CLEANUP SURVEY REPORT

FORMER WATERBURY CLOCK COMPANY
232 N Elm Street
Waterbury, Connecticut

Prepared for:
New Opportunities Inc.
232 N Elm Street
Waterbury, Connecticut

Prepared by:

DDES, LLC
25 Rundlett Way Unit 10
Middleton, MA 01949

DECEMBER 12, 2023

CLEANUP SURVEY REPORT
FORMER WATERBURY CLOCK COMPANY SITE
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1.0 EXECUTIVE SUMMARY

Decontamination Decommissioning and Environmental Services (DDES) was retained by New Opportunities Inc. to perform radium (^{226}Ra) cleanup operations at the Former Waterbury Clock Company Site in accordance with the requirements of the Cleanup Plan dated May 21st, 2023. The decontamination and final status survey work began on October 26th, 2023 and continued through October 30th, 2023. The cleanup project was performed using DDES Massachusetts Radioactive Materials License 56-0623 under reciprocal agreement with the Nuclear Regulatory Commission (NRC).

The radionuclide Radium (^{226}Ra) was present at the site. DDES performed a radiological Historic Site Assessment (HSA) prior to beginning the cleanup. The nuclide of concern for the Former Waterbury Clock Company Site has been identified in Table 2-1.

Characterization Surveys were performed to establish agreement with the findings of the May 21, 2017 ORISE "CLEANUP SURVEY". The findings of the ORISE report concludes that areas over 40 µR/hr at 1 meter could result in a member of the public occupying these areas for periods of 8 hours or greater per day (for 5 days a week over a year) could receive a dose in excess of NRC's public dose limit of 100 millirem per year (mrem/yr) in Title 10 of the Code of Federal Regulations (CFR) at 20.1301. DDES confirmed previously identified areas of radioactivity in excess of 40 uR/hr at 1 meter and located an additional (2) locations not previously identified. Decontamination and remediation was performed to satisfy the NRC's Temporary Instruction (TI) 2800/043 (NRC 2016) with previously identified locations measuring below 40 µR/hr at 1 meter post remediation.

Based upon the results of the Post Clean Up Survey, the facility now meets the TI goals based upon the following:

- All areas identified in excess of 40uR/hr 1 meter have been remediated and are below the TI suggested limit.
- The facility does not meet criteria for unrestricted release.
- None of the removable measurements obtained exceeded the administrative removable contamination limit of 20 dpm/100cm^2 for ^{226}Ra.
- The greatest structure exposure rate measurement from within the Former Waterbury Clock Company Site was at 38 µR/hr at 1 meter for ^{226}Ra.

2.0 FACILITY OPERATING HISTORY

DDES, LLC performed a Historical Site Assessment (HSA) of the facilities prior to mobilization on October 26, 2023. The property at 232 North Elm Street in Waterbury, Connecticut (CT), was identified as the former Waterbury Clock Company, a clock manufacturing facility. Previous surveys from the May, 2017 "NRC Radium Report 232 North Elm Street", and "Scientech 2003, Connecticut Radium Sites Verification Survey" were reviewed to identify areas previously measured in exceedance of the TI. The HSA was designed to determine the existing radiological status of the facilities.

2.2 Radioactive Material Use

The Waterbury Clock Company operated during the period from 1919 to the mid-1940s in Waterbury, Connecticut. The Waterbury Clock Company Site was known to have produce and repair watches containing radium-luminous paint.

A limited survey of accessible areas was performed by ORISE on behalf of the NRC in May, 2017. This survey identified 3 locations exceeding the TI of 40 uR/h. These areas of contamination needed further quantification to determine the level of remediation necessary to meet the free release criteria. Previous surveys were limited due to the amount of material being stored in the facility.

2.3 Potential Contaminants

Table 2-1 lists the potential radioactive contaminants as identified by the HSA.

Table 2-1 Potential Contaminants

Radionuclide	Half-Life	Dispersible Form	Half Life >120 Days
^{226}Ra	1,600 years	Yes	Yes

2.4 Operational Radiological Surveys

To our knowledge, the Former Waterbury Clock Company did not perform radioactive surveys when ^{226}Ra paints were used. DDES performed personnel surveys during characterization and remediation efforts. No detectable personal contamination was found on personnel or visitors for the duration of the cleanup project. There were areas of removable contamination identified during the invasive work. All work areas where contaminated flooring or building structure were

exposed were thoroughly vacuumed, and a fixative agent applied to limit the spread of loose contamination. All survey locations were below 20 dpm/100cm^2 post remediation.

2.5 Spills and Uncontrolled Release of Radioactivity

Since no radiological records were required to be kept during operation, no radiological spills had been reported over the history of the site.

2.6 Potentially Impacted Facilities and Laboratories

Table 2-2 lists areas that have been potentially impacted by the use of radioactive material and were evaluated against the cleanup criteria.

