiplier to achieve a 95% confidence level
C_{s+b}	=	gross sample counts
T_{s+b}	=	sample count time (min.)
C_b	=	gross background counts
T_b	=	background count time (min.)

Uncertainties presented with total surface activity results are additionally corrected for detection efficiency and probe area for presentation in the same units as total surface activity results.

15.8 Instrumentation Specifications

The instrumentation used for decommissioning surveys is summarized in the tables below.

Table 15-1: Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Detector Width	Meter Model	Window Thickness	Typical Efficiency
Ludlum 43-68	Gas Flow Proportional	126 cm^2	8.8 cm	Ludlum 2241-3	0.8 mg/cm^2	7.5% (C-14)
Ludlum 43-37	Gas Flow Proportional	584 cm^2	13.3 cm	Ludlum 2241-3	0.8 mg/cm^2	7.5% (C-14)
LSC	Liquid Scintillation	N/A	N/A	N/A	N/A	60% (H-3) 80% (C-14)

Table 15-2: Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Scan Rate	Count Time	Background (cpm)	MDC (dpm/100 cm^2)
Gross Beta Surface Scans	Ludlum 43-68	5 in/sec	N/A	500	4,297
Gross Beta Surface Scans	Ludlum 43-37	20 in/sec	N/A	1,500	2,612
Gross Beta Total Surface Activity	Ludlum 43-68	N/A	6 sec.	500	3,799
Gross Beta Total Surface Activity	Ludlum 43-37	N/A	6 sec.	1,500	1,370
Removable Activity	LSC	N/A	60 sec.	15 (H-3) 25 (C-14)	35 (H-3) 33 (C-14)

16.0 AREA CLASSIFICATIONS

Based on the results of the historical site assessment and characterization surveys, facility areas were classified as impacted areas or non-impacted areas.

16.1 Non-Impacted Area

Non-impacted areas are areas without residual radioactivity from licensed activities and are not surveyed during final status surveys. The following areas were classified as non-impacted:

- Rooms without a history of radioactive materials usage
- Building exterior surfaces except impacted roof surfaces
- Surface and subsurface soils of outside grounds
- Internal surfaces of positively pressurized systems (air, gas, water, etc.)

16.2 Impacted Areas

Impacted areas are those areas that have potential residual radioactivity from licensed activities. Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined as follows:

Class 1 Areas

Areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support classification as Class 2 or Class 3.

The Kimball building roof surfaces with sediment sample results greater than the C-14 soil DSV were classified as Class 1 areas.

Class 2 Areas

Areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

There were no Class 2 areas.

Class 3 Areas

Areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

There were no Class 3 areas.

17.0 SURVEY UNITS

A survey unit is a geographical area of specified size and shape for which a separate decision is made whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated, and released as a single unit. For the purposes of this project, areas of similar construction and composition were grouped together as survey units and tested individually against the DCGLs and the null hypothesis to show compliance with the release criteria. Survey units were homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small

elevated areas of residual radioactivity. Sample spacing was determined according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for building structures, based on floor area, is Class 1: up to 100 m^2 , Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit.

The impacted roof surface exceeded the Class 1 size recommendation of MARSSIM; however, the entire impacted area was designated as a single survey unit to maintain a contiguous grid pattern. To ensure sufficient sample spacing was maintained, the sample spacing was calculated based on the MARSSIM recommended maximum survey unit size; this resulted in 75 survey locations.

Survey Unit Numbering Protocol
Each survey unit is assigned a unique number consisting of the building number followed by a dash and a four-digit identifier. The four-digit identifier consists of one digit for the elevation, one digit for the classification, and two digits as a numerical identifier in the event the first 2 digits are the same for two or more survey units using the format below:

Building Number – Elevation/Classification/Numerical Identifier

The default numeric identifier is 01

Buildings:
MRIGlobal Kimball Building = MRI

Elevations:
R = Roof

Building systems are not within the scope of MARSSIM survey units; however, the term survey unit is applied to systems for consistent data management. Systems survey units were arranged by building and system type. Drains are the only type of system within the scope of this report. The drain system survey unit encompasses all of the impacted drains within the building (the drain survey results from the RSL decommissioning are included in this report to maintain all drain survey unit data together. . MRI-DR01 is MRIGlobal Kimball Building drains.

Example:
MRI-R101 is MRIGlobal Kimball Building, Roof, Class 1

Survey unit classifications and designations were determined from survey results obtained during decommissioning of the RSL, and are listed in the table below. Structural surfaces survey unit designations are also identified on the building floor plans presented in Appendix B.

Table 17-1: Survey Units

Survey Unit	Area	Approximate Floor Area (ft^2)
MRI-R101	Impacted Roof Surfaces	5,195
MRI-DR01	Drain System	N/A

18.0 FINAL STATUS SURVEY DESIGN

Final status surveys were performed using the DQO process to demonstrate that residual radioactivity in each survey unit satisfied the predetermined criteria for release for unrestricted use. Final status surveys were conducted by performing the appropriate combination of scan surveys, total activity measurements and removable activity measurements as discussed further in this section. All final status surveys were performed according to written instructions. Survey data were documented on survey maps and/or associated data information sheets.

18.1 Surface Scans

Scanning was used to identify locations within the survey unit that exceed the investigation level. Scan surveys were conducted by moving the detector probe at a distance of about 1/8 inch from the surface at the prescribed scan rate and listening for an increase in the audible response. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded every second by datalogging instrumentation. The following table summarizes the minimum percentage of accessible building structural surfaces scanned.

Table 18-1: Scan Survey Coverage

Structure	Class 1
Roof Surface (Floors)	100%

18.2 Total Surface Activity Measurements

Direct surveys (static measurements) for total surface activity were taken on building surfaces in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey received direct survey measurements. Static measurements were taken in impacted areas at each identified sample location. Scaler count times were determined to achieve the detection sensitivities stated in the DQOs. Field measurements were converted to activity concentrations using the following equation:

$$Activity\ (dpm/100\ cm^2) = \frac{R_{s+b} - R_b}{E_{total} \times \frac{A}{100\ cm^2}}$$

Where:

R_{s+b} = The gross count rate of the measurement in cpm
R_b = The background count rate in cpm
E_{total} = Total Efficiency
A = Area of the detector window (cm^2)

Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples depends on the Relative Shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration). The minimum number of samples is obtained from MARSSIM tables or calculated using equations in Section 5 of MARSSIM.

The actual standard deviation for the survey unit with the highest standard deviation of total surface activity measurements was used. The Lower Bound of The Gray Region (LBGR) was set at one half of the DCGL. The calculations performed to determine the required numbers of samples are provided below.

Relative Shift

The number of required samples depends on the ratio involving the activity level to be measured relative to the variability in the concentration. This ratio is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta/\sigma_s = \frac{DCGL - LBGR}{\sigma_s}$$

Where:

DCGL = derived concentration guideline level
LBGR = concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S = the highest standard deviation of the residual radioactivity in the survey units

The actual calculation is provided below:

$$\Delta/\sigma_s = \frac{3.7E6 - 1.85E6}{907} = 2{,}040$$

Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by passing a unit that should fail (α decision error) or failing a unit that should pass (β decision error). The decision error rates were set at 0.05 for both α and β errors.

Number of Sample Locations (Sign Test)

The number of direct measurements required for a survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

Where:

N = number of samples needed in the survey unit
$Z_{1-\alpha}$ = percentile represented by the decision error α
$Z_{1-\beta}$ = percentile represented by the decision error β

SignP = estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR
Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include this additional 20%. The following calculations were made to determine this number:

$$N = \frac{(1.645 + 1.645)^2}{4(1.0 - 0.5)^2} = 11$$

$Z_{1-\alpha}$ and $Z_{1-\beta}$ are equal to 1.645 using the error rate of 0.05 from MARSSIM Table 5.2. SignP is equal to 1.0 from MARSSIM Table 5.4. Adding an additional 20% to account for data losses resulted in a value of 14.

Therefore, the determined number of samples per survey unit for the final status surveys is **14**.

Sample Locations

Determination of survey unit sample locations was accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated start location. Sample spacing was determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

A random starting point was determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid was plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location was plotted at each intersection of the grid. A map of final status survey locations for the survey unit are included in Appendix D.

18.3 Removable Surface Activity Measurements

Removable contamination measurements were collected by wiping an area of approximately 100 cm^2 on structural surfaces and drain systems. Removable contamination measurements on drain systems are reported dpm/swab. The smears/swabs were counted to achieve the detection sensitivities stated in the DQOs. The LSC was setup for triple channel counting as follows:

Channel 1 (H-3): 0 – 18.6 keV
Channel 2 (C-14): 18.6 – 156 keV
Channel 3 (open): 0 – 2,000 keV

Channel 3 (open) results were used to verify that H-3 and C-14 are the only nuclides of concern . LSC results are reported in gross dpm/100 cm^2 for H-3 and C-14, and in gross cpm/100 cm^2 for channel 3.

18.4 Surveys of Building Mechanical System Internals

Surveys of building system components were performed. Survey design for these systems is out of the scope of MARSSIM. For the purposes of identifying potential residual contamination within these systems, a survey protocol was established and is presented in the table below. Total activity measurements were not possible at some drain locations due to geometry. System survey requirements are summarized in the table below.

Table 18-2: System Survey Coverage

System Component	Coverage
Drains	100%

18.5 Quality Assurance Surveys

Quality Assurance surveys consisted of duplicating the final status survey protocol for building structural surfaces at a rate of 5% to include scans, static measurements, and smears.

