original

DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
ARMY RESEARCH LABORATORY
2800 POWDER MILL ROAD
ADELPHI MD 20783-1197

REPLY TO
ATTENTION OF

February 20, 2007

RECEIVED
REGION 1
2007 MAR -5 PM 12: 48

Safety Office

U.S. Nuclear Regulatory Commission
Division of Nuclear Material Safety
475 Allendale Road
King of Prussia, Pennsylvania 19406-1415

Dear Director:

This letter is being submitted as directed by your May 24, 2005 letter to formally request termination of license SNM 348, docket 07000378. At enclosure 1 please find a completed NRC Form 314 certifying disposition of the licensed material. At enclosure 3 please find a historical site assessment and radiation safety survey demonstrating that the facility radiological conditions meet the NRC's criteria to release the facility for unrestricted use. And at enclosure 2, please see a copy of the most recent leak testing conducted on the sealed plutonium sources that were covered by SNM-348. The two uranium 235 source discs totaling 1.576 grams were not sealed sources and therefore were not subject to leak testing.

Termination of this license will represent an end to NRC licenses held by this organization at this site. I would like to take this opportunity to thank your office for all the assistance you have provided us over the decades that we have held NRC licenses. Our use of licensed material has been vital to us pursuing our Army mission. Your staff has always been professional, knowledgeable, and responsive. If our mission should require us to use licensed material in the future, we will look forward to working with your office again. If you have any questions or need any additional information, please contact my Radiation Safety Officer, Mr. Michael Borisky, at 301-394-6310.

Sincerely,

Teresa K. Kines
Associate Director for
Laboratory Operations

3 Enclosures

Copy Furnished:
U.S. Army Research, Development, and Engineering Command, Mission Support Office
U.S. Army Materiel Command, Surgeon General Office (Maj Prins)

139579

NMSS/RGN1 MATERIALS-002

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NRC FORM 314 (6-2004) 10 CFR 30.36(j)(1); 40.42(j)(1); 70.38(j)(1); and 72.54(j)(1)

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF DISPOSITION OF MATERIALS

APPROVED BY OMB: NO. 3150-0028 EXPIRES: 06/30/2007

Estimated burden per response to comply with this mandatory collection request: 30 minutes. This submittal is used by NRC as part of the basis for its determination that the facility is released for unrestricted use. Send comments regarding burden estimate to the Records and FOIA/Privacy Services Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0028), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE NAME AND ADDRESS	LICENSE NUMBER	DOCKET NUMBER
Department of the Army Army Research Laboratory - Adelphi Laboratory Center ATTN: AMSRD-ARL-O-SH 2800 Powder Mill Road, Adelphi, Maryland 20783	SNM 348	070-00378
	LICENSE EXPIRATION DATE 01/31/2007	

A. LICENSE STATUS *(Check the appropriate box)*

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

B. DISPOSAL OF RADIOACTIVE MATERIAL

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

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

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

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

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

All (60) Pu-239 foils transferred on 12/16/04 through Univ of Cal, LANL, for DOE, US, to NSSI, 5711 Etheridge, Houston, Texas 77087

☑ b. Disposal of radioactive materials:

☐ 1. Directly by the licensee:

☐ 2. By licensed disposal site:

☑ 3. By waste contractor:

All (2) U-235 source disks shipped by US Army Field Support Command, Rock Island, Ill, on 28 Jan 05 to Duratek Consolidation Facility, 16043, Dunbarton Blvd, Barnwell, South Carolina, 29812

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

C. SURVEYS PERFORMED AND REPORTED

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

☐ a. the absence of licensed radioactive materials

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

☐ 2. A copy of the radiation survey results:

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

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

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

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

NAME	TITLE	TELEPHONE *(Include Area Code)*	E-MAIL ADDRESS
Michael Borisky	Radiation Safety Officer	(301) 394-6310	mborisky@arl.army.mil

Mail all future correspondence regarding this license to:
Army Research Lab, ATTN: AMSRD-ARL-O-SH (M. Borisky), 2800 Powder Mill Road, Adelphi, Maryland 20783

C. CERTIFYING OFFICIAL

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

PRINTED NAME AND TITLE	SIGNATURE	DATE
MICHAEL BORISKY	Michael Borisky	28 Feb 07

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

Encl 1

Pu-239 Fission Foil Leak Tests

date: 9 Mar 04 operator: Michael Borisky

instrument: NMC PC-55, sn 91-2712-2-2, calibration due 9 May 04

1. Scaler Test: 3600 cpm, ∴ OK

2. Background Determination: (α, β channel)(N mode)(1700 volts, cpm)

1,37	0,23	0,28	0,48	
0,22	1,30	0,20	0,30	$\bar{X}_\beta$ = 27 cpm $SD_t = \sqrt{\bar{X}} = 5.19$ $SD_{obs} = 4.9$
0,18	0,28	0,27	1,30	RF = 4.9/5.19 = .94
1,24	0,29	1,19	1,30	∴ instrument operation probably OK
1,24	0,28	0,33	0,32	$\bar{X}_\alpha$ = .35 cpm $SD_t = \sqrt{\bar{X}}$ = .59 cpm

∴ LLD α = (4.65 × .59 cpm) + 3 cpm = 5.75 cpm α

3. Response/Efficiency Check

a. Am-241 (3.328×10^2 dps, NIST Traceable)(α, β)(N mode)(1700 volts)

α = 9291, β = 6522

$$\text{Am-241 } \alpha_{eff} = \frac{9{,}291 \text{ cpm}}{3.328 \times 10^2 \text{ dps} \times 60 \text{ s/min}} = .465 \quad \text{Within 2}\sigma$$

QC chart, Therefore use 9 Feb 04 calibration of .465

$$\therefore \text{ MDA Am-241}\alpha = \frac{5.75 \text{ cpm}}{.465 \text{ cpm/dpm}} = 12.4 \text{ dpm} = 5.6 \times 10^{-6} \mu\text{Ci}.$$

b. 6522 cpm β demonstrates the cross-talk between the α and β channels, and demonstrates that some beta counts are expected in the presence of alpha counts. Qualitative, not quantitative evidence of the absence or presence of alpha.

Encl 2

Test #
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4. Leak Test Analysis (α, β)(N mode)(1700 volts)

Test #	Pu-239 Source	α cpm	β cpm	α above + β bkgd + LLDα	(1) α eff	Result
1	# 208	0	33	0	.465	$< 5 \times 10^{-6}$ microcuries
2	# 209	0	38	0	.465	$< 5 \times 10^{-6}$ microcuries
3	# 210	0	29	0	.465	$< 5 \times 10^{-6}$ microcuries
4	# 211	0	26	0	.465	$< 5 \times 10^{-6}$ microcuries
5	# 212	1	28	0	.465	$< 5 \times 10^{-6}$ microcuries
6	# 213	1	28	0	.465	$< 5 \times 10^{-6}$ microcuries
7	# 214	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries
8	# 215	0	35	0	.465	$< 5 \times 10^{-6}$ microcuries
9	# 216	0	24	0	.465	$< 5 \times 10^{-6}$ microcuries
10	# 217	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries
11	# 218	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries
12	# 219	0	30	0	.465	$< 5 \times 10^{-6}$ microcuries
13	# 220	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries
14	# 221	1	24	0	.465	$< 5 \times 10^{-6}$ microcuries
15	# 222	0	32	0	.465	$< 5 \times 10^{-6}$ microcuries
16	# 223	1	34	0	.465	$< 5 \times 10^{-6}$ microcuries
17	# 224	1	28	0	.465	$< 5 \times 10^{-6}$ microcuries
18	# 225	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries
19	# 226	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries
20	# 227	0	21	0	.465	$< 5 \times 10^{-6}$ microcuries
21	# 9560	0	30	0	.465	$< 5 \times 10^{-6}$ microcuries
22	# 9561	0	24	0	.465	$< 5 \times 10^{-6}$ microcuries
23	# 9562	0	30	0	.465	$< 5 \times 10^{-6}$ microcuries

(1) use Am-241 α eff

Test #	Pu-239 Source	α cpm	β cpm	α above 7 keV + LLD α	α eff	Result	Test #
24	#9563	0	32	0	.465	$< 5 \times 10^{-6}$ microcuries	50
25	#9564	0	21	0	.465	$< 5 \times 10^{-6}$ microcuries	51
26	#9565	0	21	0	.465	$< 5 \times 10^{-6}$ microcuries	52
27	#9566	1	29	0	.465	$< 5 \times 10^{-6}$ microcuries	53
28	#9567	0	28	0	.465	$< 5 \times 10^{-6}$ microcuries	54
29	#9568	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries	55
30	#9569	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries	56
31	#115	0	32	0	.465	$< 5 \times 10^{-6}$ microcuries	57
32	#116	1	23	0	.465	$< 5 \times 10^{-6}$ microcuries	58
33	#117	0	26	0	.465	$< 5 \times 10^{-6}$ microcuries	59
34	#118	0	23	0	.465	$< 5 \times 10^{-6}$ microcuries	60
35	#119	0	23	0	.465	$< 5 \times 10^{-6}$ microcuries	
36	#120	1	39	0	.465	$< 5 \times 10^{-6}$ microcuries	5.
37	#121	0	21	0	.465	$< 5 \times 10^{-6}$ microcuries	Pu
38	#122	0	38	0	.465	$< 5 \times 10^{-6}$ microcuries	f
39	#123	0	22	0	.465	$< 5 \times 10^{-6}$ microcuries	c
40	#124	0	30	0	.465	$< 5 \times 10^{-6}$ microcuries	c
41	#125	0	27	0	.465	$< 5 \times 10^{-6}$ microcuries	
42	#126	0	23	0	.465	$< 5 \times 10^{-6}$ microcuries	
43	#127	0	37	0	.465	$< 5 \times 10^{-6}$ microcuries	
44	#128	1	30	0	.465	$< 5 \times 10^{-6}$ microcuries	
45	#129	0	23	0	.465	$< 5 \times 10^{-6}$ microcuries	
46	#130	0	28	0	.465	$< 5 \times 10^{-6}$ microcuries	
47	#131	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries	
48	#132	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries	
49	#133	1	26	0	.465	$< 5 \times 10^{-6}$ microcuries	

Test #	Pu-239 Source	α cpm	β cpm	X cpm absorber / X blank + Lab	α eff	Result
50	# 134	0	27	0	.465	$< 5 \times 10^{-6}$ microcuries
51	# 9580	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries
52	# 9581	1	36	0	.465	$< 5 \times 10^{-6}$ microcuries
53	# 9582	0	33	0	.465	$< 5 \times 10^{-6}$ microcuries
54	# 9583	0	27	0	.465	$< 5 \times 10^{-6}$ microcuries
55	# 9584	0	22	0	.465	$< 5 \times 10^{-6}$ microcuries
56	# 9585	0	29	0	.465	$< 5 \times 10^{-6}$ microcuries
57	# 9586	0	31	0	.465	$< 5 \times 10^{-6}$ microcuries
58	# 9587	0	22	0	.465	$< 5 \times 10^{-6}$ microcuries
59	# 9588	0	23	0	.465	$< 5 \times 10^{-6}$ microcuries
60	# 9589	0	25	0	.465	$< 5 \times 10^{-6}$ microcuries

5. Results / Discussion: Alpha channel results suggest none of the Pu-239 foils are leaking, nor do any exceed the license limit for leakage. Beta channel results support this conclusion, as crosstalk to the beta channel would be expected in the presence of alpha, as demonstrated by the Am-241 source count in paragraph 3a. The alpha channel result was used with the .465 alpha efficiency to calculated the $< 5 \times 10^{-6}$ microcuries Pu-239, assumming Pu-239 efficiency equals Am-241 efficiency. Beta counts were not used quantitatively, but rather to support the alpha results.

Michael Borisky
9 Mar 04

FINAL SURVEY

February 2007

NRC License SNM 348

Rad Storage Area (building 504, rm 106),
Decontamination Shower,
and underground holding tank

Adelphi Laboratory Center
2800 Powder Mill Road
Adelphi, Maryland 20783

1. Historical Site Assessment

a. Background: The Harry Diamond Lab (HDL)/Adelphi Laboratory Center (ALC) was constructed during the early to mid 1970's. Radioactive material was first moved to HDL/ALC in 1977. Michael Borisky has been serving as the Radiation Safety Officer (RSO) for most of that time, since December of 1981. During that time he has performed all RSO duties to include; periodically inventorying radioactive materials, radioactive material area surveying and surface wipe testing, sealed source leak testing, radioactive material shipment and receipt, radioactive waste management, and Nuclear Regulatory Commission (NRC) license management. Performing these duties since 1981 has kept Michael Borisky knowledgeable of the radiological status of the radioactive material storage area, decontamination shower, and holding tank that are the subject of this historical site assessment and final survey. Since 1981, sealed source leak tests and tank water samples have consistently come back uncontaminated, and with a few exceptions, so have wipe tests. Little or no contamination is therefore expected in the Radiation Storage Area, decontamination shower, or the underground 4000 gallon holding tank that captures all water draining from the Radiation Storage Area and decontamination shower. But to be even more certain, we opted to perform an exhaustive review of records that pre-dated the construction of the Rad Storage Area, decontamination shower, and underground tank in the early to mid 1970's, and the 1977 transfer of radioactive materials to the Rad Storage area from our previous licensed site. In this way, we were able to review the nature of any licensed radioactive material present prior to the arrival of Michael Borisky in 1981, as well as the nature of any material that was transferred to the Rad Storage Area in 1977 before Michael Borisky arrived. Of particular interest was the possibility of unsealed or leaking sources, and contaminated equipment or objects.

b. NRC License Records: NRC licenses and related correspondence were reviewed for the following NRC licenses held by ARL and it's predecessor organization (HDL):

(1) 19-17250-01 - Various sealed sources, some brought to HDL/ALC in 1977. In 1995, sources were transferred to license 19-17250-05, and 19-17250-01 was terminated.

Encl 3

(2) 19-17250-02 – Various sealed sources, all transferred to the University of Maryland in 1970. Sources never present at HDL/ALC Rad Storage Area. License terminated in 1978.

(3) 19-17250-03 - Various sealed sources, some brought to HDL/ALC Rad Storage Area in 1977. Sources stored and then disposed of as radioactive waste or transferred to an authorized recipient. License terminated in 1990.

(4) 19-17250-04 - Neutron irradiated/activated hardware and equipment. Some stored in HDL/ALC Rad Storage Area. All radioactive hardware and equipment was disposed of as radioactive waste or transferred to an authorized recipient. License terminated in 2000.

(5) 19-17250-05 - Sealed Co-60 and sealed Cs-137 sources, some transferred to HDL/ALC from previously licensed site in 1977, and some new sources purchased and installed at the HDL/ALC site in 1986. Eventually all sources were disposed of as radioactive waste or transferred to an authorized recipient. License terminated in 1999.

(6) SNM 348 – Sealed Pu-Be sources, encapsulated fission foils, sealed SNM calibration sources, and 2 unclad instrument calibration U-235 discs. None of these sources were ever used at the HDL/ALC site, but were stored in the Radiation Storage Area awaiting disposal or transfer. All these sources were eventually disposed of as radioactive waste or transferred to an authorized recipient. TERMINATION OF THIS SNM-348 LICENSE IS THE PURPOSE OF THIS FINAL SURVEY EFFORT.

c. Source Leak Testing/Contamination Results: Records indicate that all sealed and encapsulated sources were regularly leak tested as required by license conditions, typically every 3-6 months. This was also performed for sources that were in storage even though not required.

(1) 19-17250-01 - No history of leaking sources.

(2) 19-17250-02 – Sources physically transferred to University of Maryland in 1970, and transferred to University of Maryland license in 1977. Sources were therefore never present at the HDL/ALC Rad Storage Area.

(3) 19-17250-03 - No history of leaking sources.

(4) 19-17250-04 – Neutron activated solid electrical and mechanical components and hardware. Activated material was an integral part of the components and hardware. In some cases (according to past RSO, James Stafford), very short-lived removable contamination (typically tens to hundreds of dpm beta) was produced from neutron activation of sodium from experimenter perspiration deposited on the items by handling before irradiation. This radioactivity decayed to background levels very quickly, well before any of these items were transferred to the Rad Storage Facility at HDL/ALC in 1977. During survey efforts to terminate license 19-17250-04, no removable contamination was detected on any of these neutron irradiated electrical and mechanical components or hardware.

(5) 19-17250-05 – No history of source leakage. There was an incident in 1986 where a contaminated shipping cask was used by a contractor to deliver new Co-60 sources to our Co-60 facility, slightly contaminating our Co-60 facility pool with a micro-curie quantity of radioactivity. The pool and all contents were decontaminated by the contractor that delivered the sources. Leak testing determined that the contamination was not from a leaking Co-60 source. Although the resulting slightly contaminated resin filter bottles were stored in the Rad Storage Area awaiting disposal, subsequent wipe testing revealed that their presence did not introduce significant contamination into the Radiation Storage Area or underground holding tank. Details are provided in the license termination information submitted in 1999 to support termination of license 19-17250-05.

(6) SNM 348 – No history of leaking of any sealed or encapsulated sources. In December 2004, each of the 60 Pu-239 encapsulated fission foils were leak tested for the last time in preparation for their packaging for return to the Department of Energy. None were found to be leaking. The two unclad U-235 discs totaling 1.576 grams were not sealed or encapsulated but were kept closed inside a plastic box located inside a locked cabinet with the fission foils.

d. Incident Files: Radiation incident files dating back to 1961 where reviewed. There was no record of any NRC licensed sealed radioactive material sources leaking at the HDL/ALC site, or any leaking sealed sources being transferred to the HDL/ALC Rad Storage Area from another site. There was an incident in 1986 where a slightly contaminated shipping cask used to deliver new Co-60 sources to our Co-60 facility contaminated our pool and associated hardware with a microcurie quantity of radioactivity. The pool and all contents were decontaminated by the contractor that delivered the sources. Leak testing at that time determined the contamination was not from leaking of any old or newly delivered Co-60 sources. Subsequent wipe testing revealed that the incident did not introduce any significant contamination into the HDL/ALC Radiation Storage Area or associated underground holding tank. Details are provided in the license termination information previously submitted to support termination of license 19-17250-05.

e. Radioactive Package Wipe Tests: Review of wipe testing results for radioactive packages delivering radioactive material to HDL/ALC has never revealed any contamination that could have contaminated the Radiation Storage Area or any other areas at HDL/ALC.

f. Storage Area Wipe Tests: Records indicate that the Radiation Storage Area has been surveyed for radioactive contamination at least once every quarter. Also, a thorough wipe testing was performed in 1990 on the inside and outside of the boxes, drums, and pigs that were used to hold rad waste that had accumulated for 15 plus years before its shipment for disposal. With the few exceptions outlined below, removable contamination above a background of about 0-1 cpm alpha and 30-40 cpm beta had not been seen on facility surfaces or contents. Applying minimum detectable activity calculations for the internal proportional counter used to count the wipes, this corresponds to minimum detectable activities of about 10 dpm alpha and 50 dpm beta per 100 square centimeters, using Am-241 efficiency and Co-60 efficiencies, respectively. The few exceptions found are as follows:

(1) Neutron Irradiated Items - The neutron irradiated items brought from neutron irradiation facilities to the HDL/ALC site beginning in 1977 did not any reveal removable contamination. Pre 1975, some items showed some short-lived removable beta activity shortly after neutron irradiation at neutron facilities, but wipe testing of these items after they reached our Rad Storage Area in 1977 showed no removable contamination remained. According to our RSO in 1975, Mr. James Stafford, very short-lived removable contamination was produced from neutron activation of sodium deposited on the surface of the items by perspiration on the hands of the experimenter that handled the items before they were neutron irradiated. Since very short lived radionuclides were produced by the neutron irradiation of the sodium, decay quickly reduced the contamination to background levels. Wipe testing of neutron irradiated items remaining in the Rad Storage Area in 2000 likewise did not indicate any removable contamination above the typical minimum detectable activities indicated above.