Table 2-2 Impacted Areas

Location ID	Location	Isotope
1-5-1	5th Floor East End Office Suite	Ra-226
1-5-2	5th Floor East End Office Suite	Ra-226
1-5-3	5th Floor East End Office Suite	Ra-226
1-5-4*	5th Floor East End Office Suite	Ra-226
1-4-21	Room 426	Ra-226
1-4-22	Room 426	Ra-226
1-4-23	Room 426	Ra-226
2-4-1	Fatherhood North Wall Left	Ra-226
2-4-2	Fatherhood Column	Ra-226
2-4-3*	Fatherhood North Wall Right	Ra-226

*Additional location found by DDES exceeding 40 uR/h at 1 meter

3.0 PROJECT MANAGEMENT AND ORGANIZATION

DDES LLC has maintained primary responsibility for all activities conducted under the requirements of the Cleanup Plan and the Final Status Survey. DDES holds Massachusetts Radioactive Material License No. 56-0623 and pervromed this project via reciprocity with the NRC. The point of contact between applicable regulatory authorities and DDES has been DDES Management. DDES personnel authorized under the license were on site during cleanup operations involving radioactive materials.

4.0 TRAINING

DDES, LLC performed annual radiation safety training and project specific training for DDES personnel and subcontractors as required by DDES, LLC's license conditions.

5.0 ENVIRONMENTAL MONITORING PROGRAM

The scope of this cleanup project was limited to the interior of the facilities; therefore, a project-specific environmental monitoring program was not required.

6.0 RADIOACTIVE WASTE MANAGEMENT

Approximately three (3) cubic yards of radioactive dry active waste were generated during this project. The majority of the waste was wood flooring components and poly sheeting used for containment construction. Also included were contaminated bricks, vacuum bags, and PPE. The waste was shipped offsite on November 9, 2023 by a licensed radioactive waste broker, Chase Environmental.

7.0 SURVEY INSTRUMENTATION

7.1 Instrument Calibration

Portable field instruments were calibrated with National Institute of Standards and Technology (NIST) traceable sources for the nuclides of concern within the previous year. Instrument calibration sheets have been included in Appendix A.

7.2 Functional Checks

Functional checks for portable instrumentation were performed daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation were validated daily to ensure that statistically valid data was obtained. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument performance and site conditions.

7.3 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 Final Status Survey DQOs. Instrumentation count times and scanning rates were determined using the following equations listed in Sections 8.3.1, 8.3.2 and 8.3.3 below:

7.3.1 Static Counting

Static counting Minimum Detectable Concentration at a 95% confidence level were 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", (Strom & Stansbury, 1992):

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

Where:

MDC_{static}	=	minimum detectable concentration level in dpm/100cm^2
B_r	=	background count rate in counts per minute
t_b	=	background count time in minutes
t_s	=	sample count time in minutes
E_{tot}	=	total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters <400 keV max and 1.00 surface efficiency for gamma emitters)
A	=	detector probe area in cm^2

7.3.2 Ratemeter Scanning

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

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

Where:

MDC_{scan} = minimum detectable concentration level in dpm/100 cm^2
d' = desired performance variable (1.38)
b_i = background counts during the residence interval
i = residence interval
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters <400 keV max) and 0.50 surface efficiency for beta emitters >400keV max and 1.0 surface efficiency for gamma emitters
A = detector probe area in cm^2

7.3.3 Smear Counting

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

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

Where:

MDC_{smear} = minimum detectable concentration level in dpm/smear
B_r = background count rate in counts per minute
t_b = background count time in minutes
t_s = sample count time in minutes
E = instrument efficiency for radionuclide emission of interest

7.4 Radiological Instrumentation Specifications

Field instruments were selected based on the the nuclide of concern. Table 7-1 shows typical field instruments and associated efficiencies that were used for the post remediation survey.

Table 7-1 Radiological Field Instruments

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Typical Total Efficiency
Ludlum 43-93	ZnS(Ag) Scintillator	100 cm^2	Ludlum 2224-1	0.8 mg/cm^2	10.4% (^{230}Th)
N/A	Alpha/Beta ZnS(Ag)	20.26 cm^2	Ludlum 3030	0.4 mg/cm^2	32.0% (^{230}Th)
N/A	NaI (Tl) Scintillation	1" x 1"	Ludlum 19	N/A	17µR/hr

NOTES: These are approximate values based primarily on manufacturer's ratings. The sensitivities depend on background, count time, and other factors.

To assist with planning activities, estimated scanning MDCs for the radionuclide of interest were obtained for field survey instruments by reviewing available information, and these values are listed in Table 7-2.

Table 7-2 Typical Operating Instrument Operating Parameters

Measurement Type	Detector Model	Meter Model	Scan Rate	Count Time	Background (cpm)	MDC (dpm/100cm^2)
Surface Scans	Ludlum 43 - 93	Ludlum 2224-1	2 in./sec.	N/A	285	179 (^{230}Th)
Surface Scans	Ludlum 43 - 37B Floor Monitor	Ludlum 2221	4 in./sec.	N/A	740	69 (^{230}Th)
Total Surface Activity	Ludlum 43 - 93	Ludlum 2224	N/A	1 min	235	70 (^{230}Th)
Exposure Rate Surface Activity	N/A	Ludlum 19	N/A	N/A	12 (µR/hr)	N/A
Removable Activity	N/A	Ludlum 3030	N/A	1 min	0.3 (α) 37.3(β)	13 (^{239}Pu) 93 (^{99}Tc)

The scanning MDCs presented in Table 7-2 are representative of those that reasonably can be expected to be obtained with currently available instruments under conditions typically encountered in the field. These values were obtained from reported values and scanning experience.