19.0 SURVEY DOCUMENTATION AND DATA MANAGEMENT

19.1 Survey Packages

Each survey unit was surveyed under a survey package approved by the Project Manager and specifying the survey protocol to be followed. The survey packages contained the following elements to ensure the DQOs were met:

- Survey protocol instructions such as the number of samples, sample spacing, sample locations, areas to be scanned, etc.
- Random number generations to determine survey locations
- Instrumentation to be used
- Scan rates, static count times, and/or minimum sample volumes
- Scaled survey unit maps
- Checklists for the survey technician

19.2 Location Codes

To ensure proper data management and organization, each static and removable activity measurement location was assigned a unique alpha-numeric location code consisting of a sequence of identifiers to indicate specific information about that location, such as the building, survey unit, structural surface, structural material, and a numerically sequenced location number within the survey unit. This system was used so that survey data could be properly entered and organized in the Survey Database. A breakdown of the location code and specific code components are provided in the table below.

Table 19-1: Location Code Description

A unique location code was assigned to each individual survey location to ensure proper data management of the survey results. The following format was used to ensure consistency throughout the final status survey process:

BBB-RRRR-SS-M-LLL

Where:

BBB:	=	Building code. This field represents the facility. This will be the building number or an assigned area number. (3 characters) e.g. MRIGlobal = MRI
RRRR:	=	Survey Unit Number. This is the assigned survey unit number. (4 characters)
SS:	=	Structural Surface Code. This field represents the structural surface such as floor, wall, ceiling, etc. (2 characters) F1 = Floor (Roof Surface) D2 = Eyewash/ D3 = Roof Drain D1 = Drainpipe Shower Drain D4 = Sink Drain
M:	=	Structural Material Code. This field represents the type of structural material on which a particular measurement is taken. (1 character) M = Miscellaneous
LLL:	=	Numerical Identifier. This field represents the survey location number. The field "001" means survey point location number 1. Numerical identifiers are unique within a survey unit. (3-characters)

20.0 REMEDIATION

20.1 Roof Surface Remediation

Roof ballast materials were removed by hand using shovels. Misting and high efficiency particulate air (HEPA)-filtered ventilation units were used to control dust and to minimize the spread of contamination. All remediation activities were conducted to control the spread of contamination and to maintain personnel exposures ALARA.

Remedial action surveys were conducted in support of remediation activities to help determine when an area was ready for a final status survey and to provide updated estimates for final status survey planning. Remedial action surveys served to

monitor the effectiveness of remediation efforts and to ensure that surrounding areas were not cross-contaminated from remediation.

Remedial action surveys consisted of scan surveys and removable contamination measurements. These were conducted following remediation activities to establish the success or failure of decontamination efforts. Results of the survey were the decision basis for continued remediation or conduct of final status surveys. Remedial action surveys were designed to meet the objectives of the final status surveys and, to the extent allowed by MARSSIM, the results of the remedial action surveys were used to supplement the final status survey.

All post remediation total and removable surface activity results on building structural surfaces are below the investigation levels and well below the applicable DCGL. Remediation performed on building surfaces are summarized in the table below.

Table 20-1: Remediated Structural Surfaces

Survey Unit (Room)	Location (Area ft^2)	Maximum Activity (dpm/100 cm^2)		Remediation Method	Post-Remediation Maximum Activity (dpm/100 cm^2)	
		Total	Removable		Total	Removable
MRI-R101	Roof Surface (5,165)	88,315	110 – ^{3}H 86 – ^{14}C	Remove ballast and vacuum roof surface	3,476	53 – ^{3}H 31 – ^{14}C

20.2 Drain System Remediation

The drain system riser in Room 312E was remediating by removing piping until the investigation levels were met. This resulted in removal of final status location MRI-DR01-D1-M-001 from the RSL FSSR and the creation of five pipe openings that were surveyed for final status as well as two downstream survey locations on the second floor and one downstream survey location on the first floor.

Table 20-2: Remediated Systems

Survey Unit (Room)	Location (Linear ft)	Maximum Activity (dpm/100 cm^2)		Remediation Method	Post-Remediation Maximum Activity (dpm/100 cm^2)	
		Total	Removable		Total	Removable
MRI-DR01 (312E and 2nd Floor below)	Room 312E, through floor penetration to second floor (7.25)	68,582	385 – ^{3}H 331 – ^{14}C	Piping removal to second floor leaving five pipe openings	2,528	52 – ^{3}H 52 – ^{14}C

21.0 DATA QUALITY ASSESSMENT (DQA)

The statistical guidance contained in Section 8 of MARSSIM was used to determine if survey units were acceptable for unrestricted release, and whether additional surveys or sample measurements were needed.

21.1 Data Validation

Field data was reviewed by the Project Manager and validated to ensure:

- Completeness of forms
- Proper types of surveys were performed
- The MDCs for measurements met the established data quality objectives
- Independent calculations were performed on a representative sample of data sheets
- Satisfactory instrument calibrations and daily functionality checks were performed as required

Additionally, all final status survey data was entered into the Survey Database. This provided the means to sort survey data, verify activity calculations, and to compute the associated MDC and counting errors. Once data entry for a survey unit was complete, a verification report was printed and compared to original data sheets to ensure correct data entry.

The final status database reports for building structural surfaces and systems are provided in Appendix F and Appendix G, respectively.

21.2 Preliminary Data Review

A preliminary data review was performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data was reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units.

The following preliminary data reviews were performed for each survey unit:

- Calculations of the survey unit mean median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements to ensure a sufficient number of samples was obtained.
- Comparison of survey data with applicable investigation levels.
- Review of graphical outputs.

The actual standard deviation for all survey units were less than the assumed standard deviation used for calculating the number of measurements, therefore an adequate number of samples were collected for each survey unit.

21.3 Review of 4 Plots

No elevated activity was identified during scan surveys of the roof surface by listening to the audible detector response. Post-remediation scans were conducted, and scan data was corrected to reflect the final condition of the site. The 4-Plot graph indicates that the scan data is approximately normally distributed. 4-Plot graphs of the scan results are provided in Appendix E.

21.4 Data Summary Tables

For structural surface locations determined by the MARSSIM systematic grid pattern, the mean, standard deviation, minimum and maximum values and comparisons between survey data and investigation levels are presented for each survey unit in the tables below. Similar tables summarizing systems survey results follow. Building structural surfaces activity reports for each survey unit are included as Appendix F.

Table 21-1: Structural Surfaces Total Beta Surface Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(net dpm/100 cm^2)						
R101	75	1,223	3,884	921	-1,053	3,476	5,000	NO

Table 21-2: Building Structural Surfaces Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
R101	75	26	11	7	53	200	NO

Table 21-3: Building Structural Surfaces Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
R101	75	19	5	8	31	200	NO

Table 21-4: Building Structural Surfaces Removable Channel 3 (Open) Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
R101	75	39	7	23	53	200	NO

Table 21-5: Building Systems Total Beta Surface Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(net dpm/100 cm^2)						
DR01	9	1,010	3,983	900	-421	2,528	5,000	NO

Table 21-6: Building Systems Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
DR01	16	22	13	1	52	200	NO

Table 21-7: Building Systems Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
DR01	16	24	11	8	52	200	NO

Table 21-8: Building Systems Removable Channel 3 (Open) Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
DR01	16	38	10	25	59	200	NO

21.5 Determining Compliance for Building Structural Surfaces and Structures

Final status survey results were initially compared to the investigation levels. All locations of elevated activity on building structural surfaces were remediated to below the investigation levels.

All total and removable surface activity results on building structural surfaces were less than the DCGL and an adequate number of samples were obtained, therefore all survey units pass the Sign test. Therefore, the null hypothesis can be rejected and the survey units meet the release criteria and are suitable for release for unrestricted use.

The results of the data quality assessment and calculations of the dose from each structural surface survey unit are presented in the table below.

Table 21-9: Structural Surfaces MARSSIM Grid Location Dose Calculations

Survey Unit (MRI-)	Standard Deviation (dpm/100 cm^2)	# Samples Required	Actual # of Samples	Adequate # of Samples?	Mean (dpm/100 cm^2)	Calculated Annual TEDE [1] (mrem/yr)
R101	921	66	75	YES	1,223	**0.01**

21.6 Mechanical System Survey Data Analysis

Building systems final status survey results were initially compared to the investigation levels. All remaining drain system opening survey results are less than the investigation levels and an extremely low fraction of the DCGLs; therefore, the drain system is suitable for release for unrestricted use.

22.0 QUALITY ASSURANCE SURVEYS

Quality assurance surveys consisted of re-performing the FSS protocol for building structural surfaces to achieve a minimum of 5% duplication of scans, static measurements and smears. The Project Manager implemented QA surveys by re-performing judgmentally selected survey locations as survey unit QA02. The locations of QA survey total and removable surface activity measurements are presented in the table below.

[1] The TEDE shown is conservatively calculated by multiplying 25 mrem/yr by the ratio of the mean total surface activity to the C-14 DCGL of 3.7E6 dpm/100 cm^2.

Table 22-1: QA Survey Locations

QA Survey Location	FSS Location
MRI-QA02-F1-M-001	MRI-R101-F1-M-075
MRI-QA02-F1-M-002	MRI-R101-F1-M-001
MRI-QA02-F1-M-003	MRI-R101-F1-M-021
MRI-QA02-F1-M-004	MRI-R101-F1-M-031
MRI-QA02-F1-M-005	MRI-R101-F1-M-029

The conclusions reached based on QA surveys were the same as those based on the initial surveys. QA survey results are presented in Appendix H and are summarized in the tables below.

