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PRL S-030A Verification Survey at Former McClellan AFB, Sacramento, CA

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5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Maj Alan Hale

5d. PROJECT NUMBER

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USAF School of Aerospace Medicine
Occupational and Environmental Health Dept/OEC
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

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AFRL-SA-WP-CL-2013-0005

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine Consultative Services Division (USAFSAM/OEC) completed an independent radiological assessment/verification survey from 23-25 Oct 12 at site PRL S-030A on former McClellan AFB, CA. This verification survey was conducted at the site after the contractor had completed the majority of the excavation of contaminated soils from the site. Radium-226 was the sole radionuclide of concern. Cabrera Services, Inc., under contract with Tetra Tech, conducted all radiological field work to include the Final Status Survey (FSS). This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS report of this site.

15. SUBJECT TERMS

USAF School of Aerospace Medicine (USAFSAM), former McClellan AFB, radium-226, verification survey, final status survey, independent radiological assessment

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Col Mark Smallwood
U	U	U	SAR	27	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
WRIGHT-PATTERSON AFB OHIO

25 March 2013

MEMORANDUM FOR AFMSA/SG3PB
ATTN: MAJ DANIEL SHAW
USAF RADIOISOTOPE COMMITTEE SECRETARIAT
AIR FORCE MEDICAL SUPPORT AGENCY
7700 ARLINGTON BOULEVARD, SUITE 5158
FALLS CHURCH, VA 22042-5158

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0005, PRL S-030A Verification Survey at Former McClellan AFB, Sacramento, CA

1. INTRODUCTION:

a. *Purpose:* At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine Consultative Services Division (USAFSAM/OEC) completed an independent radiological assessment/verification survey from 23-25 Oct 2012 at site PRL S-030A on former McClellan AFB, CA. This verification survey was conducted at the site after the contractor had completed the majority of the excavation of contaminated soils from the site. Radium-226 (Ra-226) was the sole radionuclide of concern. Cabrera Services, Inc., under contract with Tetra Tech, conducted all radiological field work including the Final Status Survey (FSS). This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS report of this site.

b. *Survey Personnel:*

(1) Chief, Radiation Health Consulting Branch, USAFSAM/OEC
(2) Health Physics Technician, USAFSAM/OEC

c. *Personnel Contacted:*

(1) Radiation Program Manger, AFCEC/CIBW
(2) Radiation Safety Officer, AFCEC/CIBW

d. *Equipment:*

(1) Ludlum-Model 2221, serial number 218606, calibrated on 23 Nov 11
(2) Ludlum-Model 44-10, serial number PR276614, calibrated on 23 Nov 11
(3) Ludlum-Model 2221, serial number 78153, calibrated on 25 Nov 11
(4) Ludlum-Model 44-10, serial number PR276615, calibrated on 25 Nov 11

2. METHODOLOGY:

a. *Background Area*: The background area of 400 m^2 has been routinely used as a reference area since it was determined to be radiologically nonimpacted. The background area was characterized with the 2x2 sodium iodide detector using a gamma walkover technique. No soil samples were taken in the background area, as the background soil concentrations for former McClellan AFB were determined previously and were not relevant for this survey. After gamma walkover surveys at the survey sites, it was determined that the background area was not consistent with the survey areas, most likely due to the fact the background area still had vegetation in place. The background data are, therefore, irrelevant and are not presented.

b. *Survey Areas*: Cabrera Services, Inc. was responsible for conducting a total of two FSSs at two different sites. The week of the visit, PRL S-030A was anticipated to be available for USAFSAM verification. Therefore, after consultation with the RICS, it was chosen for this survey. During the week of the visit, PRL S-030A had not been completely remediated. The eastern portion of the site had residual contamination that the contractors were still surveying and remediating; therefore, the FSS of the site had not been completed. As a result, USAFSAM was only able to survey the area of PRL S-030A that had been remediated. The survey area underwent gamma walkover surveys and soil sampling. This verification survey required at least 10% of the survey area to be scanned by the gamma walkover technique and soil sampling totaling at least 10% of the number taken by the contractor. Further information on the surveys can be found in Attachments 1-2.

