Bristol-Myers Squibb Company

Worldwide Medicines Group
P.O. Box 5400 Princeton, NJ 08543-5400
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Q-5

December 16, 2002

Ms. Betsy Ullrich, CHP
Nuclear Material Safety Branch
US NRC Region I
475 Allendale Road
King of Prussia, PA 19406

RE: DOCKET NO. 030-05222 - AMENDMENT TO RADIOACTIVE MATERIAL LICENSE NO. 29-00139-02

Dear Ms. Ullrich:

E. R. Squibb & Sons, a wholly owned subsidiary of Bristol-Myers Squibb Company, wishes to amend its broad scope Radioactive Material License No. 29-00139-02 to include the attached Final Site Survey Plan (FSSP) for the decommissioning of the former Radiodiagnostic Manufacturing Operations and associated facilities at our New Brunswick, New Jersey site.

To facilitate your review of the FSSP, please note that Attachment One of the plan is a compliance matrix that identifies the sections of the plan that address the criteria required in NUREG 1727, NMSS Decommissioning Standard Review Plan.

If you require any additional information or wish to discuss these requests, please contact me at michael.vala@bms.com or (609) 818-4907.

Sincerely,

Michael J Vala

Michael J. Vala, CHP
Radiation Safety Officer, Manger EHS

MJV:bl

Attachment

MJV\02-AMEND1216.DOC

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FINAL STATUS SURVEY PLAN

FOR

RADIODIAGNOSTIC MANUFACTURING OPERATIONS
E. R. SQUIBB & SONS,

a wholly owned subsidiary of

BRISTOL-MYERS SQUIBB COMPANY

NRC License No. 29-00139-02
New Jersey State License No. 10071

NEW BRUNSWICK, NEW JERSEY

Prepared by: William R. Hoey, CHP Senior Radiological Engineer, Commercial Operations, Duratek, Inc. — 12/11/02 Date

Reviewed by: Paul C. Ely, Project Manager, Commercial Operations, Duratek, Inc. — 12/11/02 Date

Reviewed by: Beverly Good, Executive Engineer, Bristol-Myers Squibb — 12/12/02 Date

Approved by: Michael J. Vala, CHP, Radiation Safety Officer, Bristol-Myers Squibb — 12/12/02 Date

Approved by: T. D. Whalen, Project Manager, Bristol-Myers Squibb — 12/13/02 Date

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1.0 INTRODUCTION

The Bristol-Myers Squibb (BMS) Final Status Survey Plan (FSS) has been prepared using the guidance provided in applicable regulatory guidance documents such as NUREG-1575 (ref. 11.1), and NUREG-1727 (ref. 11.2). This plan will be used to develop survey unit packages to accomplish the Final Status Survey. Attachment 1 contains a compliance matrix for NUREG 1727, NMSS Decommissioning Standard Review Plan.

1.1 Background

E. R. Squibb & Sons, a wholly owned subsidiary of Bristol-Myers Squibb (BMS), operated a radiopharmaceutical manufacturing facility at its New Brunswick, NJ facility. This facility was operated under the requirements of a Nuclear Regulatory Commission (NRC) Materials license (No. 29-00139-02). The former radiopharmaceutical manufacturing facility was permanently shutdown in June of 2001 following the decision to cease operations and to decontaminate and decommission (D&D) the facility. Duratek, Inc (Duratek) was awarded a contract by BMS to perform a characterization of the facility. During the fourth quarter of 2001 and the first quarter of 2002, Duratek performed a characterization survey of the former radiopharmaceutical manufacturing facility and the surrounding environs to accurately assess the extent of radiological contamination and to determine the methods and costs associated with the decommissioning.

The NRC license, under which the facility was operated, and is still maintained also authorizes BMS to possess and use radioactive materials at three other BMS sites in central New Jersey. Therefore, the goal of the final status survey is not the termination of BMS's radioactive materials license. Instead, it is expected that NRC will concur in writing that the buildings and outside areas associated with the final status survey are unconditionally released and are no longer subject to the requirements of the NRC license. (The NRC license was amended in July 2001 to reflect the shutdown of the radiopharmaceutical facility. The amendment resulted in the references to the facility's operation being removed and the reduction in radioisotope quantity limits.)

BMS also has a radioactive materials license issued by the State of New Jersey's Department of Environmental Protection (NJDEP). The State of New Jersey has regulatory authority over the possession and use of accelerator-produced radioisotopes and naturally occurring radioactive materials (NORM). Specifically, the BMS radiopharmaceutical manufacturing facility processed and used ^{57}Co, ^{85}Sr, and ^{54}Mn. As with the NRC license, the NJDEP license is for the four BMS sites including the New Brunswick, NJ site. Therefore, termination of the NJDEP license is not planned. Instead, concurrence with the unconditional release of the facilities and surrounding areas from the requirements of the license is anticipated.

1.2 Characterization Survey

The characterization survey was performed during the fourth quarter of 2001 and the first quarter of 2002. The characterization survey utilized the results of the Historical Site Assessment (HSA) investigation, and entailed the preparation of plans and the performance of a comprehensive radiation survey which included sampling for potential hazardous materials at the facility and site following guidance provided in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, August 2000 (ref. 11.1), hereinafter referred to as simply MARSSIM or the MARSSIM manual as it has become commonly known. The historical site assessment involved a site walk-down, interviews with current and former employees, and a review of facility records. A HSA Report was prepared by TLG Services and Duratek, Inc., and is included as Appendix A to the Characterization Report (ref. 11.3). Based upon the information obtained from the site investigation, plans detailing the characterization survey were developed such as the Characterization Survey Plan, Quality Assurance Plan, Site Health and Safety Plan and the Project Management Plan. The Characterization Plan included a classification of each survey unit according to expected contamination levels as derived from the HSA Report. The classification system is based on the MARSSIM guidelines The plans were developed by Duratek staff from the Commercial Services office in Kingston, Tennessee and reviewed and approved for use at the project site. Data quality objectives (DQO's) were stated in the plans and the characterization of the former radiopharmaceutical production facility was performed according to these plans and the procedures referenced in the plans. A total of 3,503 total samples and measurements were collected or performed for the characterization survey. Less than 100 of the results of the samples and measurements were classified as elevated. Attachment 2 summarizes the results obtained during the characterization survey. In general, it can be stated that most of the elevated results were obtained from materials and/or equipment that either has been or will be removed as part of the D&D phase prior to the final status survey being performed for a particular survey unit.

The characterization survey results were utilized in the development of the Decommissioning Plan and this Final Status Survey Plan. Equipment and materials were identified that were to be removed from the facilities prior to the final status survey being performed. The characterization survey results also resulted in the reclassification of several areas of the facility. (The majority of the areas reclassified were lab area walls and ceilings being changed from class 1 to class 2. The floors remain as class 1.) The characterization survey results identified the contaminants present and the degree of variance of contamination within each survey unit. Both of these factors play an important role in the planning process for final status surveys. As the overall degree of contamination in the facilities is relatively small, in many cases it is expected to incorporate characterization survey data into the final status survey. Prior to doing so, it will be verified that any characterization survey data to be incorporated was collected using appropriate DQOs, all required survey instrument QC

measurements were performed, and appropriate measurement and sampling techniques were used.

1.3 Decontamination and Demolition (D&D) Activities

D&D activities began at the site in mid-August, 2002. These work activities were performed by Almasi Construction Co., Woodbridge, NJ under the direction of Duratek, Inc. health physics personnel and in accordance with BMS license requirements and the Duratek, Inc. Radiation Protection Program. D&D activities were largely dictated by the characterization survey results. Also, materials and equipment that could not be adequately surveyed and had a potential for residual contamination were incorporated into D&D activities. Major D&D activities included:

- Removal of the four underground Building 124 (B-124) 10,000 gallon waste decay tanks and associated piping and valves and the concrete vault.
- Removal of the two underground B-83 8,000 gallon waste tanks and associated piping and valves and the concrete vault and pad.
- Removal of the B-124 vent stack.
- Removal of the major portion of the B-124 exhaust ventilation ducting and HEPA and charcoal filters and filter housings.
- Removal of laboratory cabinets, countertops, and fume hoods.
- Decontamination and partial removal of hot cells.
- Removal of all process and sewer drain lines.