Table 22-2: QA Total Activity Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(net dpm/100 cm^2)						
QA01	5	2,675	3,603	1,116	1,264	4,213	5,000	NO

Table 22-3: QA Removable H-3 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
QA01	5	17	9	9	32	200	NO

Table 22-4: QA Removable C-14 Summary

Survey Unit (MRI-)	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross dpm/100 cm^2)					
QA01	5	17	5	11	24	200	NO

Table 22-5: QA Removable Channel 3 (Open) Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Investigation Level	Any Result Exceeding Investigation Level?
		(gross cpm/100 cm^2)					
MRI-QA01	5	33	4	28	38	200	NO

23.0 ALARA ANALYSIS

Due to the extremely low doses associated with residual radioactivity at the facility, a quantitative ALARA analysis is not required. Default screening values were used to establish DCGLs. NUREG 1757, Volume 2, Appendix N states in part: "For ALARA during decommissioning, all licensees should use typical good-practice efforts such as floor and wall washing, removal of readily removable radioactivity in buildings or in soil areas, and other good housekeeping practices. In addition, licensees should provide a description in the Final Status Survey Report (FSSR) of how these practices were employed to achieve the final activity levels. In light of the conservatism in the building surface and surface soil generic screening levels developed by NRC, NRC staff presumes, absent information to the contrary, that licensees who remediate building surfaces or soil to the generic screening levels do not need to provide analyses to demonstrate that these screening levels are ALARA."

24.0 CONCLUSION

Radiological surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. A sufficient number of samples was taken in the survey unit and all total and removable surface activity results were significantly less than the applicable DCGL, so no further statistical tests are required.

Conclusion: *The null hypothesis is rejected; all survey units pass the statistical tests and are suitable for release for unrestricted use.*

Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, the Total Effective Dose Equivalent (TEDE) to an average member of the critical group is 0.01 mrem/year.

25.0 REFERENCES

- USNRC Regulations
- MRIGlobal USNRC Radioactive Materials License Number 24-02564-02
- MRIGlobal Radiosynthesis Laboratory Decommissioning Work Plan, March 4, 2021 and Addendum 1, 9-30-21
- MRIGlobal Radiosynthesis Laboratory Final Status Survey Report, July 2, 2021
- Chase Radiation Safety Manual
- Chase Quality Assurance Program
- NUREG 1757, Volume 1, Revision 2, "Consolidated NMSS Decommissioning Guidance: Decommissioning Process for Materials Licensees," September 2006

- NUREG 1757, Volume 2, Revision 1, "Consolidated NMSS Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria," September 2006
- NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
- NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" Revision 1, August 2020
- ISO-7503-1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters." 1988
- ANSI/HPS N13.12-2013, "Surface and Volumetric Radioactivity Standards for Clearance," May 2013

Appendix A
Site Satellite Photo

MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report

CHASE Environmental Group inc.

Building: MRI	Site Satellite Photo	Page: A.1 of A.1

Appendix B
Facility Floor Plan

318E/220E Roof Penetration

312E/216E Roof Penetration

30.5ft

21.6ft

9.4ft

22.8ft

MRI-R101

Class 1

NORTH

MRIGlobal
Radiosynthesis Laboratory
Characterization Survey Package

CHASE Environmental Group Inc.

Building: MRI	Survey Unit: R101	Page: B.1 of B.1

Appendix C
Instrument Calibration Records

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

Perma-Fix Environmental Services
1093 Commerce Park Dr, Suite 300
Oak Ridge, TN 37830

Model 2241-3 CALIBRATION FORM

Serial number : 337992 **Customer Name :** Chase Environmental
Previous due date : 2/24/2021 **P.O Number :**
Date : 2/4/2021 **Technician :** Jacob Galyon
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
SAT	SAT

Threshold	
As Found	As Left
4.0	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1700	1700	SAT	SAT
2	1800	1800	SAT	SAT
3	1200	1200	SAT	SAT
4	1350	1350	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	250	0.04%	250	0.04%
2,500	2,498	0.08%	2,498	0.08%
25,000	24,984	0.06%	24,984	0.06%
250,000	249,844	0.06%	249,844	0.06%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:						
	1700V	**DET 1**	**Model:**	43-68	**Serial Number:**	PR149767
	1800V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR190975
	1200V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR149767
Comments :	**1350V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR190975

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 2/4/2022

Performed by : Jacob Galyon Date: 02/04/21
Printed name : Jacob Galyon

Date: 2/4/21

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR190975, Bar Code # Grey,Property # Chase202

Date: 02/04/21 **Date Last Cal. Expires:** 02/24/21 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 337992 **CAL DUE** 02/04/22

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	19.77 %
Tc-99:	24.33 %
Th-230:	17.91 %
SrY-90:	35.67 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1350 V **HV (Beta):** 1800 V **Threshold:** 4 mV

	Alpha		Beta	AF 4 πEfficiencies
Back ground:	5	CPM	857	CPM
Pu-239:	5570	CPM	N/A	19.19%
Tc-99:	N/A		7690	CPM 24.15%
Th-230:	7130	CPM	N/A	17.68%
SrY-90:	N/A		4390	CPM 37.04%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1350 V **HV (Beta):** 1800 V **Threshold:** 4 mV

	Alpha		Beta	AL 4 π Efficiencies
Back ground:	5	CPM	857	CPM
Pu-239:	5570	CPM	N/A	19.19%
Tc-99:	N/A		7690	CPM 24.15%
Th-230:	7130	CPM	N/A	17.68%
SrY-90:	N/A		4390	CPM 37.04%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4345 4395 4305 **Average:** 4348.3 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.87%	38.61%	34.76%	52.79%

Comments: Married as a set with: **Model:** 2241-3 **Serial #:** 337992 **Bar Code #:** Grey

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 02/04/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 2/4/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR190975 **Technician :** Jacob Galyon
Date of Calibration : 2/4/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	337992	Calibration Due Date:	2/4/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1800

Background: 857

C-14 Count: 8521

2π Efficiency: 29.57%
4π Efficiency: 11.30%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 337992
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 2/4/2022

Performed by : Jacob Galyon
Printed Name : Jacob Galyon
Reviewed by : [signature] Date : 2/4/21

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR149767, Bar Code # Grey,Property # Chase203

Date: 02/04/21 **Date Last Cal. Expires:** 02/24/21 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 337992 **CAL DUE** 02/24/21

Efficiencies from last calibration

Pu-239:	19.33 %
Tc-99:	24.58 %
Th-230:	16.89 %
SrY-90:	38.43 %

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1200 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	1	CPM	304	CPM	
Pu-239:	5464	CPM	N/A		18.84%
Tc-99:	N/A		7325	CPM	24.81%
Th-230:	6675	CPM	N/A		16.56%
SrY-90:	N/A		3897	CPM	37.67%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1200 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	1	CPM	304	CPM	
Pu-239:	5464	CPM	N/A		18.84%
Tc-99:	N/A		7325	CPM	24.81%
Th-230:	6675	CPM	N/A		16.56%
SrY-90:	N/A		3897	CPM	37.67%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 3871 3908 3831 **Average:** 3870.0 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.17%	39.67%	32.56%	53.68%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 337992 **Bar Code #:** Grey

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 02/04/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 2/4/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR149767 **Technician :** Jacob Galyon
Date of Calibration : 2/4/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	337992	Calibration Due Date:	2/4/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1700

Background: 304

C-14 Count: 8117

2π Efficiency: 30.14%
4π Efficiency: 11.52%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 337992
Calibrated with plastic standoffs attached.

Date instrument is due for next calibration : 2/4/2022

Performed by : Jacob Galyon Reviewed by : Date : 2/4/21
Printed Name : Jacob Galyon

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 267161 **Customer Name :** Chase
Previous due date : 11/19/2020 **P.O Number :**
Date : 12/17/2020 **Technician :** Jacob Galyon
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	5/13/2021
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
4.6	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1700	1700	SAT	SAT
2	1825	1825	SAT	SAT
3	1175	1175	SAT	SAT
4	1375	1375	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	249	0.40%	249	0.40%
2,500	2,496	0.16%	2,496	0.16%
25,000	24,960	0.16%	24,960	0.16%
250,000	249,605	0.16%	249,605	0.16%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1700V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR289347
	1825V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR148503
	1175V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR289347
Comments :	**1375V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR148503

Instrument calibrated per SEC-IS-423.
5 foot cable used for the 43-68
10 foot cable used for the 43-37

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Date: Reviewed by: Date: 12/31/20
Printed name : Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR289347, Bar Code # Purple,Property # Chase99

Date: 12/17/20 **Date Last Cal. Expires:** 11/19/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 5 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 267161 **CAL DUE** 11/19/20

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	18.87 %
Tc-99:	24.82 %
Th-230:	16.68 %
SrY-90:	37.34 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1175 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	4	CPM	204	CPM	
Pu-239:	6333	CPM	N/A		21.83%
Tc-99:	N/A		7979	CPM	27.47%
Th-230:	8651	CPM	N/A		21.46%
SrY-90:	N/A		4206	CPM	40.95%

☑ **Is the As Found Data within 20% of the efficiency from the last cal.?**

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1175 V **HV (Beta):** 1700 V **Threshold:** 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	4	CPM	204	CPM	
Pu-239:	6333	CPM	N/A		21.83%
Tc-99:	N/A		7979	CPM	27.47%
Th-230:	8651	CPM	N/A		21.46%
SrY-90:	N/A		4206	CPM	40.95%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4243 4259 4310 **Average:** 4270.7 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:

Pu-239	Tc-99	Th-230	SrY-90
43.07%	43.93%	42.18%	58.36%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 267161 **Bar Code #:** Purple

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 12/17/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Printed Name:** Jacob Galyon

Reviewed by: **Issue Date:** 12/31/20

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental
Probe Serial Number : PR289347 **Technician :** Jacob Galyon
Date of Calibration : 12/17/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/17/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1700

Background: 204

C-14 Count: 7830

2π Efficiency: 29.42%
4π Efficiency: 11.25%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161
Calibrated with plastic standoffs attached while using 5' cable.

