DEPARTMENT OF THE ARMY
WATERVLIET ARSENAL
1 Buffington Street
WATERVLIET, NY 12189-4000
March 7, 2005

REPLY TO
ATTENTION OF:

Office of the Commander

'05 MAR 25 P2:03

RECEIVED
REGION 1

US Nuclear Regulatory Commission, Region 1
Attn: Betsy Ullrich, Senior Health Physicist,
Commercial and R&D Branch
Division of Nuclear Materials Safety
475 Allendale Road
King of Prussia, PA 19406-1415

Subject: Removal of Thorium-232 from License STB1554, Control No. 136080

04000911

Dear Ms. Ullrich:

1. References:

a. Letter dated February 16, 2005, from the NRC, SUBJECT: Department of the Army, Issuance of License Amendment, Control Number 138080

b. Letter dated February 8, 2005 from this office SUBJECT: Removal of Thorium-232 from License STB1554, Control No. 136080

c. Letter dated 30 December 2004 from the NRC, SUBJECT: Department of the Army Request for additional Information Concerning Application for Amendment to License Control Number 136080

d. Letter dated 16 September 2003, from the NRC, SUBJECT: Department of the Army Request for additional Information Concerning Application for Renewal of License Control Number 1333312.

e. Letter dated 9 October 2003, from this office, SUBJECT: Nuclear Regulatory Commission (NRC), Request for additional Information Concerning Application fro Renewal of License Control Number 1333312.

NQA 9001:2000 REGISTERED COMPANY
ANSI-RAB QMS ACCREDITED

136662

NMSS/RGN1 MATERIALS-002

f. The Army Radiation Safety Program, Army Regulation 11-9.

2. The enclosed Final Survey Report for Room 255, Building 120 demonstrates that Room 255 contains no significant residual radioactivity that will limit it use in any manner. The survey conducted follows the commitments made in the survey plan and meets all requirements of the MARSSIM protocols for a Class 3 area.

3. Request your approval of the survey report and amend the Watervliet Radioactive Materials License No. STB-1554 to remove thorium.

4. The POC for this action is Ms. Sally D'Agostino, Radiation Protection Officer. She can be reached at (518) 266-5633. The contractor technical manager is Mr. Leslie Cole, CHP. If there are questions about the survey plan, Mr. Cole will be the appropriate person to contact. He can be reached at (863) 424-3222 after March 31, 2005.

Sincerely,

Donald C. Olson
Colonel, US Army
Commanding

Enclosure

WORLD ENVIRONMENTAL INCORPORATED

HAZARDOUS WASTE MANAGEMENT ENGINEERING AND CONSULTING

Final Survey Report for Room 255

Building 120, Watervliet Arsenal

March 2005

Prepared by

WORLD ENVIRONMENTAL, INC.
7857 Freedom Avenue NW
North Canton, Ohio 44720

1.0 Background

Room 255 is a single 6 meters by 9 meters laboratory room in Building 120 at the Watervliet Arsenal, Watervliet, NY. The room contains a fume hood, a laboratory sink, several cabinets and work benches and has a significant portion of the room partitioned off for an office space. The office space can be accessed only through the larger portion of Room 255. The room has been in use as a laboratory space for many years. A variety of different laboratory procedures have been performed in the room – most recently it has been used as an electronics testing facility.

The hood is vented to the outside through a HEPA filtration system. Currently no HEPA filter is installed and the hood is not in use (according to the warning label on the front of the hood). Presumably, the hood has not been recently checked for airflow.

Room 255 may have had small quantities of thorium in the form of ThO_2 used in a process to harden metals by electroplating the thorium onto the surface of the metal. No actual record of use of thorium in any form exists. There is an existing procedure showing how the thorium was to be used. The procedure specified that the use be confined to the fume hood. If the material was actually used, thoria was added to a liquid to form a slurry or a solution. In all other steps in the process, the thorium was in solution. Good contamination controls were specified, so there was little chance of spread of contamination either inside or outside the hood. Discussion with the current Radiation Safety Office indicates that she had talked with the previous RSO who would have been aware if the procedure was actually implemented. He had no recollection of the use of thorium and there are no existing records of such use. There are records of surveys in other laboratory rooms where radioactive materials were used in the time frame of the metal hardening process.

The objective of this survey is to allow thorium to be removed from the facility license. Thorium that was apparently brought to the facility for the metal hardening experiments has been disposed of and the disposal is properly recorded.

The NRC Screening Values for Th-232 will be used as the derived concentration guideline value (DCGL[1]) for the survey. This conservative value is adequate to limit the risk of any future user of the space, even for full time residential use, to less than 25 mrem of radiation dose as stipulated in 10CFR20.1402. If the space is shown to have no contamination above the DCGL it is suitable for release for unrestricted use.

A survey plan for a final survey (Enclosure 1) was approved by the Nuclear Regulatory Commission on February 16, 2005 by Amendment #5 to the Watervliet Radioactive Material license number STB-1554 (Enclosure 2). The survey was conducted on February 22-23, 2005 by Solutient Technology personnel. This report presents the finding of the Final Survey.

[1] The proper term is $DCGL_w$ where the w indicates that the DCGL is based on the Wilcoxon Rank Sum statistical test. For simplicity, the term will be shown as DCGL without the w except when the reference is to the $DCGL_{emc}$ (the guideline value for elevated measurements) in which case the emc will be added to the term.

2.0 Radionuclides of Concern

The ^{232}Th that may have been used in the hood is the radionuclide of concern. Since ^{232}Th is the parent of a naturally occurring radionuclide series, the decay progeny will also be present. For the purposed of the survey, it is assumed that the ^{232}Th is in equilibrium with its immediate progeny. It follows from this assumption that there is an equal amount of ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra present. Since ^{224}Ra decays to ^{220}Rn, it is unlikely that the equilibrium would continue beyond that point; however, it is also unlikely that the series radionuclides beyond ^{220}Rn will be totally absent from the room if thorium is present. The section below regarding the derived concentration guideline value discusses this issue.

3.0 Derived Concentration Guideline Value

The thorium contained in ThO_2 is natural thorium (^{232}Th) and is one of the long-lived naturally occurring radionuclides. The NRC published a set of screening values for surface contamination for a number of radionuclides in 1998 (63 FR 64132) that did not contain a screening value for the alpha radiation emitting radionuclides. A following Federal Register notice (64 FR 68395) approved the use of the screening values in NUREG/GR-5512 vol 3, Table 5.19 for the alpha emitting radionuclides. The screening value listed in Table 5.19 for ^{232}Th is 6.03 dpm/100 cm^2 (for ^{232}Th with the decay progeny present, as in this case).

Since the $DCGL_w$ value applies to the ^{232}Th alone and it is accompanied by the decay progeny that also decay at the same rate as the ^{232}Th, a higher value for the detected contamination will be evident. The actual value of the detected contamination is dependent on the amount of one of the decay progeny, which is in gaseous form (^{220}Rn) that may escape from the solid matrix of the deposited ThO_2 on the contaminated surface during the decay process. Some reasonable assumption can be made about the fraction of the radon that may escape during decay. The escape fraction will be low since the half life of ^{220}Rn is only 56 seconds. There are a total of 6 alpha and 4 beta radiation emissions with each ^{232}Th atom that decays occurring simultaneously. If the assumption is that 50% of the radon escapes, there would remain 4.5 alpha and 3 beta emissions with each disintegration of a ^{232}Th atom. It follows then that if the survey is for alpha radiation only, the DCGL needs to be adjusted to 27 dpm/100 cm^2. (If the radon all escapes, there would be 3 additional alphas for each ^{232}Th atom disintegration and the alpha DCGL would be 18 dpm/100 cm^2.) The following chart shows the number of alphas and betas that remain with the fraction of radon escaping.

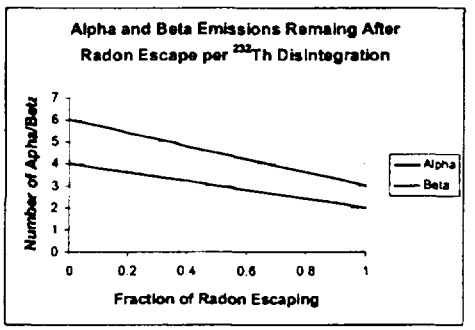


Figure 1 – Fraction of Radon Escaping

If there were enough contamination present to collect a relatively large sample, it would be possible to determine the actual fraction of radon that escaped. Since the amount of contamination is extremely small, perhaps none at all, it is not possible to make the actual determination. The survey must proceed with some reasonable assumption regarding the fraction of radon that escapes. Fifty percent is a very high fraction. Thirty percent is more reasonable and that leads to an alpha DCGL of 30 dpm/100 cm^2. This value is chosen for the final survey DCGL. Since the primary exposure for thorium as a surface contaminate is from the contaminating material re-suspended into the air, no more than 10% of the DCGL value may be removable. In this case, the removable alpha contamination may not exceed 3 dpm/100 cm^2.

4.0 Area Classification

Room 255 is approximately 54 m^2 and it meets all the criteria for a Class 3 MARSSIM classification. The room will contain only one survey unit.

5.0 Choice of Instruments

Since the DCGL is based on the alpha emission, the instrument chosen must be capable of measuring alpha radiation. The Ludlum 43-90 detector with the Ludlum 2221 Scaler/Ratemeter will be used for the survey. The direct measurement capability for the instrument is sufficient to measure ~25% of the DCGL in a ten minute timed count. These values are based on the manufacturer's specification for the background of the detector of <3 cpm. Actual background values were slightly less than 3 cpm and the minimum detectable activity was about 7.8 dpm/100 cm^2.

Calculation of Instrument MDC's

Static Measurements

Background =	2.7	cpm
Count time =	10	min
Instrument Eff =	0.2	
Source Eff =	0.5	
Area Probe =	126	cm^2

$$MDC = (4.65+3*\sqrt{BG})/(e_{inst} * e_{source} * t_{count} * A_{probe}/100)$$

MDC = 7.76 dpm/100 cm^2

Scan MDC

$$\text{Scan MDC} = (-\ln(1-P(n \geq 1))*60)/e_{inst} \bullet e_{source} \bullet t$$

Where:

ln = natural log
P = Probability of detection

Setting the probability to 0.67, time to 4 seconds (scanning at 1 in/sec) and using the efficiencies above:

Scan MDC = 170 dpm/100 cm^2

The scan MDC is adequate to provide information related to areas of elevated measurements as determined for the DCGLemc calculated below.

6.0 Elevated Measurement Criteria

A Class 3 area is not expected to contain any residual radioactivity, or expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiation surveys. The 10 data collection locations in a 54 m^2 space mean that there is one data collection point for each 5.4 m^2. The area factor for 5.4 m^2 is 13.4 (See the table below; value determined by graphic interpolation).

Table 1 – Area Factors for ^{232}Th Surface Contamination

Area (m2)	Dose* (mrem/yr)	Area Factor
72	1.83E-03	1.0
36	9.10E-04	2.0
18	4.55E-04	4.0
9	2.28E-04	8.0
4	1.01E-04	18.1
2	5.06E-05	36.2
1	2.53E-05	72.3

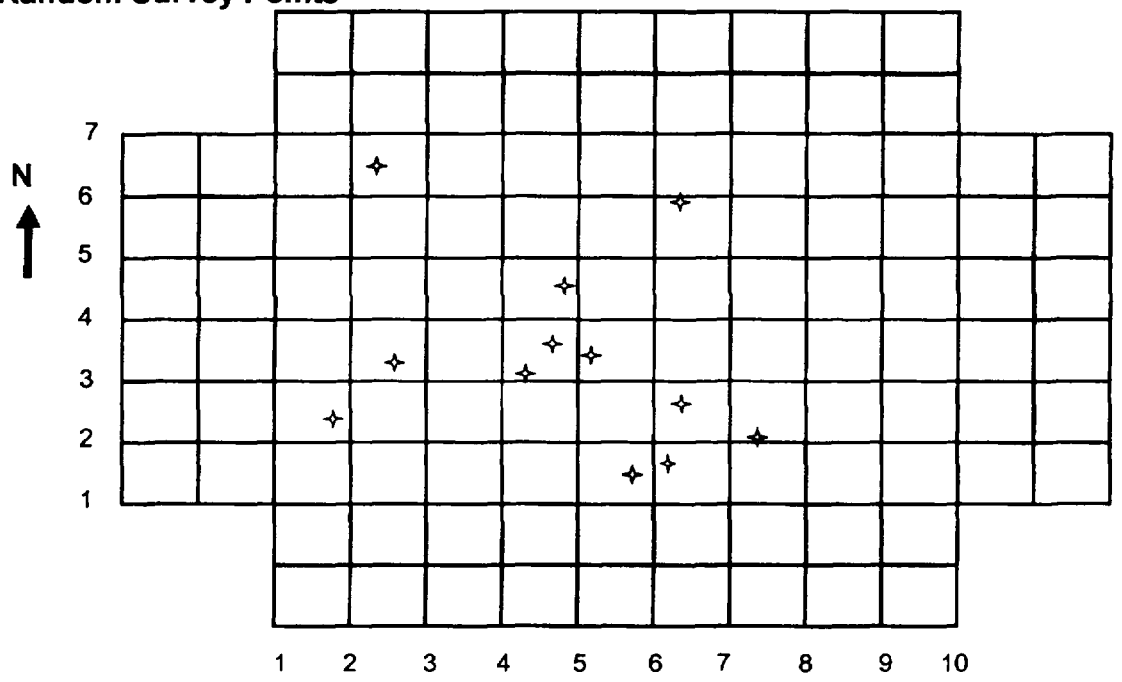
* Based on 1 pCi/m^2

The DCGLw times the area factor for the area represented by the individual data collection point is the DCGLemc. In this case the DCGLemc = 400 dpm/100 cm^2 (30 X 13.4). This also represents the minimum scan MDC required. The scan MDC as calculated above is approximately 43% of the minimum scan MDC required, i.e. the scan capability is within the general MARSSIM guideline for scanning.