(2) Fission foil cabinet – Since 1981, Michael Borisky leak tested (on a quarterly basis) the encapsulated fission foils stored in the Radiation Storage Area. Each source was typically wiped with a cotton swab or filter paper that was then counted in an internal proportional counter. None of the leak tests revealed any leakage above the typical minimum detectable activities indicated above. In 1990, a complete wipe testing of all items remaining in the Rad Storage Area (following the removal of most of the rad waste that had accumulated for 15 plus years) was conducted. In addition to the fission foil sources, the inside of the lead-lined wooden cabinet in which the fission foils were stored was wipe tested. A removable level of about 12 dpm/100cm^2 alpha (and background beta) was found on the middle shelf. The lower and upper shelves were at background levels for both alpha and beta. Besides the encapsulated fission foils, two unclad U-235 discs were also stored inside a plastic box located inside this cabinet. Wiping them each revealed removable activity of about 1200 dpm/100cm^2 alpha, and about 2000 dpm/100cm^2 beta. There was no measurable removable contamination on the outside surface of the fission foil cabinet. Since that time, all the fission foils and the two unclad U-235 discs have been removed from the cabinet and returned to the Department of Energy for disposal as radioactive waste. On 18 Mar 2005, the fission foil cabinet surfaces were reassessed. The outside surfaces and upper and lower shelves were again found to be at background levels for removable alpha and beta. Removable alpha contamination was again found on the middle shelf - 23 dpm/100cm^2 alpha, with a background level of beta. It is unclear where this low-level contamination originated. It is also unclear where the cabinet originated, and what history it has. It was clearly old and had been transferred to HDL/ALC from another location. It may have been inherited from the past Walter Reed Army Medical Center reactor from which some of our fission foils had been inherited. Or it may have been inherited from the Diamond Ordnance Radiation Facility TRIGA reactor facility operated under an Army permit from 1961-1977. Another possible source of this contamination - leak test records indicate that on 30 Mar 78, prior to the arrival of Michael Borisky, a U-238 fission foil source, #8520, appeared to be ruptured and was leak tested. It reportedly showed 0 cpm alpha and 18 cpm beta. At that time, the plastic source tray was decontaminated, and the source was sent for disposal the following day on 31 Mar 78. Since the plastic source tray was located within the fission foil cabinet, perhaps this apparently ruptured U-238 source was the source of the contamination. In any event, the contamination seemed localized inside the cabinet, and the cabinet with accompanying shelves and plastic source holders has since been disposed of as radioactive waste.

(3) Small sized lead box - In 1990 a complete wipe testing of all items remaining in the Rad Storage Area following the removal of most of the rad waste that had accumulated for 15 plus years was conducted. The inside of a small empty lead box about 4 inches by 6 inches by 2 inches was found to be contaminated. The box had never been used at the ALC site, but had been held in the Rad Storage Area awaiting disposal. The presence of lead had thwarted previous disposal efforts. The outside revealed background levels of removable alpha and beta, but the inside showed about 210 dpm/100cm^2 removable alpha, and 863 dpm/100cm^2 removable beta. At the time of this discovery in 1990, the box was taped shut, labeled to indicate contamination, and stored inside a steel storage cabinet. On 8 Mar 2005, the box was re-wiped on the inside and found to be about 109 dpm/100cm^2 removable alpha and 76 dpm/100cm^2 removable beta, and again background levels for removable alpha and beta on the outside. On 31 Mar 2005, it was determined using an Exploranium that the contamination in the small lead box was Ra-226. It was unclear where the box originated, and what history it had. It may have been inherited from the Walter Reed Army Medical Center reactor facility from which some of our fission foils were inherited. Or it may have been used at the Diamond Ordnance Radiation Facility TRIGA reactor facility operated under an Army permit from 1961 to 1977. In any event, the contamination was localized inside the box, and the box has since been disposed of as radioactive waste.

(4) Medium sized lead–lined wooden box - In 1990 a complete wipe testing of all items remaining in the Rad Storage Area following the removal of most of the rad waste that had accumulated for 15 plus years was conducted. An empty medium sized lead-lined wooden box about 8 inches by 14 inches by 5 inches was found to be contaminated on the inside surface only. The box had never been used at the ALC site, but had been held awaiting disposal. The presence of lead had thwarted previous disposal efforts. The outside revealed background levels of removable alpha and beta, but the inside showed about 14 dpm/100cm^2 removable alpha, and 106 dpm/100cm^2 removable beta. At the time of this discovery, the box was taped shut, labeled to indicate contamination, and stored inside a steel storage cabinet. On 18 Mar 2005, the box was reassessed for removable contamination and no significant removable alpha or beta contamination was found inside or outside the box. It is unclear where the box originated, and what history it had. It may have been inherited from the Walter Reed Army Medical Center reactor facility from which some of our fission foils were inherited. Or it may have been used at the Diamond Ordnance Radiation Facility TRIGA reactor facility operated under an Army permit from 1961-1977. To be safe, this box, has since been disposed of as radioactive waste.

(5) Floor/Rad Workbench – As mentioned earlier, the Radiation Storage Area has been wipe tested every 3 months since 1977. During that period, there have only been 2 instances were removable contamination was found on any facility surfaces. In Jul 90, a random wipe on the floor measured 12 dpm/100cm^2 alpha. And in Jul 02, a random wipe on the workbench top measured 25 dpm/100cm^2 alpha and 56 dpm/100cm^2 beta. These wipes tests may have been false positives. No removable contamination has been found on any facility surface wipes taken before or after these two. When using the windowless internal proportional counter, spurious counts have been observed in the past when the wipe test filter paper is bent or curled and touches or nearly touches the center wire in the windowless counting chamber. Dust on the center wire or an internal proportional counter is also a known source of spurious counts. In any event, all quarterly workbench and floor wipe tests performed between and since these

wipe tests have not exceeded the minimum detectable activities of about 10 dpm/100cm^2 alpha and 50 dpm/100cm^2 beta, using Am-241 efficiency and Co-60 efficiencies, respectively. During 1995 while working on the workbench, a small spot of fixed contamination was found on the workbench surface. It was about 500 cpm measured with a Ludlum pancake probe. A wipe was taken on the hot spot and counted in an internal proportional counter and no contamination was measured on the wipe. This confirmed that the contamination was fixed in the porous stoneware surface of the workbench. The spot was immediately covered with tape to protect it from any contact or abrasion. It is unclear where the workbench originated, and what history it had prior to 1981. It may have been inherited from the Walter Reed Army Medical Center reactor facility from which some of our fission foils were inherited. Or it may have been used at the Diamond Ordnance Radiation Facility TRIGA reactor facility operated under an Army permit from 1961 to 1977. It is known that since 1981, the workbench surface was not used for unsealed radioactive material operations. To be safe, the workbench top was removed and was disposed of as radioactive waste.

(6) Boeing Fission Fragment Counter - A 29 Mar 78 wipe test of a Boeing Fission Fragment Counter containing U-235 showed 3 cpm alpha and 21 cpm beta above background. It is unclear whether these findings were valid since subsequent wipe testing of the fission fragment counter did not reveal contamination, to include when it was shipped for rad waste disposal in Jun 1990.

(7) DORF Fume Hood - Wipe test records indicate that in Mar 78, wipe testing was performed on a fume hood transferred to the Radiation Storage Area from our Army permitted TRIGA Reactor Facility that was operated under an Army permit from 1961-1977. Of 10 wipe tests taken, one location outside the plastic hood face reportedly showed 1 cpm alpha and 20 cpm beta above background, and one location inside the hood reportedly showed 37 cpm beta above background. The hood was subsequently shipped for disposal as radioactive waste, probably in the 1990 waste disposal shipment.

g. Underground Tank Water/Sediment Tests: There have been a few occasions since 1981 when the contents of the underground radiation tank were checked for contamination. The contents have never tested significantly contaminated. This is expected because contamination was never intentionally drained into the tank, and the Co-60 Facility, Rad Storage Area, and decontamination shower surfaces and drains that lead to the tank have never been significantly contaminated.

h. Other Radioactive Materials: Over the years, a limited amount of items containing license exempt or generally licensed radioactive materials have also been stored in the Radiation Storage Area. This has included: Ra-226 containing electron tubes, switches, and components contained in Army electronic devices developed by this lab during the 1940-1970 timeframe; smoke detectors; Ni-63 and Pm-147 containing surge arrestor tubes; metal alloys containing Th-232; Th-232 coated optics; dials and gauges with Ra-226 radio-luminescent painted numbers and scales; and dilute thorium and uranium nitrate/acetate standard solutions. All of these items were wipe tested and none were found to be leaking or contaminated with removable contamination. All of these items have been disposed of as radioactive waste with the exception of some license exempt electron tubes and surge arrestors needed for ARL research efforts. The license exempt

items that we will continue to need were removed from the Radiation Storage Area before the final survey described below.

i. Removal of all Non-radioactive Items: In preparation for the final survey, all non-radioactive items with the exception of the four storage cabinets were removed from the Rad Storage Area. Although no contamination was expected, before items were removed they were wipe tested and surfaced monitored with a pancake probe. The items were also monitored along the surface using a BICRON microrem/hr meter equipped with a low energy window. The BICRON is not normally used for surface monitoring, but because it is extremely sensitive to photon radiation, it was considered of some added value as another check to ensure no significant activity was present. No removable or fixed contamination was detected on any of the non-radioactive items removed from the Rad Storage Area. These items are currently being held in another area so that the NRC can inspect/survey them if they wish to do so. Furthermore, the wipe test filter papers that were used on these items have been kept in case the NRC wishes to inspect/evaluate them. Once the final survey results are approved by the NRC, these items will be given final unrestricted release.

2. Final Survey Design. Based upon the historical site assessment summarized above, this action could have been classified as a Group 1 or Group 2 action, (both definitions seem to fit equally well), and the area was classified for final survey as a Class 3 area. The following survey plan was therefore formulated using Figure 8.1 of NUREG 1757 and Appendix B of MARSSIM (NUREG 1575).

a. Wipe Testing. To better ensure any removable contamination that might be present was detected, the floors and walls were not cleaned before wipe testing. The floors of the Rad Storage Area and shower facility were considered one survey unit totaling 354 square feet. The walls (to a height of 2 meters) were considered a second survey unit totaling 712 square feet. A floor plan of the rad storage area and shower facility with associated walls (to a height of 2 meters) folded out were placed next to each other on a grid drawn to scale. See Encl 1. A random number generator that generates fractions between 0 and 1 was then used to generate random coordinates. The fractions were multiplied by the maximum limits of the floor plan in feet for the x and y direction, therefore generating random coordinates in feet. Wherever a random x and y coordinate fell on a floor or wall (or door) on the scale drawing, it was accepted as a random location to be used for a wipe testing location. Whenever a random x and y coordinate fell outside a floor area or wall area on the scale drawing, it was disregarded. This process was repeated until 40 random locations were identified for the survey unit comprised of the floors, and 42 for the survey unit comprised of the walls (and doors). MARSSIM Appendix B permits 30 random locations per survey unit, but as an extra effort to provide better coverage, extra random locations were generated for each survey unit. Biased wipe test sample location were also established at the storage wells, phone, sink, storage cabinets, hoist controls, and the sidewalk outside the rad storage area and shower facilities. Numbered 1-5/8 inch filter papers were used for the wipe testing, using moderate pressure, and wiping an area of approximately 100 square centimeters.

b. Measurements for Total Contamination. Measurements were also made to detect any fixed contamination that might be present. Total measurements were made at each of the

random locations described above, as well as on the sink, the bottom of each storage cabinet, the sidewalk outside the doors, and in the floor drain trench inside the front door.

c. Gamma Measurements. Gamma measurements were made at a distance of 1 meter above each random location on the floors. Gamma measurements were also taken 1 meter above each storage well, at floor level above each storage well, and at one meter above the sidewalks outside the Rad Storage Area door and Shower Facility door. (There is no knowledge of evidence the storage wells were ever used).

d. Scanning survey. The surface of the floors was subjected to a 100 percent scan for total activity. This is normally considered excessive for a Class 3 area, but since the area is rather small, the NRC suggested it be performed. Due to a lack of a history of significant contamination or unsealed operations in the area, scanning of the walls was not performed. MARSSIM allows the use of such judgment for determining scanning survey requirements for Class 3 areas.

e. Tank water samples. A water sample was taken from the 4000 gallon underground storage tank after the water was vigorously mixed using the bubbler provided in the tank.

f. Further Investigations. Repeat measurements or additional measurements were made at and/or around locations wherever a reading approached the NRC's default Derived Concentration Guideline Level (DCGL).

3. Instrument Selection.

a. Wipe Test Counting. A Nuclear Measurements Corporation model PC-55, serial number 91-2712-02-02 was used to evaluate the wipe samples. Since this instrument is windowless, the wipe sample is placed in the chamber and surrounded by the PC-10 counting gas. This puts the wipe sample in direct contact with the detecting medium, leading to high efficiency and sensitivity. The instrument also performs pulse height discrimination to discriminate between alpha counts and beta counts.

b. Stationary Total Contamination Measurement. Radiation Services Organization, Inc. (RSO), of Laurel, Maryland, was contracted to perform stationary alpha and beta measurements. A Ludlum Model 2221, portable rate-meter/scaler, serial number 108857 with a Ludlum Model 43-68 gas proportional detector (126 cm^2 probe area with a 0.8 mg/cm^2 window thickness), operating at the alpha plateau was used for gross alpha measurements.

A Ludlum Model 2221, portable rate-meter/scaler, serial number 161591 with a Ludlum Model 43-68 gas proportional detector (126 cm^2 probe area with a 0.8 mg/cm^2 window thickness), operating at the alpha/beta plateau was used for gross alpha/beta measurements.

The detectors were placed in direct contact with the floor and a count of 1-minute collected.

c. Scanning for Total Contamination. RSO was also contracted to perform alpha and beta scanning. A Ludlum Floor Monitor Model FM-239-1F with a Model 2221, portable rate-

meter/scaler, serial number 174947 with a Ludlum Model 43-37 gas proportional detector (582 cm^2 probe area with a 0.8 mg/cm^2 window thickness), operating at the alpha/beta plateau was used for beta scans of the floor surfaces.

A Ludlum Model 2221, portable rate-meter/scaler, serial number 108857 with a Ludlum Model 43-68 gas proportional detector (126 cm^2 probe area with a 0.8 mg/cm^2 window thickness), operating at the alpha plateau was used for limited alpha scans of floor surfaces.

d. Gamma Measurements. A BICRON Microrem/hr meter, serial number B142Y, was used to perform the gamma measurements. This instrument uses a tissue equivalent plastic scintillation detector which renders it extremely sensitive. The tissue equivalence of the detector material allows the gamma radiation level to be measured directly in units of microrem/hr.

e. Tank Water. The four radionuclides of interest (based upon the historical site assessment) each emit an easily distinguishable gamma photon in sufficient quantities to allow their quantification utilizing gamma spectroscopy. Therefore, the water sample collected from the holding tank was analyzed on a Gamma Products G-3000 Gamma-Spec System. The G3000 utilizes an EG&G Ortec 25 % high purity germanium detector, with an EG&G amp, analog to digital converter, and an 8,000 channel multi-channel analyzer.

4. Radionuclides Surveyed. The historical site assessment summarized above indicates that the following radionuclides were involved in the few and minor cases of unsealed radioactivity and low-level contamination during the history of the Rad Storage Area: Co-60 (para 1d), U-235 (paras 1f(2) and 1f(6)), U-238 (para 1f(2)), and Ra-226 (para 1f(3)). The measurement techniques and instruments used to detect these isotopes would also be effective at detecting any other alpha or beta contamination that might be present.

5. Measurement Techniques.

a. Wipe Testing. Wipe testing was conducted before any surfaces were swept to help ensure that the presence of any contamination would be detected. Each wipe was taken using moderate pressure covering an area of approximately 100 square centimeters. The wipe test filter was then placed in the PC-55 windowless proportional counter and counted for one minute. It was determined that a one minute count would be sufficient to demonstrate compliance with the NRC DCGL default values for unrestricted area release. A result was recorded from the alpha channel and beta channel for each wipe. Comparison was then made to the established background and corresponding minimum detectable activity for the alpha channel and beta channel.

b. Stationary Total Contamination Monitoring. Once wipe testing confirmed the absence of any removable activity, the surfaces where broom swept to prevent damage to the proportional counter mylar window from debris on the surfaces, and to minimize any shielding of fixed beta and alpha by dirt. For stationary measurements, the counting time, and scan rate where selected to achieve a minimum detectable activity (MDC) at or below the NRC default DCGLs for unrestricted release.

c. Scanning for Total Contamination. For stationary and scanning measurements, the rate at which the probe was passed over the surface and the distance from the surface where regulated to achieve the predicted scan MDC.

d. Gamma Measurements. The "slow" response setting on the instrument was used to provide for a more stable reading. Using the "slow" response setting required the BICRON be held over the point of interest for 30 seconds before the exposure rate displayed was recorded. This allowed the time necessary for the meter with its corresponding RC time constant to reach the final reading for each location. Since all gamma readings were expected to be near the background level, the instrument was not reset between readings, and this further ensured the maximum reading was reached within 30 seconds.

e. Tank Water. A 500 ml sample of the tank water was transferred to a Marinelli beaker and analyzed on a Gamma Products G-3000 Gamma-Spec system. The system utilizes Ortec Gamma-Spec components. The resulting 12 hour spectrum was "background striped " and analyzed with EG&G "Gamma Vision" software.

6. Minimum Detectable Activities/Concentrations.

Un-rounded results are generally presented throughout this survey report, and the reader can round appropriately.

a. Wipe Testing. At Encl 2, see the evaluation of the wipe test samples performed on 28 Nov 06 using the Nuclear Measurements Corporation model PC 55. As shown in paragraphs 3 and 4 of Enclosure 2, the MDA's were calculated using the background count rates on that day and the Co-60 beta counting efficiency and Th-230 alpha counting efficiency established during the quarterly PC-55 calibration conducted 13 Nov 06. Using the Th-230 alpha counting efficiency for U-235, U-238, and Ra-226 alphas, the alpha MDA was calculated to be 8.97 dpm. For Co-60, the MDA was calculated to be 40.25 dpm. Since each wipe covered 100 square centimeter of surface, the MDA's therefore become 8.97 dpm/100cm^2 and 40.25 dpm/100cm^2.

b. Stationary Total Contamination Monitoring. The results of the stationary monitoring are shown in Attachments 2 and 3 of Encl 3 (the RSO Inc report). The MDA for Alpha and Alpha/Beta stationary measurements were calculated using the background count rates for the probe in the room, covered at about 1 m above the floor and using the Co-60 beta counting efficiency and Th-230 alpha counting established at the time of calibration (see calibration sheets at Attachment 4 of Encl 3 (the RSO Inc report).

Using the Th-230 alpha counting efficiency for U-235, U-238, and Ra-226 alphas, and Tc-99 efficiency for Co-60, the MDA's were calculated and were well below the DCGL's. See the survey meter information tables in Attachments 2 and 3 of Encl 3 (the RSO Inc report).

c. Scanning for Total Contamination. The floor monitor operating in the alpha/beta mode was the primary instrument used to scan the floor. Using the background count rate and the scan rate the MDC for the floor monitor was calculated. See para 3.3 of Encl 3 (the RSO Inc report).