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Reviewed by : Date : 12/31/20
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-417 Rev 5
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 43-37,Serial # PR148503, Bar Code # Purple,Property # Chase100

Date: 12/17/20 **Date Last Cal. Expires:** 11/19/20 **Technician:** Jacob Galyon **Reason For Calibration:** Due for Calibration

Temp RelHum: BP: CableLength 10 Ft

EQUIPMENT USED DURING CALIBRATION **MODEL:** 2241-3 **SERIAL #:** 267161 **CAL DUE** 12/17/21

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28993 dpm	14,696 cpm	1/20/2020
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2020
	4071-02	Th-230	40297 dpm	20498 cpm	1/20/2020
	4076-02	Sr-90	9772 dpm	6,857 cpm	1/20/2020

Efficiencies from last calibration

Pu-239:	23.64 %
Tc-99:	28.76 %
Th-230:	22.78 %
SrY-90:	40.22 %

AS FOUND DATA

AS FOUND Instrument Condition: UNSA

Calibration Setpoints

HV (Alpha): 1375 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	4	CPM	835	CPM	
Pu-239:	5715	CPM	N/A		19.70%
Tc-99:	N/A		7976	CPM	25.23%
Th-230:	6976	CPM	N/A		17.30%
SrY-90:	N/A		4776	CPM	40.33%

☑ **Is the As Found Data within 20% of the efficiency from the last cal.?**

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1375 V **HV (Beta):** 1825 V **Threshold:** 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	4	CPM	835	CPM	
Pu-239:	5715	CPM	N/A		19.70%
Tc-99:	N/A		7976	CPM	25.23%
Th-230:	6976	CPM	N/A		17.30%
SrY-90:	N/A		4776	CPM	40.33%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Sr-90 4607 4900 4671 **Average:** 4726.0 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	38.86%	40.35%	34.01%	57.47%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 267161 **Bar Code #:** Purple

Replaced damaged mylar.

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 12/17/21

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 12/31/20

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental
Probe Serial Number : PR148503 **Technician :** Jacob Galyon
Date of Calibration : 12/17/2020

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/17/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat
High Voltage: 1825

Background: 835

C-14 Count: 9348

2π Efficiency: **32.84%**
4π Efficiency: **12.56%**

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161
Calibrated with a 10' cable.

Date instrument is due for next calibration : 12/17/2021

Performed by : Jacob Galyon Reviewed by : Date : 12/31/20
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-422 Rev 3

10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Oak Ridge, TN 37830

Calibration Certificate

Calibration Certificate for 2241-2,Serial # 232684, Bar Code # ,Property # Chase196

Date: 09/17/21 **Date Last Cal. Expires:** 05/19/21 **Technician:** Noah Kaye

Location: 999999, **Reason For Calibration:** Due for Calibration

EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 **SERIAL #:** 171700 **CAL. DUE:** 06/09/22

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA **AS FOUND Instrument Condition:** SAT **AS LEFT Instrument Condition:** SAT ☐ New Batteries?

DETECTOR 1				DETECTOR 2			
HV Range 400-1500V: SAT				HV Range 400-1500V: SAT			
AF THRESHOLD:	10 mV	AL THRESHOLD:	35 mV	AF THRESHOLD:	90 mV	AL THRESHOLD:	35 mV
AF HV Reading:	1150 V	AL HV Reading:	900 V	AF HV Reading:	891 V	AL HV Reading:	900 V

SCALER

	AS FOUND	% ERROR	AS LEFT	% ERROR
250:	249	0.40%	AF	0.40%
2500:	2495	0.20%	AF	0.20%
25K:	24.9	0.40%	AF	0.40%
250K:	249	0.40%	AF	0.40%

☑ **Is the As Found Data Within 20% of the Set Point?**

☑ **Fast / Slow Response Switch Functions Properly?**

Audio Response: SAT **Push Buttons:** SAT **Lamp:** SAT **Digital:** SAT

Comments: **Married as a set with:** **Model:** 44-9 **Serial #:** PR179069 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 09/17/22

Performed by: _____ **Reviewed by:** _____ **Issue Date:** 9/27/21

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 44-9,Serial # PR179069, Bar Code # ,Property # Chase29

Date: 09/17/21 **Date Last Cal. Expires:** 07/30/21 **Technician:** Noah Kaye **Reason For Calibration:** Due for Calibration

Temp: RelHum: BP: CableLength

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-2 **SERIAL #:** 232684 **CAL DUE:** 09/17/22

MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4073-02	Tc-99	30499 dpm	19,099 cpm	1/20/2021
4065-02	Sr-90	13660 dpm	9,568 cpm	1/20/2021

Geometry = in contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 12.09% **Calibration Voltage:** 900 V **Calibration Threshold:** 35 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AF Background:	45			
Tc-99 Count:	3853	3680	3800	3777.7
Sr-90 Count:	3398			

4 π Efficiencies

Tc-99 EFF: 12.24% **Sr-90 EFF:** 24.55%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

				AVERAGE
AL Background:	45			
Tc-99 Count:	3853	3680	3800	3777.7
Sr-90 Count:	3398			

4 π Efficiencies

Tc-99 EFF: 12.24% **Sr-90 EFF:** 24.55%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ Is the AS FOUND efficiency within 20% of efficiency from last calibration?
- ☑ Reproducibility: Are the individual counts within 10% of the average?
- ☑ Does the probe meet final acceptance criteria?
- ☑ Calibration sticker attached?

Comments: Married as a set with: Model: 2241-2 Serial #: 232684 Bar Code #:

Date Instrument is Due For Next Calibration: 09/17/22

Performed by: _____ Reviewed by: _____ Issue Date: 9/21/21

Printed Name: Noah Kaye

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 44-9 **Customer Name :** Chase Environmental
Probe Serial Number : PR179069 **Technician :** Carl Hall
Date of Calibration : 9/17/2021

Instruments used during calibration					
Model Number:	2241-2	Serial Number:	232684	Calibration Due Date:	9/17/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073		30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 900

Background: 45

C-14 Count: 2500

2π Efficiency: 12.87%
4π Efficiency: 8.03%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-2 **Serial # :** 232684
Geometry = flush to surface.

Date instrument is due for next calibration : 9/17/2022

Performed by : Printed Name : Carl Hall
Reviewed by : Date : 10/13/21

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments	**Date:**	12/22/2020
Meter Model:	2241-3	**Customer Name:**	Chase
Meter Serial Number:	181288	**Technician:**	Carl Hall
Bar Code Number:		**Reason:**	Due for Cal

M&TE Used					
Instrument Model Number :	500-2	Serial Number:	209797	Cal Due:	5/13/2021

Calibration Data

	As Found Instrument Condition	SAT
Meter		
Threshold	**HV Check 400V - 1500V**	**Pass**

AF	AL
34.5mV	35mV

Digital Scaler

Target	As Found	%Error	As Left	%Error
250	250	0.00%	250	0.00%
2,500	2,498	0.08%	2,498	0.08%
25,000	24,983	0.07%	24,983	0.07%
250,000	249,833	0.07%	249,833	0.07%

Rate meter

	AF	% Error	AL	% Error
100	100	0.00%	100	0.00%
250	250	0.00%	250	0.00%
400	400	0.00%	400	0.00%
1,000	1,000	0.00%	1000	0.00%
2,500	2,500	0.00%	2500	0.00%
4,000	4,000	0.00%	4000	0.00%
10,000	10,000	0.00%	10000	0.00%
25,000	25,000	0.00%	25000	0.00%
40,000	40,000	0.00%	40000	0.00%
100,000	100,000	0.00%	100000	0.00%
250,000	250,000	0.00%	250000	0.00%
400,000	400,000	0.00%	400000	0.00%

Alarm	OK
Lamp	OK
Response	OK
Reproducible	OK
Sticker Attached	OK

As Left Instrument Condition	SAT
Probe Settings	
Probe 1	

Model Number:	44-9		
Serial Number:	RN013604		
	AF		**AL**
HV	893V	**HV**	900V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings
Probe 2

Model Number:	43-5		
Serial Number:	PR089634		
	AF		**AL**
HV	648V	**HV**	650V
Dead Time	0.00E+00	**Dead Time**	0.00E+00
CC	1.00E+00	**CC**	1.00E+00

Probe Settings
Probe 3

Model Number:	44-38		
Serial Number:	PR171581		
	AF		**AL**
HV	895V	**HV**	900V
Dead Time	1.20E-04	**Dead Time**	1.20E-04
CC	6.50E+07	**CC**	6.50E+07

Probe Settings
Probe 4

Model Number:	N/A		
Serial Number:	N/A		
	AF		**AL**
HV	N/A	**HV**	N/A
Dead Time	N/A	**Dead Time**	N/A
CC	N/A	**CC**	N/A

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.

Date Instruments are due for Next Calibration: 12/22/2021

Performed by: _____ **Reviewed by:** _____
Printed Name: Carl Hall **Date Reviewed:** 12/22/20

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-407 Rev 3

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 44-9,Serial # RN-013604, Bar Code # ,Property # Chase41

Date: 12/22/20 **Date Last Cal. Expires:** 12/05/20 **Technician:** Carl Hall **Reason For Calibration:** Due and Repair

Temp: 77.5 F RelHum: 42 % BP: 29.14 inHG CableLength 5 Ft

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 **SERIAL #** 181288 **CAL DUE:** 12/22/21

MODEL: **SERIAL #** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
4050-02	Tc-99	36799 dpm	22,999 cpm	1/20/2020
4052-02	Sr-90	15268 dpm	10,646 cpm	1/20/2020
77173-513	C-14	30557 dpm	19,073 cpm	3/5/2018

Geometry = In contact with surface unless otherwise specified.