8.0 DECONTAMINATION

Decontamination is the physical or chemical process of reducing and preventing the spread or potential exposure from contamination. Decontamination included the use of commercially available materials and/or equipment that effectively removed radioactive materials from surface areas so that the contamination could be collected and properly disposed. In some cases, the contamination has been absorbed into the material and the impacted areas must be removed. The Former Waterbury Clock Company Site has brick, metal, concrete and wood surfaces that are impacted by ^{226}Ra contamination. Elevated radiation readings on the 4th floor room 426 cubicle area were due to high contamination in the flooring of location 1-5-3. Post remediation of the 5th floor location reduced radiation levels the 423 suite to below the NRC TI.

Wood Flooring System

The flooring of the Waterbury Clock Company was composed of a top layer of 2-inch planking with a diagonal 3-inch by 1-inch subfloor. These horizontal flooring layers were supported by tongue and groove 6-inch by 6-inch floor joists. Approximately 200 ft^2 of flooring was removed and packaged for radioactive waste disposal.

Walls

Behind a layer of sheetrock there is bare brick that comprises the wall structure of the building. The brick wall on the 5th floor is also impacted by radioactivity. Approximately 20 ft^2 of impacted walls were decontaminated by scabbling the top surface of the brick to reduce contamination without compromising structural integrity.

9.0 DECONTAMINATION REVIEW

DDES has reviewed all of the applicable data pertaining to the history of radioactive materials use at the facility as well as the dose rate and removable contamination surveys completed in the specified areas of Former Waterbury Clock Company Site. A detailed summary of pre and post cleanup survey data along with location maps can be found in Appendix B.

ACRONYMS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DQO	Data Quality Objective
HSA	Historical Site Assessment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NMSS	Nuclear Materials Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission Guidance Document
QAPP	Quality Assurance Project Plan
RAM	Radioactive Materials
RSO	Radiation Safety Officer
TEDE	Total Effective Dose Equivalent

REFERENCES

10 CFR 20, Standards for Protection Against Radiation

NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"

U.S. Nuclear Regulatory Commission (NRC). NUREG/CR-5512, Residual Radioactive Contamination from Decommissioning, October 1992.

Abelquist, et al. 1998, Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG-1507. Abelquist, E., W. Brown, and G. Powers, U.S. Nuclear Regulatory Commission, Washington, D.C., June 1998.

Instrument Calibration Certificates

www.ludlums.com

CERT #4084.01

CALIBRATION CERTIFICATE

LUDLUM MEASUREMENTS, INC.
501 Oak Street
325-235-5494
Sweetwater, TX 79556, USA

Customer: DDES LLC
Address: 25 RUNDLETT WAY UNIT 10
MIDDLETON, MA 01949-2167
USA

Order No.: 20443607
Temp: 75.6 °F
Rel. H: 35%
Alt: 702.6 mm Hg
Cal Date: 09-Jun-23
Cal Due Date: 09-Jun-24
Cal Interval: 1 year

Mfg.: Ludlum Measurements, Inc. **Model: 9DP*** Desc.: ion chamber Serial No.: 25025478

Calibration tolerance is 10%.

Voltage measurements uncertainty 1.2%, Gamma Exposure/Dose uncertainty 5.6%, Neutron Dose uncertainty 7.0%, Count rate uncertainty 5.6%

Model 9DP* Parameters:
☑ New Instrument
Serial No.: 25025478
☑ Audio Check
☑ Battery Check
☑ Mechanical Check
☑ Reset Check
Radiation Alert: 2 mrem/hr
Radiation Alarm: 5 mrem/hr
☑ LMI SOP 14.9
Primary Units: rem

Digital

Reference Point	Direct Reading
4 rem/hr	4.06 rem/hr
1 rem/hr	1.09 rem/hr
400 mrem/hr	412 mrem/hr
100 mrem/hr	105 mrem/hr
40 mrem/hr	40.3 mrem/hr
10 mrem/hr	10.2 mrem/hr
4 mrem/hr	4.10 mrem/hr
1 mrem/hr	1.04 mrem/hr
400 µrem/hr	405 µrem/hr
100 µrem/hr	97.7 µrem/hr

COMMENTS:

Instrument is Auto-Ranging. Peak value and integrated dose are the available functions. All undocumented features are currently set to 0 (off). See attachment for other settings.

Ludlum Measurments, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques.
All pass/fail determinations are based on the manufacturer's specifications without considering uncertainty factors.
Measurement results represent expanded uncertainties expressed at approximately the 95% Level of confidence, using a coverage factor of k=2.
The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323AB-2013.