(1) *Gamma Walkover Survey in Survey Area*: The goals of the walkover survey were to detail site radiological conditions, identify potential spots of elevated residual Ra-226 concentrations, and identify locations for biased soil sampling. Since the gamma walkover data were to qualitatively assess the site in terms of mean reading plus amount of standard deviation (SD), minimum detectable concentration and count rates were not calculated. Table 1, in section 3, summarizes the results of the gamma walkover survey.

(2) *Soil Sampling in Survey Area*: Since the contractor planned to collect 64 soil samples at PRL S-030A, 8 biased soil samples were collected based on walkover data exhibiting elevated count rates. Each sample was taken from an area of about 8 square inches to a depth of 6 inches. The volume sampled was enough for laboratory analysis (approximately 0.25 gallon). Field soil sampling procedures were in place to prevent cross-contamination of samples. Table 2, in section 3, summarizes the soil sample results.

3. RESULTS: The results are summarized below along with some basic discussion. Additional substantiating data, including maps and survey data, can be found in Attachments 1-5.

Table 1. Gamma Walkover Results Summary

Instrument	Mean Count Rate (cpm)	SD (cpm)	No. of Readings > Mean + 3 SD
Ludlum Model 2221/44-10 (SN: 218606/PR276614)	7313	931	14
Ludlum Model 2221/44-10 (SN: 78153/PR276615)	7282	828	84

Table 2. Soil Sampling Results Summary

Sample No.	Ra-226 Concentration (pCi/g)	Ra-226 Concentration Uncertainty (pCi/g)
CS00001	17.2	±0.248
CS00002	1.09	±0.0613
CS00003	1.30	±0.0525
CS00004	7.44	±0.149
CS00005	1.99	±0.0672
CS00006	1.83	±0.0588
CS00007	0.831	±0.0489
CS00008	1.51	±0.0571

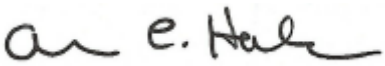
4. CONCLUSIONS:

a. All soil samples were taken in biased locations where elevated Ra-226 concentrations were expected to be found. The maximum Ra-226 concentration was 17.2 ± 0.248 pCi/g. This area was identified during the survey as needing remediation; see Figure A2-3 in Attachment 2. Additionally two other samples, CS0004 and CS0005, were greater than the cleanup goal of 2.0 pCi/g when uncertainty is added.

b. USAFSAM acknowledges that the site had not undergone a comprehensive contractor FSS when the portion of the site was verified by USAFSAM. However, the contractor failed to identify the areas USAFSAM detected during its remediation support surveys.

c. Based upon the findings of this verification survey, USAFSAM recommends the RICS carefully review the contractor's FSS report for PRL S-030A before the site is approved for unrestricted free release of radiological controls.

5. If you have any questions or need further information, please contact Maj Alan Hale at 937-938-3320 (DSN 798-3320) or alan.hale@us.af.mil.



ALAN C. HALE, Maj, USAF, BSC
Chief, Radiation Health Consulting Branch

5 Attachments:
1. Instrumentation and Survey Methodology
2. Survey of PRL S-030A
3. Laboratory Soil Analysis
4. Instrument Calibration Sheets
5. Radiation Meter QC Log

ATTACHMENT 1

INSTRUMENTATION AND SURVEY METHODOLOGY

1. *Sodium Iodide Detector*: The sodium iodide detectors used were Ludlum 44-10 2x2-inch detectors coupled with a Ludlum 2221 ratemeter/scaler. For walkover surveys, the Ludlum 2221 was connected via cable to a Trimble GeoXT handheld GPS unit. The Trimble GeoXT logged the count rates with the corresponding GPS coordinates every second. The detector was held at 10 cm above the ground for soil readings and walkover surveys. During walkovers, the scan speed was approximately 0.5 meters per second. This is consistent with the contractor methodology used during gamma walkover surveys.

