SEIKO CORPORATION OF AMERICA

November 13, 2008

Docket No. 03016033
Control No. 142853

License No. 29-29080-01

J-6
MS-16

Dennis R. Lawyer
US Nuclear Regulatory Commission
Commercial and R&D Branch
Division of Nuclear Materials Safety
Region I
475 Allendale Road
King of Prussia, PA 19406-1415

SUBJECT: SEIKO CORPORATION OF AMERICA, RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION CONCERNING APPLICATION FOR AMENDMENT TO LICENSE, CONTROL NO. 142853

Dear Mr. Lawyer,

03016033

In response to your letter as described above and dated November 3, 2008, I wish to continue to pursue my application to terminate our license No. 29-19080-01. Below I address your comments in the same format as your letter.

1. The Final Status Survey Report submitted in my September 29, 2008 letter may be publically released. I have enclosed a copy without the Privileged and Confidential stamp for your use.

2. No Tritium was used at this facility.

3. Although we had several locations on our license since the 1979 inception, with the exception of 1111 Macarthur Boulevard Mahwah, NJ, all others were closed and removed from our license by the US NRC. The decommissioning procedures including close-out surveys were followed and the sites were released by the NRC.

4a. The facility to be released is located at 1111 Macarthur Boulevard, Mahwah, New Jersey.

4b. The building is 141,000 sq. ft. The area used for radioactive materials was 6,000 sq. ft.

4c. The surrounding area is mixed residential and commercial.

4d. We ceased licensed activities on May 30, 2008.

Please advise me of any further requirements in order to terminate this license. You may reach me at 201-512-3006 or jmarione@seikousa.com

Thank you for your assistance.

RECEIVED
REGION 1
2008 NOV 14 AM 11:02

Yours truly,

Joanne Marione

Joanne Marione, RSO
Manager, Facilities & Administration

Cc: M. Marin
T. Matsuda

Encl.

142853

NMSS/RGN1 MATERIALS-002

FINAL STATUS SURVEY
REPORT

SEIKO CORPORATION OF AMERICA
1111 MACARTHUR DR., MAHWAH, NJ

SEPTEMBER 2008

Prepared by:

Radiac Environmental Services, Inc.

Survey Manager: Theodore E. Rahon Date: 9/29/08

Theodore E. Rahon, Ph.D.
Certified Health Physicist

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1 Introduction

1.1 Purpose

Seiko Corporation of America (Seiko) wishes to terminate its NRC radioactive materials license, #29-19080-01, and has removed all licensed radioactive materials from its facility. The objective of this Final Status Survey (FSS), performed in September, 2008, is to demonstrate that no levels of radioactivity exist at the facility in excess of specified limits.

1.2 Site Description

The Seiko building at 1111 MacArthur Blvd. in Mahwah, NJ, is a modern commercial building which has office, warehouse, and light assembly space. From this location, watches containing promethium-147 were distributed to the public as exempt products since the early 1980's. Malfunctioning watches returned from customers were also repaired at the facility, using parts containing Pm-147.

Parts had been stored in bins located in an approximately 6' x 40' area within a large warehouse room. Watches had been repaired on 30 benches in the repair area which also included ancillary storage and work rooms in an approximately 64'x 90' space.

1.3 Planning

Seiko engaged Radiac Environmental Services, Inc. (Radiac) as a contractor to remove its last remaining quantities of radioactive material and to perform a final status survey of the facility. No specific decommissioning plan was prepared for this project due to its small size. The contractor's generic survey procedures were used in accordance with guidance found in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM provides standardized and consistent approaches for planning, conducting, evaluating, and documenting environmental radiological surveys, with a specific focus on the final status surveys that are carried out to demonstrate compliance with cleanup regulations.

2 Remedial Operations Summary

No significant decontamination operations were necessary. Cleanup included placement of Pm-147-containing watch parts into a 5-gallon radioactive waste pail and simple detergent washing of some carts and benches. The waste pail was removed by Radiac to their storage facility from which it will be transported to a licensed waste disposal site.

3 Final Status Survey

3.1 Identity of Contaminants

The main radionuclide of concern is Promethium-147. Seiko was licensed for possession of up to 10 curies of Pm-147.

Table 1: Radionuclide of Concern (ROC)

Radionuclide	Name	Half Life	Principal Modes of Decay
Pm-147	Promethium-147	2.62 yr	β (0.2247 MeV max.)

3.2 Data Quality Objectives

3.2.1 Step 1: State the Problem

Residual radioactivity may reside on surfaces used for handling and storage of watch parts. The objective of the FSS is to obtain data of sufficient quality and quantity to support unrestricted release of the facility from license controls by the U.S. Nuclear Regulatory Commission (NRC).

3.2.2 Step 2: Identify the Decision

Principal Study Question

Do the radionuclides of concern (ROC) concentrations at the facility exceed applicable levels for unrestricted release?

Decision Statements

If ROC concentrations in the survey units do not exceed the derived concentration guideline limit ($DCGL_w$) and the specific contamination criteria of the regulatory authority, then the survey units will satisfy the release criterion. These criteria are described later in this FSS Report. The decision statements follow:

a. Determine whether survey unit (SU) ROC concentrations exceed background concentrations by more than the applicable release criteria.

b. If survey unit ROC concentrations exceed background by more than the applicable release criteria, then affected survey units must be remediated to levels satisfying the release criteria.

3.2.3 Step 3: Identify Inputs to the Decision

This section lists the data needed to resolve the applicable decision statements, including the means of obtaining the required data.

The main data inputs are:

1. Information regarding the locations of radionuclide use provided by the license; and
2. Results of measurements of residual radioactivity in the survey units by means of:
   - Direct surface radioactivity measurements for beta radiation
   - Removable activity concentration measurements, analyzed for beta activity

3.2.4 Step 4: Define the Study Boundaries

The key area of interest is the concentrations of ROCs on building surfaces and on components (e.g., benches, shelves, etc.). The study is limited to impacted areas located inside the building, namely the radioluminous parts storage bins in the warehouse and the repair shop with its ancillary rooms.

3.2.5 Step 5: State the Decision Rules

Surface Radioactivity Scan Surveys
If areas of elevated radioactivity are identified during scan surveys, fixed point surveys, or removable contamination surveys (smears), identified areas will be decontaminated as appropriate and re-surveyed.