PREVIOUS Tc-99 EFFICIENCY: 13.9 % **Calibration Voltage:** 900 V **Calibration Threshold:** 35 mV

AS FOUND Instrument Condition: SAT

AS FOUND DATA

1 MINUTE COUNTS (CPM)

AF Background:	40			**AVERAGE**
Tc-99 Count:	5071	4860	5243	**5058.0**
Sr-90 Count:	4222			

4 π Efficiencies

Tc-99 EFF: 13.64% **Sr-90 EFF:** 27.39%

AS LEFT Instrument Condition: SAT

AS LEFT DATA

1 MINUTE COUNTS (CPM)

AL Background:	40			**AVERAGE**
Tc-99 Count:	5071	4860	5243	**5058.0**
Sr-90 Count:	4222			

4 π Efficiencies

Tc-99 EFF: 13.64% **Sr-90 EFF:** 27.39%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

- ☑ Is the AS FOUND efficiency within 20% of efficiency from last calibration?
- ☑ Reproducibility: Are the individual counts within 10% of the average?
- ☑ Does the probe meet final acceptance criteria?
- ☑ Calibration sticker attached?

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 181288 **Bar Code #:**

C-14: CPM = 2,937. C-14 Efficiency = 9.48%.

Date Instrument is Due For Next Calibration: 12/22/21

Performed by: _____ **Reviewed by:** _____ **Issue Date:** 12/22/20

Printed Name: Carl Hall

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 44-9 **Customer Name :** Chase Environmental
Probe Serial Number : RN013604 **Technician :** Carl Hall
Date of Calibration : 8/20/2021

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	181288	Calibration Due Date:	12/22/2021
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used : Activity(s)

	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073		30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 900

Background: 48

C-14 Count: 2867

2π Efficiency: 14.78%
4π Efficiency: 9.23%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 181288
Geometry = flush to surface.

Date instrument is due for next calibration : 12/22/2021 ←NOT A FORMULA

Performed by : [signature] Reviewed by : [signature] Date : 8/20/21
Printed Name : Carl Hall

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-408 Rev 4
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 43-5,Serial # PR089634, Bar Code # ,Property # Chase42

Date: 12/22/20 **Date Last Cal. Expires:** 12/05/20 **Technician:** Carl Hall **Reason For Calibration:** Due for Ca

CableLength 5

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 2241-3 **SERIAL #:** 181288 **CAL DUE:** 12/22/21

MODEL: **SERIAL #:** **CAL DUE:**

NIST TRACEABLE SOURCES USED

SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
99PU470-0268	Pu-239	14197 dpm	7,188 cpm	1/20/2020
4049-02	Th-230	30198 dpm	15,299 cpm	1/20/2020

Efficiency from Last Calibration: 11.15 % **HV From Last Calibration:** 650 V **Calibration Threshold:** 35 mV

AS FOUND DATA — 1 MINUTE COUNTS (CPM)

AS FOUND Instrument Condition: SAT

HV: 650 V
Heel: 1633
Center: 1546
Toe: 1554
Background: 0
Uniformity: 3.51 %
Probe Efficiency: Pu-239 **11.11%**

AS LEFT DATA after repair of HV adjust

AS LEFT Instrument Condition: SAT

HV: 650 V
Heel: 1633
Center: 1546
Toe: 1554
Background: 0
Uniformity: 3.51 %
Probe Efficiency: Pu-239 **11.11%**

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

☑ **Is the As Found Efficiency Within 20% of the efficiency from the last cal.?**

Reproducibility: **Isotope:** Pu-239 1521 1570 1552 **Average:** 1548 ☑ **Are the individual counts within 10% of the average?**

* If As Found Efficiency (even after repair) is within 10% of the last calibration and uniformity is <10%, the technician may N/A the Plateau Data and proceed to Comments. Geometry = NaI probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU AND SET POINT DATA (CPM)

High Voltage	Source Response	Background
N/A		

HV	HEEL	CENTER	TOE	Background	Uniformity	Efficiency
V					% Pu-239	
	3228	3152	3170	0	Th-230	10.54%

Comments: **Married as a set with:** **Model:** 2241-3 **Serial #:** 181288 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 12/22/21

Performed by: _____ **Reviewed by:** _____ **Issue Date:** 12/28/20

Printed Name: Carl Hall

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation
10512 Lexington Drive, Suite 200
Knoxville, TN 37932
Calibration Certificate

Procedure # SEC-IS-425

Instrument Manufacturer:	Ludlum Instruments		**Date:**	12/22/2020
Meter Model:	2241-3		**Customer Name:**	Chase
Meter Serial Number:	181288		**Technician:**	Carl Hall
Probe Model:	44-38		**Reason:**	Due for Cal
Probe Serial Number:	PR171581		**Bar Code Number:**	

M&TE		
Model	**Serial No.**	**Cal Due**
Ludlum 500-2	209797	5/13/2021

N.I.S.T. Source(s)			
Material	**Serial No.**	**Activity**	**Due**
Cs137	KR-4097	130 mCi	2/12/2021
Cs137	0300-GY	400 Ci	2/12/2021
-	-	-	-

Calibration Data

	As Found	As Left		As Found	As Left
High Voltage	895V	900V	**Cal Constant**	6.50E+07	6.50E+07
Threshold	34.5mV	35mV	**Dead Time**	120uSEC	120uSEC

Digital Readings	**Exposure Rate**	**Instrument Reading**		**Percent Error**	
		As Found	**As Left**	**As Found**	**As Left**
	0.5 mR/hr	0.515	0.515	3.00%	3.00%
	1 mR/hr	0.97	0.97	-3.00%	-3.00%
	5 mR/hr	5.17	5.17	3.40%	3.40%
	10 mR/hr	10.1	10.1	1.00%	1.00%
	50 mR/hr	54.1	54.1	8.20%	8.20%
	100 mR/hr	102	102	2.00%	2.00%
	500 mR/hr	525	525	5.00%	5.00%

Repair and Service Record

Routine Service:
Check batteries.
Check reset button.
Check fast/slow response.
Check audio.
Check meter zero.
Perform over range test.

Precision

Exposure	Readings	% Dev.
500 mR/hr	517	-0.58%
	528	1.54%
	515	-0.96%

Comments/Remarks:
Calibration done with N.I.S.T. traceable source(s) and/or calibrated test equipment.
Calibration acceptance criteria +/- 10% of actual exposure or input rate.
If 'As Found' readings are greater than +/- 20% then values are circled in red and customer is contacted.
*Indicate pulsed scales due to naturally occurring background radiation.

Date Instruments are due for Next Calibration: **12/22/2021**

Performed by: _____
Printed Name: Carl Hall

Reviewed by: _____
Date Reviewed: 12/22/20

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-406 Rev 3
10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 2929,Serial # 160013, Bar Code # ,Property # Chase44

Date: 09/10/21 **Date Last Cal. Expires:** 09/22/21 **Technician:** Jacob Galyon

Temp RelHum: BP: **Reason For Calibration:** Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 **SERIAL #:** 268940 **CAL DUE:** 06/09/22

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA

AS FOUND Instrument Condition: SAT **AS LEFT Instrument Condition:** SAT

AS FOUND Mechanical Zero: 0 **AS LEFT Mechanical Zero:** 0

Scaler Function Check	AS FOUND		AS LEFT		
Beta Channel Window (4-50 mV):	4-50	mV	AF	mV	
Alpha Channel Threshold (175 mV):	175	mV	AF	mV	
Alpha Counts w/Pulser @ 10,000 CPM:	10,070	CPM	AF	CPM	% Error: 0.70%
Beta Counts w/Pulser @ 10,000 CPM:	10,070	CPM	AF	CPM	% Error: 0.70%

If AS FOUND data in Scaler Function Check is within 10%, the technician may place AF in AS LEFT section and proceed to High Voltage power supply section.

HIGH VOLTAGE POWER SUPPLY CALIBRATION	AS FOUND		AS LEFT	
Vernier Setting:	3.40		AF	
HV Setpoints:	850	V	AF	V
500 V Reading:	500	V	AF	V
1000 V Reading:	1000	V	AF	V
1500 V Reading:	1490	V	AF	V
Max HV (1500 V +):				

DIGITAL SCALER

AF 250: 250	**% ERR:** 0.00%	**AL 250:** AF		**% ERR:** 0.00%			
AF 2500: 2496	**% ERR:** 0.16%	**AL 2500:** AF		**% ERR:** 0.16%			
AF 25K: 24.96 K	**% ERR:** 0.16%	**AL 25K:** AF	K	**% ERR:** 0.16%			
AF 250K: 249.6 K	**% ERR:** 0.16%	**AL 250K:** AF	K	**% ERR:** 0.16%			

☑ **Is the As Found Data Within 20% of the Set Point?**

Comments: Married as a set with: **Model:** 43-10-1 **Serial #:** PR167231 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: **09/10/22**

Performed by: Jacob Galyon **Reviewed by:** **Issue Date:** 9/10/21

Printed Name: Jacob Galyon

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013
The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-414 Rev 4
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 43-10-1,Serial # PR167231, Bar Code # ,Property # Chase45

Date: 09/10/21 Date Last Cal. Expires: 09/22/21 Technician: Jacob Galyon

Temp RelHum: BP: CableLength: 3 Ft Reason For Calibration: Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION MODEL: 2929 SERIAL #: 160013 CAL DUE: 09/10/22

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration	
Pu-239:	36.14 %
Tc-99:	19.63 %
Th-230:	34.76 %
SrY-90:	39.84 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

HV: Calibration Setpoints 850 V Vernier: 3.40

Threshold Beta: 4 - 50 mV Alpha: 175 mV

Background:	Alpha		Beta		AF Efficiencies	A-B XTLK
	2	CPM	41	CPM		2.6%
Pu-239:	10702	CPM	324	CPM	36.91%	
Tc-99:	2	CPM	6370	CPM	22.36%	B-A XTLK
Th-230:	14572	CPM	N/A		36.16%	0.0%
SrY-90:	N/A		3816	CPM	39.57%	

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust, or Plateau HV: 850 V Vernier: 3.40

Background:	Alpha		Beta		AL Efficiencies	A-B XTLK
	2	CPM	41	CPM		2.6%
Pu-239:	10702	CPM	324	CPM	36.91%	
Tc-99:	2	CPM	6370	CPM	22.36%	B-A XTLK
Th-230:	14572	CPM	N/A		36.16%	0.0%
SrY-90:	N/A		3816	CPM	39.57%	

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

☑ Is the As Found Data Within 20% of the efficiency from the last cal.?