2. *Laboratory Analysis of Soil*: Soil samples were counted at the USAFSAM Radioanalytical Laboratory (OEAL) at WPAFB, OH. The soil was counted on a high purity germanium detector. The soils were also analyzed by OEAL using the appropriate in-growth method to determine Ra-226 levels in soil. Attachment 3 contains the laboratory reports.

3. All field instruments were function checked and field tested before and after use with a check source. All instruments were tested to ensure a 20% tolerance during field checks. All of the instruments passed the tolerance function check except the post-survey check of survey meter serial number 218606 with probe serial number PR276614 as documented in Attachment 5. A review of the data collected with this meter verified that the data were valid. The suspected reason for the instrument failing the post-survey check was a loose connection in the probe. While surveying, the probe was held vertically, which did not affect the connection; however, during the function check the probe was in a horizontal position, which affected the connection. All instruments are calibrated on an annual basis at WPAFB, OH. Attachment 4 contains all annual calibration sheets and Attachment 5 is the Radiation Meter QC Log.

ATTACHMENT 2

SURVEY OF PRL S-030A

1. *Location*: Figures A2-1, A2-2, and A2-3 are photographs of the PRL S-030A site during verification survey work. Note standing water in the excavation area (Figures A2-1 and A2-2), which limited the area available for the gamma walkover survey.

Figure A2-1. Photograph of PRL S-030A, Gamma Walkover Survey

Figure A2-2. Photograph of PRL S-030A, Soil Sampling

Figure A2-3. Photograph of PRL S-030A, Hotspot Found Corresponding to Soil Sample CS0001

2. *Survey Results*: Eight soil samples were taken at the PRL S-030A site. The gross Ra-226 soil concentration results are in Table A2-1, which is inclusive of the background Ra-226 concentration and can be compared directly to the cleanup goal of 2.0 pCi/g. The locations of the soil samples are in Figure A2-4. The PRL S-030A site area of approximately 5000 m^2 was characterized with a sodium iodide detector using a gamma walkover technique. Scan coverage was approximately 75%. Due to the shallow nature of the excavation, only the floor of the excavation was scanned and not the side walls. The resultant data of this walkover are listed in Figure A2-5. Since there was a disparity in the mean count rates of the background survey area and the survey unit due to soil difference, through analysis of the statistics the mean count rate of the survey unit itself and associated statistics were used as the "background" for this survey unit. The lowest readings of the survey are marked in green and correspond to less than 2 SDs above the mean background value. This green area is where soil concentrations are expected to be the lowest. The other colors represent areas of statistical significance where higher concentrations are expected to be found. Yellow and red colors correspond to greater than 2 and 3 SDs, respectively, above the mean count rate value. The color scheme demonstrates a scale of instrument data based upon SDs from background, where no regulatory values are implied.

Table A2-1. Soil Sample Results for PRL S-030A

Sample No.	GPS Coordinates (°N/°E)	Gross Ra-226 Concentration (pCi/g)
CS00001	38.650007/ -121.406722	17.2 ± 0.248
CS00002	38.650110/ -121.406746	1.09 ± 0.0613
CS00003	38.649986/ -121.406863	1.30 ± 0.0525
CS00004	38.649945/ -121.406921	7.44 ± 0.149
CS00005	38.649909/ -121.406917	1.99 ± 0.0672
CS00006	38.649484/ -121.406786	1.83 ± 0.0588
CS00007	38.649473/ -121.406710	0.831 ± 0.0489
CS00008	38.649502/ -121.407166	1.51 ± 0.0571