Residual Radioactivity
If residual radioactivity is found in an isolated area of elevated activity, in addition to residual radioactivity distributed relatively uniformly across the survey unit, the unity rule, also called the Sum of the Ratios (SOR), will be used to ensure that the total dose is within the decommissioning guidance (NRC 2002).

3.2.6 Step 6: Define Acceptable Decision Errors

NRC guidance provides a discussion regarding decision errors (NRC 2000). This discussion includes the concept that acceptable error rates, which balance the need to make appropriate decisions with the financial costs of achieving high degrees of certainty.

Errors can be made when making site remediation decisions. The use of statistical methods allows for controlling the probability of making decision errors. In setting error rates, it is important to balance the consequences of making a decision error against the cost of achieving greater certainty.

Acceptability decisions are often made based on acceptance criteria. If the mean and median concentrations of a contaminant are less than the associated acceptance criteria, for example, the results can usually be accepted. In cases where data results are not so clear, statistically based decisions are necessary. Statistical acceptability decisions, however, are always subject to error. Two possible error types are associated with such decisions.

The first type of decision error, called a Type I error, occurs when the null hypothesis is rejected when it is actually true. The probability of a Type I error is usually denoted by α. Considered in light of the null hypothesis used for this investigation, this error could result in higher potential doses to future site occupants than prescribed by the dose-based criterion. The maximum Type I error rate is 0.05.

The second type of decision error, called a Type II error, occurs when the null hypothesis is not rejected when it is actually false. The probability of a Type II error is usually denoted by β. The power of a statistical test is defined as the probability of rejecting the null hypothesis when it is false. It is numerically equal to $1-\beta$ where β is the Type II error rate. Consequences of Type II errors include unnecessary remediation expense and project delays.

For the purposes of this Final Status Survey, the acceptable error rate for both Type I and Type II errors is five percent (i.e., $\alpha = \beta = 0.05$).

3.3 Survey Design and Methodology

The survey design follows the guidance of the Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 2000). A summary of this design is provided in the following subsections.

3.3.1 Determine Impacted or Non-Impacted

Based on licensee knowledge, only the repair area and the parts storage bins were impacted. All outdoor areas, offices and bulk warehouse areas were considered to be non-impacted. These designations were subject to change if high readings had been found in the impacted areas or evidence of tracking of contamination had been found. However, no such circumstances were found during the survey.

3.3.2 Survey Unit Breakdown

Table 2 lists descriptions of survey units.

Table 2: Survey Units

Survey Area	Class	Description	Scan Required
Warehouse	1	Bins and immediate floor area	100%
Repair Shop	1	Bench tops, shelves, and floor area	100%

3.3.3 Background Area

Background levels for direct beta counts and gamma scans were established in an area in the building with no elevated radioactivity levels and with similar building construction to the surveyed areas. A hallway in the office area was used.

3.3.4 Scan Surveys

Scan measurements were conducted with appropriate instrumentation, considering the radiations being detected, background levels, and the surfaces being measured. This includes pancake Geiger Mueller probes and gas flow proportional detectors. Probe sensitivities are below the release criteria and were calculated as shown in Appendix C.

3.3.5 Smear Sample Collection and Analysis

Selected surfaces were sampled using smears to assess the presence of removable contamination. Smears were taken at every location that a fixed-point measurement was taken and at any other locations deemed necessary based on meter readings, visual inspections and professional judgment.

3.3.6 Number of Fixed Survey Points and Grid Point Determination

Appendix D describes the results of MARSSIM-based calculations to determine the number of survey points. For this survey, the minimum number of points per survey unit is 14. However, to provide more in-depth detail and greater coverage of removable contamination assessment, the actual number of survey points was greatly increased per the professional judgment of the survey manager.

Fixed-point measurements are defined as static counts performed with a portable instrument at locations of suspected contamination. Fixed-point measurements were 1-minute in duration with the instrument placed in scaler mode, or if the instrument did not have scaler capability, a count rate indication was used with the instrument's meter set to "slow response."

The fixed-point (static) survey action level is the DCGL plus the average background specific to the material type being evaluated.

The location of each measurement or sample was specified by a square measurement grid which was overlaid onto the floor plan. The maximum spacing, L, of the measurement grid is determined by the following formula:

> L = sqrt(A/n) where **A** is the area of the survey unit and **n** is the specified number of measurements.

For this survey, "L" was calculated to be a maximum of 25 feet. However, as discussed above, to provide more in-depth detail and greater coverage of removable contamination assessment, the actual "L" used was 12 feet.

The intersections of the measurement grid (i.e., sample locations) were situated on the repair shop survey drawing using a random start point, its X and Y coordinates obtained from a random number generator. The warehouse bin area was not conducive to such gridding and data point location was determined via professional judgment of the survey manager.

3.4 Regulatory Requirements – Release Criteria

The survey areas were tested to comply with the 25 mrem/yr prospective dose limits set forth in NRC decommissioning guidance and also the radioactive surface contamination limits in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material", USNRC, July 1982.

Release guidelines (DCGL's) for building surfaces and fixtures for non-controlled use were conservatively chosen as shown below:

Table 3 - Release Guidelines (DCGL's)

1000 dpm/100 sq.cm - Removable beta-gamma contamination

5000 dpm/100 sq.cm fixed beta-gamma contamination
average over any 1 square meter area

15000 dpm/100 sq.cm fixed beta-gamma contamination
maximum on any 100 sq. cm area

3.4.1.1 Determination of Field Release Limits

The detection method utilizes one of several probes, including a 100 cm^2 gas proportional probe, a floor-monitoring large area gas proportional probe, and a pancake GM probe. These probes above have varying responses to beta, gamma and alpha radiations. These responses were evaluated, and field release limits were developed to correspond to the release criteria shown above. The final field limits for this survey are summarized in Table 3 below.