All materials and equipment unconditionally released were released in accordance with the limits specified in Reg. Guide 1.86. Material and equipment that could not be unconditionally released were sent offsite for either processing for disposal as radioactive waste or decontamination and/or additional surveys and unconditional release. Surveys performed during D&D activities did not identify any sources of significant contamination that were not identified during the characterization survey.

1.4 Summary of Final Status Survey Plan

The basis for the design of the final status survey is the MARSSIM. The specific elements of the MARSSIM survey process are discussed in subsequent sections of this plan. The overall goal of the FSS design is to ensure surveys are planned and conducted in such a manner that ensure the proper decision is made as to whether or not to accept or reject the null hypothesis (Null hypothesis, H_0: residual radioactivity in the survey unit exceeds the release criterion). The COMPASS computer code (ref. 11.4) will also be used as part of the survey planning and survey assessment process. Individual survey packages will be prepared for each survey unit. Survey data obtained from the survey unit as part of the final status survey will be maintained with the survey package. Some survey units will receive their final status survey prior to

the completion of all D&D activities. Due to the extremely low source term at the facility, minimal access controls will be required for areas surveyed prior to the completion of all D&D work. Also, some survey units will have had the final status survey performed prior to the approval of the document. As is the case with characterization survey data, these survey packages will be reviewed after approval of this survey plan to ensure all requirements were met.

The major inputs into the FSS planning process are the development of Data Quality Objectives (DQOs) (see section 4.1), review and modification as necessary of the designation of class 1, 2, and 3 areas (see section 4.4), the designation of survey units within each area classification (see section 5.0), the review of contaminants and establishment of Derived Concentration Guideline Levels (DCGL) (see sections 2.3 and 4.2), and the selection of appropriate survey instrumentation (see section 6.1).

1.5 NRC and NJDEP Interface

As was the case throughout the D&D phase and the characterization phase, frequent communication will be maintained with both the NRC and NJDEP. Both regulatory agencies will be kept informed of planned final status survey activities routinely, typically on a weekly basis. These weekly updates are typically performed via e-mail by the BMS Radiation Safety Officer (RSO) or the BMS Executive Engineer for the project. All reasonable efforts will be made to accommodate either agency's requests to be present for the performance of specific planned activities.

2.0 SITE INFORMATION

2.1 Site Description

The BMS radiopharmaceutical manufacturing facility to be decommissioned is located in New Brunswick, NJ, approximately 25 miles southwest of Newark, NJ. The BMS site is shown in Figure 2-1 and the areas to be decommissioned are shown in Figure 2-2.

2.2 Scope of FSS Areas to be Unconditionally Released

2.2.1 Building 124

Building 124 was a radiopharmaceutical manufacturing and distribution building. It is a large (about 70,000 ft^2), two story building that used to contain office areas, laboratories, hot cells (caves), radiopharmaceutical packaging areas, HEPA ventilation systems, mechanical rooms, machine shop, receiving area, a shipping dock and related infrastructure including a sanitary sewer and process drains and sewer system. The facility will have had most of the equipment removed including hoods, gloveboxes, and process ventilation systems prior to the release survey being performed. Areas that previously

exhibited activity above background levels include the process caves, some glove boxes and hoods and some ventilation system components.

2.2.2 Building 122

Building 122 was used as a radiopharmaceutical storage facility. It is a single story building of approximately 3,500 ft^2 with old and new sections. The former operations in this building included the following:

- Hold-for-decay radioactive waste,
- Returned pharmaceutical and source package breakdown,
- Radioactive waste disposal shipment preparation, and
- Compaction of waste from R&D activities at several of the licensed sites.

2.2.3 Outside Areas

(a) Building 83 Tanks and Tank Pit

Two 8,000 gallon buried wastewater containment (decay) tanks were located in a pit to the south of Building 83. These tanks previously received radiopharmaceutical wastewater. The tanks sat on a concrete pad that was >2 feet thick. A concrete vault enclosed the west end of the tanks as well as associated valves and piping. The tanks were removed and transferred to the B-124 radiologically controlled area (RCA) adjacent to the B-124 tank pit. The concrete vault and pad were surveyed, released and removed prior to the collection of soil samples.

The initial survey plan for collecting the soil samples from the ground beneath the concrete was to collect 15 soil samples (2 more than the MARSSIM recommended number of samples) from random points in accordance with MARSSIM. (See Survey package E0200, attachment 3.) However, attempts to collect these samples proved to be more arduous than anticipated. Using a 2-person gasoline powered 6-inch auger, holes were drilled at 5 of the prescribed sample points. No soil sample was able to be obtained from two of these points. At these two points, bedrock that could not be penetrated was encountered after drilling through ~24" of 2"-3" gravel that was laid as a foundation below the concrete pad. It was decided that, based on the lack of contamination on the concrete pad and the results of the 4 characterization soil samples collected from each side of the tanks at depths of 17'-20', no additional soil samples would be collected. A decision on the unconditional release of the B-83 tank pit will be based

on the results of the 3 soil samples collected in conjunction with the other survey data obtained during the characterization and decommissioning phases.

(b) Building 124 Stack

A 98-foot tall steel stack was located to the west of Building 124. The stack was the release point for exhaust from the Building 124 ventilation systems. This stack was removed, surveyed and released in the D&D phase of the project.

(c) Building 124 Decay Tanks Vault

Four 10,000 gallon decay tanks were located in a concrete vault south of Building 124 and the pumps and equipment in the adjacent concrete valve pit. There is no history of spills to the soil around the Building 124 buried tank area. The Building 124 tanks did have leaks into the tank vault when the inlet pipe to one of the tanks broke. The wastewater was cleaned up and sent to another waste tank. The vault completely surrounded the tanks and contained all spilled liquids. The vault was not totally water tight however, as there was in-leakage from groundwater that was removed via a sump and sump pump. The characterization report indicates that the soils up to 20 feet deep around the tank vault were not contaminated. However, a sediment sample from the valve pit gave results >DCGL during the characterization survey. The equipment and tanks were removed, surveyed, deconned (tanks only) and released. Initial plans were to collect 15 soil samples from the area beneath the B-124 tank vault and valve pit using MARSSIM sampling protocols. Due to the anticipated high water table in this area, the plan was to core through the vault's concrete floor at the 15 designated locations and at each location to use an auger to collect a sample. However, the first two concrete cores removed from the vault floor resulted in significant water intrusion into the vault. Two other concrete cores removed from the adjacent valve pit also resulted in water intrusion and the valve pit floor is 8-10 feet higher than the vault floor. Due to the water intrusion, it was determined that usable soil samples could not be collected at the 15 sample points. Instead, the concrete vault floor and valve pit floor were broken up and removed. A backhoe was used to collect a shovelful of soil from the vault and place it on the ground adjacent to the vault. The same was performed with the dirt below the valve pit. From each shovelful of dirt, a separate soil sample was collected. These two samples will constitute the soil sampling from the ground below the B-124 tank vault and valve pit. A decision on the unconditional release of the ground below the B-124 tank vault and valve pit will be based on the results of the 2 soil samples collected in conjunction with the other survey data obtained during the characterization and decommissioning phases.

(d) Storm Water Holdup Tank

The storm water holdup tank at the north end of Building 122 does not have a history of internal activity above background levels.

(e) Storm Sewers

The storm sewers around Building 124 do not have a history of internal activity above background levels.

(f) Open Land Areas

There were some spills of radioactive material outside of Building 124. In addition there were also some work activities that could have resulted in radioactive material transfer to outdoor areas, even though no such contamination was ever reported. Based on the characterization survey data the outdoor areas do not have activity levels above background.