In addition, limited scanning of the floor and selected surfaces was performed using the survey meters with the hand-held gas proportional detectors. One operating in the alpha/beta mode the other in the alpha only mode. Using the appropriate background count rate and using appropriate values for scanning speed, distance, surface efficiency, and surveyor efficiency (human factors) the scan MDC was calculated to be about 2000 dpm/100 cm^2 for 60Co and 300 dpm/100 cm^2 for alpha contamination.

d. Gamma Measurements. With the BICRON on the 0-5 microrem/hr scale, and in a very steady and un-fluctuating gamma field, the sensitivity of the instrument and the graduations on the meter face allow the user to easily discern 1 microrem/hr, and perhaps even tenths of a microrem/hr by interpolation between meter graduations. What limits the ability in actual use is the magnitude and variability of the background radiation present. Measurements were therefore made in a reference area to determine how background might limit the sensitivity of gamma measurements. As can be seen in footnote 3 of Encl 4, the levels measured on 01 Dec 06 at 20 random locations in a background reference area varied between 1.4 and 2.5 microrem/hr, with a mean value of about 2 microrem/hr. Variations in these reference area readings (as well as those in the storage and shower area) were probably due to variations in cosmic radiation, and variations in locations and the corresponding differences in proximity to natural sources in the soil and building materials. In the absence of fixed or removable surface contamination, and without any history of radioactive material releases that could have resulted in sequestered contamination, the gamma measurements were made simply to add an additional measure of comfort that there were no gamma radiation emitters remaining in the area. The gamma measurements made in the storage and shower areas verified this, and as expected were in the range of the background levels (and well below the 12.5 microrem/hr that would result in 25 mrem during 2000 hrs/yr).

e. Tank Water. See Encl 5 for a printout of the tank water analysis. The EG&G Gamma Vision software calculated the time corrected MDAs for the various isotopes of interest as follows:

Co-60 = 7.7 E-9 uCi/ml +- 15%
U-238 = < 1.6 E-9 uCi/ml +- 3%
U-235 = < 1.3 E-10 uCi/ml +- 4%
Ra-226 = < 2.2 E-9 uCi/ml +- 4%

These MDAs were then compared to the following effluent release limits in 10CFR20 Appendix B, table 2, column 2. The MDA's were well below the 10CFR20 limits, ranging from 3.6 percent of the effluent limit for Ra-226 to 0.04 percent of the limit for U-235.

10CFR20 App B table 2 col 2, Effluent Concentrations.

Co-60	3E-6 uC/ml
U-235	3E-7 uCi/ml
U-238	3E-7 uCi/ml
Ra-226	6E-8 uCi/ml

7. Calibration and Field Testing of Instrumentation.

a. Wipe Testing. On the day that the wipe tests were evaluated, the PC-55 was subjected to a scaler self-test to ensure the proper functioning of the scaler. Twenty consecutive background counts were then made and recorded for both the alpha and beta channels. A reliability factor statistical test was then performed on the beta counts to ensure that the instrument was responding with the statistical variability expected from radioactive decay. Once that was verified, the twenty beta background counts were used to calculate the mean beta cpm for background, and the corresponding lower level of detection (LLD) for beta, using the NRC prescribed equation. The same was then done for the alpha background measurements. Once an LLD was determined for the alpha background and for the beta background, the PC-55 was response/efficiency checked using NIST traceable calibration sources. A one minute count of each source was compared to that expected considering the decay of the source, and the statistical variation of radioactivity. If the count was within plus or minus 2 sigma of the expected count rate, as displayed on a quality control chart for the instrument and each calibration source, the instrument function was considered reliable. The efficiency for the alpha calibration source and the beta calibration source from the last quarterly calibration was then adopted and used with the LLD's established above to calculate the minimum detectable activities for this days counting. The wipe samples were then counted. Following the last wipe sample, the calibration sources were then counted again to ensure the instrument was still operating correctly, and that the calibration source counts fell within plus or minus 2 sigma on the quality control charts.

b. Stationary Total Contamination Monitoring. The survey meters (Ludlum 2221 with gas proportional detectors) used for Total Contamination Monitoring were calibrated by RSO, Inc. of Laurel, MD using standard and manufacturer's procedures. Efficiency for the radionuclides of interest (60Co and alpha emitters, 226Ra and U isotopes with alpha energies of between 4.5 MeV and 5.5 MeV) was determined using a 230Th source for the alpha efficiency and 99Tc for the beta efficiency. See Attachment 4 of Encl 3 (the RSO Inc report).

On the day of use background was determined for a 10 minute count, the response and the response to a check source determined and compared to expected values. During the use the instrument response was periodically checked for both background response and check source (every 3 hours).

Each indicated sample location was surveyed for both alpha and alpha/beta activity using each of the survey meters. The detector was placed in contact with the surface (e.g., floor or wall) and a 1 minute count collected.

c. Scanning for Total Contamination. The survey meters (Ludlum 2221 with gas proportional detectors) used for surface scanning were calibrated by RSO, Inc. of Laurel, MD using standard and manufacturer's procedures. Efficiency for the radionuclides of interest (60Co and alpha emitters, 226Ra and U isotopes with alpha energies of between 4.5 MeV and 5.5 MeV) was determined using a 230Th source for the alpha efficiency and 99Tc for the beta efficiency. Scans were conducted by moving the detector over the surface at a rate of about 1 detector width per second.

d. Gamma Measurements. The BICRON B142Y is calibrated every 6 months by Radiation Services Organization of Laurel, Maryland. They are licensed by the State of Maryland to provide radiation safety instrument calibration services. The gamma measurements were made on 01 Dec 06, and the BICRON was next due for calibration 14 May 07. Before the facility gamma measurements were made, the BICRON was battery checked and high voltage checked by placing the knob in the corresponding position and ensuring the instrument needle fell within the indicated range on the meter face for each test. The meter was then response checked by placing a NIST traceable Co-60 source 0.065 microcuries, about 10 centimeters from the detector center, and comparing the exposure rate indicated to that expected from calculation using the Co-60 gamma factor. It agreed well. Once proper response of the instrument was verified, the gamma readings at 1 meter above facility surfaces were taken. Following the facility readings, the NIST traceable Co-60 source was again used to verify proper response of the instrument. See the results in the gamma results footnote on Encl 4.

e. Tank Water. The Gamma Products G-3000 system is calibrated for energy and efficiency monthly utilizing a NIST traceable "Isotope Products Standard" of the same geometry as the sample, to include density. This calibration ensures that the system efficiency is within +-5% at all energies of interest. In addition, the efficiency is "checked" at the beginning of each batch of samples (<= 9 samples) to ensure accuracy.

8. Survey Personnel Qualifications.

a. Wipe Testing. Wipe testing was conducted by Michael Borisky, Radiation Safety Officer. Michael Borisky has been serving as the sole NRC authorized Radiation Safety Officer and NRC license manager at the HDL/ALC site since 1981. Michael Borisky holds a Bachelors in Biological Sciences and a Master of Health Science in Radiation Health Science. During this period Michael Borisky has accumulated much experience conducting and evaluating wipe tests during periodic surveys, shipment and receipt of packages, and other final survey efforts. This experience was used in 1999 to successfully conduct the final survey supporting the termination of NRC license 19-17250-05.

b. Stationary Total Contamination Monitoring. Surveys were conducted by Gregory D. Smith, Certified Health Physicist and Paul Madairy, Health Physicist.

Gregory D. Smith, CHP (present during all RSO Inc measurments):

- Certification by the American Board of Health Physics (1989)
- M.S. Colorado State University-Health Physics (1986)
- 25 Years of Radiation Safety Program and Services Experience with RSO, Inc. including facility decommissioning surveys
- 4 Years Experience as support to Project Manager for USAMRICD
- X-Ray Licensed Inspector State of Maryland
- MARSSIM Training 40-Hour ORAU (October 2005)

Paul Madairy

- B.S. Nuclear Engineering Science (1986)

- 6 Years of Radiation Safety Program and Services Experience with RSO, Inc.
- 2 Years of USAMRMC Experience as Back-up to Primary HP at USAMRICD
- 5 Years of Radiation Safety Services Experience with RSO, Inc. including facility decommissioning surveys
- MARSSIM Training 40-Hour ORAU (June 2003)

c. Scanning for Total Contamination. See b. above.

d. Gamma Measurements. Gamma measurements were made by Michael Borisky, Radiation Safety Officer. Michael Borisky has been serving as the sole NRC authorized Radiation Safety Officer and NRC license manager at the HDL/ALC site since 1981. During this period Michael Borisky has accumulated much experience conducting gamma measurements during periodic surveys, shipment and receipt of packages, and other final survey efforts. This experience was used in 1999 to successfully conduct the final survey supporting the termination of NRC license 19-17250-05.

e. Tank Water. The tank water sample was collected by Michael Borisky. The tank water analysis was conducted by Richard Markland, ARL/BRL Radiation Safety Officer at our Aberdeen Proving Ground site for over 30 years. During that time, Mr. Markland has served as the Radiation Safety Officer over a broad scope license to include depleted uranium hard target testing and environmental sampling. The equipment and methods used to analyze the water sample is the same equipment and methods Richard Markland uses to evaluate environmental and water samples in support of the depleted uranium license, NRC SMB 141.

9. Interpretation of Survey Measurements.

a. Wipe Testing. The wipe test results were interpreted by Michael Borisky, HDL/ALC Radiation Safety Officers since 1981.

b. Stationary Total Contamination Monitoring. The results of the Total Contamination Monitoring were evaluated and interpreted by Gregory D. Smith, CHP and Paul Madiary of RSO, Inc. under contract to ARL.

c. Scanning for Total Contamination. The results of the Total Contamination Monitoring were evaluated and interpreted by Gregory D. Smith, CHP and Paul Madairy of RSO, Inc. under contract to ARL.

d. Gamma Measurements. The gamma measurements were interpreted by Michael Borisky, HDL/ALC Radiation Safety Officer since 1981.

e. Tank Water. The tank water measurement were interpreted by Michael Borisky and Richard Markland

10. Qualification of Personnel Interpreting Measurements.

a. Wipe Testing. See paragraph 8a above.

b. Stationary Total Contamination Monitoring. See paragraph 8b above.

c. Scanning for Total Contamination. See paragraph 8b above

d. Gamma Measurements. See paragraphs 8a above.

e. Tank Water. See paragraphs 8e above.

11. Measurement Results.

a. Wipe Testing. See Encl 1 for wipe test locations. See Encl 2 for wipe test analysis and results. See Encl 4 for a summary of the wipe test results in a spread sheet format. As can be seen, no removable contamination was detected exceeding the MDAs for each of the radionuclides of interest. Since in each case the MDA was below 10 percent of the NRC's "total" surface contamination default value for unrestricted release, the wipe tests demonstrate compliance with the "removable" portion of the default value. The following is a table of the relationship between the NRC "total" default value, 10 percent of the "total" default value representing the removable default value, and the instrument method MDA.

Radionuclide	"Total" default dpm/100cm^2 (NUREG 5512)	"Removable" default dpm/100cm^2	MDA dpm/100cm^2
Co-60	7050	705	41
U-235	97.6	9.7	9
U-238	101	10.1	9
Ra-226	315	31.5	9

b. Stationary Total Contamination Monitoring. None of the 40 random measurements taken on the facility floors, or the 42 random measurements taken on the facility walls, or the biased total measurements taken as indicated in Attachment 2 of Encl 3 (the RSO Inc report) exceeded the NRC total DCGLs indicated above. The total alpha measurement at two locations were close enough to the default DCGL's that it was decided to investigate further on and around these locations. Additional total measurements were made around RSF6'10",10'11" and RSF10'6",8'9"with the Ludlum 43-68 at positions (footprints) indicated on Encl 6. As can be seen in Attachment 2 of Encl 3 (the RSO Inc report), a few more slightly elevated readings were found around RSF6'10", 10'6". No additional elevated readings were found around RSF10'6",8'9", so they were not recorded. Each footprint was wipe tested and it was verified there was no removable alpha or beta contamination on any footprint. As an ALARA effort, all the footprints were wiped down with institutional grade foaming Windex. Each footprint was then resurveyed, and the total count came down considerably, as indicated on Attachment 3 of Encl 3 (the RSO Inc report). After the cleaning, each footprint was again wipe tested and the absence of removable contamination was again verified, with a removable alpha MDA of 8 dpm/100cm^2, and a removable beta MDA of 40 dpm/100cm^2.

c. Scanning for Total Contamination Monitoring. See the results in Attachment 2 of Encl 3 (the RSO Inc report). No areas of elevated radiation were found during the alpha or beta scans. Measurements with the maximum count rates appeared to be due to variations in background. Instrument scans were all less than the minimum detectable count rate.

d. Gamma Measurements. See Encl 1 for gamma radiation measurement locations, and Encl 4 for gamma measurement results. See footnote 3 of Encl 4 for date of measurements, instrument, date of calibration, pre and post response check results, and background reference area results. As can be seen in footnote 3, the levels measured on 01 Dec 06 at 20 random locations in a background reference area varied between 1.4 and 2.5 microrem/hr, with a mean value of about 2 microrem/hr. Variations in these reference area readings (as well as those in the storage and shower area) were probably due to variations in cosmic radiation with time, and variations in locations and the corresponding differences in proximity to natural sources in the soil and building materials. In the absence of fixed or removable surface contamination, and without any history of radioactive material releases that could have resulted in sequestered contamination, the gamma measurements were made simply to add an additional measure of comfort that there were no gamma radiation emitters remaining in the area. The gamma measurements made in the storage and shower areas verified this, and as expected were in the range of the background levels (and well below the 12.5 microrem/hr that would result in 25 mrem/yr over a period of 2000 hours/yr).

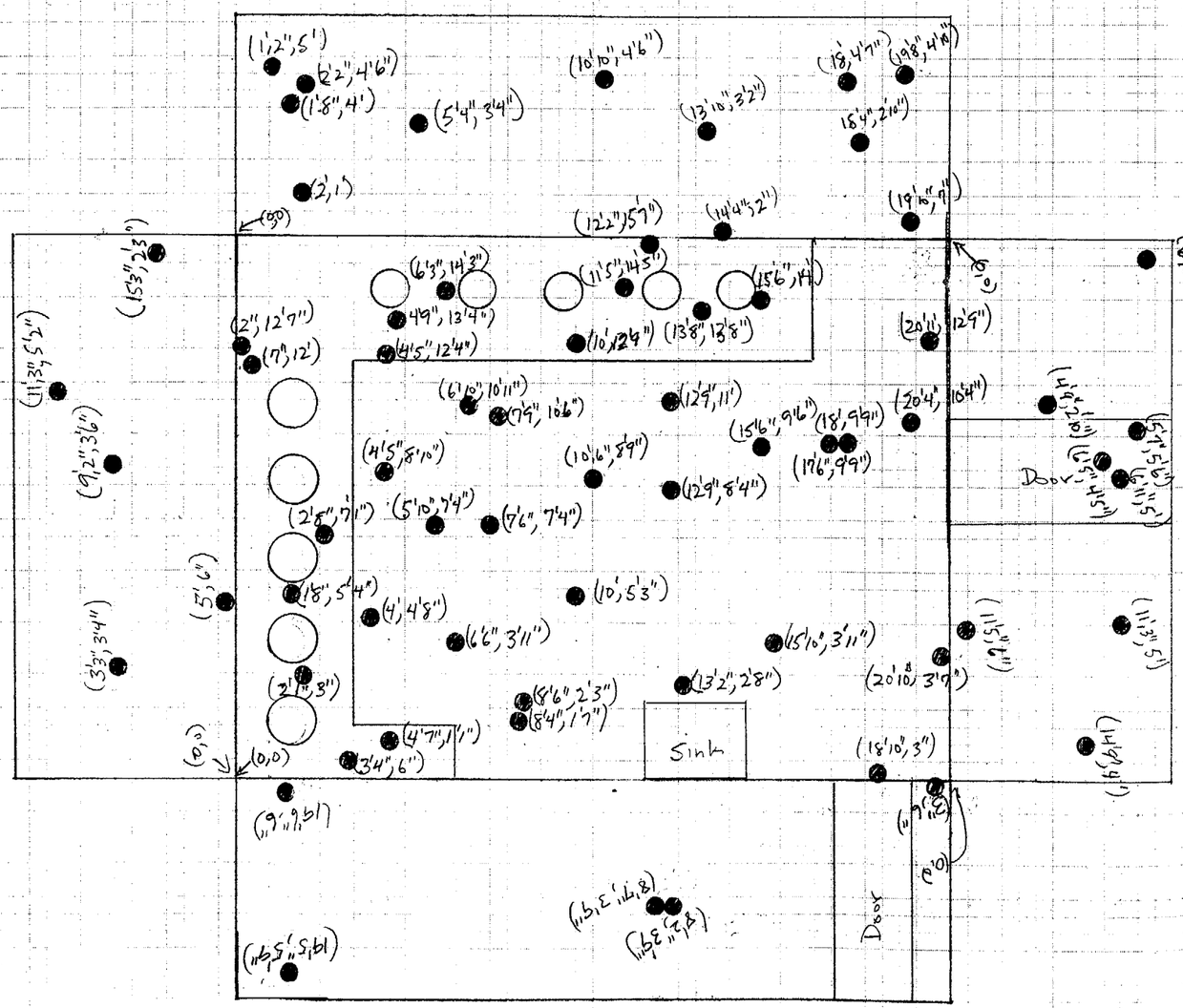
e. Tank Water. The results of the tank water sampling summarized below indicate that the tanks water was well below the allowable effluent releases as allowed by 10CFR20 App B Table 2 Col 2, Effluent Concentrations.

The time corrected results:

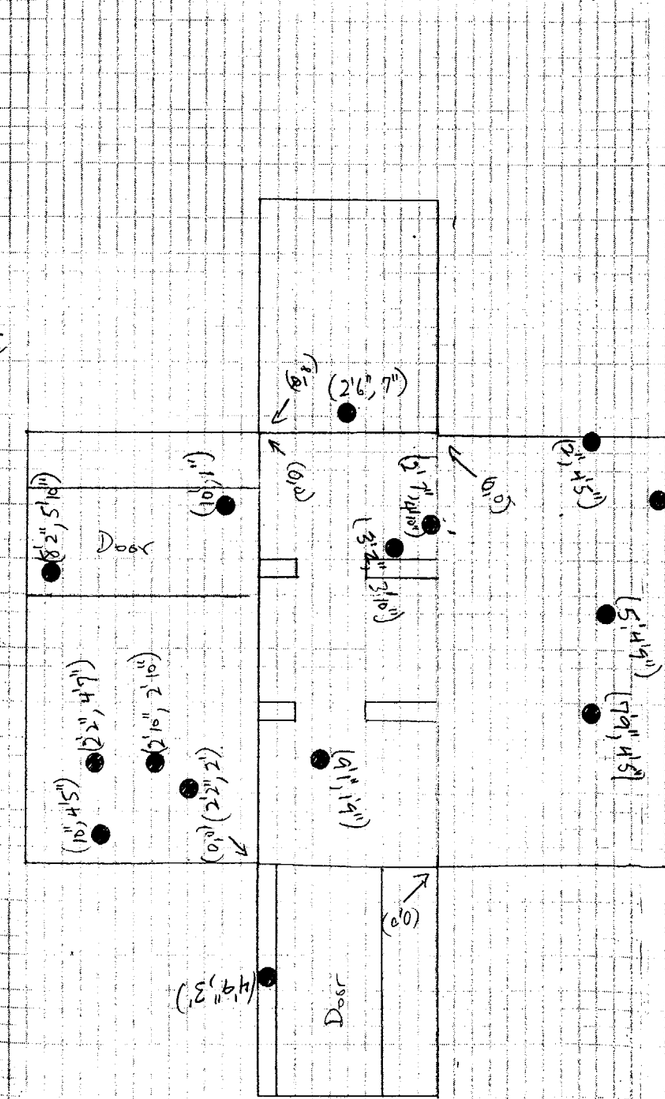
Nuclide	uCi/ml	MDA	Accuracy	10CFR20 App B Table 2 Col 2
Co-60	7.7 E-9		+- 15%3	E-6 uC/ml
U-238	< MDA	1.6 E-9	+- 3%	3E-7 uCi/ml
U-235	< MDA	1.3 E-10	+- 4%	3E-7 uCi/ml
Ra-226	< MDA	2.2 E-9	+- 4%	6E-8 uCi/ml

See Encl 5 for the complete EGG Ortec printout of the water sample analysis.