3.5 Instrumentation

3.5.1 Field Instruments

Physical and performance characteristics of each detector to be used during the project are shown in the following table:

Table 4: Types of Field Instruments used for the Final Status Survey

Detector / Instrument	Detector Type	Active Area (cm^2)	Radiation Sensitivity & Uses	Field Reading Corresponding to DCGL (cpm)*
Ludlum 44-9	Geiger-Mueller	15	Alpha-beta-gamma surface scans and fixed-point measurements	185
Ludlum 43-68	Gas Proportional	100	Alpha / beta surface scans and fixed-point measurements	1080
Ludlum 43-37	Gas Proportional	425	Beta floor scans	1560

* Note: cpm values include typical instrument background

3.5.1.1 100 or 400 cm^2 Gas Proportional Counter

A Ludlum Model 43-68 gas proportional detector and 43-37 gas proportional floor monitor was used to assess beta counts on surfaces. The probes were used with Ludlum Model 2360 scaler-ratemeter and Model 12 ratemeter set with the proper operating voltage and discriminator settings for measurement of beta radiation as appropriate.

3.5.1.2 GM Pancake Probe

Ludlum Model 44-9 Geiger-Mueller probes were used to assess gross alpha-beta-gamma count rates on small surfaces for which the larger 100 cm^2 probes were not manageable. They were also used for general health physics purposes such as hand and foot monitoring (frisking) and equipment scanning for release from controlled areas.

All of these instruments were calibrated within 1 year of use by standards traceable to the National Institute of Standards and Technology. The operation of the instruments was checked during the project by performing standard and background measurements daily. Results of efficiency and background checks were maintained in a log book.

Table 5: Specific Instrumentation used in the Final Status Survey

Manufacturer	Meter Model	Meter Serial No.	Probe Model	Probe Serial No.	Detector or Meter Type
Ludlum	12	78710	43-37	148949	Gas Flow Proportional - Floor Monitor
Ludlum	2360	141322	43-68	160690	Gas Flow Proportional - Hand Held Probe
Ludlum	3	138997	44-9	141724	Geiger Mueller Pancake Probe
Wallac*	1415	4150043			Alpha/Beta Liquid Scintillation Counter

* located at the CoPhysics Corp. laboratory in Florida, NY

3.6 Survey Results

3.6.1 Scan Survey Results

Scan surveys of survey units did not indicate any facility surfaces or fixtures above the DCGL. A summary of each survey unit is shown in the Table below.

3.6.2 Fixed Point Survey Results

The results of fixed point surveys are shown in Appendix B, which contains results of all of the fixed point results from direct beta measurements and smears counted for gross beta. The assessment was successful to the extent that there were no measurement results in any survey unit above the release criteria. No MARSSIM statistical tests were necessary to prove that the total activity in each survey area was also within the DCGL.

Table 6: Measurement Results Summary

Survey Area	Beta Scan Result	Direct Beta Count				Removable (Smear)			
				dpm/100 cm^2				dpm/100 cm^2	
		# Points	# Points > DCGL	Average	Max.	# Points	# Points > DCGL	Average	Max.
Warehouse	all < DCGL*	5	0	250	368	25	0	3	12
Repair Shop	all < DCGL	86	0	156	1688	86	0	3	25

* Several watches in the process of being repaired showed elevated radioactivity levels. However, these were non-licensed, exempt products in the public domain and such readings were not included in the results of this survey.

4 Conclusions

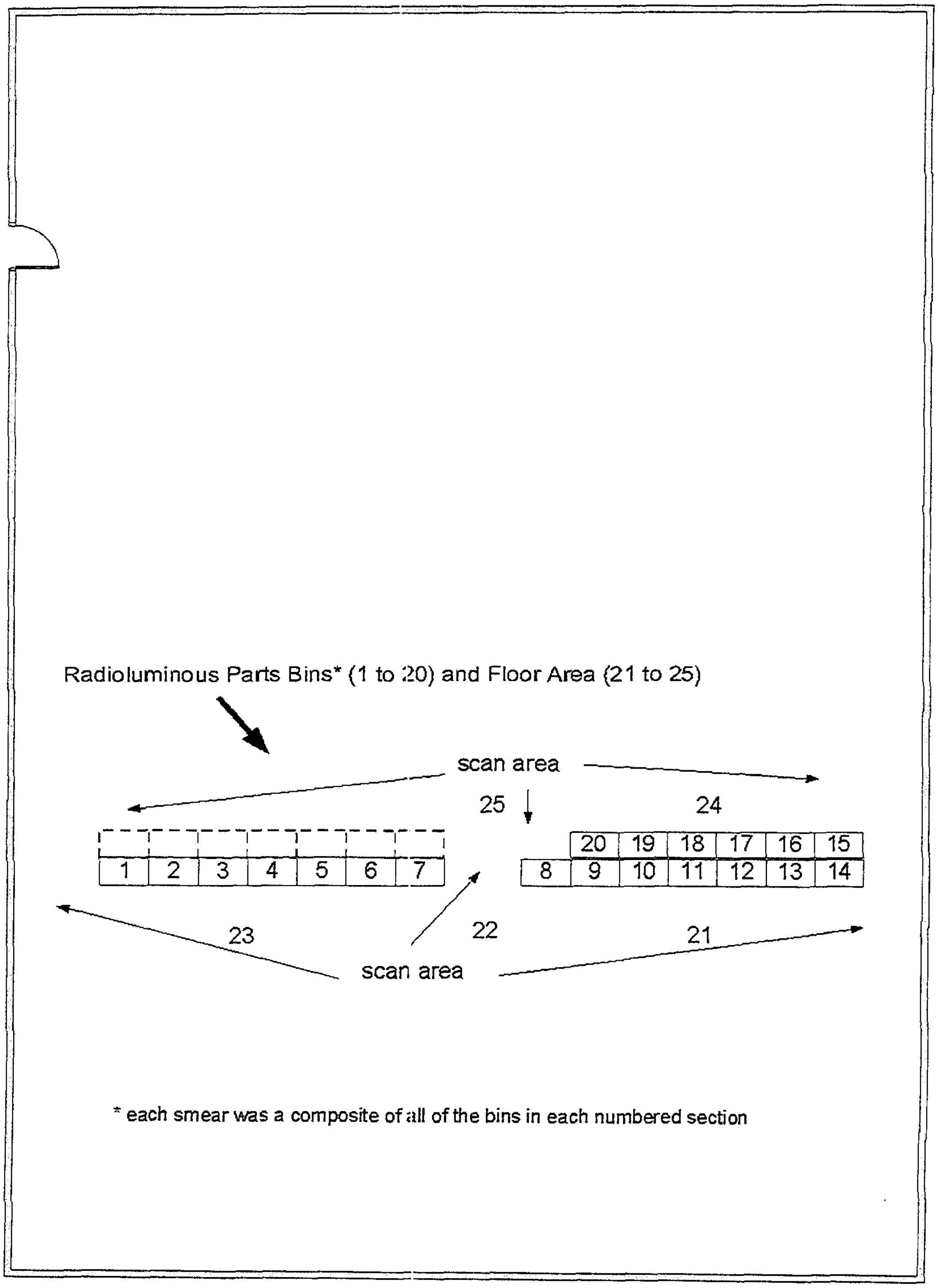
A license termination survey was conducted at the Seiko Corporation facility in Mahwah, NJ per the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The licensee has ended the use of radioactive materials contained in replacement watch parts and has disposed of all in-stock parts containing promethium-147.