2.3 Identity of Contaminants

The radionuclides of concern identified at the facility were identified based on review of process history, interviews with current and former BMS personnel, previous survey data, including sample analyses. This process is documented in the HSA portion of the Characterization Report. The radionuclides used were primarily short-lived radionuclides but traces of longer lived radionuclides present as trace impurities and the production of ^{137}Cs and ^{60}Co reference standards indicated that some longer-lived nuclides were potentially present. The radionuclides with long enough half-lives to be of concern are ^{3}H, ^{14}C, ^{22}Na ^{54}Mn, ^{57}Co, ^{60}Co, ^{75}Se, ^{85}Sr, ^{99}Tc, ^{129}I, ^{134}Cs and ^{137}Cs. The anticipated radionuclides along with approximate decay information are provided in Table 2-1 below.

During the characterization survey, alpha activity was detected, almost always in the 20-40 dpm/100 cm^2 range. However, no alpha emitters were ever used at BMS or identified as impurities. Also, gamma isotopic analyses of building materials, soil, and other debris samples showed readily identifiable naturally occurring radioactive materials (NORM). In addition, as discussed below, a 10CFR61 analysis of valve pit sediment did not identify any alpha emitters. For these reasons it has been concluded that the alpha activity identified during the characterization survey is all from NORM and no surveys for alpha activity are planned for the final status survey.

Radionuclides identified during characterization from samples analyzed by onsite gamma spectrum analysis were ^{22}Na, ^{54}Mn, ^{57}Co, ^{60}Co, ^{85}Sr, ^{99}Tc, ^{134}Cs and ^{137}Cs. This does not include the background radionuclides detected (^{40}K, ^{208}Tl, ^{212}Pb, ^{214}Pb, ^{212}Bi, ^{214}Bi, ^{226}Ra, ^{228}Ac and ^{230}Th). These radionuclides were not all present in a single sample location. For example ^{57}Co, ^{60}Co and ^{137}Cs were present in sediment from inside the Building 124 valve pit; ^{60}Co, ^{134}Cs and ^{137}Cs were present in the sediment sample from the Room 172 Cave track, ^{57}Co, ^{85}Sr and ^{137}Cs were present in

the sediment sample taken from the process sewer manhole; Na-22 and ^{137}Cs were present in a smear sample taken from the bottom of a Minitec Cave decay tank. ^{22}Na was only found in this one sample.

Table 2-1 Radionuclides with Decay Information

		Major Radiations Energies (MeV) and intensities (%)				
Nuclide	**Half-life**	**Gamma (Mev)**	**Gamma (Mev)**	**Gamma (Mev)**	**Avg. Beta (Mev)**	**Max. Beta (Mev)**
^{3}H	12.28 yr	-	-	-	0.0057	0.0186
^{14}C	5730 yr	-	-	-	0.049	0.0156
^{22}Na	2.602 yr	0.511 (180%)	1.275 (100%)		0.215*	0.545*
^{54}Mn	312.7 d	0.835 (100%)	-	-	none	none
^{57}Co	270.9 d	0.014 (10%)	0.122 (86%)	0.136 (11%)	none	none
^{60}Co	5.271 yr	1.173 (100%)	1.332 (100%)	-	0.096	0.318
^{85}Sr	64.84 d	0.514 (100%)	-	-	None	none
^{99}Tc	$2.13x10^{5}$ yr	-	-	-	0.0846	0.293
^{137}Cs	30.17 yr	0.662 (89%)	-	-	0.174	1.173

*Na-22 decays by positron (ß+) decay.

A sediment sample from the valve pit for the Building 124 decay tanks was sent off site for 10 CFR Part 61 radionuclide analysis. The sample analysis results indicated the presence of ^{14}C, ^{60}Co, ^{137}Cs, and ^{99}Tc with the other radionuclides being less than the minimum detectable concentration (MDC). The complete results are presented in Table 2-2, *BMS 10 CFR 61 Analysis Results*.

Table 2-2 BMS 10 CFR 61 Analysis Results

Radionuclide	Type of Analysis	MDC (pCi/g)	Result (pCi/g)
^{3}H	Liquid Scintillation	8.72	< MDC
^{14}C	Liquid Scintillation	1.43	3.88
^{60}Co	Gamma Spectroscopy	0.14	6.23
^{63}Ni	Liquid Scintillation	2.37	< MDC
^{90}Sr	Beta Proportional Counting	0.86	< MDC
^{99}Tc	Liquid Scintillation	0.31	4.49
^{129}I	Gamma Low Energy Photon Spectroscopy	0.66	< MDC
^{137}Cs	Gamma Spectroscopy	0.15	14
^{238}Pu	Alpha Spec	0.23	< MDC
$^{239/240}Pu$	Alpha Spec	0.16	< MDC
^{241}Pu	Alpha Spec	1.37	< MDC
^{242}Pu	Alpha Spec	0.08	< MDC
^{241}Am	Alpha Spec	0.22	< MDC
^{242}Cm	Alpha Spec	0.23	< MDC
$^{243/244}Cm$	Alpha Spec	0.20	< MDC