7.0 Conduct of the Final Survey

Room 255 is an occupied laboratory and contains a variety of laboratory equipment in addition to the fume hood mentioned in the procedure for using the thorium oxide. The room was gridded into one meter by one meter survey blocks. The corners of the grids were marked by masking tape. Some floor and wall space was not fully accessible for the gridding. Random numbers were used to select the survey point and the grids to be scanned for the survey. The diagram below shows the selection of data collection points in Room 255. The yellow shaded areas represent the floor and the orange shaded areas represent the 2 meter grids on the walls. The small crosses indicate the locations of the data collection points. These locations are shown as North / East coordinates in the table below the sketch. These points were marked on the floor using masking tape to facilitate collecting the smear samples later.

Random Survey Points



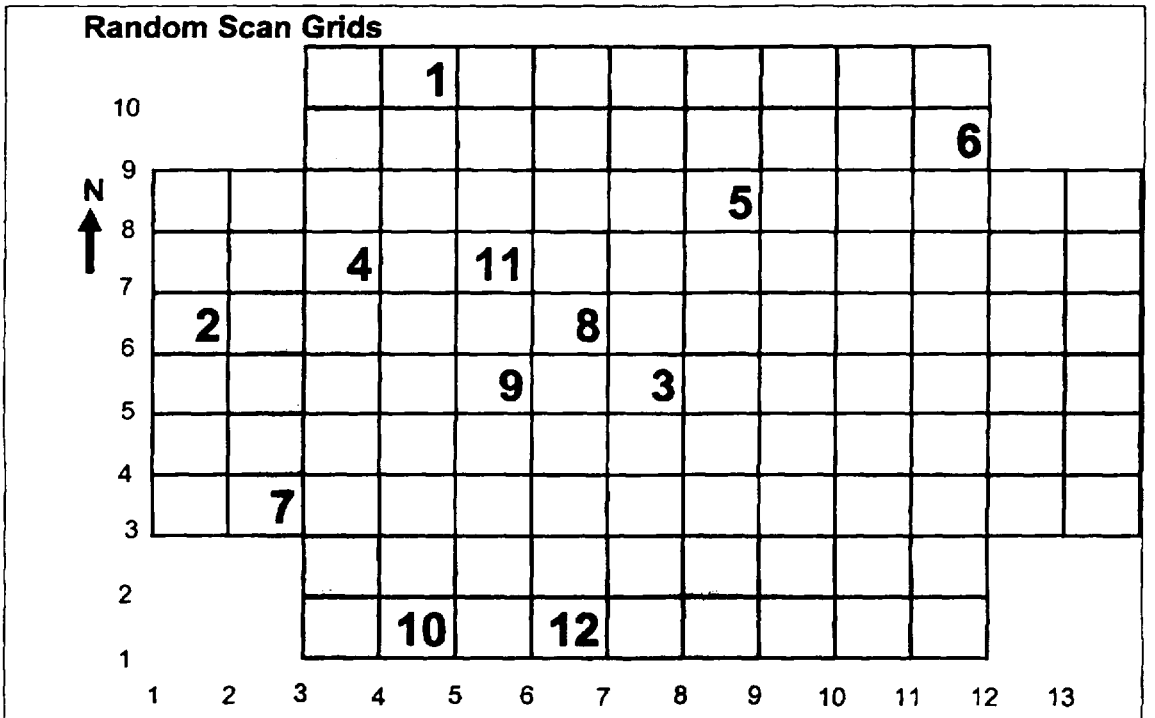
	1	2	3	4	5	6	7	8	9	10
North	1.40	3.22	3.63	3.02	2.35	4.57	1.68	2.67	5.94	3.29
East	5.72	5.08	4.72	4.27	1.83	4.88	6.13	6.41	6.37	2.60

Ten minute direct measurements were collected at each of the selected locations using a Ludlum Model 2241-2 survey meter with a Ludlum Model 43-90 alpha scintillation probe. These measurements were followed by collecting a smear at each location in the same space that the probe sat while gathering the data. Two additional measurements were made that were not included in the random selection. One measurement was made under the rug in the office space at the east end of the room and the other data point was collected on the sink cabinet at 6.50, 2.30. None of the random locations fell in the office area so an additional measurement was

made at point 7.56, 2.0. These two points are indicated on the sketch in a different color (Blue) than the locations used in the analysis for unrestricted use. After collecting the 10 minute direct measurement at the randomly selected data collection points, a swipe sample was collected. One point was resurveyed for quality control purposes.

Following the collection of the direct measurement data and the swipe sampling, 10% of the grids were scanned using the same instrument used for the direct measurements. The scanning was performed by moving the survey meter at a constant rate of 2.5 cm per second. The instrument was set to its scaler mode, the same mode used to collect the direct measurements for a 5 minute count. The total area was covered in the 5 minute scan time in each grid. This method of scanning assures that each small space in the scanned grid is under the probe for four seconds. While the scan is proceeding the surveyor listens to the audible output of the survey meter and is alert for any location where there is any noted higher activity detected. Such locations would be marked and checked after completing the scan in that one meter grid. No such locations of potential elevated activity were noted in the survey for Room 255 or in Room 232.

The sketch below shows the grids scanned in Room 255. The number in a grid indicates that it is the grid that was scanned.

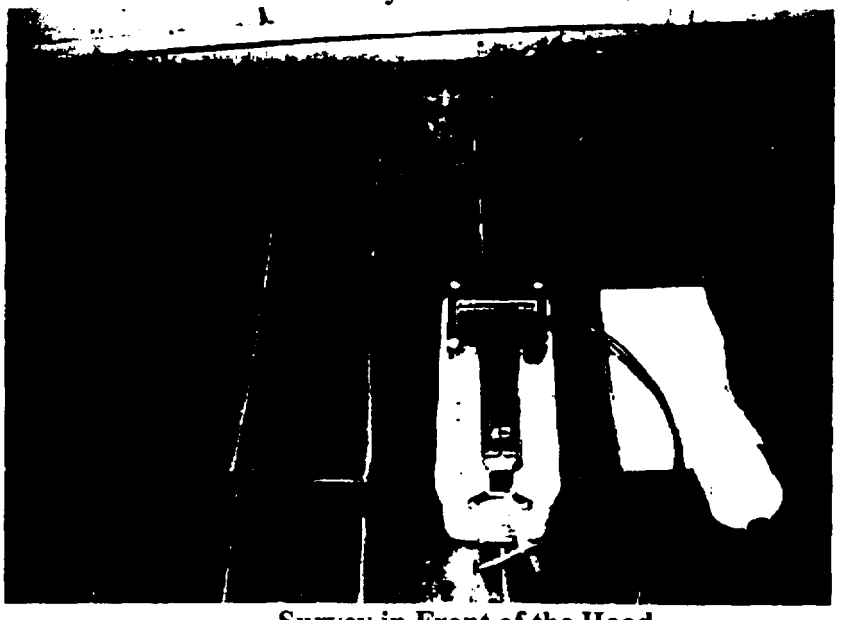


	1	2	3	4	5	6	7	8	9	10	11	12
North	10	6	7	7	8	3	3	6	5	1	7	1
East	4	1	5	3	8	4	1	6	5	2	5	6

A total of twelve grids were scanned, six on the floor and six on the walls.

An additional task was directed in the survey plan. The fume hood along the north wall was the location most likely contaminated. In the survey plan it was agreed that a survey of the base of the hood and the floor in front of the hood would be measured using a series of direct measurements that covered the entire space of the base of the hood and a like sized space on the floor in front of the hood. The base of the hood was 150 cm by 55 cm and the area on the floor chosen for the detailed survey was 150 cm by 60 cm. The pictures below show the grids layout for these two surveys.

Survey of the Hood Base



Survey in Front of the Hood

A background reference area was also surveyed following the same procedure as the survey in Room 255. Room 232, down the hall from Room 255 was selected as the background reference area. A six meter by nine meter grid was laid out in that room and data collections points selected in the same random order basis as in Room 255. A total of ten data collection points were chosen for ten minute direct measurement and smear collection after the counts. Five grids were also chosen for scanning in the same manner as the scanning for Room 255.

Scanning in the Background Reference Area

Copies of all field data collection sheets are in Enclosure 3.

8.0 Survey Data

All the data collected in the survey are presented and discussed in this section.

8.1 Direct Measurements in Room 255

The following table shows the results of the direct measurements in Room 255.

Table 2 – Direct Measurements in Room 255

Data Point	Counts (10 min)	cpm	net cpm	Calculated dpm/100cm^2	dpm/100 cm^2
1	41	4.1	1.3	10.3	10.3
2	24	2.4	-0.4	-3.5	<7.8
3	29	2.9	0.1	0.5	<7.8
4	29	2.9	0.1	0.5	<7.8
5	24	2.4	-0.4	-3.5	<7.8
6	25	2.5	-0.3	-2.7	<7.8
7	36	3.6	0.8	6.2	<7.8
8	33	3.3	0.5	3.8	<7.8
9	27	2.7	-0.1	-1.1	<7.8
10	28	2.8	0.0	-0.3	<7.8
11	24	2.4	-0.4	-3.5	<7.8
12	30	3	0.2	1.3	<7.8
5 (QC)	28	2.8	0.0	-0.3	<7.8

The ten minute count yielded a minimum detectable activity (MDA) of 7.8 dpm/100 cm^2. Only one of the measurements was above this level. The average activity per 100 cm^2 for the initial ten measurements at the data collection points, disregarding the MDA, was 1.05 dpm/100 cm^2. This is undoubtedly due to the single measurement that was detectable above the MDA since there were an equal number of negative measurements as positive ones. Adding in the QC measurement and the two additional measurements lowers the average to 0.60 dpm/100cm^2.

These measurements do not differ significantly from background. In fact, the instrument background was measured to be 3.5 cpm before these measurements were taken. The result of these measurements caused the background to be adjusted to reflect the values found in this set of measurements. The background on the instrument used for these measurements on the next day measured 2.2 cpm.

8.2 Direct Measurements in Room 232

The data for the background reference area is similar as shown in the table below.

Table 3 – Direct Measurements in Room 232

Data Point	Counts (10 min)	cpm	net cpm	Calculated dpm/100cm^2	dpm/100 cm^2
1	47	4.7	2.5	20.2	20.2
2	42	4.2	2.0	16.2	16.2
3	40	4	1.8	14.6	14.6
4	38	3.8	1.6	13.0	13.0
5	45	4.5	2.3	18.6	18.6
6	51	5.1	2.9	23.5	23.5
7	43	4.3	2.1	17.0	17.0
8	33	3.3	1.1	8.9	8.9
9	31	3.1	0.9	7.3	<7.8
10	42	4.2	2.0	16.2	16.2

While the results of the direct measurements in Room 232 indicate a higher level than in Room 255, there is not a significant difference from a statistical viewpoint. The following figure, depicting the randomly selected data collection points, is constructed to demonstrate this.