Reproducibility: Isotope: Sr-90 3782 3731 3889 Average: 3800.7 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration and the B-A Xtalk is <1% and the A-B Xtalk is <10%, then the technician may N/A the Plateau Data and go directly to Comments. Geometry = NaI probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU DATA

High Voltage	Source 1: Tc-99 Response (CPM) A ch.	B ch.	Net Eff.	Source 2: Th-230 Response (CPM) A ch.	B ch.	Net Eff.	Background (CPM) A ch.	B ch.	Net A to B Xtalk: <10%	Net B to A Xtalk: <1%
N/A									N/A	
									N/A	
									N/A	
									N/A	
									N/A	
									N/A	

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	72.81%	35.76%	71.08%	56.40%

Comments: Married as a set with: Model: 2929 Serial #: 160013 Bar Code #:

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 09/10/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

Performed by: Jacob Galyon Reviewed by: Issue Date: 9/10/21

Printed Name: Jacob Galyon

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-406 Rev 3

10512 Lexington Drive, Suite 200, Knoxville, TN 37932

Calibration Certificate

Calibration Certificate for 2929,Serial # 157336, Bar Code # ,Property # Chase178

Date: 06/02/21 **Date Last Cal. Expires:** 05/19/21 **Technician:** Jacob Galyon

Temp RelHum: BP: **Reason For Calibration:** Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION

MODEL: 500 **SERIAL #:** 100273 **CAL DUE:** 12/21/21

MODEL: **SERIAL #:** **CAL DUE:**

AS FOUND DATA

AS FOUND Instrument Condition: SAT **AS LEFT Instrument Condition:** SAT

AS FOUND Mechanical Zero: 0 **AS LEFT Mechanical Zero:** 0

Scaler Function Check	AS FOUND		AS LEFT		
Beta Channel Window (4-50 mV):	4-50	mV	AF	mV	
Alpha Channel Threshold (175 mV):	175	mV	AF	mV	
Alpha Counts w/Pulser @ 10,000 CPM:	9,958	CPM	AF	CPM	% Error: 0.42%
Beta Counts w/Pulser @ 10,000 CPM:	9,960	CPM	AF	CPM	% Error: 0.40%

If AS FOUND data in Scaler Function Check is within 10%, the technician may place AF in AS LEFT section and proceed to High Voltage power supply section.

HIGH VOLTAGE POWER SUPPLY CALIBRATION	AS FOUND		AS LEFT	
Vernier Setting:	4.31		AF	
HV Setpoints:	1050	V	AF	V
500 V Reading:	500	V	AF	V
1000 V Reading:	1000	V	AF	V
1500 V Reading:	1500	V	AF	V
Max HV (1500 V +):				

DIGITAL SCALER

AF 250:	249	**% ERR:** 0.40%	**AL 250:**	AF		**% ERR:** 0.40%
AF 2500:	2496	**% ERR:** 0.16%	**AL 2500:**	AF		**% ERR:** 0.16%
AF 25K:	24.96 K	**% ERR:** 0.16%	**AL 25K:**	AF	K	**% ERR:** 0.16%
AF 250K:	249.7 K	**% ERR:** 0.12%	**AL 250K:**	AF	K	**% ERR:** 0.12%

☑ **Is the As Found Data Within 20% of the Set Point?**

Comments: **Married as a set with:** **Model:** 43-10-1 **Serial #:** PR113801 **Bar Code #:**

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 06/02/22

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 6/2/21

Printed Name: Jacob Galyon

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

The results in this report relate only to the item calibrated or tested.

Safety and Ecology Corporation SEC PROCEDURE # SEC-IS-414 Rev 4
10512 Lexington Drive, Suite 200, Knoxville, TN 37932
Calibration Certificate

Calibration Certificate for 43-10-1,Serial # PR113801, Bar Code # ,Property # Chase179

Date: 06/02/21 **Date Last Cal. Expires:** 05/19/21 **Technician:** Jacob Galyon

Temp RelHum: BP: CableLength 3 Ft **Reason For Calibration:** Due for Calibration

NIST EQUIPMENT USED DURING CALIBRATION **MODEL:** 2929 **SERIAL #:** 157336 **CAL DUE:** 06/02/22

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4079-02	Pu-239	28992 dpm	14,696 cpm	1/20/2021
	4072-02	Tc-99	28299 dpm	17,699 cpm	1/20/2021
	4071-02	Th-230	40296 dpm	20,498 cpm	1/20/2021
	4076-02	Sr-90	9539 dpm	6,693 cpm	1/20/2021

Efficiencies from last calibration

Pu-239:	33.66 %
Tc-99:	24.99 %
Th-230:	31.99 %
SrY-90:	43.43 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

HV: **Calibration Setpoints** 1050 V **Vernier:** 4.31

Threshold Beta: 4 - 50 mV Alpha: 175 mV

	Alpha		Beta		AF Efficiencies	
Background:	0	CPM	66	CPM		A-B XTLK
Pu-239:	9877	CPM	396	CPM	34.07%	3.3%
Tc-99:	0	CPM	7384	CPM	25.86%	B-A XTLK
Th-230:	13257	CPM	N/A		32.90%	0.0%
SrY-90:	N/A		4362	CPM	45.04%	

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust, or Plateau
HV: 1050 V **Vernier:** 4.31

	Alpha		Beta		AL Efficiencies	
Background:	0	CPM	66	CPM		A-B XTLK
Pu-239:	9877	CPM	396	CPM	34.07%	3.2%
Tc-99:	0	CPM	7384	CPM	25.86%	B-A XTLK
Th-230:	13257	CPM	N/A		32.90%	0.0%
SrY-90:	N/A		4362	CPM	45.04%	

☑ **Is the As Found Data Within 20% of the efficiency from the last cal.?**

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility: Isotope: Sr-90 4371 4208 4357 **Average:** 4312.0 ☑ **Are the individual counts within 10% of the average?**

If the As Found data (even after repair) is within 10% of the last calibration and the B-A Xtalk is <1% and the A-B Xtalk is <10%, then the technician may N/A the Plateau Data and go directly to Comments. Geometry = NaI probes are 4 1/2" from source. All other probes are in contact with surface unless otherwise specified.

PLATEAU DATA

High Voltage	Source 1: Tc-99 Response (CPM)			Source 2: Th-230 Response (CPM)			Background (CPM)		Net A to B Xtalk: <10%	Net B to A Xtalk: <1%
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.		
N/A									N/A	
									N/A	
									N/A	
									N/A	
									N/A	
									N/A	

2 Pi Efficiencies: Pu-239: 67.21% Tc-99: 41.35% Th-230: 64.67% SrY-90: 64.19%

Comments: Married as a set with: Model: 2929 Serial #: 157336 Bar Code #:

☑ **Does Instrument Meet Final Acceptance Criteria?** ☑ **Calibration Sticker Attached?**

Date Instrument is Due For Next Calibration: 06/02/22

All instrumentation is calibrated in accordance with the QAP to meet the criteria of ANSI N323AB-2013

Performed by: Jacob Galyon **Reviewed by:** _____ **Issue Date:** 6/2/21

Printed Name: Jacob Galyon

SEC INSTRUMENTATION SERVICES
10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-10-1 **Customer Name :** Chase Environmental
Probe Serial Number : PR113801 **Technician :** Jacob Galyon
Date of Calibration : 6/2/2021

Instruments used during calibration					
Model Number:	2929	Serial Number:	157336	Calibration Due Date:	6/2/2022
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N		Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	77173-513		19,073	0.0305405	30,557	1/20/2020