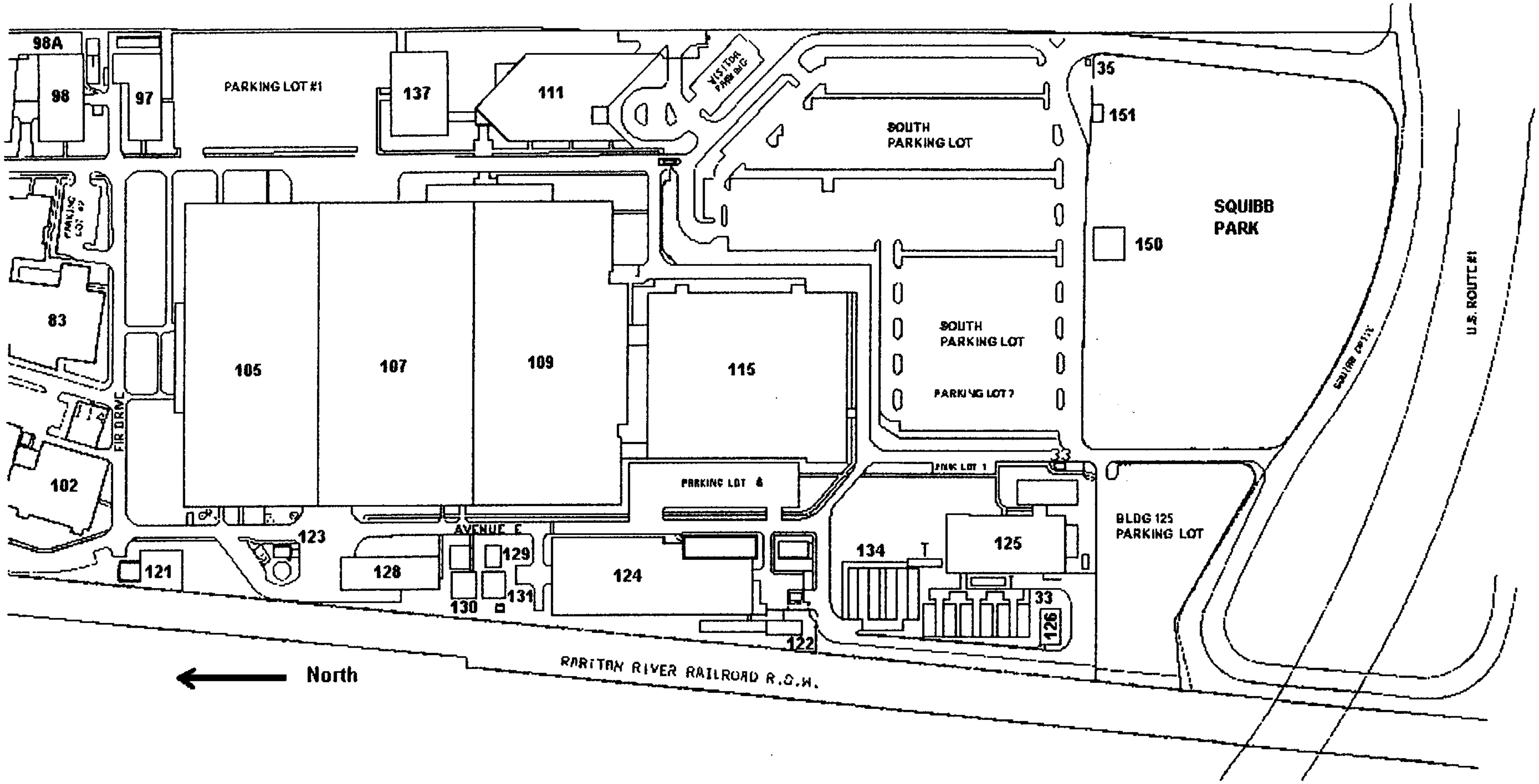


Figure 2-1 BMS Site Map

Figure 2-2 BMS Areas for Decommissioning

(This is a multi-colored diagram.)

3.0 ORGANIZATION AND RESPONSIBILITIES

Duratek will implement an integrated management approach that includes project management oversight and technical support. The resources of Duratek's main offices, including professional engineering and quality assurance staff, will support the Project Manager and the on-site team to ensure successful project execution and completion.

The on-site survey and sampling team, consisting of an engineer/supervisor and Radiation Protection technicians will be trained, qualified, and experienced in field radiological survey procedures.

3.1 Project Manager/Survey Supervisor

The Project Manager is the primary point of contact and interfaces with the BMS staff including the Executive Engineer. The Project Manager is also responsible for the design of and the performance of final survey and sampling activities and will be on site for the duration of the project. The individual will have prior experience in managing facility surveys.

3.2 Survey Specialists

The Survey Specialists are responsible for performing surveys and collecting samples. They will be qualified in the use of the survey instruments and surveying in accordance with the individual survey package instructions.

4.0 SURVEY OVERVIEW

This section provides the basis for developing the MARSSIM survey of the facility. In order to design the survey, several parameters must be set to ensure that the survey will stand up to and meet the statistical evaluations to justify the release of the facility. These include the establishment of the Data Quality Objectives DQOs, Release Criteria or Derived Concentration Guideline Levels (DCGLs), establishment of the acceptable decision errors and the calculation of the Relative Shift in order to determine the number of required measurements per survey unit. For this project, the COMPASS code (Ref. 11.4) will be used to assist with the implementation of MARSSIM.

4.1 Data Quality Objectives

To ensure the proper release of the facility, the objectives of this survey plan are to:

- Ensure the proper selection of appropriate instrumentation to adequately detect the radionuclides of concern.
- Establish proper count times and measurement techniques to ensure Minimum Detectable Concentrations (MDCs) are <50% of the $DCGL_w$ and that scan MDCs are less than the $DCGL_{emc}$.

- Ensure surveys are planned and conducted in a manner that enables the null hypothesis to be either accepted or rejected for each survey unit.
- Ensure DCGLs are established such that the total effective dose equivalent (TEDE) to an average member of the critical group from residual contamination will not exceed 25 mrem/year for NRC regulated radionuclides and 15 mrem/year for New Jersey Department of Environmental Protection (NJDEP) regulated radionuclides.
- Ensure that a statistically significant number of measurements are taken for each survey unit in accordance with the guidance provided in the MARSSIM manual.
- Ensure the final status survey is planned, conducted and documented in a manner consistent with the applicable federal and State of New Jersey regulations.

4.2 Release Criteria for Unrestricted Use

The unrestricted release criteria given in 10 CFR 20 is a dose based standard where residual radioactivity, distinguishable from background radiation and resulting in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group will not exceed 25 mrem/y. Levels of residual radioactivity that correspond to the allowable radiation dose are calculated (derived) by analysis of various scenarios and pathways.

The release criteria to be used are the NRC Screening Values for Building Surface and Soil and DandD (ref. 11.5) using default values equivalent to the 25 mrem/y. However, reasonable efforts will be made to remediate the facility below these levels when practicable.

The DCGLs for building surfaces and soils to be used are based on radionuclide specific screening values provided by the NRC in either the Federal Register (Ref. 11.6 and 11.7), or through calculations performed using the NRC's DandD Code, Version 2.1 (Ref. 11.5). The NRC screening values for ^{54}Mn, ^{57}Co, and ^{85}Sr were adjusted based on the NJDEP 15 mrem/year criteria, which is 60% of the 10CFR20 criteria. The DCGLs to be used for this survey are presented in Table 4-1 for building surfaces and Table 4-2 for soil.

4.2.1 Building Surface DCGLs

For building surfaces the final status surveys used to demonstrate compliance with the criteria for release for unrestricted use will be performed with gas flow proportional counters, or equivalent, calibrated using a National Institute of Standards and Technology (NIST) traceable source. Such surveys will include scans as well as fixed point measurements. If only one radionuclide was present, then the site-specific DCGL is the appropriate screening value.

For this project, a more conservative approach will be taken that will utilize the DCGL for the most restrictive radionuclide detected, ^{60}Co. The $DCGL_w$ for ^{60}Co is 7,100 dpm/100 cm^2. If the conservative use of the ^{60}Co $DCGL_w$ results in potentially unnecessary remediation, use of a more realistic DCGL based on actual contaminants may be done on a case-by-case basis with the prior approval of the Project Manager. If this is done, the basis for the revised $DCGL_w$ will be documented in the survey unit's final survey package.

The gross activity DCGL enables field measurements of gross activity rather than the determination of individual radionuclide activity. The gross activity DCGL can be calculated using a fraction of the total activity contributed by the radionuclides. For this FSS, all of the gross activity will be conservatively assumed to be ^{60}Co.

Table 4-1 BMS Screening Values for Building Surfaces

Radionuclide	Source	dpm/100 cm^2
^{3}H	Federal Register	120,000,000
^{14}C	Federal Register	2,900,000
Na-22	Federal Register	9,500
^{54}Mn	Federal Register	32,000
^{57}Co	Federal Register	210,000
^{60}Co	Federal Register	7,100
^{85}Sr	Federal Register	140,000
^{99}Tc	Federal Register	1,000,000
^{137}Cs	Federal Register	28,000

Table 4-2 BMS Screening Values for Soil

Radionuclide	Source	Soil pCi/g
^{3}H	Federal Register	110
^{14}C	Federal Register	12
Na-22	Federal Register	4.3
^{54}Mn	Federal Register	9.0
^{57}Co	Federal Register	90
^{60}Co	Federal Register	3.8
^{85}Sr	Federal Register	16
^{99}Tc	Federal Register	19
^{137}Cs	Federal Register	11

4.2.2 Criteria for Open Land Unrestricted Release

In open land areas the final status survey will include samples collected for gamma spectral analysis. If only one radionuclide were present, then the site specific DCGL is the appropriate screening value from Table 4.2.

For open land areas, where more than one radionuclide is present as at this BMS facility, the "sum of the fraction rule" applies and is calculated as follows:

$$\sum \frac{Conc_i}{GL_i} \leq 1$$

Where:

$Conc_i$ = Activity concentration of radionuclide i, pCi/g.

GL_i = The radionuclide specific guideline value (NRC screening values) for radionuclide i, pCi/g.

At BMS the activity concentrations will be known for each radionuclide that may be present in the mix so the above equation may be evaluated directly.

As required by New Jersey Department of Environmental Protection (NJDEP) regulations, all radiological analyses that are performed on soil samples where the results are used to support the unconditional release of the open area shall be performed by a laboratory that is properly certified by the NJDEP in accordance with NJAC 7:28.

4.3 Final Survey Process

The Final Survey process includes survey design, data collection and data assessment.