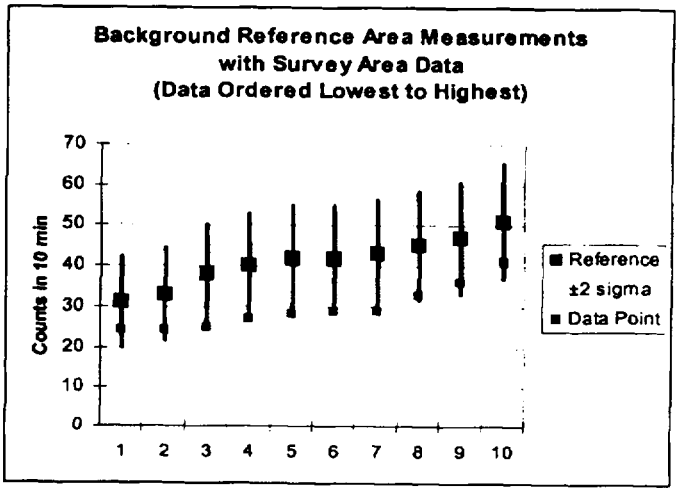


Figure 2 – Comparison of Background Reference Area Measurements with the Survey Area – Ordered Data

The chart in Figure 2 is constructed by plotting the measured values for the direct measurements (the green squares) in the background reference area with a vertical line representing the limits of the two sigma error for these measurements. The red blocks represent the measurement data from Room 255. In the case of the ordered data, the Room 255 data falls on the two sigma bar of the reference background measurement. Obviously there are errors for the Room 255 data but the spreadsheet used to plot the data will not allow a separate error bar for the second set of data plotted in this manner. If the data is plotted in the order the samples were collected, the same picture is evident. See Figure 3 below.

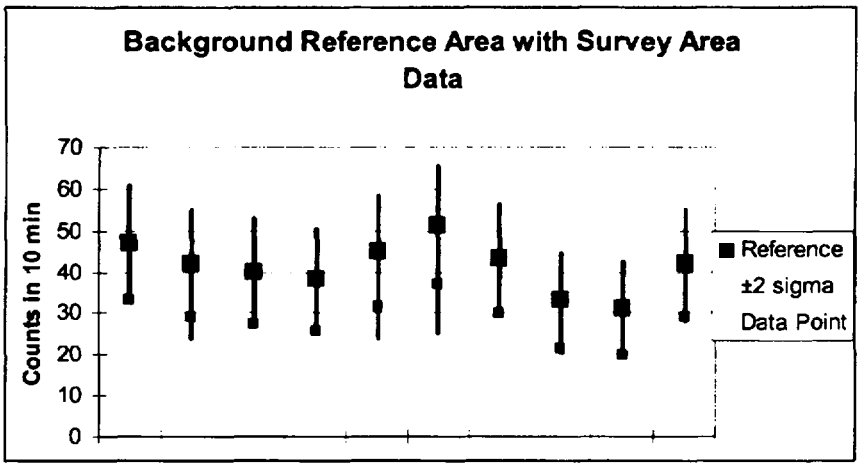


Figure 3 – Comparison of Background Reference Area Measurements with the Survey Area

It is obvious that the measurements in Room 232 are higher than those in Room 255 but this analysis shows that the difference is statistically insignificant. The important fact that is evident in examining the above data is that there is no evidence of contamination in Room 255 either standing alone or in comparison with the results measured n the background reference area.

8.3 Swipe Samples

The swipe samples were evaluated off site with a Ludlum Model 2929 laboratory counter. The Model 2929 is a manually operated counter with the capability of measuring to below 1.6 dpm. The survey plan stipulated an MDA of <1 dpm but the background was elevated more than usual and the decision to use the relative standard count time was approved. The results indicate that no sample in Room 255 was above the MDA and only one sample in Room 232 exceeded the MDA. Since the limit was actually 3 dpm, these results are deemed acceptable.

Note also that there is a discrepancy between the laboratory results and the results shown here. The laboratory calculations apparently used a different formula for calculating the MDA's than thought appropriate by this author. In addition, there appears to be some rounding difference as well as the different formatting for the alpha results. None of these differences invalidate the results or change the conclusion that Room 255 meets the release criteria. The results of the samples collected in Rooms 255 and 232 are shown in the two tables below.

Table 4 – Swipe Survey Results, Room 255

Smear #	Gross _ Counts (10 Minutes)	Gross _ Counts (10 Minutes)	_ dpm/100 cm2	_ dpm/100 cm2	Smear Location/Description
1	0	574	-0.6	18	Location 1
2	2	530	0.0	-3	Location 2
3	4	541	0.6	2	Location 3
4	2	538	0.0	10	Location 4
5	3	522	0.3	-7	Location 5
6	1	535	-0.3	-1	Location 6
7	4	598	0.6	29	Location 7
8	3	601	0.3	31	Location 8
9	2	570	0.0	16	Location 9
10	3	583	0.3	22	Location 10

Smear Counter Model:	2929	Probe Model:	43-10-1
Serial Number:	167855	Serial Number:	PR171934
Alpha Background:	0.2	Beta Background:	53.6
Alpha Source	2,075	Beta Source:	7,375
Alpha Efficiency:	33%	Beta Efficiency:	21%
Alpha MDA (dpm)	1.54	Beta MDA (dpm)	17.64
Calibration Due Date:	9/16/2005		
Count Date:	2/28/2005		

Table 5 – Swipe Survey Results, Room 232

Smear #	Gross _ Counts (10 Minutes)	Gross _ Counts (10 Minutes)	dpm/100 cm2	dpm/100 cm2	Smear Location/Description
1	1	575	-0.3	18	Location 1
2	2	545	0.0	4	Location 2
3	0	517	-0.6	-9	Location 3
4	3	527	0.3	-4	Location 4
5	1	566	-0.3	24	Location 5
6	0	545	-0.6	4	Location 6
7	2	565	0.0	14	Location 7
8	2	570	0.0	16	Location 8
9	1	578	-0.3	20	Location 9
10	8	553	1.8	8	Location 10

Smear Counter Model:	2929	Probe Model:	43-10-1
Serial Number:	167855	Serial Number:	PR171934
Alpha Background:	0.2	Beta Background:	53.6
Alpha Source	2,075	Beta Source:	7,375
Alpha Efficiency:	33%	Beta Efficiency:	21%
Alpha MDA (dpm)	1.54	Beta MDA (dpm)	17.64
Calibration Due Date:	9/16/2005		
Count Date:	2/28/2005		

A one-to-one comparison of the direct measurement data and the swipe data may not be able to show that the removable fraction is less than 10% as required for a MARSSIM survey for alpha emitters. In this case, since there is so little contamination noted in the survey area it is not necessary that this criterion be met.

The laboratory data are in Enclosure 4.

8.4 Scanning Survey

The twelve grids surveyed in Room 255 showed results that are in the range of background. The following table shows the results of the five minute scan in each of the scanned grids.

Table 6 – Scan data from Room 255

Grid	Total Counts	cpm	net cpm	Average dpm/ 100 cm^2
1	18	3.6	0.8	0.06
2	21	4.2	1.4	0.11
3	15	3	0.2	0.02
4	14	2.8	0	0.00
5	21	4.2	1.4	0.11
6	23	4.6	1.8	0.14
7	9	1.8	-1	-0.08
8	20	4	1.2	0.10
9	23	4.6	1.8	0.14
10	23	4.6	1.8	0.14
11	29	5.8	3	0.24
12	14	2.8	0	0.00

Certainly the data from all grids is below MDA, but, more importantly, the results show all data to be at or very near background. During the scan, there was no evidence of any elevated activity. The scans in Room 232 showed similar results. Only five grids were scanned in Room 232.

Table 7– Scan data from Room 232

Grid	Total Counts	cpm	net cpm	Average dpm/ 100 cm^2
1	26	5.2	3	0.24
2	25	5	2.8	0.22
3	32	6.4	4.2	0.34
4	24	4.8	2.6	0.21
5	28	5.6	3.4	0.27

The scan data reflects the conditions found in the direct measurements. Although the measurements are all below the instrument MDA, no effort has been made to correct this data for the MDA of the instrument.

3.2 Special Survey of the Fume Hood in Room 255

The area with the highest potential for contamination in Room 255 was the fume hood along the north wall. To assure that the hood and the area in front of it was free of contamination; a special survey was conducted there. This survey included a total of 47 direct measurements inside the hood and 56 direct measurements on the floor in front of the hood. The two tables below show the results of these measurements.

Table 8 – Direct Measurement on the Base of the Hood in Room 255

Sample #	counts	net cpm	dpm/100 cm^2	±1 sigma
1	8	-1.21	<22.7	
2	13	0.21	<22.7	
3	20	2.21	<22.7	
4	14	0.50	<22.7	
5	13	0.21	<22.7	
6	7	-1.50	<22.7	
7	4	-2.36	<22.7	
8	10	-0.64	<22.7	
9	13	0.21	<22.7	
10	5	-2.07	<22.7	
11	14	0.50	<22.7	
12	8	-1.21	<22.7	
13	13	0.21	<22.7	
14	5	-2.07	<22.7	
15	10	-0.64	<22.7	
16	8	-1.21	<22.7	
17	7	-1.50	<22.7	
18	6	-1.79	<22.7	
19	13	0.21	<22.7	
20	8	-1.21	<22.7	
21	4	-2.36	<22.7	
22	10	-0.64	<22.7	
23	10	-0.64	<22.7	
24	10	-0.64	<22.7	
25	7	-1.50	<22.7	
26	4	-2.36	<22.7	
27	6	-1.79	<22.7	
28	9	-0.93	<22.7	
29	8	-1.21	<22.7	
30	8	-1.21	<22.7	
31	9	-0.93	<22.7	
32	10	-0.64	<22.7	
33	8	-1.21	<22.7	
34	11	-0.36	<22.7	
35	13	0.21	<22.7	
36	23	3.07	25.8	± 5.1
37	8	-1.21	<22.7	
38	8	-1.21	<22.7	
39	9	-0.93	<22.7	
*40	29	4.79	40.2	± 6.3
41	23	3.07	25.8	± 5.1
42	25	3.64	30.6	± 5.5
43	12	-0.07	<22.7	
44	6	-1.79	<22.7	
45	4	-2.36	<22.7	
46	11	-0.36	<22.7	
47	8	-1.21	<22.7	
48	21	2.50	<22.7	
49	7	-1.50	<22.7	

Table 9 – Direct Measurements in Front of the Hood in Room 255

Sample #	α counts	net cpm	dpm/100 cm^2	±1 sigma
1	8	-0.44	<22.2	
2	6	-1.02	<22.2	
3	6	-1.02	<22.2	
4	22	3.56	28.8	± 5.4
5	29	5.56	45.0	± 6.7
6	18	2.41	<22.2	
7	8	-0.44	<22.2	
8	9	-0.16	<22.2	
9	13	0.98	<22.2	
10	12	0.70	<22.2	
11	15	1.56	<22.2	
12	10	0.13	<22.2	
13	14	1.27	<22.2	
14	17	2.13	<22.2	
15	11	0.41	<22.2	
16	8	-0.44	<22.2	
17	9	-0.16	<22.2	
18	6	-1.02	<22.2	
19	21	3.27	26.5	± 5.1
20	23	3.84	31.1	± 5.6
21	6	-1.02	<22.2	
22	10	0.13	<22.2	
23	9	-0.16	<22.2	
24	6	-1.02	<22.2	
25	9	-0.16	<22.2	
26	10	0.13	<22.2	
27	14	1.27	<22.2	
28	14	1.27	<22.2	
29	6	-1.02	<22.2	
30	8	-0.44	<22.2	
31	13	0.98	<22.2	
32	13	0.98	<22.2	
33	19	2.70	<22.2	
34	7	-0.73	<22.2	
35	12	0.70	<22.2	
36	11	0.41	<22.2	
37	14	1.27	<22.2	
38	7	-0.73	<22.2	
39	13	0.98	<22.2	
40	12	0.70	<22.2	
41	12	0.70	<22.2	
42	13	0.98	<22.2	
43	10	0.13	<22.2	
44	15	1.56	<22.2	
45	11	0.41	<22.2	
46	16	1.84	<22.2	
47	5	-1.30	<22.2	
48	9	-0.16	<22.2	
49	9	-0.16	<22.2	
50	7	-0.73	<22.2	
51	11	0.41	<22.2	
52	7	-0.73	<22.2	
53	19	2.70	<22.2	
54	10	0.13	<22.2	
55	5	-1.30	<22.2	
56	14	1.27	<22.2	

The count times for these measurements was set to be below the $DCGL_w$ of 30 dpm/100 cm^2. Most of the measurements were below the MDA but there were two measurements in each area that were above the DCGL. The two locations were surveyed with different instruments reflecting in a different MDA for each of the areas. The average for each area was far below the DCGL. The average values were 3.6 dpm/100 cm^2 for the area inside the hood and 4.8 dpm/100 cm^2 for the floor in front of the hood when the MDA's are not considered. Any other average is difficult to calculate and is likely to be less meaningful than the <MDA average. The conclusion that can be reached is that there is no significant contamination inside the hood or on the floor in front of it.