Two survey units comprising the watch repair area and a portion of the warehouse were assessed via scanning beta surveys and smear samples for removable contamination. All readings in the survey units were below the criteria for fixed and removable contamination as listed in USNRC guidance. All radioactive waste has been removed from the premises.

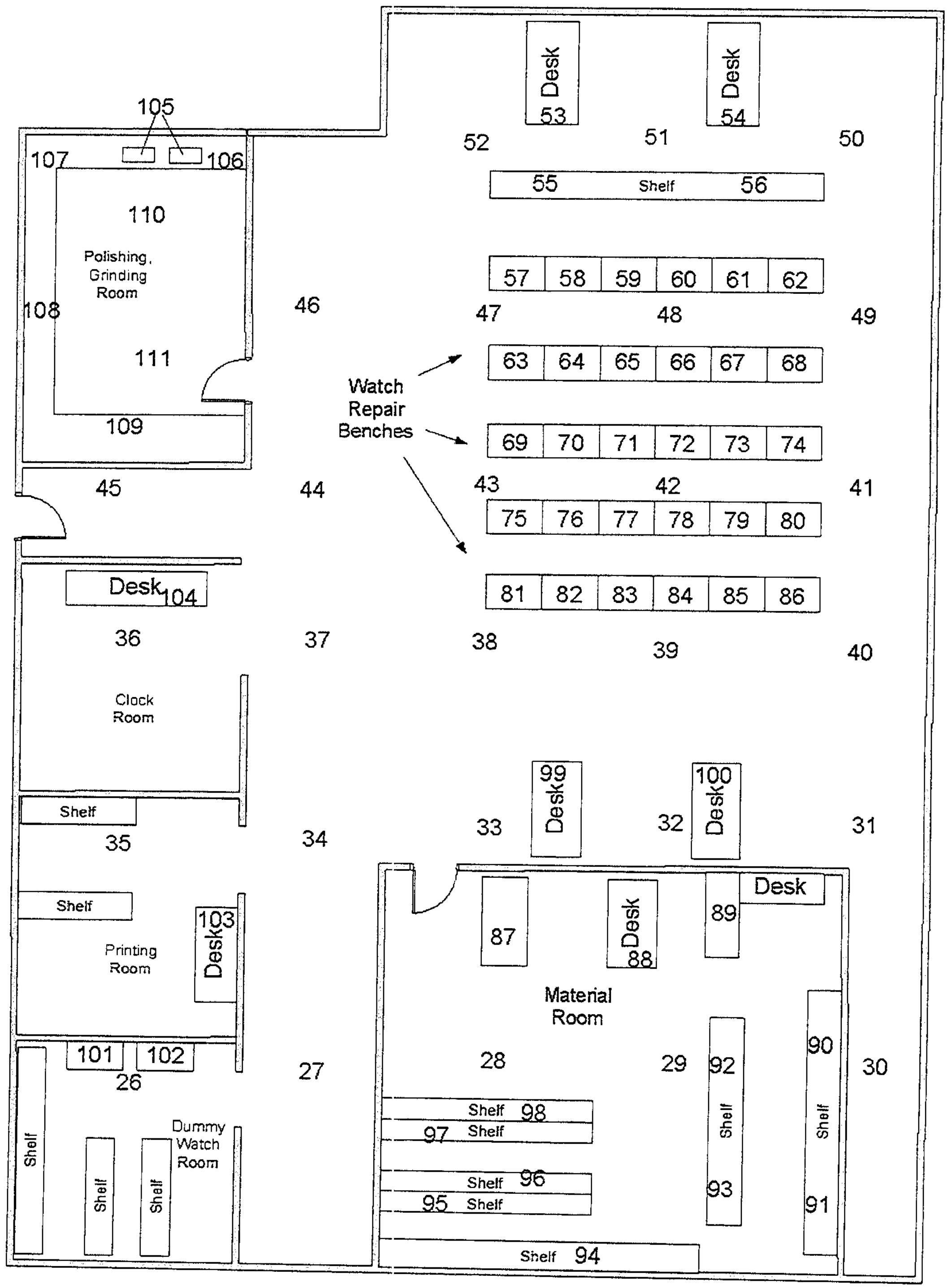
Based on the findings of this Final Status Survey, residual radioactivity in the building is far less than the USNRC release guidelines and would not cause a dose greater than 25 millirem per year to present and future occupants. The survey manager therefore recommends that the site be cleared for unrestricted use and the license terminated.