Rad Storage Area and Walls 1grid = 6"



Shower Area and Walls 1grid = 6"



Rad Storage Area/Shower Final Close-out Wipe Survey

date: 28 Nov 2006 operator: Michael Borisky, Radiation Safety Officer
instrument: NMC PC55, sn 91-2712-2-2, cal due 13 Feb 07

1. Purpose: This wipe testing was conducted to support NRC license termination. ARL-Adelphi is currently pursuing termination of our last NRC license, SNM-348. After all radioactive materials were removed from the Rad Storage Area and decon shower facilities, random and biased wipe testing was performed on the facility surfaces as prescribed by the results of the Historical Site Assessment (HSA). Based upon the HSA, no contamination was expected, and a class 3 survey was therefore prescribed. The HSA would suggest that the only potentially unsealed radionuclides that might have ever been present in the area are U-238, U-235, Ra-226, and Co-60. Alpha and beta counting was therefore performed for each wipe test.

2. Scaler Test: 3600 cpm, ∴ OK

3. Background Determination (Nmode)(1750 volts)(α, β)(cpm)

0,33	0,30	0,39	0,26	0,29	
1,30	0,34	0,29	1,25	0,29	$\bar{X}_\beta$ = 28.76 cpm SD_{obs} = 4.7 $SD_{theo} = \sqrt{\bar{X}}$ = 5.36
0,26	0,33	0,26	0,21	0,24	RF = SD_{obs}/SD_{theo} = .876
1,22	0,28	0,20	0,25	0,33	∴ instrument operation OK
0,30	0,32	0,25	0,34	0,33	$\bar{X}_\alpha$ = 0.12 cpm $SD_{theo} = \sqrt{\bar{X}}$ = .346 cpm

$LLD_\beta = (4.65 \times 5.36\,cpm) + 3\,cpm = 27.9\,cpm$

$LLD_\alpha = (4.65 \times .346\,cpm) + 3\,cpm = \cancel{0.46}\ 4.61\,cpm$

4. Pre-Count Response/Efficiency Check

a. Co-60 (0.0655 μCi as of 28 Nov 06, NIST Traceable)(Nmode)(β cpm)(1750 volts)
99,847 cpm

$$\therefore \text{eff} = \frac{99{,}847\ cpm}{0.0655\,\mu Ci \times 2.22\times10^6\ dpm/\mu Ci} = .6866\ cpm/dpm$$

Within 2σ on QC chart, therefore use Co-60 efficiency of 13 Nov 06 calibration = 0.693 cpm/dpm

$$\therefore MDA_{Co\text{-}60} = \frac{LLD\beta}{.693\ cpm/dpm} = \frac{27.9\ cpm}{.693\ cpm/dpm} = 40.25\ dpm$$

b. Th-230 (.00729 μCi, NIST Traceable)(Nmode)(α cpm)(1750 volts)
8,308 cpm. Within 2σ on QC chart, therefore use Th-230 efficiency of 13 Nov 06 calibration of 0.5136 cpm/dpm.

$$\therefore MDA_{Th\text{-}230} = \frac{LLD\alpha}{.5136\ cpm/dpm} = \frac{4.61\ cpm}{.5136\ cpm/dpm} = 8.97\ dpm$$

Go
To next page

5. Wipe Test Analysis (Nmode)(1750 volts)

Test #	Designation	Location	α cpm	β cpm	α cpm above $\bar{x}$ bkg α + LLD α	β cpm above $\bar{x}$ bkg β + LLD β	eff α	eff β	Result (dpm/100 cm²) assumed Th-230 α eff for U-235, U-238, Ra-226
1	RSF 2", 12'7"	Rad Storage Floor	0	31	0	0	.5136	.6866	<9 dpm/100 cm² U-235, U-238, Ra-226; < 41 dpm/100 cm² Co-60
2	RSF 7", 12'	Rad Storage Floor	0	33	0	0	.5136	.6866	"
3	RSF 1'8", 5'4"	Rad Storage Floor	0	26	0	0	.5136	.6866	"
4	RSF 2'1", 3'	Rad Storage Floor	0	26	0	0	.5136	.6866	"
5	RSF 2'8", 7'1"	Rad Storage Floor	0	27	0	0	.5136	.6866	"
6	RSF 3'4", 6"	Rad Storage Floor	0	24	0	0	.5136	.6866	"
7	RSF 4', 418"	Rad Storage Floor	0	24	0	0	.5136	.6866	"
8	RSF 4'5", 8'10"	Rad Storage Floor	0	26	0	0	.5136	.6866	"
9	RSF 4'5", 12'4"	Rad Storage Floor	0	32	0	0	.5136	.6866	"
10	RSF 4'7", 1'1"	Rad Storage Floor	0	25	0	0	.5136	.6866	"
11	RSF 4'9", 13'4"	Rad Storage Floor	1	26	0	0	.5136	.6866	"
12	RSF 5'10", 7'4"	Rad Storage Floor	0	30	0	0	.5136	.6866	"
13	RSF 6'3", 14'3"	Rad Storage Floor	0	31	0	0	.5136	.6866	"
14	RSF 6'6", 3'11"	Rad Storage Floor	0	30	0	0	.5136	.6866	"
15	RSF 6'10", 10'11"	Rad Storage Floor	0	25	0	0	.5136	.6866	"
16	RSF 7'6", 7'4"	Rad Storage Floor	0	26	0	0	.5136	.6866	"
17	RSF 7'9", 10'6"	Rad Storage Floor	0	24	0	0	.5136	.6866	"
18	RSF 8'4", 1'7"	Rad Storage Floor	0	25	0	0	.5136	.6866	"
19	RSF 8'6", 2'3"	Rad Storage Floor	0	26	0	0	.5136	.6866	"
20	RSF 10', 5'3"	Rad Storage Floor	0	27	0	0	.5136	.6866	"
21	RSF 10', 12'9"	Rad Storage Floor	0	28	0	0	.5136	.6866	"
22	RSF 10'6", 8'9"	Rad Storage Floor	0	27	0	0	.5136	.6866	"
23	RSF 11'5", 14'8"	Rad Storage Floor	0	30	0	0	.5136	.6866	"

5. Wipe Test Analysis (con't) (Nmade)(1750 vol/kr)

Test #	Designation/Location		α cpm	β cpm	α cpm above $\bar{X}_\alpha$ bkg + LLD_α	β cpm above $\bar{X}$ bkg β + LLD_β	eff α	eff β	Result assumed Th-230 α eff for U-235, U-238, Ra-226
24	RSF 12'2", 5'7"	Rad Storage Floor	0	29	0	0	.5136	.6866	<9 dpm/100cm² U-235, U-238, Ra-226; <41 dpm/100cm² Co-60
25	RSF 12'9", 8'4"	Rad Storage Floor	1	33	0	0	.5136	.6866	"
26	RSF 12'9", 11'	Rad Storage Floor	0	29	0	0	.5136	.6866	"
27	RSF 13'2", 2'8"	Rad Storage Floor	0	29	0	0	.5136	.6866	"
28	RSF 13'8", 13'8"	Rad Storage Floor	1	28	0	0	.5136	.6866	"
29	RSF 15'6", 9'6"	Rad Storage Floor	0	28	0	0	.5136	.6866	"
30	RSF 15'6", 14'	Rad Storage Floor	0	29	0	0	.5136	.6866	"
31	RSF 15'10", 3'11"	Rad Storage Floor	0	29	0	0	.5136	.6866	"
32	RSF 17'6", 9'9"	Rad Storage Floor	0	34	0	0	.5136	.6866	"
33	RSF 18', 9'9"	Rad Storage Floor	0	31	0	0	.5136	.6866	"
34	RSF 18'10", 3"	Rad Storage Floor	1	28	0	0	.5136	.6866	"
35	RSF 20'4", 10'4"	Rad Storage Floor	0	27	0	0	.5136	.6866	"
36	RSF 20'10", 3'7"	Rad Storage Floor	0	28	0	0	.5136	.6866	"
37	RSF 20'11", 12'9"	Rad Storage Floor	0	31	0	0	.5136	.6866	"
38	RSFW 3", 6"	Rad Storage Front Wall	0	27	0	0	.5136	.6866	"
39	RSFW 8'2", 3'9"	Rad Storage Front Wall	0	27	0	0	.5136	.6866	"
40	RSFW 8'7", 3'9"	Rad Storage Front Wall	0	37	0	0	.5136	.6866	"
41	RSFW 19'5", 5'9"	Rad Storage Front Wall	0	28	0	0	.5136	.6866	"
42	RSFW 19'6", 6"	Rad Storage Front Wall	0	24	0	0	.5136	.6866	"
43	RSLW 3'3", 3'4"	Rad Storage Left Wall	0	26	0	0	.5136	.6866	"
44	RSLW 5', 6'	Rad Storage Left Wall	0	25	0	0	.5136	.6866	"
45	RSLW 9'2", 3'6"	Rad Storage Left Wall	1	36	0	0	.5136	.6866	"
46	RSLW 11'3", 5'2"	Rad Storage Left Wall	0	28	0	0	.5136	.6866	"
47	RSLW 15'3", 2'3"	Rad Storage Lef Wall	1	39	0	0	.5136	.6866	"

5. Wipe Test Analysis (con't) (N mode)(1750 volts)

Test #	Designation/Location	α cpm	β cpm	α cpm above $\bar{x}$ bkg α + LLD α	β cpm above $\bar{x}$ bkg β + LLD β	eff α	eff β	Result assumed Th-230 α eff for U-235, U-238, Ra-226
48	RSBW 1'2", 5' Rad Storage Back Wall	0	22	0	0	.5136	.6866	<9 dpm/100 cm² U-235, U-238, Ra-226; <41 dpm/100 cm² Co-60
49	RSBW 1'8", 4' Rad Storage Back Wall	0	28	0	0	.5136	.6866	"
50	RSBW 2', 1' Rad Storage Back Wall	0	24	0	0	.5136	.6866	"
51	RSBW 2'2", 4'6" Rad Storage Back Wall	0	36	0	0	.5136	.6866	"
52	RSBW 5'4", 3'4" Rad Storage Back Wall	0	25	0	0	.5136	.6866	"
53	RSBW 10'10", 4'6" Rad Storage Back Wall	0	35	0	0	.5136	.6866	"
54	RSBW 13'10", 3'2" Rad Storage Back Wall	0	25	0	0	.5136	.6866	"
55	RSBW 14'4", 2" Rad Storage Back Wall	0	33	0	0	.5136	.6866	"
56	RSBW 18', 4'7" Rad Storage Back Wall	0	28	0	0	.5136	.6866	"
57	RSBW 18'4", 2'10" Rad Storage Back Wall	1	22	0	0	.5136	.6866	"
58	RSBW 19'8", 4'10" Rad Storage Back Wall	0	21	0	0	.5136	.6866	"
59	RSBW 19'10", 7" Rad Storage Back Wall	0	34	0	0	.5136	.6866	"
60	RSRW 6", 5'9" Rad Storage Right Wall	0	29	0	0	.5136	.6866	"
61	RSRW 4'9", 2'10" Rad Storage Right Wall	0	25	0	0	.5136	.6866	"
62	RSRW 5'7", 5'6" Rad Storage Right Wall	0	23	0	0	.5136	.6866	"
63	RSRW 6'5", 4'5" Rad Storage Right Wall	0	31	0	0	.5136	.6866	"
64	RSRW 6'11", 5' Rad Storage Right Wall	1	34	0	0	.5136	.6866	"
65	RSRW 11'3", 5' Rad Storage Right Wall	0	31	0	0	.5136	.6866	"
66	RSRW 11'5", 6" Rad Storage Right Wall	0	25	0	0	.5136	.6866	"
67	RSRW 14'9", 4' Rad Storage Right Wall	0	22	0	0	.5136	.6866	"
68	SF 2'7", 4'10" Shower Floor	0	28	0	0	.5136	.6866	"
69	SF 3'2", 3'10" Shower Floor	0	30	0	0	.5136	.6866	"
70	SF 9'1", 1'9" Shower Floor	0	31	0	0	.5136	.6866	"
71	SFW 4'9", 3' Shower Front Wall	1	34	0	0	.5136	.6866	"

5. Wipe Test Analysis (con't) (W mode)(1750 volts)

Test #	Designation	Location	α cpm	β cpm	α cpm above $\bar{X}$ bkg $\alpha + LLD_\alpha$	β cpm above $\bar{X}$ bkg $\beta + LLD_\beta$	eff α	eff β	Result assumed Th-230 α eff for U-235, U-238, Ra-226
72	SLW 10", 4'5"	Shower Left Wall	0	34	0	0	.5136	.6866	<9 dpm/100² U-235, U-238, Ra-226; <41 dpm/100cm² Co-60
73	SLW 2'2", 2'	Shower Left Wall	0	25	0	0	.5136	.6866	"
74	SLW 2'2", 4'7"	Shower Left Wall	0	26	0	0	.5136	.6866	"
75	SLW 2'10", 2'10"	Shower Left Wall	1	37	0	0	.5136	.6866	"
76	SLW 8'2", 5'10"	Shower Left Wall	1	30	0	0	.5136	.6866	"
77	SLW 10', 1"	Shower Left Wall	0	35	0	0	.5136	.6866	"
78	SBW 2'6", 7"	Shower Back Wall	0	30	0	0	.5136	.6866	"
79	SRW 2", 4'5"	Shower Right Wall	0	29	0	0	.5136	.6866	"
80	SRW 1'9", 6'3"	Shower Right Wall	0	26	0	0	.5136	.6866	"
81	SRW 5', 4'9"	Shower Right Wall	0	35	0	0	.5136	.6866	"
82	SRW 7'9", 4'5"	Shower Right Wall	1	26	0	0	.5136	.6866	"
83	W1	Bottom of storage well 1	0	34	0	0	.5136	.6866	"
84	W2	Bottom of storage well 2	0	27	0	0	.5136	.6866	"
85	W3	Bottom of storage well 3	0	31	0	0	.5136	.6866	"
86	W4	Bottom of storage well 4	0	20	0	0	.5136	.6866	"
87	W5	Bottom of storage well 5	0	30	0	0	.5136	.6866	"
88	W6	Bottom of storage well 6	2	24	0	0	.5136	.6866	"
89	W7	Bottom of storage well 7	0	36	0	0	.5136	.6866	"
90	W8	Bottom of storage well 8	1	20	0	0	.5136	.6866	"
91	W9	Bottom of storage well 9	0	26	0	0	.5136	.6866	"
92	W10	Bottom of storage well 10	0	21	0	0	.5136	.6866	"
93	phone	phone	0	34	0	0	.5136	.6866	"
94	SIB	Sink - inside bottom	0	35	0	0	.5136	.6866	"
95	SIBA	Sink - inside back	0	24	0	0	.5136	.6866	"

5. Wipe Test Analysis (con't) (N mode)(1750 volts)

Test #	Designation	Location	α cpm	β cpm	α cpm above $\bar{x}$ bkg α + LLDα	β cpm above $\bar{x}$ bkg β+LLDβ	eff α	eff β	Result assumed Th-230 α eff for U-235, U-238, Ra-226
96	SIR	Sink - inside right	0	28	0	0	.5136	.6866	<9 dpm/100cm² U-235, U-238, Ra-226; <41 dpm/100cm² Co-60
97	SIL	Sink - inside left	0	30	0	0	.5136	.6866	"
98	SSH	Sink spigot handles	1	26	0	0	.5136	.6866	"
99	CAB10B	Cabinet 1 outside bottom	0	30	0	0	.5136	.6866	"
100	CAB1SH1	Cabinet 1 shelf 1	0	27	0	0	.5136	.6866	"
1a	CAB1SH2	Cabinet 1 shelf 2	0	32	0	0	.5136	.6866	"
2a	CAB1SH3	Cabinet 1 shelf 3	0	33	0	0	.5136	.6866	"
3a	CAB1SH4	Cabinet 1 shelf 4	1	28	0	0	.5136	.6866	"
4a	CAB1SH5	Cabinet 1 shelf 5	0	33	0	0	.5136	.6866	"
5a	CAB1SH6	Cabinet 1 shelf 6	0	23	0	0	.5136	.6866	"
6a	CAB5H7	Cabinet 1 shelf 7	0	27	0	0	.5136	.6866	"
7a	CAB20B	Cabinet 2 outside bottom	1	26	0	0	.5136	.6866	"
8a	CAB2SH1	Cabinet 2 shelf 1	0	27	0	0	.5136	.6866	"
9a	CAB2SH2	Cabinet 2 shelf 2	1	37	0	0	.5136	.6866	"
10a	CAB2SH3	Cabinet 2 shelf 3	0	25	0	0	.5136	.6866	"
11a	CAB2SH4	Cabinet 2 shelf 4	1	34	0	0	.5136	.6866	"
12a	CAB2SH5	Cabinet 2 shelf 5	0	34	0	0	.5136	.6866	"
13a	CAB2SH6	Cabinet 2 shelf 6	0	34	0	0	.5136	.6866	"
14a	CAB30B	Cabinet 3 outside bottom	0	23	0	0	.5136	.6866	"
15a	CAB3SH1	Cabinet 3 shelf 1	1	21	0	0	.5136	.6866	"
16a	CAB3SH2	Cabinet 3 shelf 2	1	29	0	0	.5136	.6866	"
17a	CAB3SH3	Cabinet 3 shelf 3	1	26	0	0	.5136	.6866	"
18a	CAB3SH4	Cabinet 3 shelf 4	0	27	0	0	.5136	.6866	"
19a	CAB3SH5	Cabinet 3 shelf 5	0	26	0	0	.5136	.6866	"

5. Wipe Test Analysis (con't) (N mode)(1750 volts)

Test #	Designation	Location	α cpm	β cpm	α cpm above $\bar{X}$ bkg α+LLDα	β cpm above $\bar{X}$ bkg β+LLDβ	eff α	eff β	Result assumed Th-230 α eff for U-235, U-238, Ra-226
20a	CAB4OB	Cabinet 4 outside bottom	0	26	0	0	.5136	.6866	<9 dpm/100cm² U-235, U-238, Ra-226 ; <41 dpm/100cm² Co-60
21a	CAB4SH1	Cabinet 4 shelf 1	0	27	0	0	.5136	.6866	"
22a	CAB4SH2	Cabinet 4 shelf 2	1	31	0	0	.5136	.6866	"
23a	CAB4SH3	Cabinet 4 shelf 3	0	27	0	0	.5136	.6866	"
24a	CAB4SH4	Cabinet 4 shelf 4	0	27	0	0	.5136	.6866	"
25a	CAB4SH5	Cabinet 4 shelf 5	1	22	0	0	.5136	.6866	"
26a	CAB4SH6	Cabinet 4 shelf 6	0	25	0	0	.5136	.6866	"
27a	CC	Crane (hoist) controls	0	33	0	0	.5136	.6866	"
28a	RSDSW	Rad Storage Door Sidewalk	0	28	0	0	.5136	.6866	"
29a	SFDSW	Shower Facility Door Sidewalk	0	25	0	0	.5136	.6866	"

6. Post Count Response / Efficiency Check

a. Co-60 (0.0655 μCi, NIST Traceable)(N mode)(1750 volts)(β channel)
99,725 cpm. Still within 2σ on QC chart
∴ instrument operation OK

b. Th-230 (.00729 μCi, NIST Traceable)(N mode)(1750 volts)(α channel)
8,281 cpm. Still within 2σ on QC chart
∴ instrument operation OK

7. Discussion : There is no evidence of removable contamination on the rad storage area and shower facility surfaces and sidewalks outside the doors exceeding the minimum detectable activities indicated. There is also no evidence of removable contamination on the equipment remaining in these areas. The counting achieved MDA's below 10% of the total contamination limits published by the NRC as default values for final surveys. Since no contamination was detected, no clean-up to satisfy ALARA was required.