9.0 Survey Data Evaluation

The standard deviations of the data from the direct measurements fall well within the range of the estimated valued used in the survey planning phase. The critical measure here is the standard deviation and the two are very close and nearly the same as the preliminary data.

Table 10 – Comparison of Data (AVG, STDEV, MED)

	Survey Area net cpm	Background Area net cpm
	1.3	2.5
	-0.4	2.0
	0.1	1.8
	0.1	1.6
	-0.4	2.3
	-0.3	2.9
	0.8	2.1
	0.5	1.1
	-0.1	0.9
	0.0	2.0
Average	0.13	1.92
Standard Devation	0.55	0.61
Median	0.07	1.96

There are no measurements above the DCGL so no statistical comparisons that are identified in the MARSSIM manual are required.

10.0 Data Quality Assurance (DQA)

All data has been examined and it meets the data quality objectives. All data collection points were properly selected and the measurements were made with the correct type instruments. All data collected is valid. Additional measurements were collected for quality control and reflect the accuracy of the initial measurements. The field instruments were properly calibrated and the

daily performance checks showed that they were operating within acceptable parameters. (Instrument calibration records are in Enclosure 5.) Off site analysis of swipes were done with instruments that were in calibration and that performance checks indicated were operating within acceptable parameters.

The surveyors are properly trained and all the survey steps were completed in accordance with the survey plan.

11.0 Evaluation of Residual Activity

Based on the measurements collected, there is no significant residual activity in Room 255. There is potentially some activity in Room 232 but is most likely a build-up of the long lived radon progeny ^{210}Pb and is much below the DCGL calculated for this survey.

12.0 Recommendations

Room 255 should be releasable for unrestricted use and Watervliet Arsenal should remove thorium from its license.

Enclosures:

1. Survey Plan
2. License
3. Laboratory Data
4. Field Data Sheets
5. Instrument Calibration Records

Enclosure 1 Survey Plan

Solutient
Technologies, LLC

Final Survey Plan for Room 255

Building 120, Watervliet Arsenal

Revision 2

February 2005

Prepared by

SOLUTIENT TECHNOLOGIES, LLC
7857 Freedom Avenue NW
North Canton, Ohio 44720

1. Background

Room 255 is a single 25 feet by 40 feet laborat om in Building 120 at the Watervliet Arsenal, Watervliet, NY. The room contains a fume hood, a laboratory sink, several cabinets and work benches and has a significant portion of the room partitioned off for an office space. The office space can be accessed only through the larger portion of Room 255. The room has been in use as a laboratory space for many years. A variety of different laboratory procedures have been performed in the room – most recently it has been used as an electronics testing facility.

The hood is vented to the outside through a HEPA filtration system. Currently no HEPA filter is installed and the hood is not in use (according to the warning label on the front of the hood). Presumably, the hood has not been recently checked for air flow.

Room 255 may have had small quantities of thorium in the form of ThO_2 used in a process to harden metals by electroplating the thorium onto the surface of the metal. No actual record of use of thorium in any form exists. There is an existing procedure showing how the thorium was to be used. The procedure specified that the use was confined to the fume hood. If the material was actually used, thoria was added to a liquid to form a slurry or a solution. In all other steps in the process, the thorium was in solution. Good contamination controls were specified, so there was little chance of spread of contamination either inside or outside the hood. Discussion with the current Radiation Safety Office indicates that she had talked with the previous RSO who would have been aware if the procedure was actually implemented. He had no recollection of the use of thorium and there are no existing records of such use. There are records of surveys in other laboratory rooms where radioactive materials were used in the time frame of the metal hardening process.

The objective of this survey is to allow thorium to be removed from the facility license. Thorium that was apparently brought to the facility for the metal hardening experiments has been disposed of and the disposal is properly recorded.

The NRC Screening Values for Th-232 will be used as the derived concentration guideline value (DCGL[2]) for the survey. This conservative value is adequate to limit the risk of any future user of the space, even for full time residential use, to less than 25 mrem of radiation dose as stipulated in 10CFR20.1402. If the space is shown to have no contamination above the DCGL it is suitable for release for unrestricted use.

2. Previous Surveys of Room 255

[2] The proper term is $DCGL_w$ where the w indicates that the DCGL is based on the Wilcoxon Rank Sum statistical test. For simplicity, the term will be show as DCGL without the w except when the reference is to the $DCGL_{emc}$ (the guideline value for elevated measurements) in which case the emc will be added to the term.

Some older routine smear surveys of the room exist but there are no recent surveys conducted by the facility radiation safety office. The older survey exists from the time the previous RSO used the space for his office/laboratory. These surveys showed that the office space was not contaminated.

A preliminary scoping survey was conducted October 25-26, 2004 (see Attachment 1). The scoping survey focused on the hood and the area surrounding the hood. No contamination was found. This room had surface contamination insignificantly lower than other, empty laboratory rooms in Building 120.

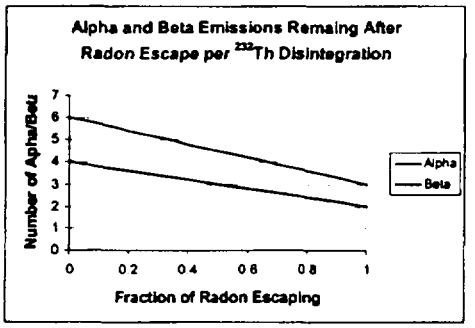
3. Radionuclides of Concern

The ^{232}Th that may have been used in the hood is the radionuclide of concern. Since ^{232}Th is the top of a naturally occurring radionuclide series, the decay progeny will also be present. For the purposed of the survey, it is assumed that the ^{232}Th is in equilibrium with its immediate progeny. It follows from this assumption that there is an equal amount of ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra present. Since ^{224}Ra decays to ^{220}Rn, it is unlikely that the equilibrium would continue beyond that point; however, it is also unlikely that the series radionuclides beyond ^{220}Rn will be totally absent from the room if thorium is present. The section below regarding the derived concentration guideline value discusses this issue.

4. Derived Concentration Guideline Value

The thorium contained in ThO_2 is natural thorium (^{232}Th) and is one of the long-lived naturally occurring radionuclides. The NRC published a set of screening values for surface contamination for a number of radionuclides in 1998 (63 FR 64132) that did not contain a screening value for the alpha radiation emitting radionuclides. A following Federal Register notice (64 FR 68395) approved the use of the screening values in NUREG/GR-5512 vol 3, Table 5.19 for the alpha emitting radionuclides. The screening value listed in Table 5.19 for ^{232}Th is 6.03 dpm/100 cm^2 (for ^{232}Th with the decay progeny present, as in this case).

Since the $DCGL_w$ value applies to the ^{232}Th alone and it is accompanied by the decay progeny that also decay at the same rate as the ^{232}Th, a higher value for the detected contamination will evident. The actual value of the detected contamination is dependent on the amount of one of the decay progeny, which is in gaseous form (^{220}Rn) that may escape from the solid matrix of the deposited ThO_2 on the contaminated surface during the decay process. Some reasonable assumption can be made about the fraction of the radon that may escape during decay. The escape fraction will be low since the half life of ^{220}Rn is only 56 seconds. There is a total of 6 alpha and 4 beta radiation emissions with each ^{232}Th atom that decays occurring simultaneously. If the assumption is that 50% of the radon escapes, there would remain 4.5 alpha and 3 beta emissions with each disintegration of a ^{232}Th atom. It follows then that if the survey is for alpha radiation only, the DCGL needs to be adjusted to 27 dpm/100 cm^2. (If the radon all escapes, there would be 3 additional alphas for each ^{232}Th atom disintegration and the alpha DCGL would be 18 dpm/100 cm^2.) The following chart shows the number of alphas and betas that remain with the fraction of radon escaping.



If there were enough contamination present to collect a relatively large sample, it would be possible to determine the actual fraction of radon that escaped. Since the amount of contamination is extremely small, perhaps none at all, it is not possible to make the actual determination. The survey must proceed with some reasonable assumption regarding the fraction of radon that escapes. Fifty percent is a very high fraction. Thirty percent is more reasonable and that leads to an alpha DCGL of 30 dpm/100 cm^2. This value is chosen for the final survey DCGL. Since the primary exposure for thorium as a surface contaminate is from the contaminating material re-suspended into the air, no more than 10% of the DCGL value may be removable. In this case, the removable alpha contamination may not exceed 3 dpm/100 cm^2.

5. Area Classification

Room 255 is approximately 95 m^2 and it meets all the criteria for a Class 3 MARSSIM classification. The room will contain only one survey unit.

6. Choice of Instruments

Since the DCGL is based on the alpha emission, the instrument chose must be capable of measuring alpha radiation. The Ludlum 43-90 detector with the Ludlum 2221 Scaler/Ratemeter will be used for the survey. The direct measurement capability for the instrument is sufficient to measure ~30% of the DCGL in a ten minute timed count. These values are based on the manufacturer's specification for the background of the detector of <3 cpm. Past experience has shown the detector to have a lower background. If the actual instruments in use prove to have lower background, the detection limits will be better than indicated.

The calculations for the MDC's are:

Calculation of Instrument MDC's

Static Measurements

Background = 3 cpm
Count time = 10 min
Instrument Eff = 0.2
Source Eff = 0.5
Area Probe = 100 cm^2

$$MDC = (4.65+3*\sqrt{BG})/(e_{inst} * e_{source} * t_{count} * A_{probe}/100)$$

MDC = 10 dpm/100 cm^2

Scan MDC

$$\text{Scan MDC} = (-\ln(1-P(n \geq 1))*60)/e_{inst} * e_{source} * t$$

Where:

ln = natural log
P = Probability of detection

at 1 in/sec) and using the efficiencies above:

Scan MDC = 170 dpm/100 cm^2

The scan MDC is adequate to provide information related to areas of elevated measurements as determine for the DCGLemc calculated below.

7. Elevated Measurement Criteria

A Class 3 area is not expected to contain any residual radioactivity, or expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiation surveys. The 10 data collection locations in a 95 m^2 space mean that there is one data collection point for each 9.5 m^2. The area factor for 9.5 m^2 is 7.6 (See the table below; value determined by interpolation).

Area (m2)	Dose* (mrem/yr)	Area Factor
72	1.83E-03	1.0
36	9.10E-04	2.0
18	4.55E-04	4.0
9	2.28E-04	8.0
4	1.01E-04	18.1
2	5.06E-05	36.2
1	2.53E-05	72.3

* Based on 1 pCi/m^2

The DCGLw times the area factor for the area represented by the individual data collection point is the DCGLemc. In this case the DCGLemc = 228 dpm/100 cm^2 (30 X 7.6). This also represents the minimum scan MDC required.

8. Reference Background Area

Another laboratory room will be selected that has similar fixtures and surfaces that is known to be uncontaminated for a background reference area. An attempt was made to find such a room during the preliminary scoping survey and it was not successful. The measurements in five other rooms were somewhat, probably insignificantly, higher than Room 255. When the background reference area is identified, a similar number of measurements will be taken in the reference area as in Room 255 and the measurements in the two rooms compared using one of the statistical test identified in MARSSIM assuming that some measurements are greater than the DCGL.

9. Survey Procedure

12.1 General

Guidance provided in the MARSSIM (DoD 1997) will be the basis for this survey. The MARSSIM process was developed collaboratively by the Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), Department of Energy (DOE), and Department of Defense (DoD), for use in designing, implementing, and evaluating radiological surveys. The objective of the final survey described in this Plan is to demonstrate that Room 225 meets the unrestricted release criteria. The primary focus of MARSSIM is to demonstrate compliance of a site or facility with regulatory agency criteria for future use without radiological restrictions.

The final survey inside buildings consists of surface scans with alpha/beta (alpha only in the case of Room 255) detection survey instruments and direct measurements at randomly selected locations. The direct measurements are compared to the unrestricted release criteria (DCGL).