4.3.1 Survey Design

Survey design identifies relevant components of the FSS process and established the assumptions, methods, and performance criteria to be used. Areas ready for FSS are classified as Class 1, Class 2 or Class 3 and divided into survey units. Systematic scan and static measurements are prescribed according to a pattern and frequency established for each classification.. Investigation levels are established which, if exceeded, initiate an investigation of the survey data. A measurement from the

survey unit that exceeds an investigation level may indicate a localized area of elevated residual radioactivity. Such locations are marked and investigated to determine the area and the level of the residual radioactivity present. Depending on the results of the investigation, the survey unit may require remediation, and/or re-survey or re-classification.

4.3.2 Survey Data Collection

As deemed appropriate, after completion of D&D activities, a final post-remediation survey is performed using similar instrumentation, quality control and survey techniques to be used in the FSS process. A review of the final post-remediation survey data is then carried out to verify that residual radioactivity levels are acceptable and that no additional remediation will be needed in the survey unit. If an area of elevated residual radioactivity is identified, and remediation is determined to be ALARA, the area is remediated and re-surveyed to ensure meeting FSS requirements. The data collected during the final post-remediation survey (when performed), provides a sound basis for interpreting radiological conditions that may be encountered during the FSS process.

Following the collection of acceptable post-remediation survey results (as applicable), the FSS is performed. It ensures that any remaining residual radioactivity meets the release criteria. Measurement results stored as FSS data constitute the FSS of record and are included in the data set used to determine compliance with the release criteria.

4.3.3 Survey Data Assessment

Survey data assessment is performed to verify that the final survey data are of adequate quantity and quality. Assessments are performed to verify that the data support the underlying assumptions necessary for the statistical tests. If the quality, quantity, or one or more of the assumptions are called into question, previous survey steps are re-evaluated and additional data are collected as necessary before further statistical analyses are applied. Statistical tests are then applied and conclusions are drawn from the data as to whether the survey unit meets the release criteria.

4.3.4 Survey Results

Survey results are documented in the FSS report which summarizes the data and states the conclusions of the survey process.

4.4 Survey Unit Classification

In accordance with the guidance presented in the MARSSIM, all areas at a licensed site are classified as either impacted (potentially having residual contamination as a result of previous operations) or non-impacted (no potential for residual contamination as a result of previous operations). All of Building 124, the fenced area outside of B-124 and the area immediately surrounding and under the B-83 waste tanks are designated as impacted. All other areas of the BMS New Brunswick site are designated as non-impacted and beyond the scope of this FSS. These designations are identical to those assigned prior to the characterization survey. Prior to the performance of the characterization survey and based partly on the HSA, the impacted areas, or those areas to be unconditionally released, were divided into one of three classes of areas based on their known or potential for radioactive contamination. The criteria for each class are given below:

Class 1 - Areas which have, or had prior to remediation, a potential for radioactive contamination based on site operating history or known contamination above the $DCGL_W$ (DCGL for average concentrations over a wide area).

Class 2 – Areas which have, or had prior to remediation, a potential for radioactive contamination or known contamination which is not expected to exceed the $DCGL_W$.

Class 3 - Areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual activity at a small fraction of the $DCGL_W$.

For the final status survey, the classification designations from the characterization survey have been reviewed against the results of the characterization survey. Several classifications were changed for the final status survey based on this review. The majority of the changes were made due to the walls and ceilings of several of the laboratory rooms being changed from class 1 to class 2. The floors in these rooms remain a class 1.

A list of the survey units as planned is provided in Attachment 2 and the survey units are generally described in the following sections. Included in Attachment 2 is the classification for each survey unit, and a listing of any elevated measurements in that survey unit from the characterization survey.

Individual survey units were established based on several criteria. First, the entire survey unit had to be within the same classification. Second, the area of the survey unit had to meet the total area guidelines established in MARSSIM, section 4.6.

Also, where possible, physical boundaries such as walls were used to establish survey units.

4.4.1 Class 1 Areas

These are areas which are known to be radioactively contaminated based upon the characterization survey operations conducted in the area. These areas have the greatest potential for contamination and therefore receive the highest degree of survey effort.

The objective of surveys in Class 1 areas will be to demonstrate that remediation activities have removed licensed radioactive materials and that the remediated areas now meet regulatory requirements for unrestricted release of these areas. Class 1 areas are shown in Figure 4-1.

The class 1 areas include the following:

(a) Building 124 Caves

The equipment in these caves will have been removed along with the shield doors, shield door tracks and door operators.

The under-slab process ventilation ducts and process drain lines will have been removed exposing surface soils under the floor slab.

(b) Class 1 Lab Area Floors

The floors of lab rooms 146 through 153 are Class 1 areas along with the floors of cave production support rooms 142, 171, 176, 177, 178, 180, 181 and 190. Prior to the characterization survey, all surfaces of these rooms were considered class 1, however, after review of the characterization survey results, only the floors remain as class 1.

(c) Building 122, Room 222 Floor

The floors of the south end of this room are Class 1. This is the area where the radwaste compactor was located and was used as a temporary storage area for radwaste generated during the D&D phase.

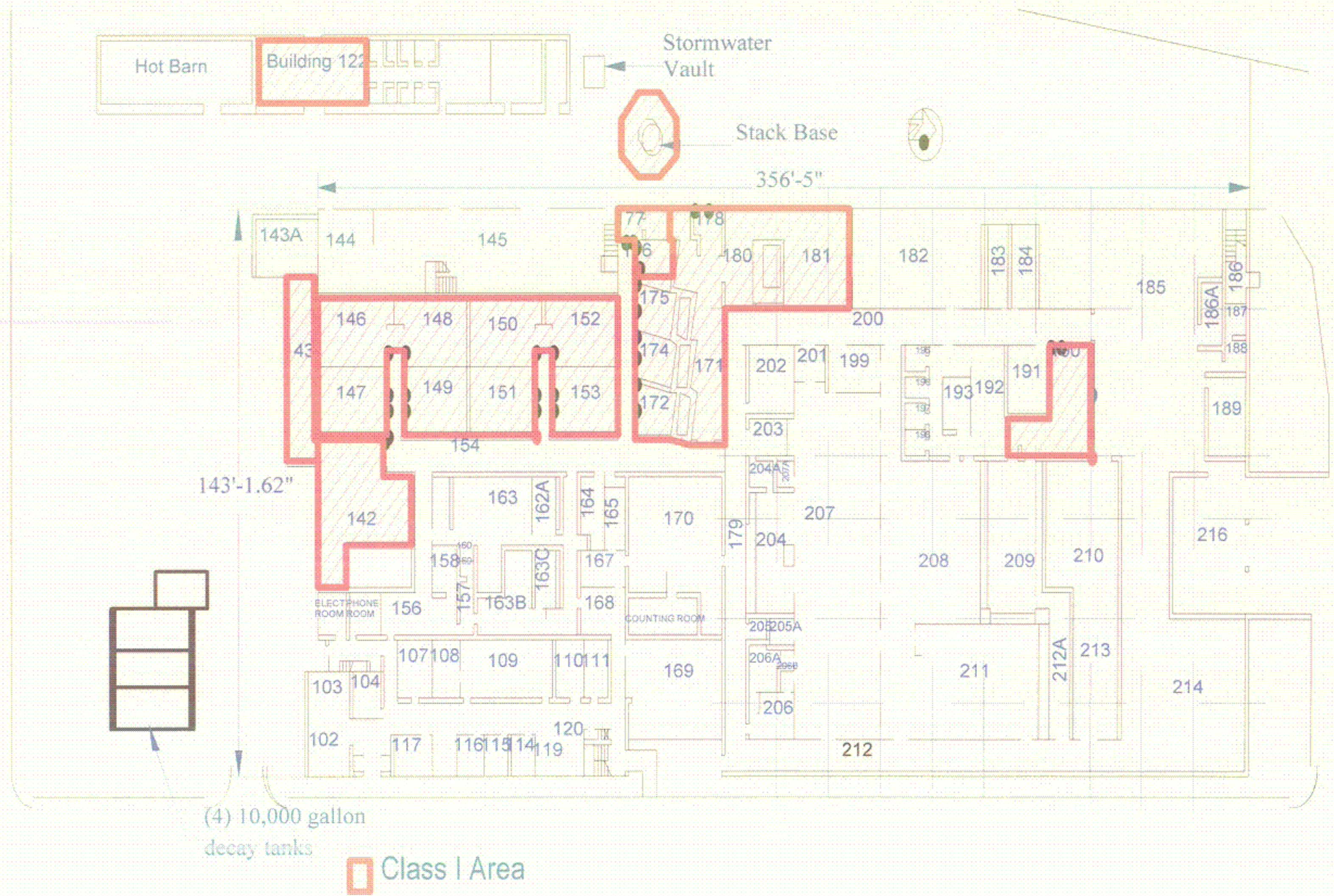


Figure 4-1 BMS Building 122 and 124 First Floor Class 1 Areas

(This is a multi-colored diagram.)