Data

Instrument condition : Sat
High Voltage: 1050

Background: 66

C-14 Count: 4707

2π Efficiency: 24.33%
4π Efficiency: 15.19%

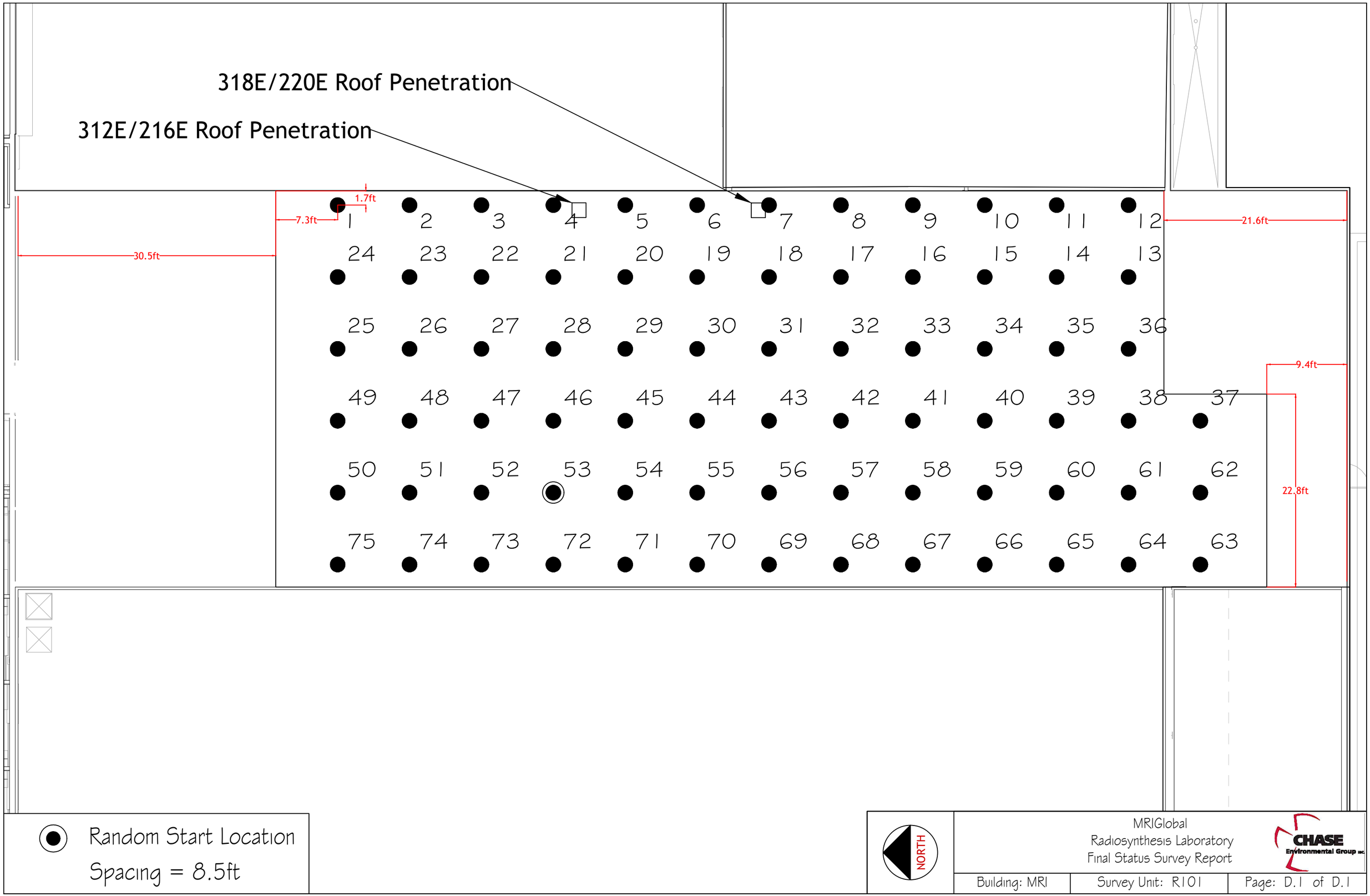
Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2929 **Serial # :** 157336

Date instrument is due for next calibration : 6/2/2022

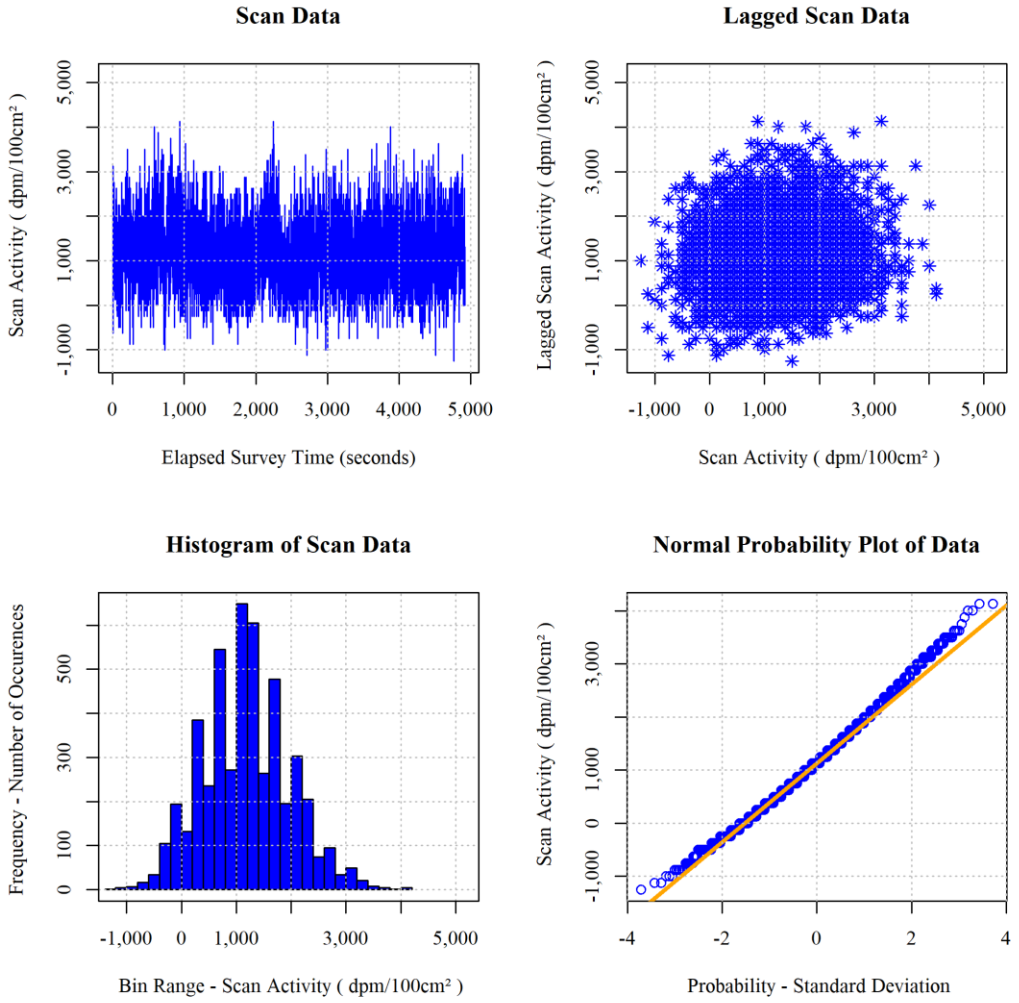
Performed by : Jacob Galyon Reviewed by : Date : 6/2/21
Printed Name : Jacob Galyon
Entered in computer inventory by: Date :

Appendix D
Final Status Survey Location Maps


318E/220E Roof Penetration
312E/216E Roof Penetration
1.7ft
7.3ft
30.5ft
21.6ft
9.4ft
22.8ft
1 2 3 4 5 6 7 8 9 10 11 12
24 23 22 21 20 19 18 17 16 15 14 13
25 26 27 28 29 30 31 32 33 34 35 36
49 48 47 46 45 44 43 42 41 40 39 38 37
50 51 52 53 54 55 56 57 58 59 60 61 62
75 74 73 72 71 70 69 68 67 66 65 64 63
Random Start Location
Spacing = 8.5ft
NORTH
MRIGlobal
Radiosynthesis Laboratory
Final Status Survey Report
CHASE Environmental Group inc.
Building: MRI
Survey Unit: R101
Page: D.1 of D.1

Appendix E
4-Plot Graphs

Survey Unit: MRI-R101 Probe: PR148503_Beta (43-37)



Appendix F
Building Structural Surfaces Survey Results

Survey Results

Building: MRI Survey Unit: R101 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-R101-F1-M-001	527 +/- 2,175	3,884	23	35	12	33	33	36
MRI-R101-F1-M-002	0 +/- 2,125	3,884	17	35	26	33	**42**	36
MRI-R101-F1-M-003	737 +/- 2,195	3,884	**53**	35	15	33	**48**	36
MRI-R101-F1-M-004	1,791 +/- 2,290	3,884	**50**	35	18	33	**51**	36
MRI-R101-F1-M-005	-737 +/- 2,054	3,884	**37**	35	24	33	**49**	36
MRI-R101-F1-M-006	843 +/- 2,204	3,884	14	35	27	33	**39**	36
MRI-R101-F1-M-007	2,528 +/- 2,354	3,884	32	35	22	33	**37**	36
MRI-R101-F1-M-008	1,053 +/- 2,223	3,884	24	35	22	33	**39**	36
MRI-R101-F1-M-009	2,528 +/- 2,354	3,884	26	35	22	33	34	36
MRI-R101-F1-M-010	2,423 +/- 2,345	3,884	**43**	35	15	33	**47**	36
MRI-R101-F1-M-011	527 +/- 2,175	3,884	27	35	14	33	**37**	36
MRI-R101-F1-M-012	632 +/- 2,185	3,884	26	35	19	33	35	36
MRI-R101-F1-M-013	1,159 +/- 2,233	3,884	22	35	11	33	26	36
MRI-R101-F1-M-014	105 +/- 2,135	3,884	29	35	22	33	**41**	36
MRI-R101-F1-M-015	2,212 +/- 2,327	3,884	20	35	25	33	**38**	36
MRI-R101-F1-M-016	737 +/- 2,195	3,884	21	35	18	33	**44**	36
MRI-R101-F1-M-017	632 +/- 2,185	3,884	27	35	27	33	**45**	36
MRI-R101-F1-M-018	0 +/- 2,125	3,884	**50**	35	22	33	**50**	36
MRI-R101-F1-M-019	2,107 +/- 2,317	3,884	**52**	35	16	33	**52**	36
MRI-R101-F1-M-020	421 +/- 2,165	3,884	29	35	21	33	**41**	36
MRI-R101-F1-M-021	1,264 +/- 2,243	3,884	27	35	22	33	**43**	36
MRI-R101-F1-M-022	316 +/- 2,155	3,884	14	35	21	33	35	36
MRI-R101-F1-M-023	737 +/- 2,195	3,884	33	35	17	33	**46**	36
MRI-R101-F1-M-024	1,053 +/- 2,223	3,884	**41**	35	23	33	**45**	36
MRI-R101-F1-M-025	843 +/- 2,204	3,884	32	35	19	33	**46**	36
MRI-R101-F1-M-026	1,264 +/- 2,243	3,884	27	35	23	33	**53**	36