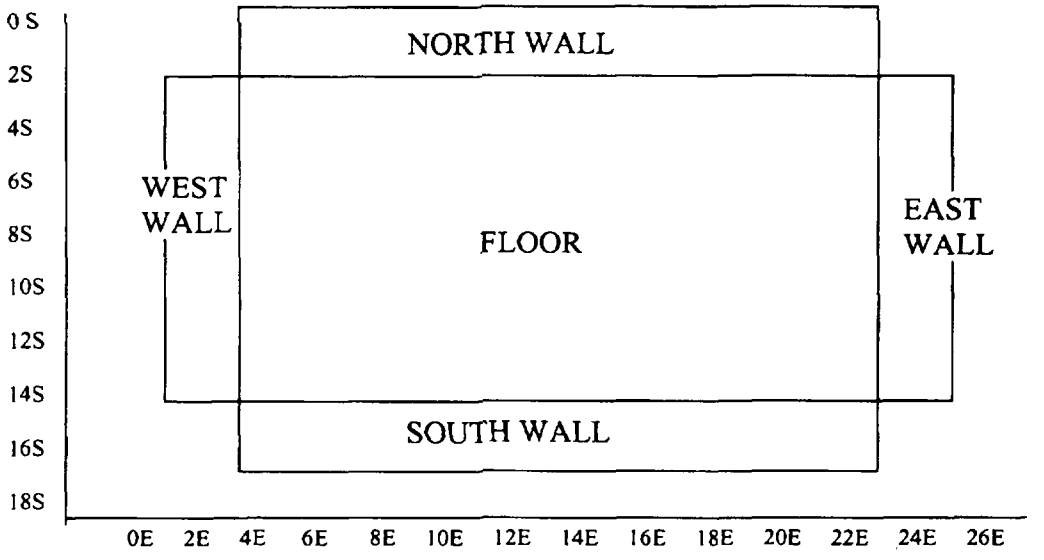
The preliminary scoping survey did not identify any elevated measurement locations in and around the hood in Room 255. The measurement locations included inside the hood, on the floor in front of the hood and inside the HEPA ventilation filter housing as well as some randomly selected locations. This leads to a level of confidence in assigning the MARSSIM Class 3 to the room.

9.2 Determination of the Number of Survey Points for Interior Areas

The modeling program COMPASS[3] was used to determine the number of sample locations. Attachment 2 is the program output. A total of 10 data collection point are determined to be needed to demonstrate the acceptance criteria for Room 255. No additional data points are required for the elevated measurement criteria.

9.3 Survey Procedure

The floor area and the lower 2 meters of the walls will be sketched as shown in the sketch below. The line with the numbers to the left and below the sketch represents a grid system for the room.



A Class 3 area requires 10% of the area to be scanned for elevated measurements. There will be 96 floor grids and 80 wall grids. Ten of the floor grids and 8 of the wall grids will be chosen for scanning. The hood and the floor in front of the hood will be among the grids scanned. The scanning in the hood and the floor in front of the hood will be measured so that the DCGLw (not the DCGLemc) will be detectable. This will require 4 minute direct counts on the entire surface of these two grids (100 counts in each grid).

Data collection points will be selected by using pairs of random numbers to select south and east values. Any number pairs that fall in the corner locations will be discarded. A total of 10 locations will be chosen. The location in the room will be measured from the south west corner

---

[3] **COMPASS**—Computerization Of the MARSSIM for Planning and Assessing Site Surveys. Developed by Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, TN 2001

and marked on the floor or the wall. At each location, a 10 minute direct measurement will be taken followed by a 100 cm^2 smear that is under the area where the detector measured. The direct measurements will be recorded on a survey sheet prepared for this purpose along with the date and time and the surveyors initials. The instrument used will be identified on the survey sheet.

The smears will be evaluated using a low-background counter. This low-background counter will be set to measure below 1 dpm per smear.

10. Background Survey

A room of similar size and composition i.e. floors and walls as much like Room 255 as possible, will be chosen and a survey taken in the same manner as in Room 255. The background survey is required since thorium and it decay progeny and other alpha emitting radionuclides are present in the background. The DCGL is based on the contamination that is "above background." Some of the background radioactive residual is related to housekeeping and general cleanliness so it will be necessary to evaluate the area selected for the background survey with this in mind. The background survey area should have similar housekeeping as Room 255 has.

11. Data Quality Objectives

Data Quality Objectives (DQOs) are established to assure that the data collected are accurate, representative and reliable. Acceptable decision errors have been selected for this project to enable statistical testing of data. The decision error levels define the level of confidence for Type 1 errors, α, and Type 2 errors, β. Type 1 errors are defined as false positives and Type 2 errors are false negatives. A 95 percent confidence level for both Type I ($\alpha = 0.05$) and Type 2 ($\beta = 0.05$) has been selected. The selection of these decision error levels provides a:

- 95% confidence level that the statistical tests will not incorrectly determine that a surveyed area does not satisfy criteria when, in fact, it does satisfy the criteria ($\alpha = 0.05$).

- 95% confidence level that the statistical tests will not incorrectly determine that a surveyed area satisfies criteria when, in fact, it does not satisfy the criteria ($\beta = 0.05$).

Data quality indicators for precision, accuracy, representativeness, completeness, and comparability have also been established.

- *Precision* measures the reproducibility of measurements and will be determined by comparison of replicate values from direct measurements and smear sample analysis; the objective will be a relative percent difference of 35% or less for smear samples. Direct measurement replicates will be analyzed at a minimum frequency of five percent.

- *Accuracy* is the degree of agreement between the true and measured values. Accuracy will be measured through calibration with known standards. The objective for this parameter will be +/- 30% at 50% of the criterion value.

- *Representativeness* and comparability do not have numeric values. Performance for these indicators is assured through the selection and proper implementation of systematic sampling and measurement techniques as promulgated in approved site protocols and those protocols promulgated in the MARSSIM guidance document.

- *Completeness* is defined at the percentage of measurements judged to be valid. The results will be considered valid if they are not rejected during data validation. The objective is 90% for this project.

If the data are determined to satisfy the established guidelines and meet the release criteria following statistical testing, a final report will be prepared, documenting the survey procedures and results.

12. QA/QC Procedures

a. Survey Instrumentation

Instruments will be current in calibration as specified by the manufacture. A daily source check and background check of each instrument will be performed before each day of survey and at the end of the day.

b. Survey

At least 10% of the measurement points will be resurveyed including a smear survey for verification.

c. Smear Counts

In addition to the extra smears indicated above, 10% of the smears will be recounted. The low-background counter will be calibrated following the manufacture's procedures and daily check sources counted before and after counting smears.

13. Data Verification

All data will be examined for completeness and accuracy. Any data not complete will be discarded. The added measurements/samples collected for verification maybe substituted for any discarded measurements/samples.

14. Final Survey Report

A final survey report will be prepared to compile the data and evaluate the survey results to determine if the survey objective is met. The report will be submitted to NRC after approval by the Watervliet Arsenal Command.

Attachment 1

SCOPING SURVEY

Room 255, Building 120, Watervliet Arsenal, NY

1. Background

Room 255 is a single 25 feet by 40 feet laboratory room in Building 120 at the Watervliet Arsenal, Watervliet, NY. The room contains a fume hood, a laboratory sink, several cabinets and work benches and has a significant portion of the room partitioned off for an office space. The office space can be accessed only through the larger portion of Room 255. (See the room sketch in Enclosure 1.)

Room 255 is to be released for unrestricted use. The release procedure to be followed is the procedure specified in the MARSSIM manual. The initial planning for the process leading to the use is to follow the guidance of Appendix B in the MARSSIM manual.

Room 255 may have had small quantities of thorium in the form of ThO_2 (thoria) used is a process to harden metals by electroplating the thorium onto the surface of the metal. No actual record of use of thorium in any form exists. There is an existing procedure showing how the thorium was to be used. The procedure specified that the use was confined to the fume hood. If the material was actually used, thoria was added to a liquid to form a slurry or a solution. In all other steps in the process, the thorium was in solution. Good contamination controls were specified, so there was little chance of spread of contamination either inside or outside the hood. The purpose of this survey is to determine if there is residual contamination in the room.

2. Survey Parameters

Since this is a preliminary survey with no prior survey information, the only pertinent MARSSIM related parameter is the derived concentration guideline limit (DCGL). The NRC screening value of 6 dpm/100 cm^2 for ^{232}Th will be used for the DCGL. Since this screening value is for the ^{232}Th alone, the actual value used will be increased to account for the decay progeny that accompany the decay of the thorium. The alpha component will be the type radiation evaluated in the survey. The thorium plus the decay progeny include a total of 6 alpha and 4 beta emissions. Some of the decay progeny may be lost due to the emulation of the ^{220}Ra and a conservative assumption of the emulation fraction is selected as 30%. This will leave 5 alpha emissions with each thorium atom that undergoes decay. With that assumption, the DCGL is recalculated as 30 dpm/100 cm^2 (alpha).

3. Instruments Used

The best available instrument for this survey is the Ludlum 2241-2/43-90 Scaler/Ratemeter-detector combination. The Model 43-92 detector is approximately 20% efficient for the thorium alpha emission and the Model 2241-2 scale/ratemeter provides sufficient flexibility for adequate

measurement for thorium contamination. (A source efficiency of 0.7 is also used in the calculations.) Some scanning was done with a Ludlum model 3 with a Ludlum model 44-9 detector. This instrument is sensitive to alpha and beta radiation but it is not the appropriate instrument for this survey but it is small enough to get into places not accessible with the model 43-90 detector. The likely scanning MDA for the model 44-9 is greater than 100 dpm. It is only useful to locate gross contamination relative to the thorium DCGL. In direct measurement mode and a five minute count time the MDA for the area under the probe is approximately 50 dpm.

Enclosure 2 contains the calibration information for the instruments used.

4. Conduct of the Survey

A preliminary scoping survey was conducted by Mr. Leslie Cole, CHP and Mr. Dell Ruess, Solutient Technology, October 25-26, 2004. The survey included scanning the area in and around the fume hood, the floor near the hood, the sink, direct measurements at selected locations and smear samples in a variety of locations including locations near the direct measurement locations. There were no elevated measurement locations identified by the scan survey. At every point where there was indication of any activity, a one minute direct measurement was made and none of these measurements were greater than the background measurement.

The sketch in Enclosure 1 represents the room layout. Direct measurement locations are at the locations indicated by the numbered squares. The measurements were collected using a Ludlum Model 2241-2 Scaler/Ratemeter with a Ludlum Model 43-90 detector. All direct measurements were measured for a 5 minute period. Table 1 below shows the measurement results.

TABLE 1

Direct Measurements in Room 255

Location	α dpm/100 cm^2*	$\pm 2\,\delta$
1	13.6	7.4
2	10.1	<MDA
3	19.4	8.8
4	20.5	9.1
5	9.0	<MDA
6	15.9	8.0
7	13.6	7.4
8	5.5	<MDA

BG = 4.25 cpm
Efficiency = 19.6%
MDA = 12.5 ± 3.5 dpm (5 min Count)
*Corrected for BG, Inst Eff, Source Eff and Probe Area

Several smear samples were collected in Room 255. Smear samples were collected at all the locations where the direct measurements were made. These smears were analyzed on a low-background counter for gross alpha. The results are shown in Table 2 below.

TABLE 2
Room 255 Smear Survey Results

Smear #	Gross Alpha dpm	Gross Beta dpm	Smear Location/Description
1	1.1	839	Inside Hood Right Side
2	0.6	762	Inside Hood Left Side
3	0.6	743	Floor in Front of Hood
4	1.7	820	Inside Sink
5	1.1	746	Counters Around Hood Right
6	0.0	740	Counters in Front of Hood
7	2.3	788	Inside Filter Housing
8	2.3	749	Floor Behind Hood
9	0.6	730	Hood Drain Trap
10	1.1	771	Sink Trap

Smear Counter Model:	2929	Probe Model:	43-10-1
Serial Number:	167855	Serial Number:	PR171934
Alpha Background:	0.1	Beta Background:	66.0
Alpha Source	2,176	Beta Source:	286,569
Alpha Efficiency:	35%	Beta Efficiency:	12%
Alpha MDA (dpm)	0.57	Beta MDA (dpm)	786
Calibration Due Date:	9/16/2005		
Count Date:	10/28/2004		

An attempt was made to find a similar room to Room 255 to serve as a background area for the final survey. Several empty laboratory rooms were checked and none were found to have as low direct measurements as low as found in Room 255. Room 232 had a lower α/δ background than Room 255 as measured with the Model 44-9 detector; however, the 5 minute direct alpha measurements were somewhat higher than the similar measurements in Room 255. Six direct measurements were collected in Room 232, Building 120. This higher measurement may be explained by the degree of housekeeping in Room 255 versus the other rooms considered. All the rooms checked for use as a background area were empty and had had little housekeeping activity in the recent past. Room 255 is still occupied and receives some housekeeping. The long term build-up of ^{222}Rn daughters may be higher in the unused rooms than in Room 255. The relatively long lived ^{210}Pb can become measurable and its progeny ^{210}Po is an alpha emitter at the final decay to stable lead. While the build-up is minor, it could be sufficient to explain the higher alpha radiation levels found. Table 3 below shows the measurement results in Room 232.