Michael Brisk
Radiation Safety Officer 28 Nov 06

RSO, Inc.

Radiation Service Organization

February 26, 2007

Mike Borisky
U.S. Army Research Laboratory
ATTN: AMSRD-ARL-O-PA
2800 Powder Mill Rd.
Adelphi, MD 20783-1197 Phone: 301-394-6310

Re: Radiological Static and Scan Survey Report

Dear Mr. Borisky:

Enclosed please find the original copy of the Radiological Static and Scan Survey Report of the Radioactive Storage Area at the ARL facility in Adelphi, MD.

Please call me if you have any questions or if you need any additional information.

Thank-you,

Gregory D. Smith, CHP

P.O. Box 1450, Laurel, Maryland 20725-1450
Washington (301) 953-2482 Fax (301) 498-3017 Baltimore (410) 792-7444

Encl 3 of Encl 3

RADIOLOGICAL
STATIC AND SCAN SURVEY REPORT

U.S. Army Research Laboratory
Radioactive Storage Area

February 2007

Prepared for:

U.S. Army Research Laboratory
ATTN: AMSRD-ARL-O-SH
2800 Powder Mill Rd
Adelphi, MD 20783-1197

Prepared by:

RSO, Inc.
Laurel, MD

RADIOLOGICAL
STATIC AND SCAN SURVEY REPORT

U.S. Army Research Laboratory
Radioactive Storage Area

Revision 0
February 2007

For The

U.S. Army Research Laboratory
ATTN: AMSRD-ARL-O-SH
2800 Powder Mill Rd
Adelphi, MD 20783-1197

Prepared by: Gregory D. Smith, CHP Date 2/26/07

RSO, Inc.
Laurel, Maryland

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1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

The US Army ARL plans to terminate a materials license for the ARL facility in Adelphi, MD. To support the request for termination, ARL will provide a Final Radiological Survey (Final Status Survey or FSS) to the Nuclear Regulatory Commission (NRC). As part of this survey, ARL has contracted for direct and scanning surveys of selected areas at ARL.

Facility: U.S. Army Research Laboratory
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2800 Powder Mill Rd
Adelphi, MD 20783-1197

ARL performed a radiological Historical Site Assessment (HSA), determined the areas to be surveyed, performed wipe tests for removable contamination and determined locations for static measurements and areas for the scan surveys.

RSO, Inc. (RSO) supplied selected calibrated radiation survey equipment and provided an analysis of the sensitivity of the survey meters for the selected potential contaminate radionuclides. RSO supplied trained and experienced personnel to operate the equipment, collect and provide radiation survey data (with data reduction).

1.2 Scope

This report provides the results of the static measurements and scanning surveys. Specifically, RSO, Inc. provided:

1. Calibration of survey meters w/ certificates of fixed and scanning survey instruments for U-238, U-235, Ra-226 with daughters, and Co-60.

2. Calculation of MDA for fixed and scanning instrument for each of the above nuclides, with comparison to the following NRC screening values.

Concentration (dpm/100 cm^2) equivalent to 25 mrem/y for the specified value of P_{crit} (from NUREG 5512 Vol.3, Table 5.19).

Radionuclide	Surface Contamination (dpm/100 cm^2)
U-238	101
U-235	97.6
Ra-226	315
Co-60	7050

3. Surveys of approximately 160 static locations measurements (80 random plus 80 biased) with MDA meeting the above limits.

4. Scan of 396 square feet floor area.

5. Scan of 40 sq feet sidewalk area.

6. a report for submission to NRC as part of the radiological survey and license termination

request, to include instrument description, calibration, efficiency, operator qualifications, etc., and whatever other information the NRC might request to support license termination.

1.3 Background Site Information

Specific site information will be provided by ARL as part of the Final Status Survey. A short description of the survey area is proved here.

The area surveyed was the former Radioactive Material Storage Room and the adjacent shower area. The room was on grade with poured concrete walls and floor. A composite concrete material (about ¼" thick) covered the floor in both the main former storage area and the shower area. There were 10 steel storage wells set in an elevated area of the perimeter of the room. The back wall of the shower area was concrete block. The slab overhead was a thick section of concrete as shielding for the past use radiation producing machines in other areas of the building.

1.4 Summary of History of Use

Specific site information will be provided by ARL as part of the Final Status Survey.

1.5 Summary of Decommissioning

Specific site information will be provided by ARL as part of the Final Status Survey.

2.0 FINAL SURVEY - APPROACH

2.1 Design Basis

This Final Status Survey (FSS) was designed by ARL in consideration of NUREG 1757 for a Group 1 and Group 2 facilities. These 2 groups are for facilities that would not have contaminated work areas at the levels above the decommissioning screening criteria.

From NUREG 1757 v1 Chapter 6: "Group 1 facilities typically involve licensed material used in a way that would preclude its release into the environment, would not cause the activation of adjacent materials, or would not have contaminated work areas above the levels of the decommissioning screening criteria (see Appendix B)."

"Additionally, licensees in Group 2 typically possess historical records of material receipt, use, and disposal, such that quantifying past radiological material possession and use may be developed with a high degree of confidence."

MARSSIM

This survey was designed and conducted using guidance provided in NUREG-1575, EPA 402-R-97-016, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM): Revision 1, August 2000.

2.2 Area Classification

Impacted Areas

Impacted areas were identified by ARL using knowledge of past site operations together with site historical surveys. In the Final Status Survey (FSS), radiation surveys do not need to be conducted in non-impacted areas.

- Impacted areas are areas that may have residual radioactivity from the licensed activities.
- Non-impacted areas are areas without residual radioactivity from licensed activities.

Area Classification

Impacted areas can be classified into one of the three classes, listed below, based on levels of residual radioactivity.

- Class 1 Areas are impacted areas that, prior to remediation, are expected to have concentrations of residual radioactivity that exceed the $DCGL_W$. ($DCGL_W$ is defined in Section 2.2 of MARSSIM);
- Class 2 Areas are impacted areas that, prior to remediation, are not likely to have concentrations of residual radioactivity that exceed the $DCGL_W$.;
- Class 3 Areas are impacted areas that have a low probability of containing residual radioactivity.

2.3 Decommissioning Criteria

The release criteria, against which the survey findings were considered, were those specified by the NRC in Radiological Criteria for License Termination (10 CFR Part 20 Subpart E). Specifically:

> The site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem per year, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

From NUREG 5512 Table 5.19 Concentration (dpm/100 cm2) equivalent to 25 mrem/y for the specified value of P_{crit} the following screening values were provided:

Radionuclide	Surface Contamination (dpm/100 cm^2)
U-238	101
U-235	97.6
Ra-226	315
Co-60	7050

2.4 Survey Approach

The survey conducted by RSO, Inc. included static measurements of floors and walls at survey locations selected by ARL and scans of the floor. ARL conducted wipe tests for removable contamination and gamma dose rate measurements. The wipe tests indicated no removable contamination and gamma dose rates of the Radioactive Material storage room were generally lower than typical indoor gamma dose rates (as expected due to the thick shielding walls and ceiling of this area). It should be noted that the adjacent shower/exit was not under the thick portion of the overhead slab.

The HSA survey identified 60Co (beta decay) and 226Ra, 235U and 238U as the potential radionuclide contaminates in the survey areas. These radionuclides emit beta and alpha radiation. Survey meters with large area gas flow proportional detectors were used operating in both alpha only modes (alpha plateau) and at the alpha/beta plateau. These survey meters provide excellent sensitivity to beta or alpha emitting radionuclides for the surface scans and Static measurements.

Surveys were performed as follows:

Alpha Static Measurements:

Survey meter in the scaler mode, operating at the alpha only plateau, coupled to a gas proportional detector (126 cm^2 window area and 0.8 mg/cm^2 window thickness) in direct contact with the surface (e.g.: floor or wall) and a 1-minute count time.

Beta Static Measurements:

Survey meter in the scaler mode, operating at the alpha/beta plateau, coupled to a gas proportional detector (126 cm^2 window area and 0.8 mg/cm^2 window thickness) in direct contact with the surface (e.g.: floor or wall) and a 1-minute count time.

Beta Scan Measurements:

Survey meter in the rate mode (analog rate-meter), operating at the alpha/beta plateau, coupled to a gas proportional detector (126 cm^2 window area and 0.8 mg/cm^2 window thickness) at about 1 cm from the surface (e.g.: floor or wall) also using digital rate function.

This survey meter/detector was used to survey floor areas inaccessible to the large detector (582 cm^2) of the floor monitor.

Alpha Scan Measurements:

Survey meter in the rate mode (analog rate-meter), operating at the alpha only plateau, coupled to a gas proportional detector (126 cm^2 window area and 0.8 mg/cm^2 window thickness) at about 0.5 to 1 cm from the surface (e.g.: floor or wall) also using digital rate function.

This survey meter was used for alpha scans of selected sections of floor.

Floor Monitor Beta Scan Measurements:

Survey meter in the rate mode (analog rate-meter), operating at the alpha/beta plateau, coupled to a gas proportional detector (582 cm^2 window area and 0.8 mg/cm^2 window thickness) at about 1 cm from the surface (e.g.: floor or wall) also using digital rate function.

Approximately 85% of the floor was accessible and was surveyed with this unit.

2.5 Background Radiation Level Determination

Daily backgrounds were performed and recorded for each instrument before starting survey work each day.

Background for the gas proportional detectors was determined with the detector in the survey area, at about 1 m above the floor, not in contact with room surface (aka: air), with a protective cover only.

2.6 Survey Methods

Survey Locations

Survey maps were provided by ARL for floor and wall surfaces for the purpose of referencing locations of wipes, Static measurements and other survey activities. The sample locations had been selected by ARL at random and biased locations.

Removable Contamination

The area had been surveyed by ARL for removable contamination prior to the survey with no removable contamination detected. Following the results of the wipe tests, the area was made "broom clean" to clear any debris that might damage the detectors used for the Static and scan measurements.

Scan Survey

Primarily scans were performed of the floor using a cart mounted large area proportional detector coupled to an analog/digital rate-meter with an audio output. Surface scanning speeds were 1 detector width per second. To optimize detection of elevated radiation levels (1.5 to 3 times background) during scanning, the survey meter audio was used in addition to noting the fluctuations in the analog meter reading and the survey meter digital rate function.

Static Measurements

Static radiation measurements for alpha, and or alpha/beta surface activity were performed at random and biased locations using a portable gas flow proportional counter. Measurements were conducted by integrating counts over a 1 minute period.

Exposure Rate Measurements

Gamma exposure rates were measured by ARL.

Other Sampling

The sink, dry drain trench, the exterior bottom (~15 cm) of 4 steel cabinets, the shower stalls and the outdoor concrete sidewalk were surveyed using scans and static measurements.

Laboratory Services

No laboratory services such as radioanalytical services were provided by RSO, Inc.

Quality Assurance

Survey meters used to perform the Final Survey had been calibrated within 6 months of their use using radioactive standards traceable to NIST. Also, performance checks were completed on each survey meter at the beginning of each day of use and periodically throughout the day.

The data was reviewed for consistency and data reduction method.

2.7 Organization and Responsibilities

Oversight of the contract was provided by Michael Borisky, the ARL Radiation Safety

Officer.

The Radiological Final Survey was performed by the following personnel from RSO, Inc.:

Mr. Gregory D. Smith, Certified Health Physicist, RSO, Inc.

- Certification by the American Board of Health Physics (1989)
- M.S. Colorado State University-Health Physics (1986)
- 25 Years of Radiation Safety Program and Services Experience with RSO, Inc. including facility decommissioning surveys
- 4 Years Experience as support to Project Manager for USAMRICD
- X-Ray Licensed Inspector State of Maryland
- MARSSIM Training 40-Hour ORAU (October 2005)

Mr. Paul Madairy, Health Physicist, RSO, Inc.

- B.S. Nuclear Engineering Science (1986)
- 6 Years of Radiation Safety Program and Services Experience with RSO, Inc.
- 2 Years of USAMRMC Experience as Back-up to Primary HP at USAMRICD
- 5 Years of Radiation Safety Services Experience with RSO, Inc. including facility decommissioning surveys
- MARSSIM Training 40-Hour ORAU (June 2003)

Personnel Qualifications

All personnel had levels of training and experience commensurate with their assigned tasks. For those individuals involved in taking radiological measurements and samples, special instruction was provided when necessary on equipment, special techniques, and practices relating to survey activities.

3.0 SURVEY INSTRUMENTATION

3.1 Description of Instrumentation

The survey instruments that were used to perform the Final Survey are shown in Table 3 below:

Table 3. Survey meters used to conduct the Final Survey.

Survey Meter	Detector Model	Detector Type	Probe Area/Size	Description
Floor Monitor Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-37	Gas Flow Proportional Detector	582 cm^2	Scans of Floors
Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-68 (Alpha Plateau)	Gas Flow Proportional Detector	126 cm^2	Scans of Surfaces and Static Measurement of Floors, Wall and Other Surfaces
Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-68 (Alpha/Beta Plateau)	Gas Flow Proportional Detector	126 cm^2	Scans of Surfaces and Static Measurement of Floors, Wall and Other Surfaces

3.2 Instrument Calibration and Efficiency Data

The calibration and efficiency data for the survey meters that were used during the Final Survey are summarized in Table 4. See Attachment 4 for copies of the calibration certificates.

Table 4. Survey meter calibration information.

Meter w/ Probe	Serial Number	Calibration Date	Detector Model	Radionuclide	Total Efficiency (4π)-Sensitivity
Ludlum 2221 Scaler/Ratemeter	174947	1/15/07	Ludlum 43-37	99Tc	17% cpm per dpm
Ludlum 2221 Scaler/Ratemeter	161591	1/15/07	Ludlum 43-68 (Alpha/Beta Plateau)	99Tc	19% cpm per dpm
Ludlum 2221 Scaler/Ratemeter	108857	1/15/07	Ludlum 43-68 (Alpha Plateau)	230Th	21% cpm per dpm

3.3 Minimum Detectable Concentration for Scanning Technique

Alpha Scans:

The minimum detectable concentration for the alpha scans was estimated using the methods suggested in Abelquist 2001 (See 9.3.3.1) with generic assumptions:

These assumptions were:

The smallest area of contamination is 100 cm^2.

Scan speed = 1 detector width per 1 s.

A count-rate of at least 120 cpm must be present to provide 2 counts observed in 1 s.

Using a typical total efficiency of ~20% the activity of this area is estimated to be 600 dpm.

Beta Scans:

The minimum detectable concentration for the beta scans was estimated using the suggested method in MARSSIM and in Abelquist 2001 (See 9.3.3.2).

Equation 1

$$\text{Scan MDC} = \frac{MDCR}{\sqrt{p} * E_i E_s}$$

Where:

Scan MDC = estimated minimum activity (dpm/100 cm^2) that can be

detected during a scan,

MDCR = Minimum detectable count rate, see Table 6.5 MARSSIM

p = surveyor efficiency considered to be 0.5

E_i = 2π efficiency (c/d), and

E_s = surface efficiency,

Note: E_i estimated assuming the 4π efficiency is approximately ½ the 2π efficiency.

Table 5. MDC for Scanning.

Survey Meter	Detector Model	Probe Area/Size	Contaminate	Estimated scanMDC (dpm/100 cm^2)
Floor Monitor Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-37	582 cm^2	Beta	~19,000
Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-68 (Alpha Plateau)	126 cm^2	Alpha	~600
Ludlum Model 2221 Scaler/Ratemeter	Ludlum 43-68 (Alpha/Beta Plateau)	126 cm^2	Beta	~3,500

3.4 Static Measurement Data Reduction

Determinations of the total surface activity were based on static measurements with the detector in direct contact with the surface. For each analysis gross counts were converted into area activity concentration using the following method of data reduction:

Equation 2

$$A = \frac{\left(\frac{C}{T}\right) - R_B}{E * \left(\frac{a}{100 \text{ cm}^2}\right)}$$

Where:

A = total activity (dpm/100 cm^2),

C = integrated gross counts (counts),

T = count time (min),

R_B = background count rate (cpm),

E = total efficiency (c/d), and

a = detector area (normalized to 100 cm^2).

3.5 Minimum Detectable Concentration for Scanning Technique

Using the equation shown below the minimum detectable activity for the static measurements was estimated using the following equation for instances in which the background and sample are counted for the same time intervals:

Equation 3

$$\text{Static MDC} = \frac{3 + 4.65\sqrt{R_B * T_{S+B}(1 + {T_{S+B}}/{T_B})}}{K * \left(\frac{\text{detector area}}{100cm^2}\right) * T_{S+B}}$$

Using the equation shown below the minimum detectable activity for the static measurements was estimated using the following equation for instances in which the background and sample are counted for different time intervals:

Equation 4

$$\text{Static MDC} = \frac{3 + 3.29\sqrt{R_B * T_{S+B}(1 + {T_{S+B}}/{T_B})}}{K * \left(\frac{\text{detector area}}{100cm^2}\right) * T_{S+B}}$$

Where:

Static MDC = activity (dpm/100 cm^2),

C = integrated gross counts (counts),

T_{S+B} = sample count time

T_B = background count time

R_B = background count rate (cpm),

4.0 SURVEY RESULTS

4.1 Results

The results for the surveys conducted at the facility are reported by survey method and survey unit. Attachment 1, 2 and 3 contain the survey diagrams and a survey data sheets for each area surveyed.

Data sheets include survey meter data, background response, and the minimum detectable concentration for Static measurement techniques.

4.2 Background Levels

During the survey, background levels in some areas were higher due to natural activity in different building materials. This was evident in the higher background count-rate on concrete block walls vs. the poured concrete of floor and most of the wall and the lower radiation levels for doors (steel construction).

4.3 Exposure Rate Measurements

A check of the exposure rates indoors in the survey area and indoors and in other areas of the facility appeared to be lower than normal background.

4.4 Alpha Scan and Static Measurements

No areas of elevated radiation were found during the Alpha Scans. Instrument scans were all less than the minimum detectable count rate.

All of the Alpha Static measurements were less than the DCGL for alpha the alpha emitting radionuclides. However, 2 survey locations, Location 15 Rsf6'10",10'11" and Location 22 Rsf10'6",8'9", with elevated static measurements were identified during the survey. Location 15 Rsf6'10",10'11" was further investigated with additional static measurements. These areas were subsequently cleaned and resurveyed with additional static measurements. The cleaning appeared to reduce the alpha activity by about 50% (See Attachment 3).

4.5 Beta Scan and Static Measurements

No areas of residual activity were found during the beta scan and beta static measurements. Instrument scans were all less than the minimum detectable count rate. Measurements with the maximum count rates appeared to be due to variations in background.