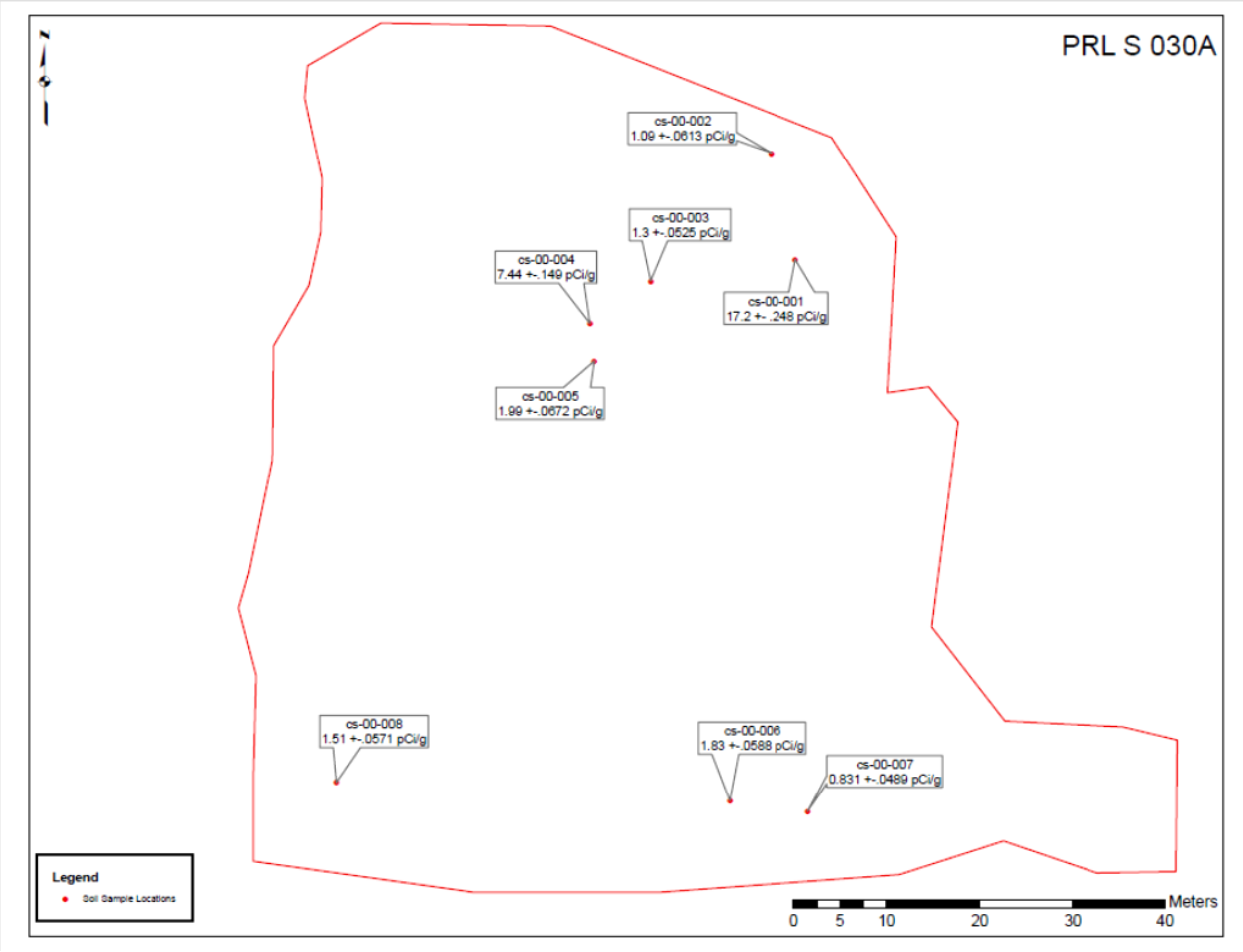


Figure A2-4. Soil Sample Locations for PRL S-030A

Figure A2-5. Gamma Walkover Data for PRL S-030A

ATTACHMENT 3

LABORATORY SOIL ANALYSIS

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200280

Customer Address 0117Z
77 MDOS/SGPB
5942 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00001 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.72E+01 +/- 2.48E-01 pci/g	7.71E-02 / 1.57E-01 pci/g

COMMENTS

RA226

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200281

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00002 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.09E+00 +/- 6.13E-02 pci/g	5.63E-02 / 1.15E-01 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200282