TABLE 3

Direct Measurements in Room 232

Location	α dpm/100 cm^{2*}	$\pm 2\,\delta$
1	30.9	11.1
2	21.7	9.3
3	18.2	8.5
4	20.5	9.1
5	28.6	10.7
6	18.2	8.5

BG = 4.25 cpm
Efficiency = 19.6%
MDA = 12.5 ± 3.5 dpm (5 min Count)
*Corrected for BG, Inst Eff, Source Eff and Probe Area

Smears were also collected in Room 232. These smears were collected at the same locations as the first five of the direct measurements. These smears were analyzed on a low-background counter for gross alpha. The results are shown in Table 4 below.

TABLE 4
Room 232 Smear Survey Results

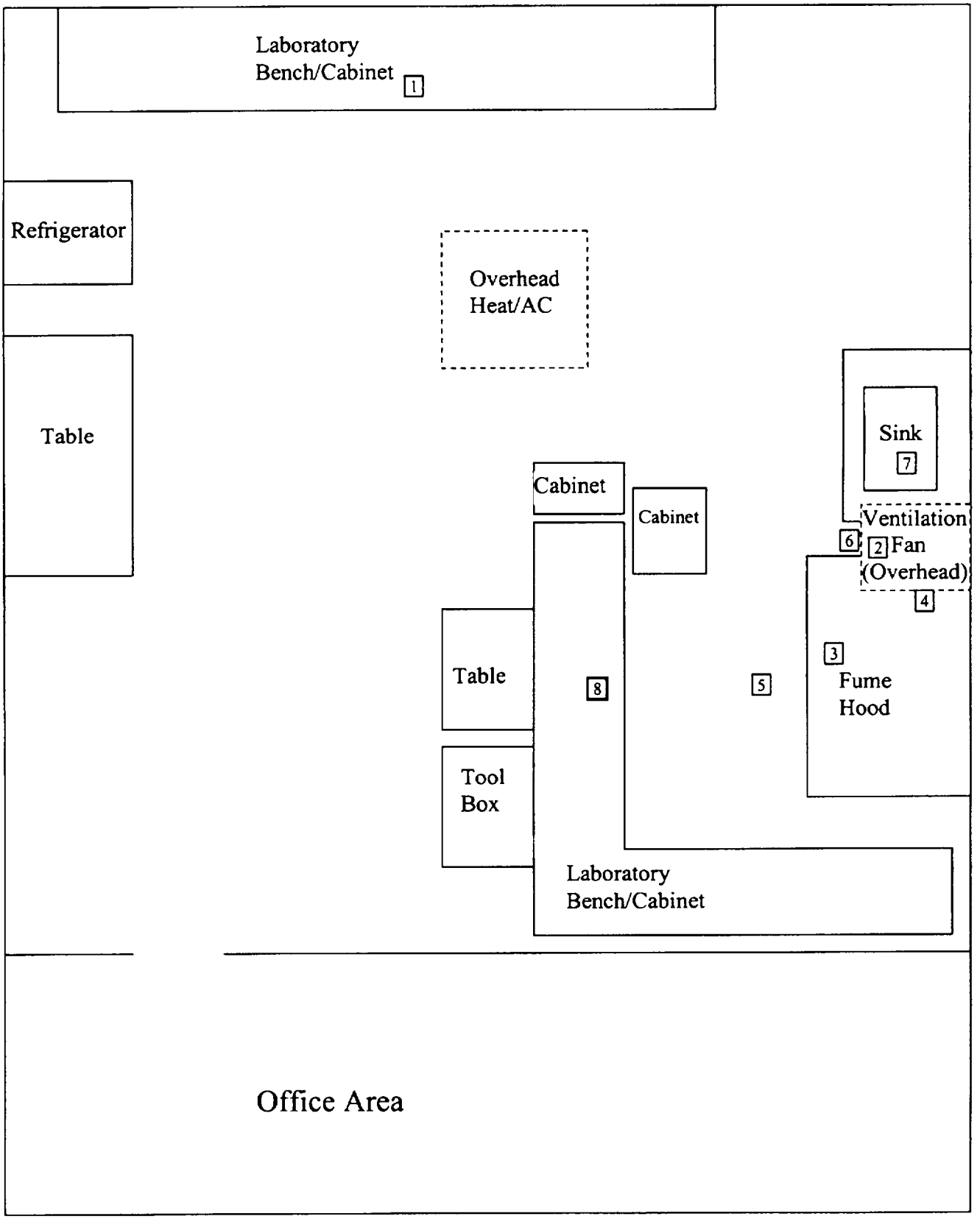
Smear #	Gross Alpha dpm	Gross Beta dpm	Smear Location/Description
1	2.9	729	Floor in front of Lab Bench
2	2.3	783	Lab Bench Top
3	1.1	792	Hood Inside
4	1.1	787	Floor in front of Hood
5	1.1	755	Counter next to Hood

Smear Counter Model:	2929	Probe Model:	43-10-1
Serial Number:	167855	Serial Number:	PR171934
Alpha Background:	0.1	Beta Background:	66.0
Alpha Source	2,176	Beta Source:	286,569
Alpha Efficiency:	35%	Beta Efficiency:	12%
Alpha MDA (dpm)	0.57	Beta MDA (dpm)	786
Calibration Due Date:	9/16/2005		
Count Date:	10/28/2004		

5. Evaluation of Data

Examination of the data indicates that it has been collected in correct manner, that it is accurate and that the instrumentation used is appropriate for the survey. The smear sample data indicates that removable contamination is less than 10% of the total contamination. There were no samples indicating that the room contained other than background contamination. The data collected in this preliminary survey confirms that there is little, if any, contamination present in the room.

Enclosure 1


Laboratory
Bench/Cabinet
1
Refrigerator
Overhead
Heat/AC
Table
Sink
7
Cabinet
Cabinet
Ventilation
6
2
Fan
(Overhead)
4
Table
8
5
3
Fume
Hood
Tool
Box
Laboratory
Bench/Cabinet
Office Area

Enclosure 2

INSTRUMENT DATA

Ludlum Model 2241-2 with Model 43-90 Detector

Meter Serial No. 174211
Detector Serial No. PR180327
Last Calibrated 3/24/2004

The instrument was checked using a Th-230 plated source before measurements and afterwards on each day. The background was also checked before and after survey.

Ludlum Model 3 with Model 44-9 Detector

Meter Serial No. 165881
Detector Serial No. PR190327
Last Calibrated 3/24/2004

The instrument was checked using a Tc-99 plated source before measurements and afterwards on each day. The background was also checked before and after survey.

Attachment 2 COMPASS Calculations

Site Report

Site Summary

Site Name: Rm255r2
Planner(s): L Cole

Contaminant Summary

NOTE Surface soil DCGLw units are pCi/g
Building surface DCGLw units are dpm/100 cm²

Contaminant	Type	DCGLw	Screening Value Used?	Area (m²)	Area Factor
Th-232+C	Building Surface	6	No	1	72 4
				2	36 2
				4	18 1
				9	8
				18	4
				36	2
				72	1
Th-232+C	Surface Soil	1.1	Yes	N/A	N/A

Site Report

Site Summary

Site Name: Rm255r2

Planner(s): L Cole

Contaminant Summary

NOTE: Surface soil DCGLw units are pCi/g
Building surface DCGLw units are dpm/100 cm²

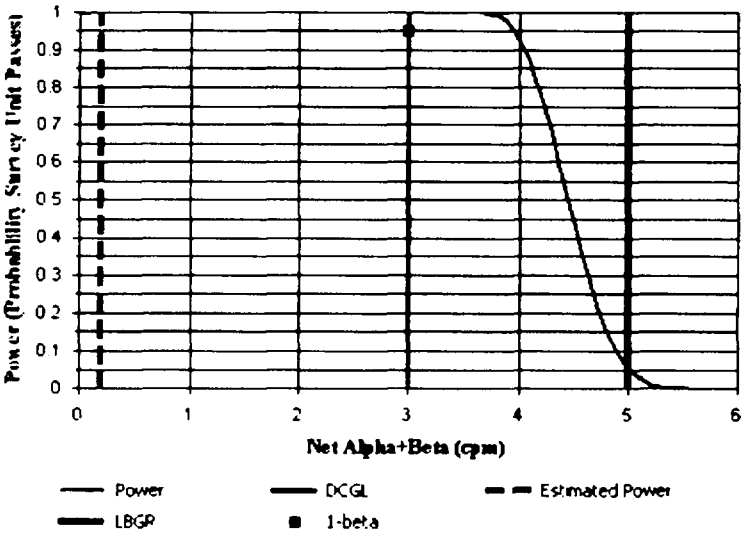
Contaminant	Type	DCGLw	Screening Value Used?	Area (m²)	Area Factor
Th-232+C	Building Surface	6	No	1	72.4
				2	36.2
				4	18.1
				9	8
				18	4
				36	2
				72	1
Th-232+C	Surface Soil	1.1	Yes	N/A	N/A

Building Surface Survey Plan

Survey Plan Summary

Site:	Rm255r2		
Planner(s):	L Cole		
Survey Unit Name:	Room 255 WRS		
Comments:			
Area (m²):	96	Classification:	3
Selected Test:	WRS	Estimated Sigma (cpm):	0.7
DCGL (cpm):	5	Sample Size (N/2):	10
LBGR (cpm):	3	Estimated Conc. (cpm):	0.2
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.050		

Prospective Power Curve

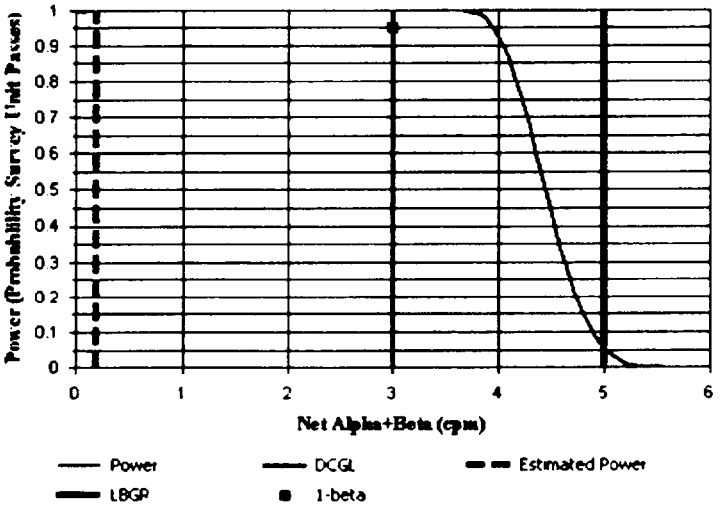


Building Surface Survey Plan

Survey Plan Summary

Site:	Rm255r2		
Planner(s):	L Cole		
Survey Unit Name:	Room 255 WRS		
Comments:			
Area (m²):	98	Classification:	3
Selected Test:	WRS	Estimated Sigma (cpm):	0.7
DCGL (cpm):	5	Sample Size (N/2):	10
LBGR (cpm):	3	Estimated Conc. (cpm):	0.2
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.050		

Prospective Power Curve



Enclosure 2 – Watervliet Arsenal License STB 1554

Enclosure 3 – Field Data Sheets

Survey Data

Site: Watervliet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

Wipe Number	Description	Wipe tests: α cpm	Wipe tests: α dpm	α Direct: 10 min α cpm	α Direct: α dpm	Grid Number	Comments
	Floor Point 1			41			
	Floor 2			24			
	Floor 3			29			
	Floor 4			29			
	Floor 5			24			
	Floor 6			25			
	Floor 7			36			
	Floor 8			33			
	Floor 9			27			
	Floor 10			28			
	Floor 11 (20, 7.5)			24			2-23-05 extra ct
	Sink Drainboard 12 (6.5, 3.2)			30			2-23-05 extra ct

Ludlum - 2241-2 S/N 174195 Pr. 43-90 S/N 180327

BKG 3.5 cpm Source 1183 cpm ^{230}Th - 6305 dpm

Survey Data

Site: Watervliet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

Scans

Grid ~~Wipe~~ Number	Description	Wipe tests: a cpm	Wipe tests: a dpm	a Direct 5 min: a ~~dpm~~ cpm	a Direct 5 min: a dpm	Grid Number	Comments
6	Grid Scans			23		6	2/22/05
10				23		10	
12				14		12	
1				18		1	
2				21		2	
4				14		4	
11				29		11	
9				23		9	
8				20		8	2/22/05
3				15		3	2/23/05
7				9		7	2/23/05
5				21		5	2/23/05