ISO/IEC 17025: 2017 (E)
State of Texas Calibration License No. LO-1963

Reference Instruments and/or Source(s):
Sources: Cs-137: 1616, 720, 734, 2324/2521

Form ID #: AC237809540602

Calibrator: Tina Gonzales Tina Gonzales Title: Calibrator Date: 09-Jun-23

QC'd by: Diana Shelley Title: Final QC Date: 12 Jun 23

RSCS
Radiation Safety & Control Services

Calibration Certificate
ID Number: 275925185367-0

Customer: Gary Nadeau
DDES, LLC
25 Rundlett Way
Unit 10
Middleton, MA 01949

Instrument	Serial Number
Ludlum Model 3030	275925

Precision Check

Test 1	Test 2	Test 3	Mean	Results
7.98 Kcpm	**7.98 Kcpm**	**7.98 Kcpm**	**7.98 Kcpm**	**Satisfactory**

Accuracy Check

Range	Target Value	As Found	As Left
Alpha	8 Kcpm	7.981 Kcpm #	7.981 Kcpm #
Alpha	2 Kcpm	1.995 Kcpm #	1.995 Kcpm #
Beta	8 Kcpm	7.981 Kcpm #	7.981 Kcpm #
Beta	2 Kcpm	1.993 Kcpm #	1.993 Kcpm #

Readings with * indicate ranges where As-Found readings are >20% of Target value. Readings with ** indicate As-left readings are >10% of Target value
Readings with # indicate ranges were calibrated using a pulser

Probe Model & SN	Isotope	Efficiency	NIST Source ID	Geometry
Internal Probe	C-14	0.0917 C/D (4 Pi)	C-14 (SN: T6-693)	In Holder
Internal Probe	C-14	0.3210 C/P (2 Pi)	C-14 (SN: T6-693)	In Holder
Internal Probe	Sr/Y-90	0.3748 C/D (4 Pi)	Sr/Y-90 (SN: T6-173)	In Holder
Internal Probe	Sr/Y-90	0.7700 C/P (2 Pi)	Sr/Y-90 (SN: T6-173)	In Holder
Internal Probe	Tc-99	0.2350 C/D (4 Pi)	Tc-99 (SN: T6-695)	In Holder
Internal Probe	Tc-99	0.5700 C/P (2 Pi)	Tc-99 (SN: T6-695)	In Holder
Internal Probe	Th-230	0.3103 C/D (4 Pi)	Th-230 (SN: T6-691)	In Holder
Internal Probe	Th-230	0.6140 C/P (2 Pi)	Th-230 (SN: T6-691)	In Holder

MTE Instrument Type	Model	CalDueDate
Pulser	Ludlum 500-4SN: 98756	11/16/2023

Outer Physical Check: *Pass*
Tap Test: *Pass*

Electronics Checks	As Found	As Left
High Voltage	**646Volts**	**646 Volts**

Comments: Alpha into Beta crosstalk = 3.8% (Pu-239)
Beta into Alpha crosstalk = 0.1% (Sr/Y-90)

Chris Pirie
Calibration
Technician

QA
Review:

Date: 01/26/2023
Expires: 01/26/2024

Atmospheric Conditions - Temperature: 70° F Humidity: 32% Barometric Pressure:29.22 in/hg

This calibration was performed by RSCS using one or more of the following NIST Traceable radiation sources:
Tech Ops Model 773 Cs-137 Beam Calibrator (S/N S-1110), characterized using Exradin Model A6 (S/N 185) and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-008, with estimated uncertainty of 6.0%.
J.L. Shepherd and Associates Model 89 Cs-137 Box Calibrator (S/N 9141), characterized using Exradin, Model A6 (S/N 185), A3 (S/N 197), A12 (S/N XA091124), and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-001, with estimated uncertainty of 2.7%.
J.L. Shepherd and Associates Model 81-12 Cs-137 Dual Source Gamma Calibrator (SN 7145), characterized using Exradin Models A6 (S/N 185) / A4 (S/N 220) / A5 (S/N 261), GE RSS-131 (S/N 95I00178), and Standard Imaging Electrometer Electrometer Model Maxx4000 (S/N J171510) in accordance with methods specified in RSCS TSD 20-023, with estimated uncertainty of 6.7%.
RSCS Model 149 Neutron Calibrator, Pu:Be Source Model MRC Model 2726-B (S/N 495), characterized using Far West Technologies Model Rem500 TEPC (S/N 271) in accordance with the methods specified in RSCS TSD 21-049, with an uncertainty of 9.4% at a 95% confidence interval.
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.
Unless otherwise stated, calibrations performed in conformance to the following documents: ANSI N323AB-2013; RSCS New Hampshire Radioactive Material License Number 381R.
RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and Standard Operating Procedures.
Calibration Laboratory is operated in accordance with ANSI/NCSL Z540-1-1994
RSCS, Inc. has been assessed by ANAB and meets the requirements of ISO/IEC 17025:2005 while demonstrating technical competence in the field of calibration. Refer to the Scope of Accreditation AC-2079 for information on the types of calibrations to which this accreditation applies.