Instrument Static measurements were less than the DCGL (Note: The background count-rate used was the ambient background (air) not a background for the concrete floor or wall which appeared to be 50% higher. This resulted in measurements that were above the MDA). The response of the survey instruments varied with apparent variations in background and the type of surface (eg: composite cover over poured concrete floor vs. concrete block vs. steel door).

4.6 Other Sampling

No other sampling was performed during this survey.

4.7 Summary

- All radioactive material and waste had been removed prior to the survey.
- The survey techniques had sufficient sensitivity to detect residual contamination at levels less than the derived contamination guideline levels.
- Alpha scan surveys showed no detectable levels of residual contamination.
- Alpha static measurements revealed 2 areas that although below the DCGL prompted further investigation. The contamination appeared to be fixed since

wipe tests did not detect removable contamination. These areas were cleaned by ARL and resurveyed showing a reduction in the amounts of detectable alpha activity.

- Beta scans showed no detectable levels of residual contamination.
- Beta Static measurements showed no levels of residual contamination above the DCGL for 60Co.

5.0 SUMMARY AND CONCLUSIONS

ARL used and stored radioactive material in the survey area since 1977. The last of the remaining radioactive material was removed within the last year. The radioactive material was primarily sealed sources or neutron activated components with little propensity for creating contamination. Despite this, a few cases of low levels of contamination were documented in the Historical Site Assessment which instigated further radiological surveys.

A Final Radiological Status Survey was conducted of the potentially impacted areas. RSO, Inc. as part of this survey conducted Static Measurements and Scan surveys of the area.

The release criteria chosen for the final survey were the screening level Derived Concentration Guideline Levels from NUREG 1575. These were summarized as approximately 97.6 dpm/100 cm^2 for alpha and 7,000 dpm/100 cm^2 for beta.

MARSSIM was used to guide the survey design, plan and implementation. Historical knowledge and scoping surveys did not indicate significant residual contamination to be present and no contamination above the DCGLs was expected. The rooms were categorized as Class III survey areas.

The Survey results showed that all survey measurements (except for one area before further cleaning) were well less than the DCGLs, and only minor amounts of apparent contamination was found in any of the areas surveyed. There was no radioactive material remaining in these areas. The survey area that is the subject of this survey appears to meet the criteria for removal from the NRC license.

6.0 REFERENCES

6.1 Abelquist EW 2001 Decommissioning Health Physics, A Handbook for MARSSIM Users, Institute of Physics Publishing, Philadelphia, PA.

6.2 NUREG-1575, Rev. 1, EPA 402-R-97-016, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), August 2000.

6.3 NUREG-1757, Vol. 1, Rev. 1, Consolidated Decommissioning Guidance, Decommissioning Process for Materials Licensees, Final Report, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC, September 2003.

6.4 NUREG-5512, Vol. 3, Residual Radioactive Contamination from Decommissioning, Draft Report for Comment, Office of Nuclear Material Research, U.S. Nuclear Regulatory Commission, Washington, DC, October 1999.

6.5 Decontamination and Decommissioning (DandD) software, U.S. NRC, Version 2.1.0

6.6 RadCalcLE, Ludlum Measurements Edition, Version 1.0, ©1999, RSA Publications.

7.0 ATTACHMENTS

Attachment 1	Survey Area Drawings Radioactive Waste Storage Area/Walls and Shower Area/Walls Radioactive Waste Storage Area (Detail of Probe "Footprints")
Attachment 2	Survey Results with Survey Meter Information
Attachment 3	Survey Results Elevated Area Post Decontamination with Survey Meter Information
Attachment 4	Survey Meter Calibration Certificates

Attachment 1

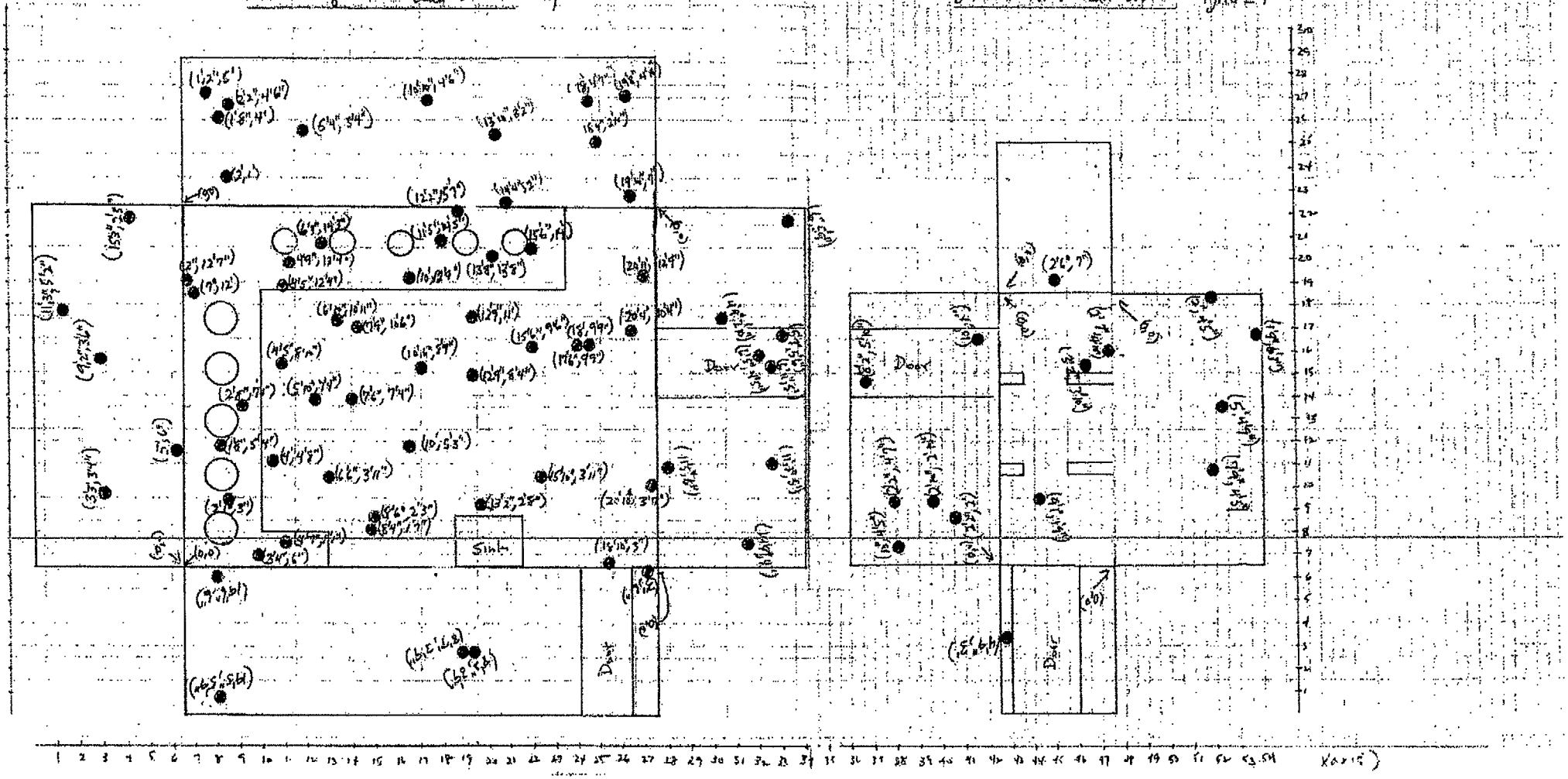
Survey Area Drawings

Radioactive Waste Storage Area/Walls and Shower Area/Walls

Radioactive Waste Storage Area (Detail of Probe "Footprints")

Real Storage Area and Walls 1grid = 6"

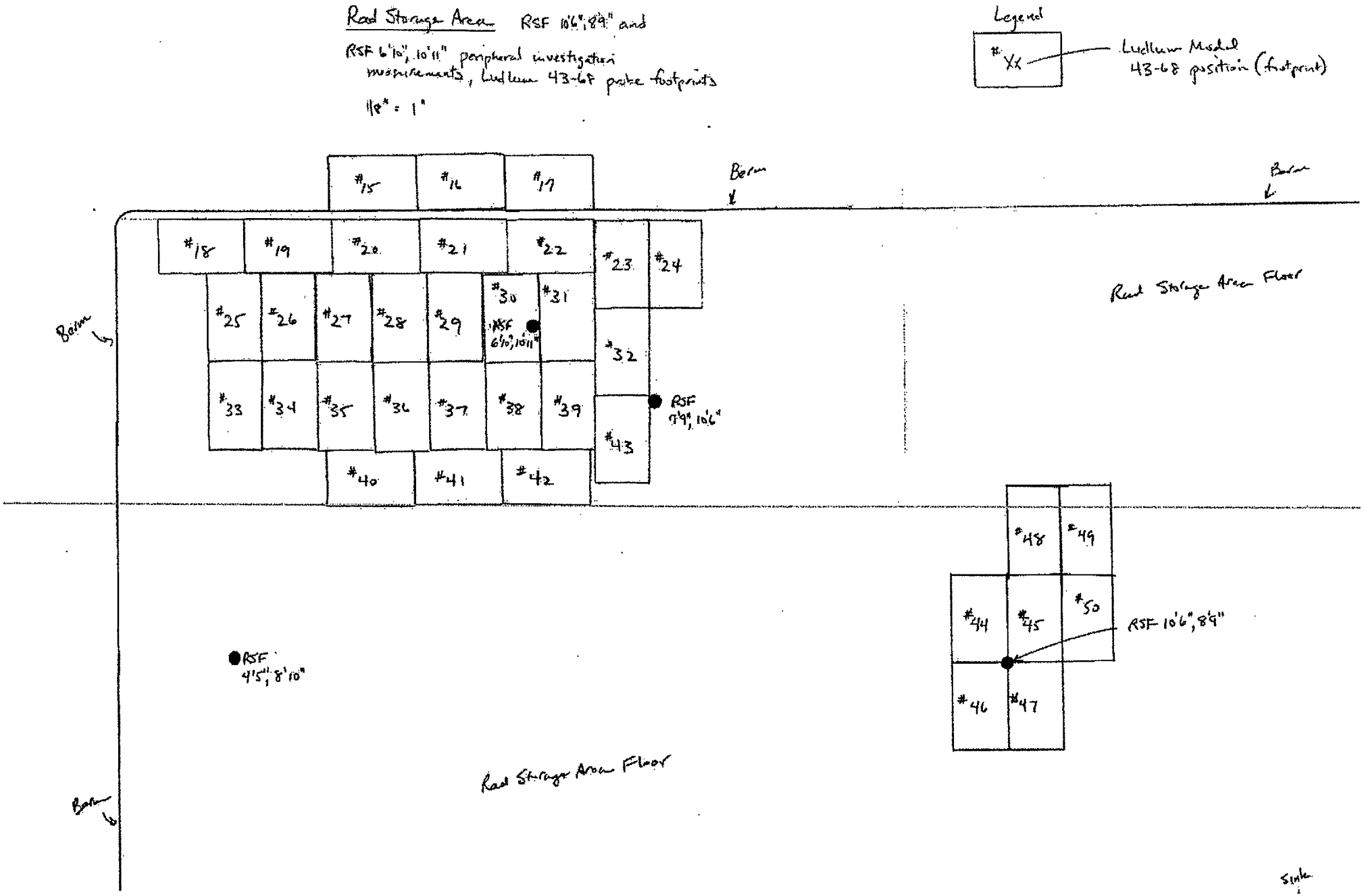
Shower Area and Walls 1grid = 1"



Rad Storage Area RSF 10'6", 8'9" and

RSF 6'10", 10'11" peripheral investigation measurements, Ludlum 43-68 probe footprints

1/8" = 1"



Sink

Attachment 2

Survey Results with Survey Meter Information

Site: ARL

Building: Rad Storage and Shower 106

Lab/Room: Storage and Shower

Start Date: 01/17/07

Surveyor: Paul Madairy

Surveyor: Greg Smith

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm² (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm² (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm² (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm² (Tc-99)
1	Rsf2",12"7"	Floor	3	3	8	2	188	272	3	7	3	8	1	1100	900	262
2	Rsf7",12'	Floor	3	7	23	2	346	931	3	7	3	8	1	1100	900	262
3	Rsf1'8",5'4"	Floor	3	4	12	2	219	401	3	7	3	8	1	1100	900	262
4	Rsf2'1",3'	Floor	3	8	27	2	214	380	3	7	3	8	1	1100	900	262
5	Rsf2'8",7'1"	Floor	3	1	1	2	185	259	3	7	3	8	1	1100	900	262
6	Rsf3'4",6"	Floor	3	4	12	2	174	213	3	7	3	8	1	1100	900	262
7	Rsf4',4'8"	Floor	3	2	5	2	172	205	3	7	3	8	1	1100	900	262
8	Rsf4'5",8'10"	Floor	3	3	8	2	217	393	3	7	3	8	1	1100	900	262
9	Rsf4'5",12'4"	Floor	3	4	12	2	208	355	3	7	3	8	1	1100	900	262
10	Rsf4'7",1'1"	Floor	3	5	16	2	222	414	3	7	3	8	1	1100	900	262
11	Rsf4'9",13'4"	Floor	3	12	42	2	200	322	3	7	3	8	1	1100	900	262
12	Rsf5'10",7'4"	Floor	3	1	1	2	206	347	3	7	3	8	1	1100	900	262
13	Rsf6'3",14'3"	Floor	3	11	39	2	221	409	3	7	3	8	1	1100	900	262
14	Rsf6'6",3'11"	Floor	3	2	5	2	185	259	3	7	3	8	1	1100	900	262
15	Rsf6'10",10'11"	Floor	3	25	91	2	227	434	3	7	3	8	1	1100	900	262
16	Rsf7'6",7'4"	Floor	3	4	12	2	177	226	3	7	3	8	1	1100	900	262
17	Rsf7'9",10'6"	Floor	3	10	35	2	178	230	3	7	3	8	1	1100	900	262
18	Rsf8'4",1'7"	Floor	3	11	39	2	176	221	3	7	3	8	1	1100	900	262
19	Rsf8'6",2'3"	Floor	3	10	35	2	204	338	3	7	3	8	1	1100	900	262
20	Rsf10',5'3"	Floor	3	4	12	2	226	430	3	7	3	8	1	1100	900	262
21	Rsf10',12'9"	Floor	3	4	12	2	191	284	3	7	3	8	1	1100	900	262
22	Rsf10'6",8'9"	Floor	3	17	61	2	219	401	3	7	3	8	1	1100	900	262
23	Rsf11'5",14'5"	Floor	3	6	20	2	188	272	3	7	3	8	1	1100	900	262
24	Rsf12'2",5'7"	Floor	3	6	20	2	206	347	3	7	3	8	1	1100	900	262
25	Rsf12'9", 8'4"	Floor	3	3	8	2	188	272	3	7	3	8	1	1100	900	262
26	Rsf12'9",11'	Floor	3	7	23	2	194	297	3	7	3	8	1	1100	900	262
27	Rsf13'2",2'8"	Floor	3	6	20	2	241	493	3	7	3	8	1	1100	900	262
28	Rsf13'8",13'8"	Floor	3	2	5	2	195	301	3	7	3	8	1	1100	900	262
29	Rsf15'6",9'6"	Floor	3	4	12	2	204	338	3	7	3	8	1	1100	900	262
30	Rsf15'6",14'	Floor	3	3	8	2	170	196	3	7	3	8	1	1100	900	262

Site: ARL

Building: Rad Storage and Shower 106

Lab/Room: Storage and Shower

Start Date: 01/17/07

Surveyor: Paul Madairy

Surveyor: Greg Smith

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm² (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm² (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm² (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm² (Tc-99)
31	Rsf15'10",3'11"	Floor	3	1	1	2	225	426	3	7	3	8	1	1100	900	262
32	Rsf17'6",9'9"	Floor	3	2	5	2	181	242	3	7	3	8	1	1100	900	262
33	Rsf18',9'9"	Floor	3	4	12	2	186	263	3	7	3	8	1	1100	900	262
34	Rsf18'10",3"	Floor	3	5	16	2	196	305	3	7	3	8	1	1100	900	262
35	Rsf20'4",10'4"	Floor	3	3	8	2	158	146	3	7	3	8	1	1100	900	262
36	Rsf20'10",3'7"	Floor	3	3	8	2	190	280	3	7	3	8	1	1100	900	262
37	Rsf20'11",12'9"	Floor	3	10	35	2	175	217	3	7	3	8	1	1100	900	262
38	Rsfw3",6",	Wall	3	0	-3	2	158	146								
39	Rsfw8'2",3'9"	Wall	3	3	8	2	141	75								
40	Rsfw8'7",3'9"	Wall	3	2	5	2	180	238								
41	Rsfw19'5",5'9"	Wall	3	2	5	2	178	230								
42	Rsfw19'6",6"	Wall	3	4	12	2	173	209								
43	Rslw3'3",3'4"	Wall	3	2	5	2	164	171								
44	Rslw5',6"	Wall	3	2	5	2	190	280								
45	Rslw9'2",3'6"	Wall	3	2	5	2	165	175								
46	Rslw11'3",5'2"	Wall	3	1	1	2	154	129								
47	Rslw15'3",2'3"	Wall	3	4	12	2	151	117								
48	Rsbw1'2",5'	Wall	3	2	5	2	192	288								
49	Rsbw1'8",4'	Wall	3	2	5	2	177	226								
50	Rsbw2',1'	Wall	3	2	5	2	186	263								
51	Rsbw2'2",4'6"	Wall	3	4	12	2	178	230								
52	Rsbw5'4",3'4"	Wall	3	1	1	2	166	180								
53	Rsbw10'10",4'6"	Wall	3	2	5	2	171	201								
54	Rsbw13'10",3'2"	Wall	3	3	8	2	172	205								
55	Rsbw14'4",2"	Wall	3	1	1	2	162	163								
56	Rsbw18',4'7"	Wall	3	1	1	2	157	142								
57	Rsbw18'4",2'10"	Wall	3	2	5	2	177	226								
58	Rsbw19'8",4'10"	Wall	3	3	8	2	197	309								
59	Rsbw19'10",7"	Wall	3	3	8	2	209	359								
60	Rsrw6",5'9"	Wall	3	2	5	2	185	259								

Site: ARL Building: Rad Storage and Shower 106 Lab/Room: Storage and Shower

Start Date: 01/17/07

Surveyor: Paul Madairy Surveyor: Greg Smith

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm² (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm² (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm² (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm² (Tc-99)
61	Rsrw4'9",2'10"	Wall	3	1	1	2	170	196								
62	Rsrw5'7",5'6"	Steel Door	3	2	5	2	106	-71								
63	Rsrw6'5",4'5"	Steel Door	3	0	-3	2	109	-58								
64	Rsrw6'11",5'	Steel Door	3	1	1	2	119	-17								
65	Rsrw11'3",5'	Wall	3	0	-3	2	142	79								
66	Rsrw11'5",6"	Wall	3	1	1	2	203	334								
67	Rsrw14'9",4'	Wall	3	0	-3	2	164	171								
68	Sf2'7",4'10"	Floor	3	1	1	2	192	288	3	7	3	8	2	250	200	322
69	Sf3'2",3'10"	Floor	3	0	-3	2	225	426	3	7	3	8	2	250	200	322
70	Sf9'1",1'9"	Floor	3	2	5	2	223	418	3	7	3	8	2	250	200	322
71	Sfw4'9",3'	Wall	3	1	1	2	171	201								
72	Slw10",4'5"	Wall	3	1	1	2	184	255								
73	Slw2'2",2'	Wall	3	1	1	2	224	422								
74	Slw2'2",4'7"	Wall	3	2	5	2	207	351								
75	Slw2'10",2'10"	Wall	3	0	-3	2	205	343								
76	Slw8'2",5'10"	Wall	3	3	8	2	242	497								
77	Slw10',1"	Steel Door	3	0	-3	2	124	4								
78	Sbw2'6",7"	Wall	3	1	1	2	177	226								
79	Srw2",4'5"	Concrete Blockwall	3	2	5	2	302	748								
80	Srw1'9",6'3"	Concrete Blockwall	3	3	8	2	377	1061								
81	Srw5',4'9"	Concrete Blockwall	3	1	1	2	338	898								
82	Srw7'9",4'5"	Concrete Blockwall	3	2	5	2	373	1044								
83	Outside Sidewalk 106	Concrete	3	14	50	2	262	581	3	7	3	8	1	1200	1000	363
84	Outside Sidewalk 107	Concrete	3	15	54	2	279	652	3	7	3	8	1	1200	1000	363
85	Sink	Steel	3	2	5	2	149	109	3	7	3	8	2	250	200	322
86	Free Standing Cabinet	Sheet Metal							3	1	1	1	2	250	200	322
87	Free Standing Cabinet	Sheet Metal							3	1	1	1	2	250	200	322