Ludlum 2241-2 S/N 174211 P. 43-40 S/N 220588 Cal Due 24 March 05

2/22/05 BKG - 3.5 cpm

Source 1239 cpm

2/23/05 BKG 2.4 cpm

Source 1207 cpm

Survey Data

Site: Waterviet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

Floor in front of Hood

Wipe Number	Description	Wipe tests a cpm	Wipe tests a dpm	a Direct 3.5 min a ~~cpm~~	a Direct a dpm	Grid Number	Comments
1	Floor In front of Hood	8		8			
2		6		6			
3		6		6			
4		22		22			
5		21		29			
6				18			
7				8			
8				9			
9				13			
10				12			
11				15			
12				10			
13				14			
14				17			
15				11			
16				8			
17				9			
18				6			
19				21			
20				23			
21				6			
22				10			
23				9			
24				6			
25				9			
26				10			

Inst Model 2241-2 SN 179195
Probe 43-90 SN PR136327
BG 3.5 cpm
Cal date 17 Feb 05

Survey Data

Site: Watervliet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/22/05

Surveyor: R Thomas
Surveyor: L Cole

Floor in front of Hood (Continued)

Wipe Number	Description	Wipe tests a cpm	Wipe tests a dpm	a Direct a cpm	a Direct a dpm	Grid Number	Comments
27				14			
28				14			
29				6			
30				8			
31				13			
32				13			
33				19			
34				7			
35				12			
36				11			
37				14			
38				7			
39				13			
40				12			
41				12			
42				18			
43				10			
44				15			
45				11			
46				16			
47				5			
48				9			
49				9			
50				7			
51				11			
52				13			
53							
54							
55							

Survey Data

Site: Watervliet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/22/05

Surveyor: R Thomas
Surveyor: E Cole

		Wipe tests		a Direct			
Wipe Number	Description	a cpm	a dpm	a cpm	a dpm	Grid Number	Comments
53				7 19 hr			
54				19 10 hr			
55				10 5 hr			
56				5 14 hr			
				14 hr			

Survey Data

Site: Watervliet
Building: 120
Lab: 255

Start Date: 2/22/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

		Wipe tests		α Direct			
~~Wipe~~ Number	Description	α cpm	α dpm	3.5 min α ~~cpm~~	α dpm	Grid Number	Comments
1	Hood Base			8			
2				13			
3				20			
4				14			
5				13			
6				7			
7				4			
8				10			
9				13			
10				5			
11				14			
12				8			
13				13			
14				5			
15				10			
16				8			
17				7			
18				6			
19				13			
20				8			
21				4			
22				10			
23				10			
24				10			
25				7			
26				4			

Ludlum - 2241-2 S/N 174211 Pr. 43-10 S/N 220858

BKG 2.9 cpm Source 1234 cpm ^{230}Th - 6305 dpm

Survey Data

Site	Watervliet	Start Date	2/22/05	Surveyor	R. Thomas
Building	120	End Date	2/22/05	Surveyor	L. Cole
Lab	255				

		Wipe tests		α Direct			
Wipe Number	Description	α cpm	α dpm	3.5 min α cpm	α dpm	Grid Number	Comments
27	Hood Base			6			
28				9			
29				8			
30				8			
31				9			
32				10			
33				8			
34				11			
35				13			
36				23			
37				8			
38				8			
39				9			
40				29/RC 36			
41				23			
42				25			
43				13			
44				6			
45				4			
46				11			
47				8			
48				21			
49				7			
Recount 40				45/			
40	After Wipe Down w/Soap+Water			29			

Ludlum 2241-2 S/N 174211 Probe 43-90 S/N 220888

Bkg 2.4 cpm Source 1239 cpm ^{230}Th - 6305 dpm

Background Room 232.

Survey Data

Site: Watervliet
Building: 120
Lab: 232

Start Date: 2/23/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

Wipe Number	Description	Wipe tests a cpm	Wipe tests a dpm	a Direct 10 min a ~~cpm~~	a Direct a dpm	Grid Number	Comments
1	Floor Point 1			47			
2	2			42			
3	3			40			
4	4			38			
5	5			45			
6	6			51			
7	7			43			
8	8			33			
9	9			31			
10	10			42			
11 4 (~~Blank~~ Low)	4 (Round)			41			

Ludlum 2241-2 S/N 174195 Probe 43-90 S/N 180327 Cal Due 17 Feb 06

BKG 2.4 cpm Source 1207 cpm 230 Th .. 6305 dpm Activity S/N ~~[illegible]~~ A3-224 (12/01) 2.840 nl

Background Room 232

Survey Data

Site: Watervliet
Building: 120
Lab: 232

Start Date: 2/23/05
End Date: 2/23/05

Surveyor: R. Thomas
Surveyor: L. Cole

Wipe Number	Description	Wipe tests a cpm	Wipe tests a dpm	5 min Scan a ~~Direct~~ 5 min a ~~cpm~~	a dpm	Grid Number	Comments
	Grid Scans 1			26		1	
	2			25		2	
	3			32		3	
	4			24		4	
	5			28		5	
	6						
	7						
	8						
	9						
	10						

Ludlum 2241-2 S/N 174211 Probe 43-40 S/N 220888 Cal Due 24 March 05
BKG 2.2 cpm Source check 1214 cpm 230 Th 6305 dpm S/N ~~[illegible]~~ A3-224 (12/01)
activity

2,84

Sally

2/22/05 Watervliet Ext. 5633

Pr. 220888 2241-2 S/N 174211 Pr 180307/2241-2 S/N 174195

10 min BKG 34 counts 16 counts 55 counts / 28 cou 27 counts 32 counts

3.4 cpm 2.7 cpm

Source 1142 cpm 1239 cpm

230 Th 1224 cpm eff. 18.7 % eff. 19 %

UN 2910 1183 Avg.

6305 dpm 3.5 cpm 2.9 cpm

Afternoon Source | Checks

240 sec. Ludlum 2241-2 S/N 174211 | Ludlum 2241-2 S/N 174195

4 min. Source 1234 cpm | Source ~~1234~~ 1294 cpm

1294 cpm

2/23/05

Ludlum 2241-2 S/N 174211 | Ludlum 2241-2 S/N 174195

10 min BKG 22 counts 2.2 cpm 10 min BKG 24 counts 2.4 cpm

1 min Source 1214 cpm Source 1207 cpm

Source S/N ~~UN 2910~~ A3-224 (12/01) 2.840 nCi

Activity 6305 dpm

2/23/05 - 10:45 - end of task

1 min Source 1222 1220

Enclosure 4 – Lab Data

Solutient Technologies

Model # 2929	Serial #	167658	Cal Due	9/16/2006

Source Check Location: Solutient Lab

Background Location: Solutient Lab

MDA (1 min readings)=(3+3.29(SQRT(BKGD))/(E*A*100)
A= Probe Area Factor (Area/100 cm²)

Probe Model #:		43-10-1	Serial #	171934	Cal Due:	9/16/2005
Probe Description:		Alpha / Beta Counter				
Threshold	NA	HV	750	Response Switch		NA
Area Correction Factor: (A=126 cm²/100 cm²): A =						NA
Type of Source		Serial #	Isotope	Source Date	uCi	dpm
α Source ID #		A3-736	230Th	12/1/01	0.003	6,306
β Source ID #		97Tc-67930	99Tc	6/17/1998	0.016	34,800

Date		Background Measurements (cpm)						Source Counts		α eff	β,γ eff	Operation Checks				Average Bkgd		
		Start of Shift			End of shift			α cpm	β,γ cpm			α Source In Range	β,γ Source In Range	α Bkgd In Range	β,γ Bkgd In Range	2σB	3σB	A
02/28/05	β,γ	52.9	53.8	54.9	52.7	54.0	53.3		7,375	0.01	0.21		TRUE	TRUE	#REF!	53.9	53.6	
	α	0	0.3	0.3	0.1	0.2	0.1	2076		0.33	0.00	TRUE		TRUE	#REF!	0.2	0.1	
	β,γ									#DIV/0!	#DIV/0!		FALSE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	α									#DIV/0!	#DIV/0!	FALSE		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	β,γ									#DIV/0!	#DIV/0!		FALSE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	α									#DIV/0!	#DIV/0!	FALSE		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	β,γ									#DIV/0!	#DIV/0!		FALSE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	α									#DIV/0!	#DIV/0!	FALSE		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	β,γ									#DIV/0!	#DIV/0!		FALSE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	α									#DIV/0!	#DIV/0!	FALSE		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	β,γ									#DIV/0!	#DIV/0!		FALSE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	α									#DIV/0!	#DIV/0!	FALSE		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

10 Source Measurements	1	2	3	4	5	6	7	8	9	10	Average
Alpha	2132	2067	2048	2082	2109	2134	2102	2107	2083	2076	2096
Beta / Gamma	7,449	7,301	7,509	7,322	7,429	7,339	7,332	7,311	7,364	7,375	7,375
10 Bkgd Measurements	1	2	3	4	5	6	7	8	9	10	Average
Alpha	0	0.3	0.3	0.1	0.4	0.1	0.3	0.1	0.2	0.1	0.2
Beta / Gamma	52.9	53.9	54.9	52.6	54.1	53.3	54.4	52.7	54.0	53.3	53.8

Radiation Type	Alpha	Average	St. Dev.	2 σ	3 σ
Source Check		2096	37.5	75.0	112.5
Bkgd		0.2	0.13	0.26	0.39
Source Range +/- 2 σ	2022	to	2171		
Source Range +/- 3 σ	1984	to	2210		
Bkgd Range +/- 2 σ	-0.1	to	0.4		
Bkgd Range +/- 3 σ	-0.5	to	0.8		

Radiation Type	Beta	Average	St. Dev.	2 σ	3 σ
Source Check		7375	65.8	131.4	197.3
Bkgd		53.8	2.9	5.8	8.8
Source Range +/- 2 σ	7243	to	7506		
Source Range +/- 3 σ	7177	to	7573		
Bkgd Range +/- 2 σ	48.0	to	61.7		
Bkgd Range +/- 3 σ	47.0	to	64.7		

Laboratory Sheet

Solutient Technologies

Instrument Survey and Contamination Survey Data Sheet

Lab Instrument Counter		Model #5929	Probe 43-10	Background Start of Shift	Field Survey Instrument	Model #	Model #	Date:	3/28/2005
Serial#		187886	177834	N/A	Inst Serial#	0	0		
Cal Due		8/16/2005	8/17/2005	End of Shift	Cal Due	N/A	N/A		
Background Ct Tm	Min	10		N/A	Background Ct Tm, min	N/A	N/A		
Background Ct Tm	Min	10		Average	Survey Ct Tm, min	N/A	N/A	Technician:	Richard Thomas
Background α cpm		0.2		#DIV/0!	Survey cpm	#DIV/0!	#DIV/0!		
Background β_γ cpm		54			Efficiency	0%	0%		
Efficiency α		33%			Probe Type	N/A	N/A		
Efficiency β_γ		21%			Probe Serial #	0	0		
MDA α DPM		3			Probe Cal Date	N/A	N/A		
MDA β_γ DPM		83			Probe Air, cm²/2	15	100		
Date		3/28/2005			MDA β_γ DPM	#DIV/0!	#DIV/0!	Signature:	
MDA = (3+3.29 $(B_\alpha)_{avg}(1+t_{avg}/t_B)^{1/2}$) / ($E^*t_{avg}$)					MDA = (3+4.65$(B_\beta)^{1/2}$) / ($E^*(A/100)$)				

Material Equipment	Watervliet Army Arsenal

	Criteria		Results for Smears				Results for Surface Surveys						
Smear #	< 1000 dpm β_γ / < 20 dpm α		α gross counts per 100 cm²	β_γ gross counts per 100 cm²	α dpm per 100 cm²	β_γ dpm per 100 cm²	Direct Frisk β_γ cpm	Direct Frisk β_γ dpm	Criteria < 5000 dpm	Direct Frisk α cpm	Direct Frisk α dpm	Criteria < 100 dpm	Description
1	Qe	Qe	0	574	-1	16	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 253 (floor)
2	Qe	Qe	2	630	0	-3	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 255 (floor)
3	Qe	Qe	4	641	1	2	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 256 (floor)
4	Qe	Qe	1	648	0	19	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 265 (floor)
5	Qe	Qe	3	622	0	-7	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 258 (floor)
6	Qe	Qe	1	635	0	-1	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 259 (floor)
7	Qe	Qe	4	666	1	29	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 264 (floor)
8	Qe	Qe	3	661	0	26	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 266 (floor)
9	Qe	Qe	2	670	0	16	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 254 (floor)
10	Qe	Qe	3	669	0	22	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 259 (floor)
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qe	Qe					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	