Radiation Safety and Control Services, Inc.
93 Ledge Road, Seabrook, NH 03874
1-800-525-8339 (603) 778-2871 www.radsafety.com

ANAB ACCREDITED CALIBRATION LABORATORY

RSCS
Radiation Safety & Control Services

Calibration Certificate
ID Number: 292260178419-1

Customer: Gary Nadeau
DDES, LLC
2229 Main Streeet
Concord, MA 01742

Instrument
Ludlum Model 3-663C

Serial Number
292260

Probe Model
Ludlum 44-10

Serial Number
312489

Precision Check				
Test 1	Test 2	Test 3	Mean	Results
4.00 Kcpm	4.00 Kcpm	4.00 Kcpm	4.00 Kcpm	Satisfactory

Accuracy Check			
Range	Target Value	As Found	As Left
X100	400 Kcpm	400 Kcpm #	400 Kcpm #
X100	100 Kcpm	110 Kcpm #	110 Kcpm #
X10	40 Kcpm	40 Kcpm #	40 Kcpm #
X10	10 Kcpm	10 Kcpm #	10 Kcpm #
X1	4 Kcpm	4 Kcpm #	4 Kcpm #
X1	1 Kcpm	1 Kcpm #	1 Kcpm #
X.1	400 cpm	400 cpm #	400 cpm #
X.1	100 cpm	100 cpm #	100 cpm #

Readings with * indicate ranges where As-Found readings are >20% of Target value. Readings with ** indicate As-left readings are >10.00% of Target value
Readings with # indicate ranges where pulser was used.

Probe Model & SN	Isotope	Efficiency	NIST Source ID	Geometry
44-10 312489	Cs-137(Beta)	0.0609 C/D (4 Pi)	Cs-137(Beta) (SN: T6-696)	@1cm
44-10 312489	Cs-137(Beta)	0.1250 C/P (2 Pi)	Cs-137(Beta) (SN: T6-696)	@1cm
44-10 312489	Cs-137(Gamma)	0.0654 C/D (4 Pi)	Cs-137(Gamma) (SN: 14290)	@1cm
44-10 312489	Cs-137(Gamma)	0.1332 C/P (2 Pi)	Cs-137(Gamma) (SN: 14290)	@1cm

MTE Instrument Type	Model	CalDueDate
Pulser	Ludlum 500-4 SN: 66151	02/23/2023

Outer Physical Check: *Pass*
Internal Check: *Pass*
Geotropism Check: *Pass*
Mechanical Zero: *Pass*
Tap Test: *Pass*

Electronics Checks	As Found	As Left
High Voltage	**1430 Volts**	**1430 Volts**

Comments: Analog and digital scaler displays reflect appropriate congruence.

Kirsten Zeller
Calibration
Technician

QA
Review:

SEP 0 7 2022

Calibration Date: 09/03/2022
Expires: 09/03/2023

Atmospheric Conditions - Temperature: 72°F Humidity: 40% Barometric Pressure: 30.24"hg

This calibration was performed by RSCS using one or more of the following NIST Traceable radiation sources:
Tech Ops Model 773 Cs-137 Beam Calibrator (S/N S-1110), characterized using Exradin Model A6 (S/N 185) and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-008, with estimated uncertainty of 6.0%.
J.L. Shepherd and Associates Model 89 Cs-137 Box Calibrator (S/N 9141), characterized using Exradin, Model A6 (S/N 185), A3 (S/N 197), A12 (S/N XA091124), and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-001, with estimated uncertainty of 2.7%.
J.L. Shepherd and Associates Model 81-12 Cs-137 Dual Source Gamma Calibrator (SN 7145), characterized using Exradin Models A6 (S/N 185) / A4 (S/N 220) / A5 (S/N 261), GE RSS-131 (S/N 95I00178), and Standard Imaging Electrometer Electrometer Model Maxx4000 (S/N J171510) in accordance with methods specified in RSCS TSD 20-023, with estimated uncertainty of 6.7%.
RSCS Model 149 Neutron Calibrator, Pu:Be Source Model MRC Model 2726-B (S/N 495), characterized using Far West Technologies Model Rem500 TEPC (S/N 271) in accordance with the methods specified in RSCS TSD 21-049, with an uncertainty of 9.4% at a 95% confidence interval.
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.
Unless otherwise stated, calibrations performed in conformance to the following documents: ANSI N323AB-2013; RSCS New Hampshire Radioactive Material License Number 381R.
RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and Standard Operating Procedures.
Calibration Laboratory is operated in accordance with ANSI/NCSL Z540-1-1994
RSCS, Inc. has been assessed by ANAB and meets the requirements of ISO/IEC 17025:2005 while demonstrating technical competence in the field of calibration. Refer to the Scope of Accreditation AC-2079 for information on the types of calibrations to which this accreditation applies.
This calibration certificate shall not be reproduced except in full without the express written consent of RSCS, Inc.