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00003 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.30E+00 +/- 5.25E-02 pci/g	4.43E-02 / 9.07E-02 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200283

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00004 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	7.44E+00 +/- 1.49E-01 pci/g	6.11E-02 / 1.25E-01 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200284

Customer Address 0117Z
77 MDOS/SGPB
5942 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00005 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.99E+00 +/- 6.72E-02 pci/g	4.31E-02 / 8.87E-02 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2953.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200285

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00006 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.83E+00 +/- 5.88E-02 pci/g	4.46E-02 / 9.18E-02 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTANITY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200286

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00007 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	8.31E-01 +/- 4.89E-02 pci/g	4.11E-02 / 8.47E-02 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

Sample Analysis Results Reported on 07-Jan-2013

USAFSAM/OEHHL ID 11200287

Customer Address 0117Z
77 MDOS/SGPB
5342 DUDLEY BLVD

MCCLELLAN AFB CA 95652-1074

IDENTIFICATION

Base Sample # CS00008 Serial #
Date Collected 10/25/2012 Received 10/29/2012 Completed 12/20/2012

Analytes	Activity +/- Uncertainty	Lc / MDA
RADIUM 226	1.51E+00 +/- 5.71E-02 pci/g	3.86E-02 / 7.92E-02 pci/g

COMMENTS

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

If you have any questions concerning the information provided above, please contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC
Chief, Analytical Laboratory Branch

ATTACHMENT 4

INSTRUMENT CALIBRATION SHEETS

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 218606 Index # 099333 Date: 23 Nov 11
Mfg. Ludlum Model 44-10 Serial # PR276614 Index # 100861 Cal. Due Date: 23 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	*Serial #*	*Cert. Date*	*DPM*	*Mfg.*	*Model*	*Serial #*	*Cal. Due Date*
Cs-137	**RP3067**	**1 Nov 04**	**2,454,000**	**Ludlum**	**500-1**	**102951**	**8 Feb 2012**

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. ☑ F/S Resp. Ck. ☑ Window Op.

As Found HV 991 VDC Temperature 72.7 °F Relative Humidity 55 %

Final Volt. Set 1000 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V
Inst. Readout: 500 V ± 2% Inst. Readout: 1000 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	400,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	39,886 CPM	39,886 CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window Out"
Cs-137 Eff: 6,500 CPM/μci/m² @ 1"

Procedural Authority - ICP#22210000

Calibrated By: SIU Hutchinson Date: 23 Nov 2011
Reviewed By: Ryan Nill Date: 30Nov11

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Meter
Mfg. Ludlum Model 2221 Serial # 218606 Index # 099333 Date: 23 Nov 11
Cal. Due Date: 23 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs-137	RP3067	1 Nov 04	2,454,000

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	500-1	102951	8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1
Mfg. Ludlum
Model 44-10
Serial # PR276614
Index # 100861
Isotope: Cs-137

High Voltage	CPM
750	7834
800	9964
850	11523
900	12240
950	12771
1000	12851
1050	13589
1100	13500
1150	13697
1200	13684
1250	13908
1300	13966
1350	17410
Bkgd@ 1100	4664

Final Volt. Set 1100 VDC
Efficiency 6500 CPM/μci/m² @12"

Probe #2
Mfg.
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

Probe #3
Mfg.
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ % 2π@¼"

COMMENTS: Calibration Interval = 1 year Use "Window Out"

Calibrated By: Stu Hutchinson Date: 23 Nov 2011
Reviewed By: [signature] Date: 30/11/11

HotSpot FIDLER Text File Outou:
HotSoot FIDLER Calibration Informatior

Report Date	:	Nov 23 2011 07:07 AM
Calibration Date	:	23 Nov, 2011
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	100861
Meter Barcode Number	:	099333
Detector Manufacturer	:	Ludlum
Detector Model Number	:	44-10
Detector Serial Number	:	PR276614
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	218606
Check Source I.D.	:	RP 3067
Calibration Date	:	23 Nov, 2011
Calibrated by	:	Stu Hutchinson
Check Source Activity (uCi):		1.100E+00
Check Source 17-keV Self	:	1.000E+00
Sample Counting Time (minutes)	:	1.000E+00
Detector Height (cm)	:	3.000E+01