Survey #

Page of

2

Laboratory Sheet

Solutient Technologies

Instrument Survey and Contamination Survey Data Sheet

Lab Instrument		Model	Probe	Background	Field Survey Instrument	Model #	Model #	Date:	2/28/2005
Counter		S2929	43-10	Start of Shift		0	0		
Backup		187853	7719314	N/A	Inst. Number				
Cal Due		9/16/2005	9/17/2005	End of Shift	Cal Due	N/A	N/A		
Bkgd Ct Tm	Min	10		N/A	Bkgd Ct Tm, min	N/A	N/A		
Sample Ct Tm	Min	10		Average	Bkg Ct Tm, min	N/A	N/A	Technician:	Richard Thomas
Bkd α cpm		0.2		#DIV/0!	Bkg. cpm	#DIV/0!	#DIV/0!		
Bkd β,γ cpm		54			Efficiency	0%	0%		
Efficiency α		33%			Probe Type	N/A	N/A		
Efficiency βγ		21%			Probe Serial #	0	0	Signature:	
MDA α DPM		3			Probe Cal Due	N/A	N/A		
MDA βγ DPM		83			Probe Ai, cm^2	15	100		
Date		2/28/2005			MDA βγ DPM	#DIV/0!	#DIV/0!		
MDA=(3+3.29 (Rb/t)^0.5)/(E * Ea *)					MDA =3+4.65(bkgd)^0.5 / EF*(A/100)				
					Scaler "Ctrl" dpm	Manual			

Material Equipment: Watervliet Army Arsenal

	Criteria		Results for Smears				Results for Surface Surveys						
Smear #	< 1000 dpm βγ < 20 dpm α		α gross counts per 100 cm²	βγ gross counts per 100 cm²	α dpm per 100 cm²	βγ dpm per 100 cm²	Direct Frisk βγ cpm	Direct Frisk βγ dpm	Criteria < 6000 dpm	Direct Frisk α cpm	Direct Frisk α dpm	Criteria < 100 dpm	Description
1	Qc	Qc	1	576	0	18	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
2	Qc	Qc	2	545	0	4	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
3	Qc	Qc	0	617	-1	-10	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
4	Qc	Qc	3	577	0	-6	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
5	Qc	Qc	1	586	0	14	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
6	Qc	Qc	0	545	-1	4	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
7	Qc	Qc	2	586	0	13	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
8	Qc	Qc	2	570	0	16	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
9	Qc	Qc	1	578	0	20	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
10	Qc	Qc	0	553	1	8	N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	Lab 232 (floor)
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	
	Qc	Qc					N/A	#VALUE!	#VALUE!	N/A	#VALUE!	#VALUE!	

Enclosure 5 – Instrument Calibration Sheets

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER SOLUTIENT TECHNOLOGIES ORDER NO. 230961/289212

Mfg. Ludlum Measurements, Inc. Model 2241-2 Serial No. 174195

Mfg. Ludlum Measurements, Inc. Model 43-90 Serial No. PR180327

Cal. Date 17-Feb-05 Cal Due Date 17-Feb-06 Cal. Interval 1 Year Meterface cpm

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 20 % Alt 700.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☐ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation
☑ Audio ck. ☑ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/06/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens Comments mV Det. Oper Comments V at Comments mV Threshold Dial Ratio ____ = ____ mV

COMMENTS: Calibrated with 39" cable

	Det 1	Det 2
Deadtime:	75uSec	0uSec
Cal Constant:	100-2	100-2
Alert:	20Kc/m	20Kc/m
Alarm:	50Kc/m	50Kc/m
High Voltage:	900V	700V
Input Sens:	35mV	
Firmware:	P0609	

Overload checked but not set.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
AUTO			
AUTO			

*Uncertainty within ± 10% C.F. within ± 20% All Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Ratemeter Readout	800K cpm	801 Kc/m	801 Kc/m
	200K cpm	200	200
	80K cpm	80	80
	20K cpm	20	20
	8K cpm	8.0	8.0
	2K cpm	2.0	2.0
	800 cpm	800 c/m	800 c/m
	200 cpm	201	201

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Scaler Readout	800K cpm	801860	801860
	200K cpm	200610	200610
	80K cpm	80270	80270
	20K cpm	20040	20040
	8K cpm	8010	8010
	2K cpm	2006	2006
	800 cpm	800	800
	200 cpm	210	210

Ludlum Measurements, 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. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☑ G112 ☐ M566 ☐ 5105 ☐ T1008 ☐ T879 ☐ E562 ☑ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N 8744 ☐ Beta S/N ____ ☐ Other ____

☑ m 500 S/N 189509 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 80820360

Calibrated By: Michael J Thomas Date 17-Feb-05

Reviewed By: [signature] Date 17 FEB 05

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Alpha Detector

Detector 43-90 Serial No. PR 180327

Customer SOLUTIENT TECHNOLOGIES Order #. 230961/289212

Counter 2241-2 Serial No. 174195 Counter Input Sensitivity 10 mV

Count Time 1 minute Distance Source to Detector Surface

Isotope Pu-239 186kcpm Other

43-4/43-44 HV Adjust for Altitude

Altitude	High Voltage
Sea Level	2050 V
1000 foot	2025 V
2000 foot	2000 V
3000 foot	1975 V
4000 foot	1950 V
5000 foot	1925 V
6000 foot	1900 V
7000 foot	1875 V

Alpha Scintillation Detector

HV Plateau	Background	Source Count
550	1	63249
600	2	73236
650	2	78041
700	2	79727
750	2	80887
800	250	83258

Operating Voltage Set at 700 V

Air Proportional	43-5	43-65	43-90	Background	Meter Reading	Range/Scale
Toe	Toe	L/S*	Toe	2	77203	Dig
Center	Center	Center	Center	2	79727	↓
Heel	Heel	Other**	Heel	2	79313	↓

☑ Uniformity (± 10%) Average Efficiency 42.3 % (2π)

* Least Sensitive Position (Heel of Detector)
** Opposite Least Sensitive Position (Top of Detector)

Signature Michael J Thomas Date 17-Feb-05

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer SOLUTIENT TECHNOLOGIES Date 17-Feb-05 Order #. 230961/289212

Model 2241-2 Serial No. 174195 Detector Model 44-9 Serial No. PR 154567

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Count time Ratemeter Input Sensitivity 35 mV

Reference Point	"As Found" Readings (CPM): with Deadtime	"As Found" Readings (CPM): w/o Deadtime	After Adjustment Readings (CPM): with Deadtime	After Adjustment Readings (CPM): w/o Deadtime
150 mR/hr	481 kc/m	N/A	481 kc/m	N/A
50 mR/hr	164		164	
15 mR/hr	50.0		50.0	
5 mR/hr	16.3		16.3	
1.5 mR/hr	4.73		4.73	
1.0 mR/hr	3.18		3.18	

Signature: Michael J Thomas Date 17-Feb-05

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER REEL, LLC ORDER NO. 213071/280211

M Ludlum Measurements, Inc. Model 2241-2 Serial No. 174211

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR038479

Cal. Date 24-Mar-04 Cal Due Date 24-Mar-05 Cal. Interval 1 Year Meterface 44-9

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 34 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☑ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation
☑ Audio ck. ☑ Alarm Setting ck. ☐ Batt. ck. (Min. Volt) 2.2 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens Comments mV Det. Oper Comments V at Comments mV Threshold Dial Ratio ____ = ____ mV

COMMENTS:

	Det 1	Det 2
Deadtime:	0uSec	115uSec
Cal Constant:	100-2	100-2
Alert:	20Kc/m	20Kc/m
Alarm:	50Kc/m	50Kc/m
High voltage:	950V	900V
Input Sens:	35mV	35mV
Firmware:	P06 09	

New detector settings
Calibrated with 39" cable

Overload set @ 1 R/hr with 44-9.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
AUTO			
AUTO			

*Uncertainty within ± 10% C.F. within ± 20% All Range(s) Calibrated Electronically

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Ratemeter Readout	800K cpm	801 Kc/m	801 Kc/m
	200K cpm	200	200
	80K cpm	80.0	80.0
	20K cpm	20.0	20.0
	8K cpm	8.03	8.03
	2K cpm	1.99	1.99
	800 cpm	801 c/m	801 c/m
	200 cpm	200	200

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Scaler Readout	800K cpm	801756)	801756)
	200K cpm	199746)	199746)
	80K cpm	80226)	80226)
	20K cpm	20026)	20026)
	8K cpm	8026)	8026)
	2K cpm	2006)	2006)
	800 cpm	806)	806)
	200 cpm	206)	206)

Ludlum Measurements, 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. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☑ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☑ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N 2928-01 ☐ Beta S/N ____ ☐ Other ____

1500 S/N ____ ☐ Oscilloscope S/N ____ ☐ Multimeter S/N ____

Calibrated By: Michael J Flores Date 24-Mar-04

Reviewed By: [signature] Date 31 Mar 04

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer REEL, LLC Date 24-Mar-04 Order #. 213071/280211

Model 2241-2 Serial No. 174211 Detector Model 44-9 Serial No. PR038479

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Count time Ratemeter Input Sensitivity 35 mV

Reference Point	"As Found" Readings (CPM): with Deadtime	"As Found" Readings (CPM): w/o Deadtime	After Adjustment Readings (CPM): with Deadtime	After Adjustment Readings (CPM): w/o Deadtime
150 mR/hr	N/A	N/A	458 kc/m	N/A
50 mR/hr			163	
15 mR/hr			49.8	
5 mR/hr			17.1	
1.5 mR/hr			4.93	
1.0 mR/hr			3.40	

Signature: Michael J Thomas Date 24-Mar-04

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Alpha Detector

Detector 43-90 Serial No. PR180327

Customer REEL, LLC Order #. 213071/280211

Counter 2241-2 Serial No. 174211 Counter Input Sensitivity 35 mV

Count Time 1 minute Distance Source to Detector Surface

Isotope Pu-239 12,600 cpm Other

43-4/43-44 HV Adjust for Altitude

Altitude	High Voltage
Sea Level	2050 V
1000 foot	2025 V
2000 foot	2000 V
3000 foot	1975 V
4000 foot	1950 V
5000 foot	1925 V
6000 foot	1900 V
7000 foot	1875 V

Alpha Scintillation Detector

HV Plateau	Background	Source Count
800	1	3057
850	2	4994
900	3	5265
950	3	5628
1000	5	5563

Operating Voltage Set at 950 V

Air Proportional	43-5	43-66	43-90	Background	Meter Reading	Range/Scale
Toe	Toe	L/S*	Toe	3	5323	Dig
Center	Center	Center	Center	3	5628	↓
Heel	Heel	Other**	Heel	3	5365	↓

☑ Uniformity (± 10%) Average Efficiency 43 % (2π)

* Least Sensitive Position (Heel of Detector)
** Opposite Least Sensitive Position (Top of Detector)

Signature Michael J Thomas Date 24-Mar-04

This is to acknowledge the receipt of your letter/application dated

3/7/2005, and to inform you that the initial processing which includes an administrative review has been performed.

Amendment STB-1554

☒ There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

☐ Please provide to this office within 30 days of your receipt of this card

---

A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 136662.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader

	:	(FOR LFMS USE)
	:	INFORMATION FROM LTS
BETWEEN:	:	---
	:	
License Fee Management Branch, ARM	:	Program Code: 11300
and	:	Status Code: 0
Regional Licensing Sections	:	Fee Category: EX 2C
	:	Exp. Date: 20131031
	:	Fee Comments: _____
	:	Decom Fin Assur Reqd: N
	::	

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED
   Applicant/Licensee: ARMY, DEPARTMENT OF THE
   Received Date: 20050325
   Docket No: 4009011
   Control No.: 136662
   License No.: STB-1554
   Action Type: Amendment

2. FEE ATTACHED
   Amount: /
   Check No.: /

3. COMMENTS

Signed Rebecca Juncos
Date 3/28/2005

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered /__/)

1. Fee Category and Amount: _____

2. Correct Fee Paid. Application may be processed for:
   Amendment _____
   Renewal _____
   License _____

3. OTHER _____
   _____

Signed _____
Date _____