RSCS
Radiation Safety & Control Services

Calibration Certificate
ID Number: 351010192828-0

Customer: Gary Nadeau
DDES, LLC
25 Rundlett Way
Unit 10
Middleton, MA 01949

Instrument	Serial Number
Ludlum Model 2224-1 783C	351010
Probe Model	**Serial Number**
Ludlum 43-93	356611

Precision Check

Test 1	Test 2	Test 3	Mean	Results
0.99 Kcpm	**0.99 Kcpm**	**0.99 Kcpm**	**0.99 Kcpm**	**Satisfactory**

Accuracy Check

Range	Target Value	As Found	As Left
x1000	400 KCPM	399.6 KCPM #	399.6 KCPM #
x1000	100 KCPM	99.4 KCPM #	99.4 KCPM #
x100	40 KCPM	39.9 KCPM #	39.9 KCPM #
x100	10 KCPM	9.93 KCPM #	9.93 KCPM #
x10	4 KCPM	3.99 KCPM #	3.99 KCPM #
x10	1 KCPM	0.993 KCPM #	0.993 KCPM #
x1	400 CPM	399 CPM #	399 CPM #
x1	100 CPM	99 CPM #	99 CPM #

Readings with * indicate ranges where As-Found readings are >20% of Target value. Readings with ** indicate As-left readings are >10% of Target value
Readings with # indicate ranges were calibrated using a pulser

Probe Model & SN	Isotope	Efficiency	NIST Source ID	Geometry
43-93 356611	C-14	0.0830 C/P (2 Pi)	C-14 (SN: T6-693)	@1cm
43-93 356611	C-14	0.0235 C/D (4 Pi)	C-14 (SN: T6-693)	@1cm
43-93 356611	Sr/Y-90	0.3730 C/P (2 Pi)	Sr/Y-90 (SN: T6-173)	@1cm
43-93 356611	Sr/Y-90	0.1817 C/D (4 Pi)	Sr/Y-90 (SN: T6-173)	@1cm
43-93 356611	Tc-99	0.2380 C/P (2 Pi)	Tc-99 (SN: T6-695)	@1cm
43-93 356611	Tc-99	0.0980 C/D (4 Pi)	Tc-99 (SN: T6-695)	@1cm
43-93 356611	Th-230	0.1920 C/P (2 Pi)	Th-230 (SN: T6-691)	@1cm
43-93 356611	Th-230	0.0970 C/D (4 Pi)	Th-230 (SN: T6-691)	@1cm

MTE Instrument Type	Model	CalDueDate
Pulser	Ludlum 500-4SN: 98756	11/16/2023

Outer Physical Check: *Pass*
Internal Check: *Pass*
Geotropism Check: *Pass*
Mechanical Zero: *Pass*
Tap Test: *Pass*

Electronics Checks	As Found	As Left
High Voltage	**605 Volts**	**605 Volts**

Comments: Analog and digital scaler displays reflect appropriate congruence.
Alpha into Beta crosstalk = 8.01% (Pu-239)
Beta into Alpha crosstalk = 0.08% (Sr/Y-90)

Atmospheric Conditions - Temperature: 69° F Humidity: 50% Barometric Pressure:29.75 in/hg

This calibration was performed by RSCS using one or more of the following NIST Traceable radiation sources:
Tech Ops Model 773 Cs-137 Beam Calibrator (S/N S-1110), characterized using Exradin Model A6 (S/N 185) and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-008, with estimated uncertainty of 6.0%.
J.L. Shepherd and Associates Model 89 Cs-137 Box Calibrator (S/N 9141), characterized using Exradin, Model A6 (S/N 185), A3 (S/N 197), A12 (S/N XA091124), and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-001, with estimated uncertainty of 2.7%.
J.L. Shepherd and Associates Model 81-12 Cs-137 Dual Source Gamma Calibrator (SN 7145), characterized using Exradin Models A6 (S/N 185) / A4 (S/N 220) / A5 (S/N 261), GE RSS-131 (S/N 95I00178), and Standard Imaging Electrometer Electrometer Model Maxx4000 (S/N J171510) in accordance with methods specified in RSCS TSD 20-023, with estimated uncertainty of 6.7%.
RSCS Model 149 Neutron Calibrator, Pu:Be Source Model MRC Model 2726-B (S/N 495), characterized using Far West Technologies Model Rem500 TEPC (S/N 271) in accordance with the methods specified in RSCS TSD 21-049, with an uncertainty of 9.4% at a 95% confidence interval.
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.
Unless otherwise stated, calibrations performed in conformance to the following documents: ANSI N323AB-2013; RSCS New Hampshire Radioactive Material License Number 381R.
RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and Standard Operating Procedures.
Calibration Laboratory is operated in accordance with ANSI/NCSL Z540-1-1994
RSCS, Inc. has been assessed by ANAB and meets the requirements of ISO/IEC 17025:2005 while demonstrating technical competence in the field of calibration. Refer to the Scope of Accreditation AC-2079 for information on the types of calibrations to which this accreditation applies.