Appendix A – Survey Area Diagrams

Survey Locations – Warehouse



Survey Locations – Repair Department



Appendix B – Surface Activity Survey Results

SURFACE ACTIVITY SURVEY RESULTS

Location #	Item	Description	Survey Unit	Surface Activity Measurement Results: Removable Beta (dpm/100 sq cm)	Beta Count (GPC) (dpm/100 sq cm)	Beta Scan (GPC) Notes
1	bin	parts storage bin (scan result)	Warehouse	4 ± 4	N/A	scan <= DCGL
2	bin	parts storage bin (scan result)	Warehouse	2 ± 4	N/A	scan <= DCGL
3	bin	parts storage bin (scan result)	Warehouse	4 ± 4	N/A	scan <= DCGL
4	bin	parts storage bin (scan result)	Warehouse	-1 ± 4	N/A	scan <= DCGL
5	bin	parts storage bin (scan result)	Warehouse	3 ± 4	N/A	scan <= DCGL
6	bin	parts storage bin (scan result)	Warehouse	5 ± 4	N/A	scan <= DCGL
7	bin	parts storage bin (scan result)	Warehouse	2 ± 4	N/A	scan <= DCGL
8	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
9	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
10	bin	parts storage bin (scan result)	Warehouse	3 ± 4	N/A	scan <= DCGL
11	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
12	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
13	bin	parts storage bin (scan result)	Warehouse	3 ± 4	N/A	scan <= DCGL
14	bin	parts storage bin (scan result)	Warehouse	10 ± 5	N/A	scan <= DCGL
15	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
16	bin	parts storage bin (scan result)	Warehouse	2 ± 4	N/A	scan <= DCGL
17	bin	parts storage bin (scan result)	Warehouse	12 ± 5	N/A	scan <= DCGL
18	bin	parts storage bin (scan result)	Warehouse	3 ± 4	N/A	scan <= DCGL
19	bin	parts storage bin (scan result)	Warehouse	1 ± 4	N/A	scan <= DCGL
20	bin	parts storage bin (scan result)	Warehouse	2 ± 4	N/A	scan <= DCGL
21	floor	floor near parts bins	Warehouse	3 ± 4	257 ± 248	scan <= DCGL
22	floor	floor near parts bins	Warehouse	5 ± 4	368 ± 250	scan <= DCGL
23	floor	floor near parts bins	Warehouse	2 ± 4	316 ± 248	scan <= DCGL
24	floor	floor near parts bins	Warehouse	4 ± 4	13 ± 248	scan <= DCGL
25	floor	floor near parts bins	Warehouse	3 ± 4	296 ± 248	scan <= DCGL

Warehouse Statistics:	Removable Beta	Beta Count (GPC)	Notes
Minimum Detectable Activity:	28	274	scan MDA: 1370 hand held GPC
Average	3 ± 3	250 ± 138	scan MDA: 584 floor monitor GPC
Max	12	368	
N	25	5	

Location #	Item	Description	Survey Unit	Surface Activity Measurement Results		
				Removable Beta (dpm/100 sq cm)	Beta Count (GPC) (dpm/100 sq cm)	Beta Scan (GPC) Notes
26	floor	dummy, printing, clock rooms	Repair Shop	4 ± 4	-188 ± 238	scan <= DCGL
27	floor	hall	Repair Shop	1 ± 4	-240 ± 236	scan <= DCGL
28	floor	material room	Repair Shop	1 ± 4	-161 ± 236	scan <= DCGL
29	floor	material room	Repair Shop	3 ± 4	-227 ± 238	scan <= DCGL
30	floor	hall	Repair Shop	-1 ± 4	-141 ± 236	scan <= DCGL
31	floor	shop area	Repair Shop	0 ± 4	174 ± 236	scan <= DCGL
32	floor	shop area	Repair Shop	-1 ± 4	-214 ± 236	scan <= DCGL
33	floor	shop area	Repair Shop	4 ± 4	-89 ± 238	scan <= DCGL
34	floor	shop area	Repair Shop	2 ± 4	-201 ± 236	scan <= DCGL
35	floor	dummy, printing, clock rooms	Repair Shop	3 ± 4	10 ± 238	scan <= DCGL
36	floor	shop area	Repair Shop	2 ± 4	-207 ± 238	scan <= DCGL
37	floor	shop area	Repair Shop	2 ± 4	-188 ± 238	scan <= DCGL
38	floor	shop area	Repair Shop	0 ± 4	174 ± 236	scan <= DCGL
39	floor	shop area	Repair Shop	3 ± 4	385 ± 238	scan <= DCGL
40	floor	shop area	Repair Shop	3 ± 4	385 ± 238	scan <= DCGL, watch in progress on cabine
41	floor	shop area	Repair Shop	4 ± 4	451 ± 238	scan <= DCGL
42	floor	shop area	Repair Shop	0 ± 4	345 ± 236	scan <= DCGL
43	floor	shop area	Repair Shop	1 ± 4	516 ± 236	scan <= DCGL
44	floor	shop area	Repair Shop	6 ± 5	280 ± 238	scan <= DCGL
45	floor	shop area	Repair Shop	4 ± 4	510 ± 238	scan <= DCGL
46	floor	shop area	Repair Shop	3 ± 4	332 ± 238	scan <= DCGL
47	floor	shop area	Repair Shop	0 ± 4	385 ± 236	scan <= DCGL
48	floor	shop area	Repair Shop	1 ± 4	516 ± 236	scan <= DCGL
49	floor	shop area	Repair Shop	3 ± 4	694 ± 238	scan <= DCGL
50	floor	shop area	Repair Shop	2 ± 4	477 ± 236	scan <= DCGL
51	floor	shop area	Repair Shop	2 ± 4	194 ± 238	scan <= DCGL
52	floor	shop area	Repair Shop	1 ± 4	378 ± 236	scan <= DCGL
53	desk	shop area	Repair Shop	1 ± 4	-76 ± 236	scan <= DCGL
54	desk	shop area	Repair Shop	4 ± 4	-82 ± 238	scan <= DCGL
55	shelves	shop area	Repair Shop	6 ± 5	293 ± 238	scan <= DCGL
56	shelves	shop area	Repair Shop	6 ± 5	181 ± 238	scan <= DCGL
57	bench	shop area	Repair Shop	1 ± 4	-63 ± 236	scan <= DCGL
58	bench	shop area	Repair Shop	2 ± 4	582 ± 236	scan <= DCGL
59	bench	shop area	Repair Shop	4 ± 4	339 ± 238	scan <= DCGL
60	bench	shop area	Repair Shop	25 ± 7	819 ± 246	scan <= DCGL