Cs-137 Window Information:

Background (cpm)	:	4,669
Areal Limit of Sensitivity (uCi/m2)	:	4.9E-02
Point Limit of Sensitivity (uCi)	:	1.0E-01
K-factor (m2)	:	2.07

Counting Data (counts):

0-cm:	8120
20-cm:	7179
40-cm:	6081
60-cm:	5469
80-cm:	5167
100-cm:	5069

Instrument Type :Other
Window Option:Only 60 keV
Units:Classic
This is an actual 2 x2 calibration and the values are typical of most 2 x2 configurations.

Detector Calibration Results

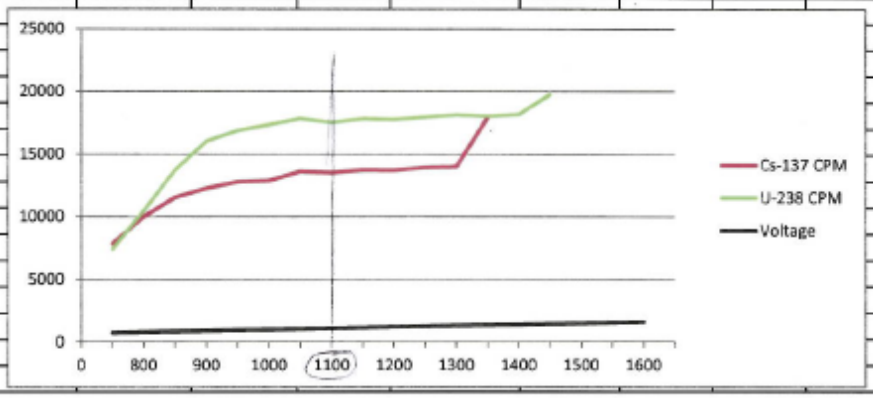
Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2))	:	6.5E+03
Cs-137 Detector Areal LOS (uCi/m2)	:	4.9E-02
Cs-137 Detector Point LOS (uCi)	:	1.0E-01
Cs-137 Detector Background Rate (cpm)	:	4,669
Cs-137 Detector Check Source Rate (cpm)	:	3,451
Cs-137 Detector K-Factor (m2)	:	2.07
Cs-137 Detector K-Factor sdev (%)	:	7.5

Cs-137 Eff: 6,500 CPM/uci/m² @ 12"

Page 1

VDC	CS-137 CPM	DU Slug		Ludlum 2221	SN 218606			
				Ludlum 44-10	SN 276614			
750	7834	7417						
800	9969	10456						
850	11523	13713						
900	12240	16030						
950	12771	16869						
1000	12851	17336						
1050	13589	17835						
1100	13500	17515						
1150	13697	17816						
1200	13684	17764						
1250	13908	17946						
1300	13966	18133						
1350	17910	18023						
1400		18159						
1450		19730						
1500								
1550								
1600								



DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 78153 Index # 04125 Date: 25 Nov 11
Mfg. Ludlum Model 44-10 Serial # PR276615 Index # 100862 Cal. Due Date: 25 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	*Serial #*	*Cert. Date*	*DPM*	*Mfg.*	*Model*	*Serial #*	*Cal. Due Date*
Cs-137	**RP3067**	**1 Nov 04**	**2,454,000**	**Ludlum**	**500-1**	**102951**	**8 Feb 2012**

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. (E) F/S Resp. Ck. ☑ Window Op.