Radiation Safety and Control Services, Inc.
93 Ledge Road, Seabrook, NH 03874
1-800-525-8339 (603) 778-2871 www.radsafety.com

ANAB ACCREDITED CALIBRATION LABORATORY

RSCS
Radiation Safety & Control Services

Calibration Certificate
ID Number: 351010192828-0

Customer: Gary Nadeau
DDES, LLC
25 Rundlett Way
Unit 10
Middleton, MA 01949

Instrument	Serial Number
Ludlum Model 2224-1 783C	351010
Probe Model	**Serial Number**
Ludlum 43-93	356611

Nicole Wedig
Calibration
Technician

QA
Review:

Date: 10/10/2023
Expires: 10/10/2024

Atmospheric Conditions - Temperature: 69° F Humidity: 50% Barometric Pressure:29.75 in/hg

This calibration was performed by RSCS using one or more of the following NIST Traceable radiation sources:
Tech Ops Model 773 Cs-137 Beam Calibrator (S/N S-1110), characterized using Exradin Model A6 (S/N 185) and Keithley Electrometer Model 617 (S/N 0547677) in accordance with methods specified in RSCS TSD 11-008, with estimated uncertainty of 6.0%.
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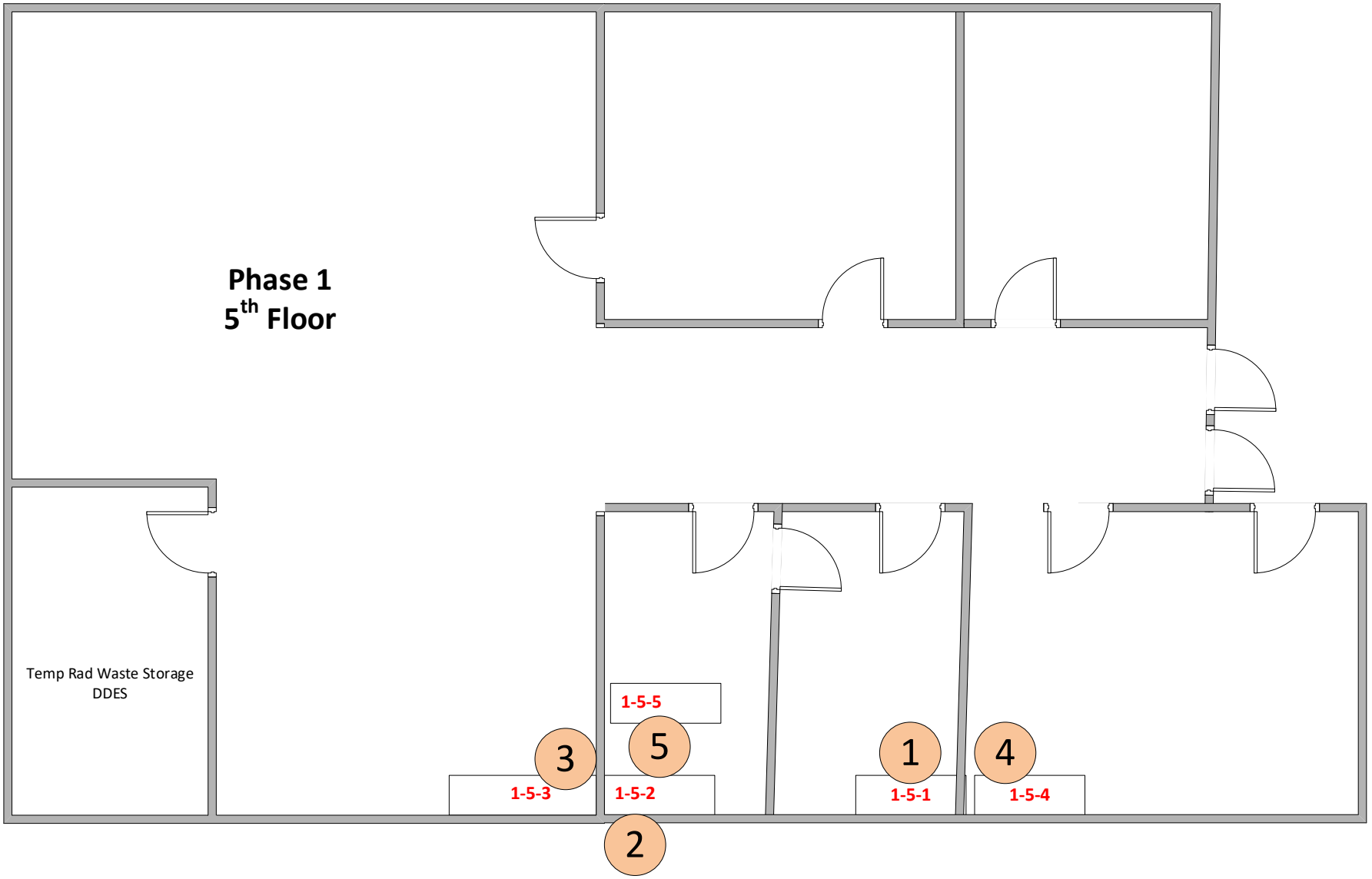
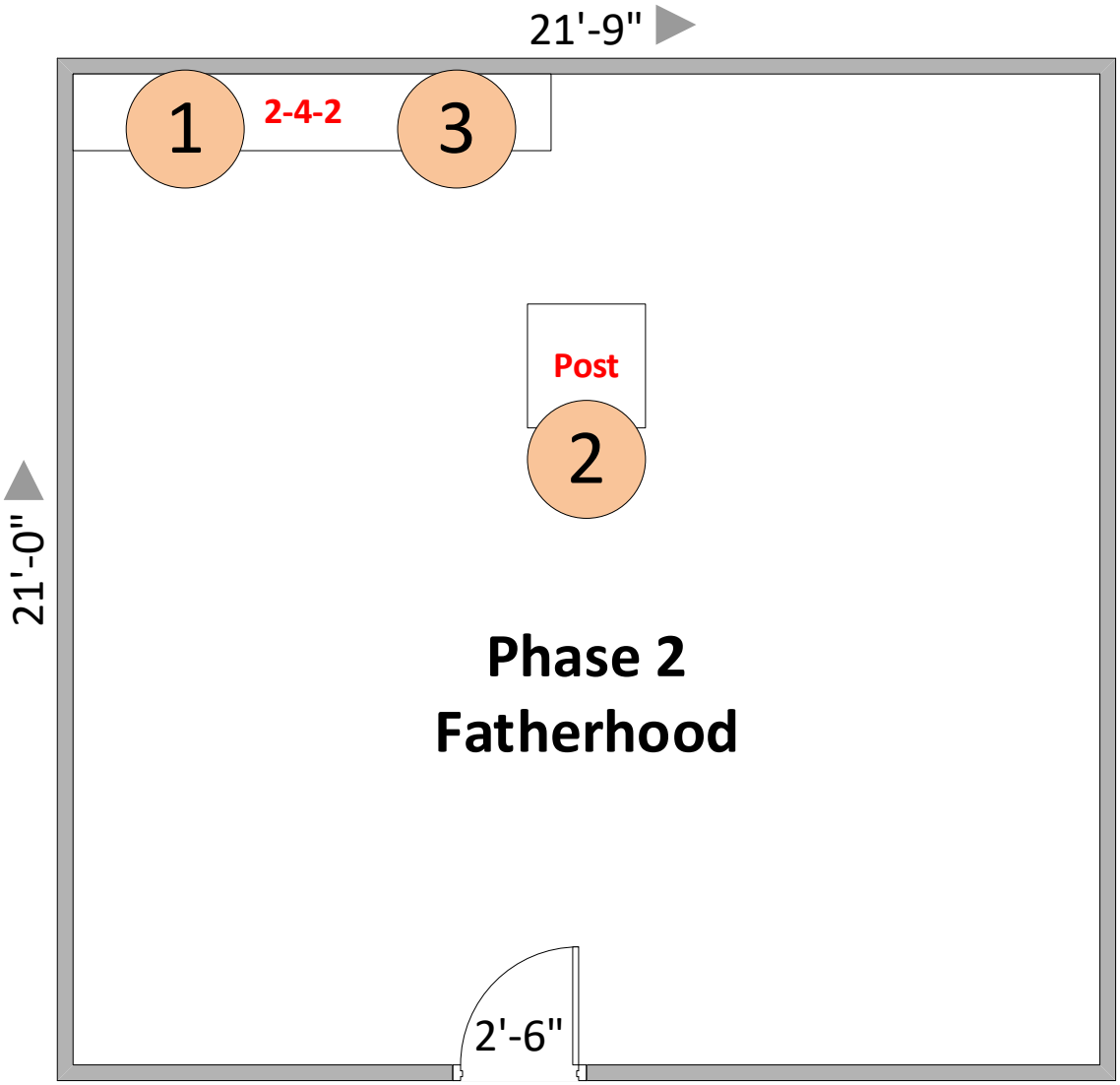
Clean Up Survey Summary