Location #	Item	Description	Survey Unit	Surface Activity Measurement Results: Removable Beta (dpm/100 sq cm)	Surface Activity Measurement Results: Beta Count (GPC) (dpm/100 sq cm)	Beta Scan (GPC) Notes
61	bench	shop area	Repair Shop	3 ± 4	43 ± 238	scan <= DCGL
62	bench	shop area	Repair Shop	7 ± 5	234 ± 238	scan <= DCGL
63	bench	shop area	Repair Shop	3 ± 4	115 ± 238	scan <= DCGL
64	bench	shop area	Repair Shop	7 ± 5	63 ± 238	scan <= DCGL
65	bench	shop area	Repair Shop	5 ± 4	-181 ± 238	scan <= DCGL
66	bench	shop area	Repair Shop	4 ± 4	207 ± 238	scan <= DCGL
67	bench	shop area	Repair Shop	3 ± 4	234 ± 238	scan <= DCGL
68	bench	shop area	Repair Shop	1 ± 4	69 ± 236	scan <= DCGL
69	bench	shop area	Repair Shop	3 ± 4	247 ± 238	scan <= DCGL
70	bench	shop area	Repair Shop	-1 ± 4	477 ± 236	scan <= DCGL
71	bench	shop area	Repair Shop	5 ± 4	-76 ± 238	scan <= DCGL
72	bench	shop area	Repair Shop	5 ± 4	128 ± 238	scan <= DCGL
73	bench	shop area	Repair Shop	4 ± 4	365 ± 238	scan <= DCGL
74	bench	shop area	Repair Shop	0 ± 4	977 ± 236	scan <= DCGL
75	bench	shop area	Repair Shop	8 ± 5	1688 ± 240	scan <= DCGL
76	bench	shop area	Repair Shop	6 ± 5	-69 ± 238	scan <= DCGL
77	bench	shop area	Repair Shop	1 ± 4	628 ± 236	scan <= DCGL
78	bench	shop area	Repair Shop	4 ± 4	-523 ± 238	scan <= DCGL
79	bench	shop area	Repair Shop	5 ± 4	-405 ± 238	scan <= DCGL
80	bench	shop area	Repair Shop	8 ± 5	161 ± 240	scan <= DCGL
81	bench	shop area	Repair Shop	8 ± 5	753 ± 240	scan <= DCGL
82	bench	shop area	Repair Shop	4 ± 4	43 ± 238	scan <= DCGL
83	bench	shop area	Repair Shop	3 ± 4	23 ± 238	scan <= DCGL
84	bench	shop area	Repair Shop	-2 ± 3	122 ± 236	scan <= DCGL
85	bench	shop area	Repair Shop	2 ± 4	-148 ± 238	scan <= DCGL
86	bench	shop area	Repair Shop	2 ± 4	234 ± 238	scan <= DCGL
87	bench	material room	Repair Shop	3 ± 4	-141 ± 238	scan <= DCGL
88	desk	material room	Repair Shop	4 ± 4	-234 ± 238	scan <= DCGL
89	desk	material room	Repair Shop	4 ± 4	-109 ± 238	scan <= DCGL
90	shelves	material room	Repair Shop	7 ± 5	-253 ± 238	scan <= DCGL
91	shelves	material room	Repair Shop	2 ± 4	-227 ± 236	scan <= DCGL, watch in progress
92	shelves	material room	Repair Shop	0 ± 4	-240 ± 236	scan <= DCGL
93	shelves	material room	Repair Shop	3 ± 4	220 ± 238	scan <= DCGL
94	shelves	material room	Repair Shop	3 ± 4	-135 ± 238	scan <= DCGL
95	shelves	material room	Repair Shop	1 ± 4	-115 ± 236	scan <= DCGL

Location #	Item	Description	Survey Unit	Surface Activity Measurement Results: Removable Beta (dpm/100 sq cm)	Surface Activity Measurement Results: Beta Count (GPC) (dpm/100 sq cm)	Beta Scan (GPC) Notes
96	shelves	material room	Repair Shop	4 ± 4	141 ± 238	scan <= DCGL
97	shelves	material room	Repair Shop	0 ± 4	497 ± 236	scan <= DCGL
98	shelves	material room	Repair Shop	6 ± 5	359 ± 238	scan <= DCGL
99	desk	shop area	Repair Shop	4 ± 4	-194 ± 238	scan <= DCGL
100	desk	shop area	Repair Shop	4 ± 4	-155 ± 238	scan <= DCGL
101	cart	dummy, printing, clock rooms	Repair Shop	5 ± 4	326 ± 238	scan <= DCGL
102	cart	dummy, printing, clock rooms	Repair Shop	17 ± 6	832 ± 242	scan <= DCGL
103	desk	dummy, printing, clock rooms	Repair Shop	3 ± 4	-174 ± 238	scan <= DCGL
104	shelves	dummy, printing, clock rooms	Repair Shop	3 ± 4	201 ± 238	scan <= DCGL
105	sinks	polishing, grinding room	Repair Shop	5 ± 4	622 ± 238	scan <= DCGL
106	ctr top	polishing, grinding room	Repair Shop	1 ± 4	-36 ± 236	scan <= DCGL
107	ctr top	polishing, grinding room	Repair Shop	1 ± 4	-3 ± 236	scan <= DCGL
108	ctr top	polishing, grinding room	Repair Shop	2 ± 4	16 ± 236	scan <= DCGL
109	ctr top	polishing, grinding room	Repair Shop	4 ± 4	280 ± 238	scan <= DCGL
110	floor	polishing, grinding room	Repair Shop	1 ± 4	128 ± 236	scan <= DCGL
111	floor	polishing, grinding room	Repair Shop	2 ± 4	43 ± 238	scan <= DCGL

Repair Shop Statistics:		Removable Beta	Beta Count (GPC)	Notes
	Minimum Detectable Activity:	28	274	scan MDA: 1370 hand held GPC
	Average	3 ± 4	156 ± 349	scan MDA: 584 floor monitor GPC
	Max	25	1688	
	N	86	86	

Notes:

Results are net, with instrument background subtracted

Uncertainty is the 2-sigma counting error, or: $2 \times \mathrm{sqrt}(R_g/t+R_b/t)/Eff$

$MDA=4.65 \times s_{bkg}$

Appendix C – Determination of Scan Minimum Detectable Concentrations

INTRODUCTION

A radiological Final Status Survey (FSS) includes scanning surveys of building surfaces for various radionuclides of concern. This requires developing scanning sensitivities or scan minimum detectable concentrations (MDCs) for the instrumentation that are used. The scan MDC can be estimated by using the methodology in MARSSIM Section 6.7.2.1.

OBJECTIVE

The specific objective of this technical memorandum is to estimate the scan MDCs for a 100 cm^2 gas proportional detector (Ludlum 43-68) and a gas-proportional floor monitor (Ludlum 43-37) to measure beta emitters on selected structural materials in the buildings. This is accomplished utilizing the methodology and approach documented in MARSSIM (Section 6.7.2.1) for scanning of beta emitters. Other instruments can be calculated in a similar manner as shown below.