Site: ARL
Building: Rad Storage and Shower 106
Lab/Room: Storage and Shower
Start Date: 01/17/07
Surveyor: Paul Madairy
Surveyor: Greg Smith

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm² (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm² (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm² (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm² (Tc-99)
88	Free Standing Cabinet	Sheet Metal							3	1	1	1	2	250	200	322
89	Free Standing Cabinet	Sheet Metal							3	1	1	1	2	250	200	322
15 Additional Investigation	Rsf6'10",10'11"	Footprint 15	3	7	23											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 16	3	8	27											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 17	3	5	16											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 18	3	8	27											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 19	3	12	42											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 20	3	40	148											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 21	3	23	84											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 22	3	8	27											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 23	3	12	42											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 24	3	6	20											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 25	3	8	27											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 26	3	4	12											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 27	3	4	12											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 28	3	10	35											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 29	3	19	69											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 30	3	26	95											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 31	3	5	16											

Site: ARL

Building: Rad Storage and Shower 106

Lab/Room: Storage and Shower

Start Date: 01/17/07

Surveyor: Paul Madairy

Surveyor: Greg Smith

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm^2 (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm^2 (Tc-99)
15 Additional Investigation	Rsf6'10",10'11"	Footprint 32	3	3	8											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 33	3	5	16											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 34	3	5	16											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 35	3	4	12											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 36	3	28	103											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 37	3	17	61											
15 Additional Investigation	Rsf6'10",10'11"	Footprint 38	3	21	76											
itional Inves	Rsf6'10",10'11"	Footprint 39	3	6	20											
itional Inves	Rsf6'10",10'11"	Footprint 43	3	6	20											
itional Inves	Rsf6'10",10'11"	Footprint 40	3	10	35											

Survey Meter Information

Site: ARL Building: Rad Storage and Shower 106 Lab/Room: Storage and Shower

	Meter 1		Meter 2		Meter 3		Meter 4	Meter 5	
Date:	1/18/2007		1/18/2007		1/18/2007		Not In Service	Not In Service	
Make:	Ludlum		Ludlum		Ludlum				
Model:	2221		2221		2221				
SN:	174947		161591		108857				
Probe Make:	Ludlum		Ludlum		Ludlum				
Probe Model:	43-37		43-68		43-68				
Probe SN:	124945		178512		178394				
Probe Area (cm^2):	582		126		126				
Next Cal. Date:	1/15/2008		1/15/2008		1/15/2008				
Background Surface Material	Air		Air		Air				
Background(c) - Time(min)):	6410	10	1230	10	8	10			μRem/hr
Sample Count Time (min)		1		1		1			
CS Isotope - Activity(μCi):	Tc-99	0.038	Tc-99	0.038	Th-230	0.009			
CS Source(cpm)	21657		23000		4206				
L_c, L_d (Counts)	59	121	26	55	2	7		NA	NA
Direct MDC, Scan MDC (dpm/100cm^2)	91	18960	156	1996	23	571		NA	NA
MDCR , MDC Count Rate	912		118.6		120			NA	NA
Instrumen 4π Eff, Isotope:	17.0%	Tc-99	21.0%	Tc-99	21.0%	Th-230			
E_s Surface Effciency:	50.0%	Concrete	50.0%	Concrete	50.0%	Concrete			
E Total Effciency:	17.0%		21.0%		21.0%				

Please See MARSSIM Chapter 6 for a more detailed explanation of equations.

Lc= Critical Detection Level

Ld= a priori Detection limit

MDC= Minimum Detectable Concentration

MDCR= Minimum Detectable Count Rate

$MDCR = s_i * (60/i)$

$s_i = 1.38*SQRT(b_i)$

$b_i = B/T_B*1*1min/60s$

Direct MDC= $\frac{3+3.29*SQRT(B/T(1+T_{S+B}/T_B))}{K * T_{S+B}}$

Beta

Scan MDC= $\frac{MDCR}{SQRT(p)*E*E_s*K}$

B = Background Counts

T_B = BKG Counting Time In Minutes

T_{S+B} = Sample-Bkg Counting Time In Minutes

E = Total Detector Efficiency in Counts/Disintegration

A = Physical Probe Area in cm^2

K = Other Constants and Factors When Needed

p = Surveyor Efficiency = 0.5

E_s = Surface Efficiency $s_i = 1.38*SQRT(B_r)$

i = Counting Interval

Attachment 3

Survey Results Elevated Area Post Decontamination with Survey Meter Information

Site: ARL Building: Rad Storage and Shower 106 Lab/Room: Storage and Shower

Start Date: 01/30/07

Surveyor: Greg Smith Surveyor:

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm² (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm² (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm² (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm² (Tc-99)
1 Post Cleaning	Rsf6'10",10'11"	Footprint 15	3	8	25	2	220	334								
2 Post Cleaning	Rsf6'10",10'11"	Footprint 16	3	10	33	2	205	271								
3 Post Cleaning	Rsf6'10",10'11"	Footprint 17	3	7	21	2	158	75								
4 Post Cleaning	Rsf6'10",10'11"	Footprint 18	3	5	14	2	227	363								
5 Post Cleaning	Rsf6'10",10'11"	Footprint 19	3	5	14	2	216	317								
6 Post Cleaning	Rsf6'10",10'11"	Footprint 20	3	9	29	2	174	142								
7 Post Cleaning	Rsf6'10",10'11"	Footprint 21	3	2	2	2	194	225								
8 Post Cleaning	Rsf6'10",10'11"	Footprint 22	3	4	10	2	203	263								
9 Post Cleaning	Rsf6'10",10'11"	Footprint 23	3	1	-2	2	181	171								
10 Post Cleaning	Rsf6'10",10'11"	Footprint 24	3	3	6	2	199	246								
11 Post Cleaning	Rsf6'10",10'11"	Footprint 25	3	5	14	2	189	204								
12 Post Cleaning	Rsf6'10",10'11"	Footprint 26	3	3	6	2	202	259								
13 Post Cleaning	Rsf6'10",10'11"	Footprint 27	3	3	6	2	197	238								
14 Post Cleaning	Rsf6'10",10'11"	Footprint 28	3	11	36	2	215	313								
15 Post Cleaning	Rsf6'10",10'11"	Footprint 29	3	9	29	2	189	204								
16 Post Cleaning	Rsf6'10",10'11"	Footprint 30	3	3	6	2	206	275								
17 Post Cleaning	Rsf6'10",10'11"	Footprint 31	3	4	10	2	178	158								
18 Post Cleaning	Rsf6'10",10'11"	Footprint 32	3	1	-2	2	196	234								
19 Post Cleaning	Rsf6'10",10'11"	Footprint 33	3	3	6	2	210	292								

Site: ARL

Building: Rad Storage and Shower 106

Lab/Room: Storage and Shower

Start Date: 01/30/07

Surveyor: Greg Smith

Surveyor:

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm^2 (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm^2 (Tc-99)
20 Post Cleaning	Rsf6'10",10'11"	Footprint 34	3	6	17	2	211	296								
21 Post Cleaning	Rsf6'10",10'11"	Footprint 35	3	4	10	2	215	313								
22 Post Cleaning	Rsf6'10",10'11"	Footprint 36	3	5	14	2	234	392								
23 Post Cleaning	Rsf6'10",10'11"	Footprint 37	3	7	21	2	225	355								
24 Post Cleaning	Rsf6'10",10'11"	Footprint 38	3	4	10	2	224	350								
25 Post Cleaning	Rsf6'10",10'11"	Footprint 39	3	6	17	2	185	188								
26 Post Cleaning	Rsf6'10",10'11"	Footprint 43	3	3	6	2	no data									
27 Post Cleaning	Rsf6'10",10'11"	Footprint 40	3	2	2	2	181	171								
28 Post Cleaning	Rsf6'10",10'11"	Footprint 41	3	1	-2	2	200	250								
29 Post Cleaning	Rsf6'10",10'11"	Footprint 42	3	4	10	2	217	321								
30 Post Cleaning	Rsf10'6",8'9"	Footprint 48	3	9	29	2	212	300								

Site: ARL

Building: Rad Storage and Shower 106

Lab/Room: Storage and Shower

Start Date: 01/30/07

Surveyor: Greg Smith

Surveyor: _____

Area Survey Results			α Direct Measurements			β Direct Measurements			α Scan Measurements				β Scan Measurements			
Sample Number	Description	Surface	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Th-230)	Survey Meter #	Gross (cpm)	dpm/100 cm^2 (Tc-99)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	α dpm/100 cm^2 (Th-230)	Survey Meter #	Gross High (cpm)	Gross Average (cpm)	β dpm/100 cm^2 (Tc-99)
31 Post Cleaning	Rsf10'6",8'9"	Footprint 49	3	7	21	2	207	279								
32 Post Cleaning	Rsf10'6",8'9"	Footprint 44	3	4	10	2	197	238								
33 Post Cleaning	Rsf10'6",8'9"	Footprint 45	3	14	48	2	242	426								
34 Post Cleaning	Rsf10'6",8'9"	Footprint 50	3	3	6	2	191	213								
35 Post Cleaning	Rsf10'6",8'9"	Footprint 46	3	8	25	2	193	221								
36 Post Cleaning	Rsf10'6",8'9"	Footprint 47	3	7	21	2	199	246								
37 No Cleaning	Rsf18'10",3"	Trench 1	3	3	6	2	242	426								
38 No Cleaning	Rsf18'10",3"	Trench 2	3	8	25	2	203	263								
39 No Cleaning	Rsf18'10",3"	Trench 3	3	2	2	2	215	313								

Survey Meter Information

Site: ARL

Building: Rad Storage and Shower 106 Lab/Room: Storage and Shower

	Meter 1	Meter 2		Meter 3		Meter 4	Meter 5	
Date:	Not In Service	1/30/2007		1/30/2007		Not In Service	Not In Service	
Make:		Ludlum		Ludlum				
Model:		2221		2221				
SN:		161591		108857				
Probe Make:		Ludlum		Ludlum				
Probe Model:		43-68		43-68				
Probe SN:		178512		178394				
Probe Area (cm^2):		126		126				
Next Cal. Date:		1/15/2008		1/15/2008				
Background Surface Material		Air		Air				
Background(c) - Time(Min)):		1401	10	14	10			µRem/hr
Sample Count Time (min)			1		1			
CS Isotope - Activity(µCi):		Tc-99	0.038	Th-230	0.009			
CS Source(cpm)		27975		4283				
L_c, L_d (Counts)		28	58	3	9		NA	NA
Direct MDC, Scan MDC ($dpm/100cm^2$)		166	2130	27	571		NA	NA
MDCR , MDC Count Rate		127		120			NA	NA
Instrumen 4π Eff, Isotope:		21.0%	Tc-99	21.0%				
E_s Surface Effciency:		50.0%	Concrete	50.0%				
E, Total Effciency:		21.0%		21.0%	Th-230			

Please See MARSSIM Chapter 6 for a more detailed explanation of equations.

Lc= Critical Detection Level
Ld= a priori Detection limit
MDC= Minimum Detectable Concentration
MDCR= Minimum Detectable Count Rate

Direct MDC= $\frac{3+3.29*SQRT(B/T(1+T_{S+B}/T_B))}{K * T_{S+B}}$

Beta
Scan MDC= $\frac{MDCR}{SQRT(p)*E*E_s*K}$

MDCR= $s_i * (60/i)$

B = Background Counts
T_B = BKG Counting Time In Minutes
T_{S+B} = Sample-Bkg Counting Time In Minutes
E = Total Detector Efficiency in Counts/Disintegration
A = Physical Probe Area in cm^2
K = Other Constants and Factors When Needed
p = Surveyor Efficiency
E_s = Surface Efficiency $s_i = 1.38*SQRT(B_r)$
i = Counting Interval

Attachment 4

Survey Meter Calibration Certificates

RSO, Inc.
P.O. Box 1450
Laurel, MD 20725
(301) 953-2482

Certificate of Calibration

RSO Job No. r6978

ISSUED TO: RSO, Inc.
5206 Minnick Road
Laurel, MD 20707

CONTACT: Greg Smith
PHONE:

PO NO:

INSTRUMENT: LUDLUM
MODEL: 2221
TYPE: SCALER/RATE MET
SN: 108857

RSO, Inc. certifies that on 01/15/2007 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity. Pulsed using Ludlum 500-2, S/N 159110.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	1	100	102	cpm	0.98
		400	400	cpm	1.00
X	10	1000	998	cpm	1.00
		4000	4001	cpm	1.00
X	100	10000	9980	cpm	1.00
		40000	39990	cpm	1.00
X	1000	100000	99782	cpm	1.00
		400000	399900	cpm	1.00
				C.F. AVERAGE	1.00

Probe type(s) Probe1: PROPORTIONAL Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
43-68	PR178394	FIXED	CONTACT	1233	Th230	21	Am241	22				

HIGH VOLTAGE SETTING = 1248 DIAL.

INSTRUMENT CHECKS

1 mR/hr CHECK: N/A
BATTERY CHECK: NORMAL
CHECK SOURCE 1: N/A READING:
CHECK SOURCE 2: N/A READING:

ENVIRONMENTAL

TEMP: 23°C
PRESS: 759 mmHg
HUMID: 34 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 01/15/2008

Calibrated By: Dorsey Austin Reviewed By: Cal Date: 01/15/2007

Maryland License MD-33-021-01

4215

RSO, Inc.
P.O. Box 1450
Laurel, MD 20725
(301) 953-2482

Certificate of Calibration

RSO Job No. R6978

ISSUED TO: RSO, Inc.
5206 Minnick Road
Laurel, MD 20707

CONTACT: Greg Smith
PHONE:

PO NO:

INSTRUMENT: LUDLUM
MODEL: 2221
TYPE: SCALER/RATE MET
SN: 174947

RSO, Inc. certifies that on 01/15/2007 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity. Pulsed using Ludlum 500-2, S/N 159110.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	1	100	103	cpm	0.97
		400	402	cpm	1.00
X	10	1000	1002	cpm	1.00
		4000	4004	cpm	1.00
X	100	10000	10001	cpm	1.00
		40000	40022	cpm	1.00
X	1000	100000	99906	cpm	1.00
		400000	400233	cpm	1.00
				C.F. AVERAGE	1.00

Probe type(s) **Probe1:** PROPORTIONAL **Probe2:** **Probe3:**

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
43-37	PR124945	FIXED	CONTACT	1648	Th230	21	Am241	19				
HIGH VOLTAGE SETTING =1650 DIAL.												
				1871	C14	16	Tc99	17	Sr90	19		
HIGH VOLTAGE SETTING =1878 DIAL.												

INSTRUMENT CHECKS

1 mR/hr CHECK: N/A
BATTERY CHECK: NORMAL
CHECK SOURCE 1: N/A READING:
CHECK SOURCE 2: N/A READING:

ENVIRONMENTAL

TEMP: 23°C
PRESS: 759 mmHg
HUMID: 34 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS **01/15/2008**

Calibrated By: Dorsey Austin Reviewed By: Cal Date: 01/15/2007

Maryland License MD-33-021-01

4213

RSO, Inc.
P.O. Box 1450
Laurel, MD 20725
(301) 953-2482

Certificate of Calibration

RSO Job No. **R6978**

ISSUED TO: RSO, Inc.
5206 Minnick Road
Laurel, MD 20707

INSTRUMENT: LUDLUM
MODEL: 2221
TYPE: SCALER/RATE MET
SN: 161591

CONTACT: Greg Smith
PHONE:

PO NO:

RSO, Inc. certifies that on 01/15/2007 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity. Pulsed using Ludlum 500-2, S/N 159110.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	1	100	101	cpm	0.99
		400	401	cpm	1.00
X	10	1000	1000	cpm	1.00
		4000	4000	cpm	1.00
X	100	10000	9980	cpm	1.00
		40000	39979	cpm	1.00
X	1000	100000	99830	cpm	1.00
		400000	400327	cpm	1.00
				C.F. AVERAGE	1.00

Probe type(s) **Probe1:** PROPORTIONAL **Probe2:** **Probe3:**

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
43-68	PR178512	FIXED	CONTACT	1821	C14	18	Tc99	19	Sr90	25		

HIGH VOLTAGE SETTING = 1817 DIAL.