Exposure Rates										
ID	Area	NaI CPM Pre-Clean Up	NaI CPM Post-Clean Up	Pre-Clean Up Exposure Rate (µR/hr)			Post-Clean Up Net Exposure Rate (µR/hr)			
							Floor			Ceiling
				Contact	30 cm	1 Meter	Contact	30 cm	1 Meter	30 cm
Phase 1 (Building 1)										
1-5-1	5th Floor East End Office Suite	620,000	75,000	750	N/A	75	90	62	33	-
1-5-2	5th Floor East End Office Suite	740,000	150,000	950	N/A	75	157	82	38	-
1-5-3	5th Floor East End Office Suite	2,900,000	200,000	4,000	N/A	210	150	73	38	-
1-5-4	5th Floor East End Office Suite *	Over Range	55,000	750	N/A	75	75	47	38	-
1-4-21	Room 426	74,000	20,000	60	N/A	40	29	22	30	19
1-4-22	Room 426	200,000	25,000	27	N/A	33	27	24	29	21
1-4-23	Room 426	230,000	30,000	200	N/A	15	25	28	31	22
Phase 2 (Building 2)										
2-4-1	Fatherhood North Wall Left	250,000	75,000	270	N/A	42	50	35	28	28
2-4-2	Fatherhood Column	98,000	35,000	110	N/A	25	50	30	20	20
2-4-3	Fatherhood North Wall Right *	140,000	45,000	150	N/A	26	40	28	24	24

*Newly Found Area of Contamination



N	*New Opportunities* *5th Floor Phase 1*	*Areas of Remediation*	*DDES, LLC* *25 Rundlett Way, Unit 10* *Middleton, MA 01949*



N	*New Opportunities* *4th Floor Phase 2*	*Areas of Remediation*	*DDES, LLC* *25 Rundlett Way, Unit 10* *Middleton, MA 01949*