ESTIMATION OF MINIMUM DETECTABLE COUNT RATE

The minimum detectable count rate (MDCR) is dependent upon several factors including surveyor performance, instrument sensitivity, distribution of contamination, etc.

<u>Ludlum Model 43-68 or Equivalent</u>

Determination of Number of Source Counts

The MDCR is calculated by obtaining the minimum detectable number of source counts (Si) in a given time interval, i. Si is calculated by using equation 6-8 in MARSSIM as:

$$S_i = \mathrm{d}'\sqrt{\mathrm{b_i}}$$

Where: d' = is the detectability value associated with the desired performance selected from Table 6-5 in MARSSIM

bi = background counts during interval, i

The number of background counts will fluctuate with the type of structural material due to the varying concentration of naturally occurring radioactive material present. Based on the background rates for the 43-68 gas proportional detector at a typical commercial building, a typical background count rate of 300 counts pre minute is used.

It is assumed that during a typical scanning survey an elevated source of radioactivity remains under the probe for one second. The width of the detector is 10 cm. This corresponds to a scan speed of 10 cm per second and assumes that elevated radioactivity is a point source. Therefore, the number of background counts in the observation interval of one second when scanning brick is calculated as:

$$b_i = (300\ \text{cpm})(1\ \text{second})\left(\frac{\text{minute}}{60\ \text{seconds}}\right) = 5.0\ \text{counts}$$

The value of d' is selected from Table 6.5 in MARSSIM and is based upon the acceptable true and corresponding false positive proportions or rates during scanning. A 95% confidence level is used for correctly detecting the presence of radioactivity, with an allowance for 60% false positive detection. Having a higher percentage of false positives does not require increased sampling, but rather further investigation by either slowing the scan speed in the location of interest or performing an integrated count. A higher false positive value is actually conservative because background locations are investigated as though they contained residual radioactivity. The ramification of increasing the false positive proportion is that survey scanning time is increased. The value for d' in Table 6-5 of MARSSIM for the confidence levels specified above is 1.38. Therefore, the minimum number of source counts, when scanning, is calculated as:

$$S_i = 1.38\sqrt{5.0} = 3.1\ \text{counts}$$

Calculation of MDCR

The MDCR is calculated by using equation 6-9 in MARSSIM.

$$\text{MDCR} = \text{S}_\text{i}\ \frac{60}{\text{i}}$$

As stated in above, it is assumed that during a typical scanning survey an elevated source of radioactivity remains under the probe for one second. Therefore, when scanning, the MDCR is calculated as:

$$MDCR = (3.1\ counts)\left(\frac{60\ \text{sec.}}{1\ \text{sec. min.}}\right) = 185\ cpm$$

Estimation of Scan MDC

The scan MDC is determined from the Minimum Detectable Count Rate (MDCR) by applying necessary conversion factors that account for surveyor performance, detector efficiency, probe area, etc. The scan MDC is calculated by using equation 6-10 in MARSSIM as:

$$Scan\ MDC(dpm/100cm^2) = \frac{MDCR}{\sqrt{p}\,\epsilon_i \epsilon_s \dfrac{probe\ area}{100\ cm^2}}$$

Where: MDCR = minimum detectable count rate

εi = instrument efficiency

εs = surface efficiency

p = surveyor efficiency

NUREG-1507 recommends surveyor efficiency values between 0.75 and 0.5. To be conservative, 0.5 is chosen. The efficiency for the Model 43-68 probe for Pm-147 is about 22%. In addition, a value of 0.7 is assumed for the surface efficiency, so the combined surface and instrument efficiency is conservatively chosen as 15.2%. The physical window area of the Model 43-68 is 126 cm^2, with an active portion of 100 cm2. The Scan MDC is thus calculated as:

$$\text{Model 43-68 } Scan\ MDC = \frac{185\ cpm}{\sqrt{0.5}\left(0.152\dfrac{c}{d}\right)\left(\dfrac{126\ cm^2}{100\ cm^2}\right)} = 1370\ dpm/100cm^2$$

The conservatisms used in these calculations assure that the instrumentation can meet the Derived Concentration Guideline Level (DCGL) of 5000 dpm/100cm^2.

Floor Monitor, Ludlum 43-37 Probe, or Equivalent

An estimate of Scan MDC is discussed for Ludlum 43-37 floor monitor probe. The 43-37 gas proportional floor monitor has a detector window area of approximately 550 cm2. The scan MDC can be calculated in a similar manner as above, with consideration given to the larger detection area of the Model 43-37 to that of the Model 43-68.

Determination of Number of Source Counts

The MDCR is calculated as above by obtaining the minimum detectable number of source counts (Si) in a given observation interval, i. The number of background counts fluctuates with the type of structural material due to the varying concentration of naturally occurring radioactive material present. Based on the background rates for the 43-37 gas proportional detector at the facility, a typical background count rate of 1200 counts per minute was used.

$$Typical\ Background = 800\ cpm$$

The observation interval, i can be estimated based on an assumed a scan rate of 10 cm per second (as in the case above) and considering the width of the floor monitor detector (16 cm).

$$i = \frac{Width}{Rate} = \frac{10cm}{10cm/\sec} = 1.0\sec$$

Therefore, the number of background counts in the observation interval of 1.6 seconds when scanning concrete floor is calculated as:

$$b_i = (800\text{ cpm})(1.0\text{ sec})\left(\frac{\text{minute}}{60\text{ sec}}\right) = 13.3\text{ counts}$$

Utilizing a value for d' of 1.38, as above, the minimum number of source counts, when scanning concrete floor, is calculated as:

$$S_i = 1.38\sqrt{13.3} = 5.04\text{ counts}$$

Calculation of MDCR

The MDCR is calculated as above as:

$$MDCR = (5.04\ counts)\left(\frac{60\text{ sec.}}{1.0\text{ sec. min.}}\right) = 302\ cpm$$