4.4.2 Class 2 and 3 Areas

These are areas, which the characterization indicated that remediation was not required, but radioactive material may be present in low concentrations. The objective of surveys in Class 2 and 3 areas will be to confirm with 95 percent confidence the presence or absence of radioactive material in excess of the DCGL's. The number of fixed survey points will be sufficient to confirm the absence of radioactive material requiring remediation by comparisons to DCGLs. Class 2 and 3 areas are shown in Figures 4-2 through 4-5.

The class 2 and 3 areas include the following:

(a) Laboratory (except for floors), Office, and Production areas inside Buildings 122 and 124

(b) Exterior of Building 122 and 124

(c) Building Exterior Open Land Areas (Buildings 122, 124, and Building 83)

(d) Soils below Building 124 Tank areas and below Building 83 Tank area.

4.4.3 Non-Impacted Areas

These are areas in which the presence of radioactive material is not expected. These areas comprise those portions of the BMS property not falling within the two preceding categories.

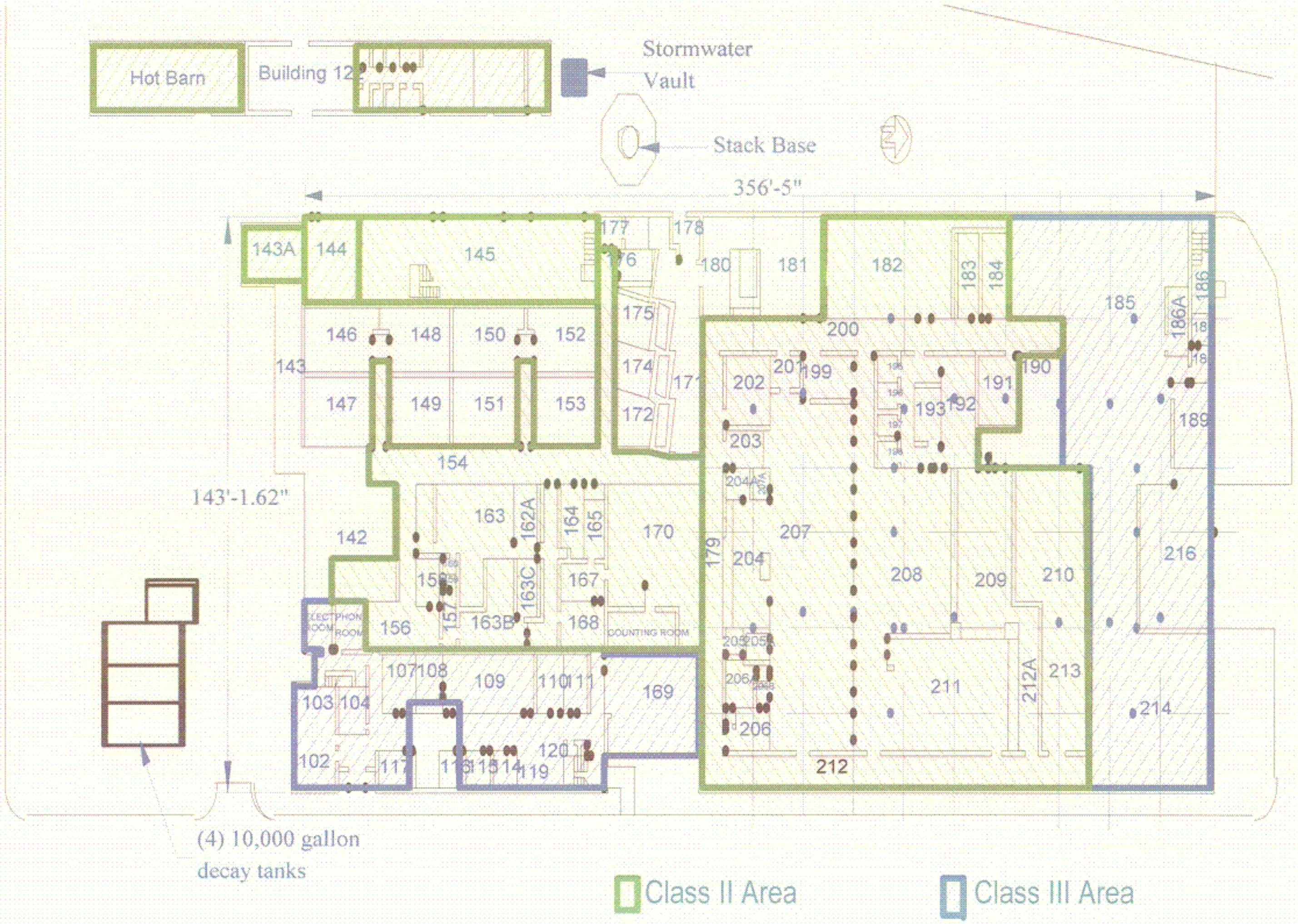


Figure 4-2 BMS Building 124 First Floor Structure Class 2 and Class 3 Areas

(Note: This is a multi-colored diagram.)