As Found HV 703 VDC Temperature 73.1 °F Relative Humidity 54.6 %

Final Volt. Set 1250 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V
Inst. Readout: 499 V ± 2% Inst. Readout: 1000 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING		CORRECTED READING	
x 1000	400 CPM	400,000	CPM	400,000	CPM
x 1000	100 CPM	100,000	CPM	100,000	CPM
x 100	400 CPM	40,000	CPM	40,000	CPM
x 100	100 CPM	10,000	CPM	10,000	CPM
x 10	400 CPM	4,000	CPM	4,000	CPM
x 10	100 CPM	1,000	CPM	1,000	CPM
x 1	400 CPM	400	CPM	400	CPM
x 1	100 CPM	100	CPM	100	CPM
Log Scale	200 CPM	199	CPM	199	CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING		CORRECTED READING	
40,000 CPM	39,889	CPM	39,889	CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window Out"
Cs-137 Eff. 2,900 CPM/μCi/m² @ 1"
DU-238 response curve determined. **Procedural Authority - ICP#22210000**

Calibrated By: Stg Hutchinson Date: 25 Nov 2011
Reviewed By: [signature] Date: 30 Nov 11

DEPARTMENT OF THE AIR FORCE
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WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Meter Mfg. Ludlum Model 2221 Serial # 78153 Index # 04125 Date: 25 Nov 11 Cal. Due Date: 25 Nov 12

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	*Serial #*	*Cert. Date*	*DPM*	*Mfg.*	*Model*	*Serial #*	*Cal. Due Date*
Cs-137	**RP3067**	**1 Nov 04**	**2,454,000**	**Ludlum**	**500-1**	**102951**	**8 Feb 2012**

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1
Mfg. Ludlum
Model 44-10
Serial # PR276615
Index # 100562
Isotope: Cs-137

High Voltage	CPM
900	11393
950	12953
1000	13,581
1050	14,078
1100	14,215
1150	15,057
1200	15,173
1250	15,017
1300	15,267
1350	15,501
1400	15,212
1450	15,503
Bkgd@1250	4532

Final Volt. Set 1250 VDC
Efficiency 29.0 CPM/μci/m² @12"

Probe #2
Mfg. Ludlum
Model 44-10
Serial # PR276615
Index # 100862
Isotope: DU-slug

High Voltage	CPM
900	10,618
950	13,590
1000	16,229
1050	17,132
1100	17,581
1150	17,881
1200	18,157
1250	18,419
1300	18,455
1350	18,452
1400	18,499
~~1450~~	

Final Volt. Set 1250 VDC
Efficiency NA CPM/μci/m² @12"

Probe #3
Mfg. _____
Model _____
Serial # _____
Index # _____
Isotope: _____

High Voltage	CPM

Final Volt. Set _____ VDC
Efficiency _____ % 2π@¼"

COMMENTS: Calibration Interval = 1 year Use "Window Out"
DU-238 response curve determined.

Calibrated By: Stu Hutchinson Date: 25 Nov 2011
Reviewed By: Piper Wilds Date: 30 Nov 11

HotSpot FIDLER Text File Output
HotSpot FIDLER Calibration Information

Report Date	:	Nov 23 2011 11:12 AM
Calibration Date	:	23 Nov, 2011
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	100862
Meter Barcode Number	:	04125
Detector Manufacturer	:	Ludlum
Detector Model Number	:	44-10
Detector Serial Number	:	PR276615
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	78153
Check Source I.D.	:	RP 3067
Calibration Date	:	23 Nov, 2011
Calibrated by	:	Stu Hutchinson
Check Source Activity (uCi)	:	1.100E+00
Check Source 17-keV Self	:	1.000E+00
Sample Counting Time (minutes)	:	1.000E+00
Detector Height (cm)	:	3.000E+01

Cs-137 Window Information:

Background (cpm)	:	4,532
Areal Limit of Sensitivity (uCi/m2)	:	1.1E-01
Point Limit of Sensitivity (uCi)	:	9.3E-02
K-factor (m2)	:	0.84

Counting Data (counts):

0-cm:	8279
20-cm:	7135
40-cm:	6023
60-cm:	5398
80-cm:	5067
100-cm:	4747

Instrument Type :Other
Window Option:Only 60 keV
Units:Classic
This is an actual 2 x2 calibration and the values are typical of most 2 x2 configurations.

Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2))	:	2.9E+03
Cs-137 Detector Areal LOS (uCi/m2)	:	1.1E-01
Cs-137 Detector Point LOS (uCi)	:	9.3E-02
Cs-137 Detector Background Rate (cpm)	:	4,532
Cs-137 Detector Check Source Rate (cpm)	:	3,747
Cs-137 Detector K-Factor (m2)	:	0.84
Cs-137 Detector K-Factor sdev (%)	:	7.4

Cs-137 Eff: 2,900 CPM/uCi/m² @ 12"

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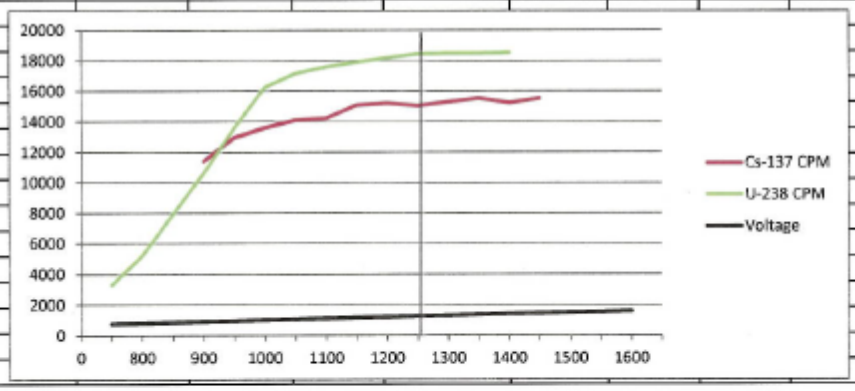
VDC	CS-137 CPM	DU Slug		Ludlum 2221	SN78153			
				Ludlum 44-10	SN276615			
750		3301						
800		5205						
850		7923						
900	11393	10618						
950	12953	13590						
1000	13581	16229						
1050	14078	17132						
1100	14215	17581						
1150	15057	17881						
1200	15173	18157						
1250	15017	18419						
1300	15267	18455						
1350	15501	18452						
1400	15212	18499						
1450	15503							
1500								
1550								
1600								



ATTACHMENT 5

RADIATION METER QC LOG

Radiation Meter QC Log

Model	S/N	Date/Time	HV/cables/Bat check	Source Check Reading	Acceptable Range
2221 3x3	78153 PR2 76615	22oct12/1800	✓	21772 cpm	17418 – 26,126 cpm
2221 2x2	218606 PR 276614	22oct12/1800	✓	20476 cpm	16381 – 24571 cpm
2221 2x2	78153 PR 276615	23oct 12 /1400	✓	20283 cpm	17418 – 26,126 cpm
2221 2x2	218606 PR 276614	23oct12/1400	✓	19821 cpm	16381 – 24571 cpm
2221 2x2	78153 PR276615	23oct12/1446	✓	19839 cpm	17418 – 26126 cpm
2221 2x2	218606 PR 276614	23oct12 /1447	✓	19210 cpm	16381 – 24571 cpm
2221 2x2	78153 PR276615	24 oct12/1300	✓	22047 cpm	17418 – 26126 cpm
2221 2x2	218606 PR 276614	24oct12/1300	✓	19763 cpm	16381 – 24751 cpm
2221 2x2	78153 PR276615	24oct12/1529	✓	21,546 cpm	17418 – 26,126 cpm
2221 2x2	218606 PR 276614	24oct12/1532	✓	656 cpm ☆	16381 – 24571 cpm
2221 2x2	78153 PR276615	25OCT12/1300	✓	19,572 cpm	17418 – 26,126 cpm
2221 2x2	78153 PR276615	25OCT12/1433	✓	21,413 cpm	17418 – 26,126 cpm

☆ The post check did not meet acceptable range. It appears the crystal connection to PMT or BNC is bad. Data collected w. the this meter will be closely evaluated to see if is usable.