Estimation of Scan MDC

An instrument efficiency of 19% is used, and a value of 0.7 is assumed for the surface efficiency, so the combined surface and instrument efficiency is conservatively chosen as 13.3%. The physical window area of the Model 43-37 is approximately 550 cm2. The Scan MDC is thus calculated as:

$$Scan\ MDC(dpm/100cm^2) = \frac{MDCR}{\sqrt{p}\ \epsilon_i \epsilon_s}\ (1)$$

$$\text{Model 43-37 } Scan\ MDC = \frac{302\ cpm}{\sqrt{0.5}\left(0.133\frac{c}{d}\right)(550cm2/100cm2)} = 584\ dpm/100cm^2$$

Appendix D - MARSSIM Area Classification and Sample Frequency Calculations

The following is a summary of MARSSIM statistical sampling and scanning recommendations simplified for use in small to medium scale release surveys:

Area Classification: For purposes of establishing the sampling and measurement frequency and pattern, MARSSIM discusses non-impacted and impacted areas in which there are 3 sub-classifications:

Impacted Areas - have potential radioactive contamination (based on facility operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). These include areas where radioactive materials were used or stored, or potential for unusual occurrences which could have resulted in contamination. Areas adjacent to locations where radioactive materials were used or stored are normally included in this classification because of the potential for inadvertent spread of contamination. These areas are further classified as:

- Class 1 Areas: (areas experiencing prior remedial action, spills, waste storage or disposal, relatively large quantities of loose radioactivity)
- Class 2 Areas: (areas handling low concentrations or small quantities of radioactivity in unsealed forms, upper walls and ceilings in airborne radioactivity areas, perimeters of contamination control areas, etc. where no individual measurement result would be expected to exceed guideline values before remediation)
- Class 3 Areas: (areas in which residual radioactivity is expected but at a small fraction of guideline values such as buffer areas to contaminated areas, lab offices, hallways, loading docks used for radioactive shipments, etc.)

Non-impacted areas - All areas not classified as affected. These areas are not expected to contain residual radioactivity, based on knowledge of site history and/or previous survey information. No measurements are required for non-impacted areas.

Sample Frequencies: The frequencies of surface activity or concentration measurements are derived from MARSSIM based on expected standard deviation of measurement results.

The Wilcoxon Rank Sum (WRS) Test is used in MARSSIM equation 5.1 to calculate the minimum number of samples to be collected from the survey and background units (if the contaminant is present in the background):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2} \qquad \text{Eq. 5.1}$$

Where,

N = number of samples required for the background and survey area (N should be optionally increased by 20% as a contingency for non-analyzable samples, etc.). N may be divided between the background and survey areas as N/2 each.

Z = standard normal statistic for α and β (both specified to be 0.05 for a 95% confidence level) = 1.645

P_r = a probability statistic based on the ratio of the shift (Δ) to the standard deviation of the impacted or background area measurements

Δ = the shift, a statistical activity parameter usually set equal to 1/2 of the guideline release limit.

The one-sample Sign Test is used in MARSSIM equation 5.2 to calculate the minimum number of samples to be collected from the survey unit (if the contaminant is **not** present in the background):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\mathit{Sign}\ P - 0.5)^2} \qquad \text{Eq. 5.2}$$

Where,

N = number of samples required for the survey unit (N should be optionally increased by 20% as a contingency for non-analyzable samples, etc.).

Z = standard normal statistic for α and β (both specified to be 0.05 for a 95% confidence level) = 1.645

Sign P = a probability statistic based on the ratio of the shift (Δ) to the standard deviation of the survey area measurements

Δ = the shift, a statistical activity parameter usually set = 1/2 of the guideline release limit.

Determine the Number of Discrete Sample Locations

Relative Shift

The relative shift describes the relationship of site residual radionuclide concentrations to the DCGL, and is calculated using the following equation, found in Section 5.5.2.2 of MARSSIM (NRC 2000):

$$\Delta/\sigma = \frac{DCGL_w - LBGR}{\sigma}$$

Where:

$DCGL_w$ = the derived concentration guideline level (release limit = 5,000 dpm/100 cm^2)

LBGR = concentration at the lower bound of the gray region. The LBGR effectively becomes the survey's action level. The LBGR is set at 2500 dpm/100 cm^2 for this FSS.

σ = An estimate of the standard deviation of the concentration of residual radioactivity in the survey unit (which includes real spatial variability in the concentration as well as the precision of the measurement system). σ is estimated at 1,000 dpm/100 cm2, or 1/5 the $DCGL_W$.

A relative shift for the FSS is calculated as (5000 – 2500) / 1000 = 2.5. The Type I error is set at 0.05 (probability of declaring an area clean when it is contaminated), and the Type II error is set at 0.10 (probability of declaring an area contaminated when it is in fact clean). Based on these acceptable decision errors, the minimum number of measurement locations in the survey unit is determined by comparison to the MARSSIM Table 5.3, "Values of N/2 when using the Wilcoxen Rank Sum Test". Using Table 5.3, and the errors of $\alpha = 0.05$ and $\beta = 0.10$, the number of survey points per survey unit is 9. The table values have already been increased by 20% to account for missing or unusable data.

Survey Unit Grid Spacing

Grid spacing and placement of fixed-point measurement locations within each Survey Unit was based on a relative coordinate system. The starting point is randomly selected and the data points are located within the survey unit using a square grid for Class 1 and Class 2 areas. For Class 2 survey units, the systematic locations for floor layouts also included the first 2 meters of each wall and additional biased points on the ceiling. For Class 1 survey units, the layout is separate for each survey unit (floor, walls, ceiling, and components). The grid areas are calculated as follows:

$$L = \sqrt{A/n}$$

where:

L = grid spacing; A = survey unit area
n = number of data points (9)

For example: Area of floor = A = 6000 ft^2 No. of points = n = 9

$$L = \sqrt{A/n} = (8000/14)^{1/2} = 26 \text{ ft}$$

Scan Coverage: Guidance on scan coverage area is obtained from MARSSIM Table 5.9 which allows subjective estimates of the percent coverage based on the potential for contamination in excess of guideline limits. Guidance on scan coverage is summarized in the following table:

Scan Coverage Guidance

Area Classification	Structures	Land Areas
	Coverage of Surface Scans	Coverage of Gamma Surface Scans
Impacted Class 1	100%*	100%
Impacted Class 2	10 to 100% floors / lower walls 10 to 50% ceiling / upper walls Based on potential contam.levels	10 to 100% Based on potential contam.levels
Impacted Class 3	Judgmental	Judgmental
Non-Impacted	none	none