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: R101 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-R101-F1-M-027	-737 +/- 2,054	3,884	**39**	35	22	33	**47**	36
MRI-R101-F1-M-028	316 +/- 2,155	3,884	16	35	21	33	34	36
MRI-R101-F1-M-029	843 +/- 2,204	3,884	20	35	27	33	**50**	36
MRI-R101-F1-M-030	1,159 +/- 2,233	3,884	31	35	13	33	35	36
MRI-R101-F1-M-031	1,685 +/- 2,280	3,884	34	35	13	33	**40**	36
MRI-R101-F1-M-032	2,212 +/- 2,327	3,884	29	35	14	33	**36**	36
MRI-R101-F1-M-033	2,001 +/- 2,308	3,884	11	35	11	33	25	36
MRI-R101-F1-M-034	2,317 +/- 2,336	3,884	25	35	19	33	**43**	36
MRI-R101-F1-M-035	2,001 +/- 2,308	3,884	22	35	23	33	**41**	36
MRI-R101-F1-M-036	1,791 +/- 2,290	3,884	33	35	12	33	**38**	36
MRI-R101-F1-M-037	2,001 +/- 2,308	3,884	**42**	35	14	33	**41**	36
MRI-R101-F1-M-038	1,685 +/- 2,280	3,884	23	35	26	33	**43**	36
MRI-R101-F1-M-039	1,475 +/- 2,261	3,884	7	35	25	33	**41**	36
MRI-R101-F1-M-040	737 +/- 2,195	3,884	33	35	19	33	**39**	36
MRI-R101-F1-M-041	421 +/- 2,165	3,884	26	35	21	33	35	36
MRI-R101-F1-M-042	-1,053 +/- 2,023	3,884	**38**	35	25	33	**51**	36
MRI-R101-F1-M-043	843 +/- 2,204	3,884	31	35	11	33	31	36
MRI-R101-F1-M-044	421 +/- 2,165	3,884	26	35	15	33	33	36
MRI-R101-F1-M-045	948 +/- 2,214	3,884	25	35	14	33	33	36
MRI-R101-F1-M-046	948 +/- 2,214	3,884	31	35	20	33	**39**	36
MRI-R101-F1-M-047	527 +/- 2,175	3,884	7	35	23	33	33	36
MRI-R101-F1-M-048	2,317 +/- 2,336	3,884	13	35	20	33	31	36
MRI-R101-F1-M-049	211 +/- 2,145	3,884	**36**	35	15	33	**44**	36
MRI-R101-F1-M-050	211 +/- 2,145	3,884	21	35	19	33	**41**	36
MRI-R101-F1-M-051	1,685 +/- 2,280	3,884	**38**	35	20	33	**43**	36
MRI-R101-F1-M-052	3,055 +/- 2,399	3,884	12	35	18	33	32	36

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: R101 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-R101-F1-M-053	632 +/- 2,185	3,884	**44**	35	17	33	**47**	36
MRI-R101-F1-M-054	-527 +/- 2,075	3,884	25	35	22	33	**38**	36
MRI-R101-F1-M-055	1,685 +/- 2,280	3,884	19	35	18	33	**38**	36
MRI-R101-F1-M-056	1,475 +/- 2,261	3,884	29	35	10	33	31	36
MRI-R101-F1-M-057	1,475 +/- 2,261	3,884	25	35	18	33	**37**	36
MRI-R101-F1-M-058	1,053 +/- 2,223	3,884	11	35	21	33	31	36
MRI-R101-F1-M-059	1,264 +/- 2,243	3,884	22	35	20	33	33	36
MRI-R101-F1-M-060	0 +/- 2,125	3,884	**38**	35	23	33	**48**	36
MRI-R101-F1-M-061	2,212 +/- 2,327	3,884	23	35	17	33	35	36
MRI-R101-F1-M-062	2,317 +/- 2,336	3,884	19	35	19	33	33	36
MRI-R101-F1-M-063	2,633 +/- 2,363	3,884	9	35	31	33	**47**	36
MRI-R101-F1-M-064	1,685 +/- 2,280	3,884	14	35	9	33	25	36
MRI-R101-F1-M-065	1,791 +/- 2,290	3,884	13	35	22	33	33	36
MRI-R101-F1-M-066	2,423 +/- 2,345	3,884	32	35	22	33	**42**	36
MRI-R101-F1-M-067	1,475 +/- 2,261	3,884	17	35	21	33	31	36
MRI-R101-F1-M-068	3,476 +/- 2,434	3,884	24	35	12	33	34	36
MRI-R101-F1-M-069	1,475 +/- 2,261	3,884	20	35	11	33	27	36
MRI-R101-F1-M-070	316 +/- 2,155	3,884	13	35	26	33	**38**	36
MRI-R101-F1-M-071	1,580 +/- 2,271	3,884	28	35	21	33	**43**	36
MRI-R101-F1-M-072	2,001 +/- 2,308	3,884	23	35	11	33	23	36
MRI-R101-F1-M-073	1,580 +/- 2,271	3,884	29	35	8	33	30	36
MRI-R101-F1-M-074	2,317 +/- 2,336	3,884	27	35	14	33	33	36
MRI-R101-F1-M-075	1,685 +/- 2,280	3,884	18	35	23	33	**41**	36

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Survey Results

Building: MRI Survey Unit: R101 Survey Type: Structural Class: 1

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
Static Count	75	Sample Count	75		75		75	
Average	1,223		26		19		39	
Minimum	-1,053		7		8		23	
Maximum	3,476		53		31		53	
Standard Deviation	921		11		5		7	

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Appendix G
Building Systems Survey Results

Survey Results

Building: MRI Survey Unit: DR01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
MRI-DR01-D2-M-002	+/-		29	35	30	33	**48**	36
MRI-DR01-D1-M-003	755 +/- 1,855	3,292	28	35	11	33	26	36
MRI-DR01-D2-M-004	+/-		**52**	35	14	33	**43**	36
MRI-DR01-D1-M-005	755 +/- 1,855	3,292	19	35	24	33	35	36
MRI-DR01-D4-M-006	+/-		**36**	35	15	33	**41**	36
MRI-DR01-D2-M-007	+/-		12	35	25	33	35	36
MRI-DR01-D2-M-008	+/-		4	35	26	33	33	36
MRI-DR01-D3-M-009	+/-		18	35	28	33	**40**	36
MRI-DR01-D3-M-010	+/-		14	35	31	33	**41**	36
MRI-DR01-D1-M-011	632 +/- 2,243	3,983	22	35	**37**	33	**59**	36
MRI-DR01-D1-M-012	948 +/- 2,271	3,983	22	35	14	33	28	36
MRI-DR01-D1-M-013	421 +/- 2,223	3,983	32	35	17	33	35	36
MRI-DR01-D1-M-014	2,212 +/- 2,381	3,983	23	35	**52**	33	**52**	36
MRI-DR01-D1-M-015	2,528 +/- 2,408	3,983	31	35	29	33	**45**	36
MRI-DR01-D1-M-016	1,264 +/- 2,299	3,983	1	35	23	33	28	36
MRI-DR01-D1-M-017	-421 +/- 2,145	3,983	16	35	8	33	25	36

Static Count	9	**Sample Count**	16	16	16
Average	1,010		22	24	38
Minimum	-421		1	8	25
Maximum	2,528		52	52	59
Standard Deviation	900		13	11	10

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Appendix H
QA Survey Results

Survey Results

Building: MRI Survey Unit: QA02 Survey Type: QA Class: QA

	Total Activity Measurements		Removable Activity Measurements					
Location Code	**Activity**	**MDC**	**H-3**	**MDC**	**C-14**	**MDC**	**CH3**	**MDCR**
MRI-QA02-F1-M-001	3,055 +/- 2,252	3,603	9	35	24	33	32	36
MRI-QA02-F1-M-002	2,001 +/- 2,155	3,603	11	35	21	33	30	36
MRI-QA02-F1-M-003	2,844 +/- 2,233	3,603	18	35	11	33	28	36
MRI-QA02-F1-M-004	1,264 +/- 2,085	3,603	13	35	17	33	**37**	36
MRI-QA02-F1-M-005	**4,213** +/- 2,354	3,603	32	35	14	33	**38**	36
Static Count	5	**Sample Count**	5		5		5	
Average	2,675		17		17		33	
Minimum	1,264		9		11		28	
Maximum	4,213		32		24		38	
Standard Deviation	1,116		9		5		4	

Total surface activity results are reported in net dpm/100 cm²
H-3 and C-14 removable results reported in gross dpm/100 cm². CH3 removable results are reported in gross cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 =0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.
Static measurements not performed inside some drain openings due to small geometry.

Pavon, Martha

From: Tomczak, Tammy
Sent: Tuesday, July 12, 2022 11:07 AM
To: Pavon, Sandy; Pavon, Martha
Subject: FW: Completed NRC Form 314, Certificate of Disposition of Materials
Attachments: 301S Final survey.pdf; Chase decommissioning MRI Global FSSR Rev 0 7-6-21.pdf; Final Survey Rad Shed complete.pdf; MRI Global Roof FSSR, Rev 0, 11-22-21 with Appendices.pdf; signed 314.pdf

Good morning, Sandy and Martha,

Can you please add the attached to ADAMS?

Thank you!!
Tammy

From: Wimmer, Brian <bwimmer@MRIGLOBAL.ORG>
Sent: Tuesday, July 12, 2022 11:02 AM
To: R3DNMSMAIL Resource <R3DNMSMAIL.Resource@nrc.gov>
Cc: Wimmer, Brian <bwimmer@MRIGLOBAL.ORG>
Subject: [External_Sender] Completed NRC Form 314, Certificate of Disposition of Materials

Hello,
Please find attached the NRC Form 314 to terminate the license for MRIGlobal, license number 24-02564-02. Also attached are supporting documents for the decommissioning of our radioactive materials lab, waste area, a storage area, and remediation.

Let me know if you need further information.
Thank you,
Brian

Brian J. Wimmer
Manager, Environment, Safety and Health
RSO, LSO, ARO

Phone: 816-326-5076 **Cell:** 816-400-2499
425 Dr. Martin Luther King Jr. Blvd., Kansas City, MO 64110
www.mriglobal.org
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