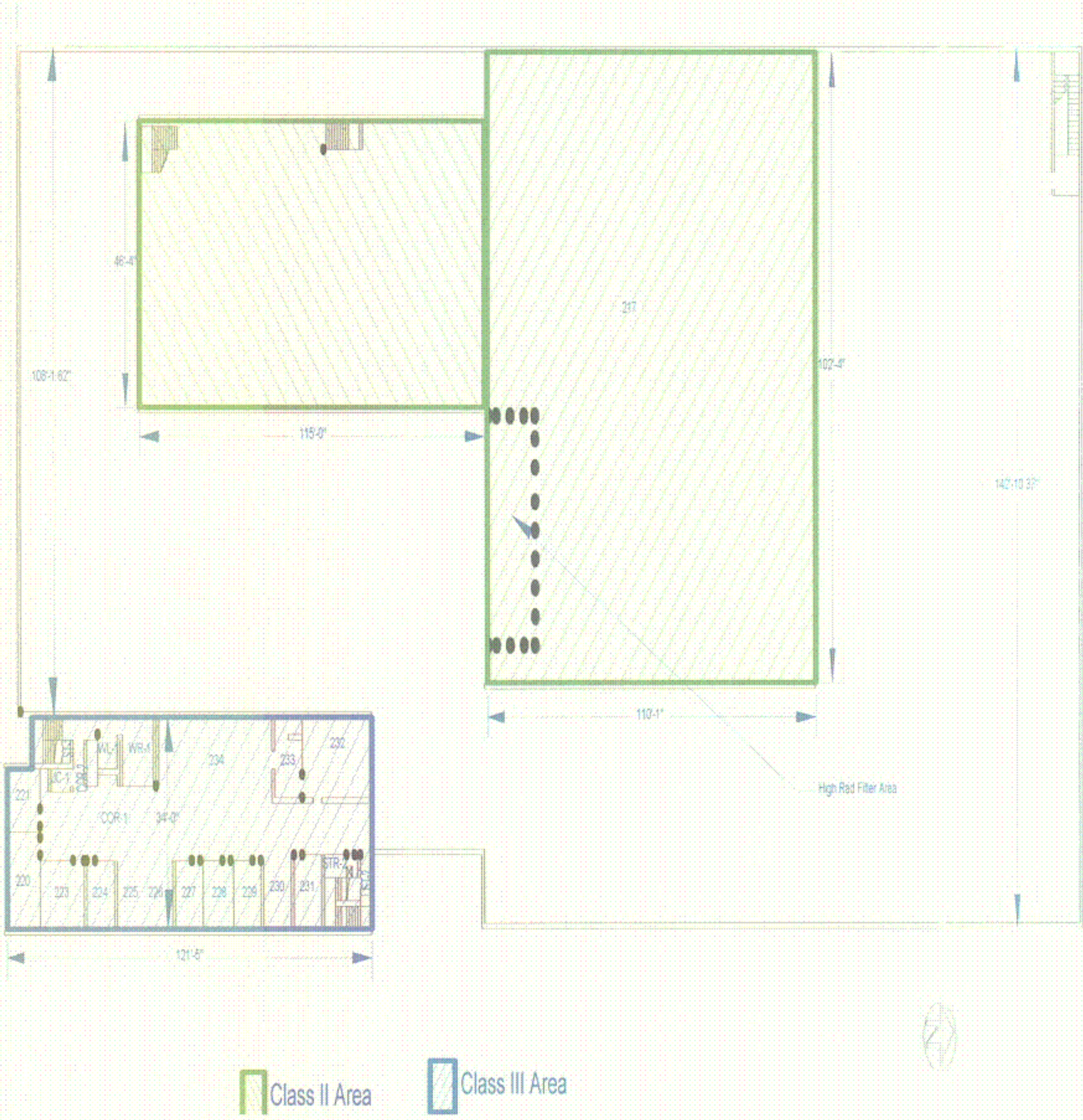


Figure 4-3 BMS Building 124 Second Floor Structure Class 2 and Class 3 Areas

(Note: This is a multi-colored diagram.)

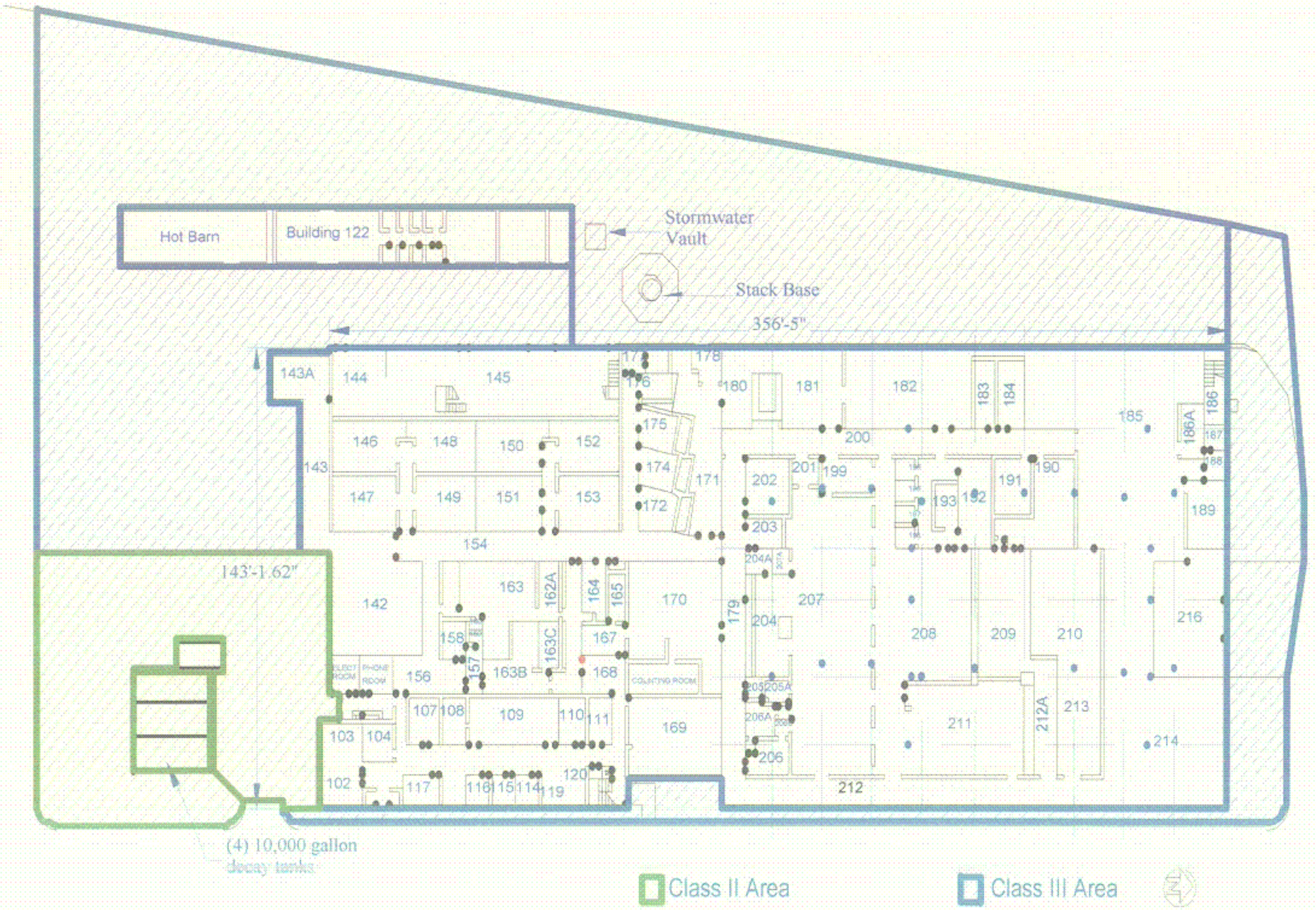


Figure 4-4 BMS Building 124 Outdoor Class 2 and Class 3 Areas

(Note: This is a multi-colored diagram.)