INSTRUMENT CHECKS

1 mR/hr CHECK: N/A
BATTERY CHECK: NORMAL
CHECK SOURCE 1: N/A READING:
CHECK SOURCE 2: N/A READING:

ENVIRONMENTAL

TEMP: 23°C
PRESS: 759 mmHg
HUMID: 34 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 01/15/2008

Calibrated By: Dorsey Austin Reviewed By: Cal Date: 01/15/2007

Maryland License MD-33-021-01

4214

Encl 3
Enl 4 of 4

RAD STORAGE AREA AND SHOWER FACILITY WIPE TESTS AND STATIC MEASUREMENT LOCATIONS AND RESULTS

RANDOMLY GENERATED LOCATIONS

DESIGNATION	Number	LOCATION	WIPED	RESULT (dpm/100cm2)(see footnote 1)	TOTAL measured	TOTAL RESULT (dpm/100cm2)(ftnote2)	GAMMA Measured	urem/hr incl bkg (see footnote 3)
RSF2",12"7"	1	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.6 @ 1m
RSF7",12'	2	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.0 @ 1m
RSF1'8",5'4"	3	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.3 @ 1m
RSF2'1",3'	4	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.5 @ 1m
RSF2'8",7'1"	5	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.5 @ 1m
RSF3'4",6"	6	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.8 @ 1m
RSF4',4'8"	7	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.9 @ 1m
RSF4'5",8'10"	8	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.5 @ 1m
RSF4'5",12'4"	9	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSF4'7",1'1"	10	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSF4'9",13'4"	11	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.6 @ 1m
RSF5'10",7'4"	12	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.0 @ 1m
RSF6'3",14'3"	13	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.3 @ 1m
RSF6'6",3'11"	14	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	1.9 @ 1m
RSF6'10",10'11"	15	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.3 @ 1m
RSF7'6",7'4"	16	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.0 @ 1m
RSF7'9",10'6"	17	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.0 @ 1m
RSF8'4",1'7"	18	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.6 @ 1m
RSF8'6",2'3"	19	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.3 @ 1m
RSF10',5'3"	20	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF10',12'9"	21	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSF10'6",8'9"	22	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF11'5",14'5"	23	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF12'2",5'7"	24	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	1.8 @ 1m
RSF12'9", 8'4"	25	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSF12'9",11'	26	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.3 @ 1m
RSF13'2",2'8"	27	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.4 @ 1m
RSF13'8",13'8"	28	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSF15'6",9'6"	29	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	1.9 @ 1m
RSF15'6",14'	30	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.0 @ 1m
RSF15'10",3'11"	31	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF17'6",9'9"	32	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF18',9'9"	33	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.1 @ 1m
RSF18'10",3"	34	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	1.8 @ 1m
RSF20'4",10'4"	35	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.5 @ 1m
RSF20'10",3'7"	36	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	1.9 @ 1m
RSF20'11",12'9"	37	RAD STORAGE FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		YES	2.2 @ 1m
RSFW3",6",	38	RAD STO FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSFW8'2",3'9"	39	RAD STO FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSFW8'7",3'9"	40	RAD STO FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSFW19'5",5'9"	41	RAD STO FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSFW19'6",6"	42	RAD STO FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSLW3'3",3'4"	43	RAD STO LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSLW5',6"	44	RAD STO LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSLW9'2",3'6"	45	RAD STO LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSLW11'3",5'2"	46	RAD STO LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSLW15'3",2'3"	47	RAD STO LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSBW1'2",5'	48	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSBW1'8",4'	49	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSBW2',1'	50	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSBW2'2",4'6"	51	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	
RSBW5'4",3'4"	52	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES		NO	

RSBW10'10",4'6"		53	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW13'10",3'2"		54	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW14'4",2"		55	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW18',4'7"		56	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW18'4",2'10"		57	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW19'8",4'10"		58	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSBW19'10",7"		59	RAD STO BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW6",5'9"		60	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW4'9",2'10"		61	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW5'7",5'6"		62	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW6'5",4'5"		63	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW6'11",5'		64	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW11'3",5'		65	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW11'5",6"		66	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
RSRW14'9",4'		67	RAD STO RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SF2'7",4'10"		68	SHOWER FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	YES	3.5 @ 1m
SF3'2",3'10"		69	SHOWER FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	YES	3.5 @ 1m
SF9'1",1'9"		70	SHOWER FLOOR	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	YES	2.8 @ 1m
SFW4'9",3'		71	SHOWER FRONT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW10",4'5"		72	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW2'2",2'		73	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW2'2",4'7"		74	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW2'10",2'10"		75	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW8'2",5'10"		76	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SLW10',1"		77	SHOWER LEFT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SBW2'6",7"		78	SHOWER BACK WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SRW2",4'5"		79	SHOWER RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SRW1'9",6'3"		80	SHOWER RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SRW5',4'9"		81	SHOWER RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SRW7'9",4'5"		82	SHOWER RIGHT WALL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
BIASED LOCATIONS								
W1		83	STORAGE WELL 1 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.6 @ 1m above top, 2.1 @ top
W2		84	STORAGE WELL 2 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	1.9 @ 1m above top, 2.2 @ top
W3		85	STORAGE WELL 3 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.0 @ 1m above top, 2.8 @ top
W4		86	STORAGE WELL 4 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.6 @ 1m above top, 2.5 @ top
W5		87	STORAGE WELL 5 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.8 @ 1m above top, 2.0 @ top
W6		88	STORAGE WELL 6 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.8 @ 1m above top, 2.1 @ top
W7		89	STORAGE WELL 7 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.5 @ 1m above top, 2.2 @ top
W8		90	STORAGE WELL 8 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.1 @ 1m above top, 2.1 @ top
W9		91	STORAGE WELL 9 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.2 @ 1m above top, 2.6 @ top
W10		92	STORAGE WELL 10 BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	YES	2.3 @ 1m above top, 2.1 @ top
PHONE		93	PHONE	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
SIB		94	SINK INSIDE BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SIBA		95	SINK INSIDE BACK	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SIR		96	SINK INSIDE RIGHT	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SIL		97	SINK INSIDE LEFT	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
SSH		98	SINK SPIGOT HANDLES	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1OB		99	CABINET 1 OUTSIDE BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
CAB1SH1		100	CABINET 1 SHELF 1	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH2	1a		CABINET 1 SHELF 2	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH3	2a		CABINET 1 SHELF 3	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH4	3a		CABINET 1 SHELF 4	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH5	4a		CABINET 1 SHELF 5	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH6	5a		CABINET 1 SHELF 6	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB1SH7	6a		CABINET 1 SHELF 7	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2OB	7a		CABINET 2 OUTSIDE BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	

CAB2SH1	8a	CABINET 2 SHELF 1	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2SH2	9a	CABINET 2 SHELF 2	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2SH3	10a	CABINET 2 SHELF 3	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2SH4	11a	CABINET 2 SHELF 4	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2SH5	12a	CABINET 2 SHELF 5	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB2SH6	13a	CABINET 2 SHELF 6	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB3OB	14a	CABINET 3 OUTSIDE BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
CAB3SH1	15a	CABINET 3 SHELF 1	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB3SH2	16a	CABINET 3 SHELF 2	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB3SH3	17a	CABINET 3 SHELF 3	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB3SH4	18a	CABINET 3 SHELF 4	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB3SH5	19a	CABINET 3 SHELF 5	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4OB	20a	CABINET 4 OUTSIDE BOTTOM	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	NO	
CAB4SH1	21a	CABINET 4 SHELF 1	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4SH2	22a	CABINET 4 SHELF 2	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4SH3	23a	CABINET 4 SHELF 3	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4SH4	24a	CABINET 4 SHELF 4	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4SH5	25a	CABINET 4 SHELF 5	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CAB4SH6	26a	CABINET 4 SHELF 6	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
CC	27a	CRANE CONTROLS	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	NO	NO	
RSDSW	28a	RAD STOR DOOR SIDEWALK	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	YES	2.8 @ 1m
SFDSW	29a	SHOWER FAC DOOR SIDEWAL	YES	< 9 U-235, U-238, Ra-226; < 41 Co-60	YES	YES	3.0 @ 1m

footnote 1 - see green record book in safety office for detailed wipe test analysis

footnote 2 - see attached Radiation Services Organization report for total measurement details

footnote 3 - gamma measurements were made on 01 Dec 06 by Michael Borisky using BICRON microrem/hr meter serial number B142Y, calibration due 14 May 07.
BICRON was response checked before and after making gamma measurements using NIST traceable Co-60 check source, serial number 95CO220, 0.065 microcuries, at a distance of 4 inches (10 cm) from the detector center. The "before" check registered 11 microrem/hr in a 3.5 microrem background for a net of 7.5 microrem/hr, which using the gamma factor for C0-60 compares favorably with the 8.6 microrem/hr expected. The "after" check registered 10.5 microrem/hr and was considered adequate. Before gamma measurements were made, the bay area of the buidling which is of similar construction but with no history of radioactive material use was used as a reference area to measure the typical backgound level. Twenty random locations were chosen, and the following readings at 1 meter above the floor where measured:
2.0, 1.8, 1.8, 1.8, 1.5, 1.4, 2.3, 2.3, 2.0, 2.1, 1.8, 2.5, 2.3, 1.6, 2.0, 1.8, 1.6, 2.3, 2.0, 1.9.
All readings shown in the table above were at 1 meter above the surface except those designated "at the top" of the storage well, which correponded to the floor surface level.

Sample description
Water Sample From Holding Tank ALC

Spectrum Filename: C:\MEIER\1WMike1113066-1001.An1

Acquisition information

Start time	15-Dec-2006 00:32:11
Live time	43200
Real time	43233
Dead time	.08%
Detector/Geometry IDs	1 & 0

Detector system
MCB 1 Input 1

Calibration
Filename: 1N-1195-57-2.Clb
Created: 13-Dec-2006 13:29:46 & 14-Dec-2006 08:19:02
DETECTOR 1N CALIBRATION OF LOW DENSITY STNDARD + U-238

Zero offset -1.987 keV; Gain .232 keV/channel
Quadratic -.606E-08 keV/channel^2

Library Files
Main analysis library: 1N-1195-57-2mike.LIB
Library Match Width: .500

Analysis parameters

Start channel	10 for an energy of	.33keV
Stop channel	9000 for an energy of	2083.49keV
Peak rejection level	1000.000%	
Peak search sensitivity:	3	?
Sample Size:	410.070 ml	

Activity scaling factor 1.0000E+00/(1.0000E+00* 4.1007E+02)
= 2.4386E-03

Detection limit method:
Nureg 4.16 Method

Additional random error:	1.0000000E+00
Additional systematic error:	1.0000000E+00
Fraction Limit:	.000%

Background width: best method (based on spectrum).

Corrections	Status	Comments
Decay correct to date	YES	30-Nov-2006 12:00:00

Decay during acquisition	NO
Decay during collection	NO
Peaked background correction	NO
Absorption (Internal)	NO
Geometry correction	NO
Random summing	NO

Energy calibration normalized difference: 1.0000

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

PEAK CHANNEL	CENTROID ENERGY	BACKGROUND COUNTS	NET AREA COUNTS	INTENSITY CTS/SEC	UNCERT 1 SIGMA %	FWHM keV	SUSPECTED NUCLIDE	
1185.00	272.66	0.	11.	.000	30.15	.232	RB-89	sM
1331.00	306.49	0.	22.	.001	21.32	.232	-	sM
1417.00	326.43	0.	29.	.001	18.57	.232	-	sM
1489.00	343.11	0.	19.	.000	22.94	.232	-	sM
1562.87	360.23	0.	15.	.000	25.82	.232	-	sM
1795.00	414.03	0.	19.	.000	22.94	.232	-	sM
1857.00	428.40	0.	12.	.000	28.87	.232	SB-125	sM
1913.00	441.38	0.	11.	.000	30.15	.232	-	sM
1942.00	448.10	0.	18.	.000	23.57	.232	-	sM
1969.00	454.35	0.	11.	.000	30.15	.232	-	sM
2100.00	484.71	0.	12.	.000	28.87	.232	-	sM
2129.56	491.56	0.	25.	.001	20.00	.432	-	sM
2187.00	504.87	0.	12.	.000	28.87	.232	-	sM
2217.00	511.83	0.	61.	.001	12.80	.232	RH-106M	sM
2361.00	545.20	0.	14.	.000	26.73	.232	-	sM
2474.29	571.45	0.	14.	.000	26.73	.309	-	sM
2592.00	598.73	0.	12.	.000	28.87	.232	-	sM
2646.39	611.34	0.	18.	.000	23.57	.397	-	sM
2677.00	618.43	0.	15.	.000	26.23	1.398	W-187	D
2689.00	621.21	0.	15.	.000	25.49	1.401	J-132	D
2760.16	637.70	18.	24.	.001	32.92	1.415	J-131	D
2769.00	639.75	12.	16.	.000	40.68	1.416	SB-126	D
2897.42	669.51	0.	26.	.001	19.61	.386	PA-234	sM
3019.20	697.73	0.	20.	.000	22.36	.579	BR-82	sM
3259.25	753.36	0.	12.	.000	28.87	.290	-	sM
3483.88	805.41	0.	31.	.001	17.96	.649	PA-234	sM
3610.43	834.74	0.	23.	.001	20.85	.794	MN-54	sM
3940.70	911.27	0.	54.	.001	13.61	.623	AC-228	sM
4013.00	928.03	0.	25.	.001	20.00	.255	-	sM
4052.07	937.08	0.	14.	.000	26.73	.463	AG-110M	sM
4520.13	1045.54	4.	55.	.001	16.67	.617	RH-106M	sM
5070.58	1173.09	0.	51.	.001	14.00	.420	J-132	s

s Peak fails shape tests.
D Peak area deconvoluted.
M Peak is close to a library peak.

********** I D E N T I F I E D P E A K S U M M A R Y **********

NUCLIDE	PEAK CHANNEL	CENTROID ENERGY	BACKGROUND COUNTS	NET AREA COUNTS	INTENSITY CTS/SEC	UNCERT 1 SIGMA %	FWHM keV
U-238	280.00	62.91	0.	0.	.000	.00	.000s
U-235	395.00	89.56	0.	0.	.000	.00	.000s
U-235	410.00	93.04	0.	0.	.000	.00	.000s
U-235	460.00	104.63	0.	0.	.000	.00	.000s
U-235	478.00	108.80	0.	0.	.000	.00	.000s
U-235	627.00	143.33	0.	0.	.000	.00	.000s
U-235	712.00	163.03	0.	0.	.000	.00	.000s
U-235	809.89	185.72	0.	0.	.000	.00	.980
Ra-226	810.62	185.89	0.	0.	.000	.00	.980
U-235	879.00	201.74	0.	0.	.000	.00	.000s
U-235	894.41	205.31	0.	0.	.000	.00	.000D
CO-60	5071.19	1173.23	46.	0.	.000	.00	1.800
CO-60	5764.66	1333.91	0.	45.	.001	14.91	.270s

s Peak fails shape tests.
D Peak area deconvoluted.

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- NUCLIDE - NAME	CODE	AVERAGE ACTIVITY microCi	PEAK ENERGY keV	PEAK ACTIVITY microCi	PEAK CODE	PEAK MDA VALUE microCi	COMMENTS
CO-60		3.0750E-06	1332.51	3.075E-06	&(	1.852E-07	
			1173.23	0.000E+00	-	2.264E-06	
U-238	N	0.0000E+00	63.29	0.000E+00	?(	6.587E-07	X
U-235		0.0000E+00	185.72	0.000E+00	(	5.462E-08	
			143.76	0.000E+00	?(	2.534E-07	
			205.31	0.000E+00	?(	6.610E-07	
			163.35	0.000E+00	?(	5.933E-07	
			93.35	0.000E+00	?(	8.991E-08	
			109.14	0.000E+00	?(	2.569E-07	
			89.96	0.000E+00	?(	4.010E-07	
			202.12	0.000E+00	?(	3.080E-06	
			105.00	0.000E+00	?(	5.282E-07	
Ra-226	N	0.0000E+00	185.89	0.000E+00	(	8.996E-07	G

(- This peak used in the nuclide activity average.

uCi/ml ?

* - Peak is too wide, but only one peak in library.
! - Peak is part of a multiplet and this area went negative during deconvolution.

? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
+ - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
P - Peakbackground subtraction

Nuclide Codes:
T - Thermal Neutron Activation
F - Fast Neutron Activation
I - Fission Product
N - Naturally Occurring Isotope
P - Photon Reaction
C - Charged Particle Reaction
M - No MDA Calculation

Peak Codes:
G - Gamma Ray
X - X-Ray
P - Positron Decay
S - Single-Escape
D - Double-Escape
K - Key Line
A - Not in Average

- -

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

NUCLIDE		TIME OF COUNT ACTIVITY uCi/EA	TIME CORRECTED ACTIVITY uCi/EA	UNCERTAINTY COUNTING	1 SIGMA TOTAL	LIMIT
CO-60		7.4986E-09	7.5379E-09	1.491E+01%	1.533E+01%	3N6
U-238	<	1.6063E-09	1.6063E-09	0.000E+00%	3.277E+00%	3N7
U-235	<	1.3319E-10	1.3319E-10	0.000E+00%	3.581E+00%	3N7
Ra-226	<	2.1938E-09	2.1938E-09	0.000E+00%	3.581E+00%	6N8

uCi/ml ?

S U M M A R Y

TOTAL ACTIVITY (.3 to 2083.5 keV) 7.4986430E-09 uCi/EA
TOTAL DECAYED ACTIVITY (.3 to 2083.5 keV) 7.5379460E-09 uCi/EA

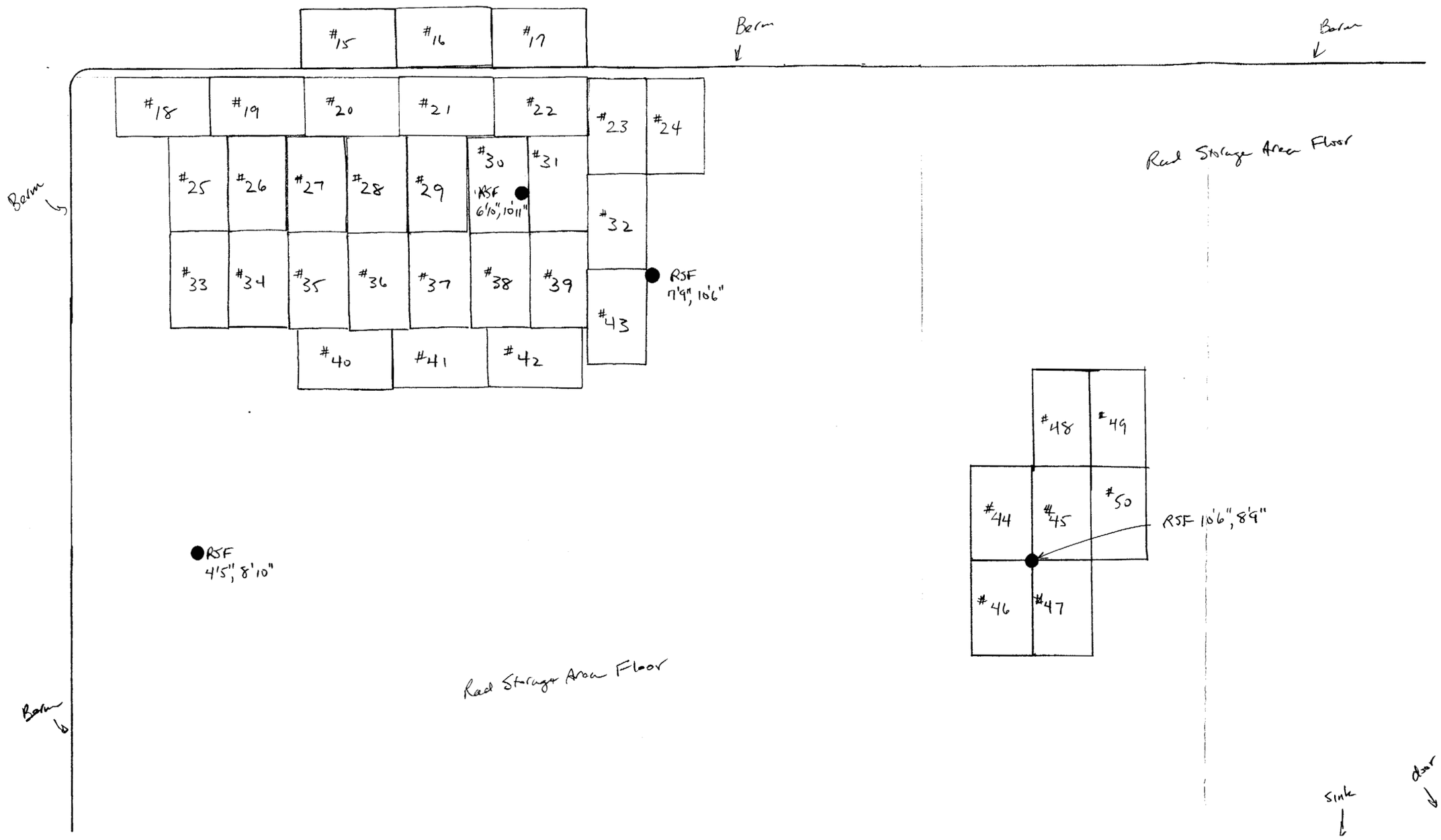
Analyzed by: ~~JEFF DUDLEY~~ Richard A Markland

Reviewed by: _____
Supervisor

Laboratory: Risk Management - ARL APG Site

Rad Storage Area RSF 10'6", 8'9" and RSF 6'10", 10'11" peripheral investigation measurements, Ludlum 43-68 probe footprints

1/8" = 1"

Legend

XX — Ludlum Model 43-68 position (footprint)