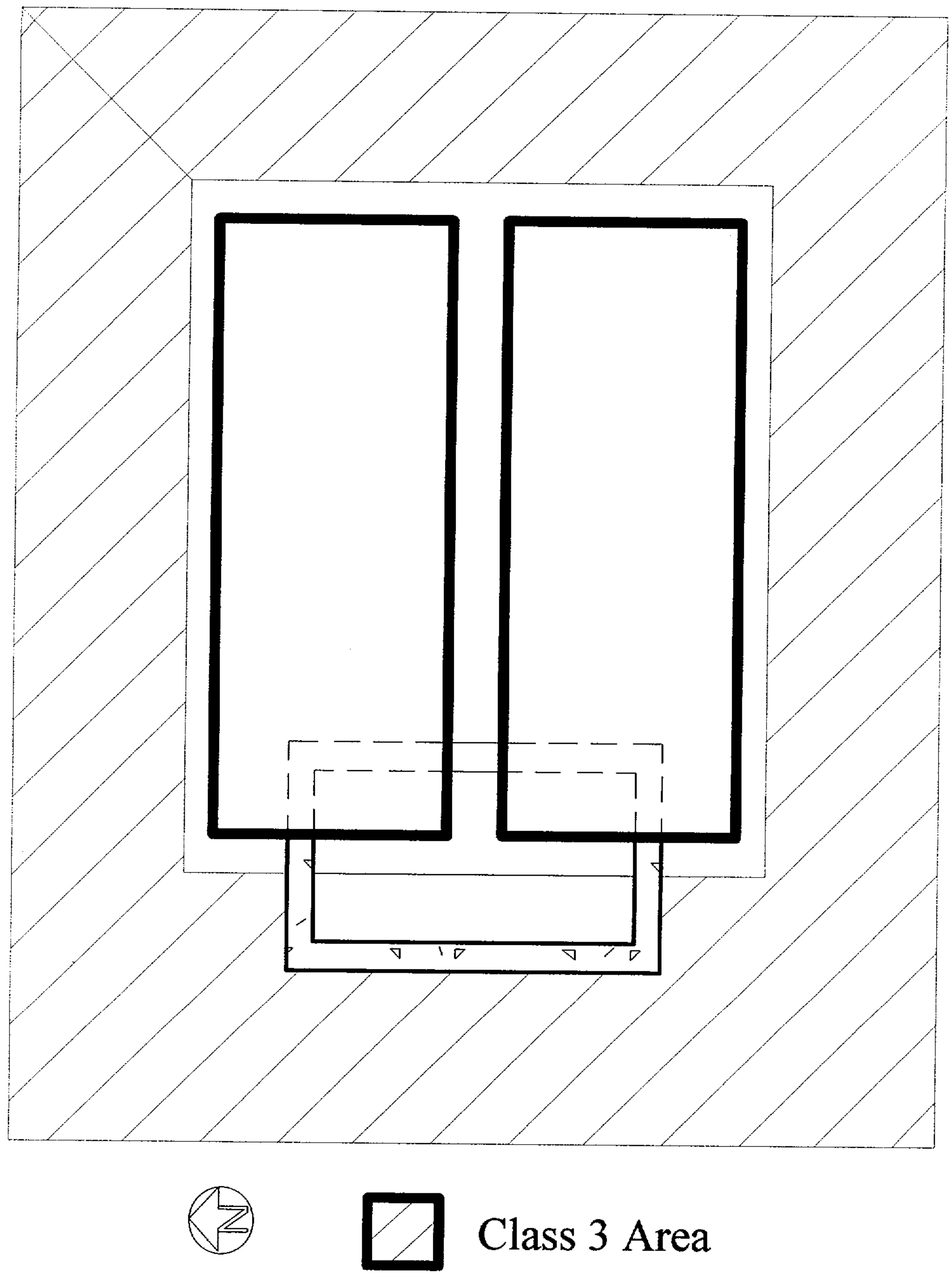


Figure 4-5 BMS Tank 83 Outdoor Class 2 and Class 3 Areas

(Note: This is a multi-colored diagram.)

5.0 SURVEY DESIGN

The survey design identifies relevant components of the FSS process, and establishes the assumptions, methods, and performance criteria to be used. The survey design is summarized in Table 5-1.

The application of survey design criteria to structures and land areas will vary based on the type of survey media and the relative potential for elevated residual radioactivity.

The NRC's COMPASS computer code will be routinely used in the survey design process. (It will also be used in the survey assessment process.) A description of the inputs required for COMPASS and the sources for these inputs is given in section 8.4.

Table 5-1 Survey Design Summary

Specification	Class 1		Class 2		Class 3	
	Structures	Land Areas	Structures	Land Areas	Structures	Land Areas
SURVEY UNITS						
Size Range=>	10 to 100 m^2	100 to 2,000 m^2	10 to 1,000 m^2	100 to 10,000 m^2	No Limit	No Limit
Reference Coordinate Grid=>	1 to 2 m	10 to 20 m	1 to 2 m	10 to 20 m	5 to 10 m	20 to 50 m
SCAN MEASUREMENTS						
Scan Coverage=>	100%		10 to 100[a]%		0 to 10 %	
Scan Area Selection=>	Accessible surface areas		Judgmental; systematic along transects or of randomly selected grids		Judgmental; random	
STATIC MEASUREMENTS						
Number of Measurements	Calculated using the MARSSIM methodology and COMPASS computer code.					
Location Selection=>	Random starting point, systematic spacing				Random	
Spacing (L)=>	$L = (A/(0.866*N))^{1/2}$ $L = (A/N)^{1/2}$ for square grid A = total survey unit area; N = # of measurements				N/A	
Type of Survey[b]=>	SC	SO	SC	SO	SC	SO

a. Where scanning coverage greater than 50% is judged appropriate, the survey unit may be reclassified as a Class 1 survey unit.

b. SC represents surface contamination measurements; SO represents soil measurements.

5.1 Survey Units

As reflected in Table 5-1, impacted areas are divided into survey units to facilitate survey design. A survey unit is a physical area of specified size and shape with similar characteristics and potential for residual radioactivity for which data analysis and statistical analysis are performed. A separate decision is made for each survey unit as to its acceptability for release.

5.1.1 Survey Unit Size

The MARSSIM guidelines coupled with professional judgement is used to divide facilities and areas into appropriately sized survey units. Survey unit sizing is sufficient to assure that the total number of data points, based on the measurement frequency, will allow statistical evaluation of the data. Considerations for establishing survey units are physical characteristics, concentration levels, and previous remediation efforts, as well as spatial and logistical considerations.

Survey units are sized to ensure data points are relatively uniformly distributed among areas of similar potential for residual contamination. Small survey units are developed to ensure a conservatively established coverage of an area.

Survey units sizes are given in Table 5-1. Survey unit sizes may be adjusted as necessary as long as assumptions used to develop area dose models remain valid.

5.2 Scan Measurements

Scan measurements are performed to locate elevated areas of residual radioactivity that will require further investigation. They are performed according to a preset pattern established for each classification. The level of scanning effort is proportional to the potential for finding elevated measurement results.

Scan measurements of Class 1 survey units are performed over 100 percent of the accessible surface area. Scan surveys are designed to detect small areas of elevated radioactivity that would not be detected by static measurements using a systematic measurement pattern. If the sensitivity of the scanning method is not sufficient to detect levels of residual radioactivity below the $DCGL_W$, the number of static measurements may be adjusted appropriately.

Scan measurements of Class 2 survey units are typically performed over 10 to 100 percent of the surface area. Class 2 survey units have a lower probability of elevated residual radioactivity than Class 1 survey units. Those areas with the highest potential for elevated residual radioactivity are included in the survey based on professional judgment. A 10 percent scanning coverage is appropriate if it is unlikely that any area would exceed the DCGL. Coverage of 25 to 50 percent is appropriate when there might be locations above the DCGL. Where scanning coverage of greater than 50 percent is judged appropriate, the survey unit may be reclassified as a Class 1 survey unit.

Scan measurements of Class 3 survey units are performed typically over approximately 10 percent of the surface area. Class 3 survey units have the lowest probability of containing elevated residual radioactivity. Those areas with the highest potential for elevated residual radioactivity, based on professional judgment are selected for scanning in a Class 3 area.

5.3 Static Measurements

Static measurements provide a quantitative measure of the radioactivity present at the location measured. Static measurements are performed at a frequency and location throughout each survey unit, such that a statistically sound conclusion can be developed. Static measurements may be performed at locations of elevated residual radioactivity identified by scan measurements. These types of static measurements may include direct surface contamination measurements, and soil and bulk material measurements.

5.4 Data Investigations

The data collection, investigation and evaluation process should provide a high degree of confidence that all data requirements have been met.

5.4.1 Investigation Levels

Examples of typical investigation levels are shown in Table 5-2, taken from the MARSSIM manual (NUREG-1575, Table 5.8). Investigation levels are radioactivity levels that are based on the release criteria, which if exceeded, initiate an investigation of the survey data. Investigation levels are typically established for each class of survey unit.

Table 5-2 Typical Investigation Levels (from NUREG-1575)

Survey Unit Classification	Flag Direct Measurements or Sample Result When:	Flag Scan MeasurementsWhen:
Class 1	$>DCGL_{EMC}$ or $>DCGL_W$ and > a statistical parameter based value	$>DCGL_{EMC}$
Class 2	$>DCGL_W$	$>DCGL_W$ or > MDC
Class 3	>fraction of $>DCGL_W$	$>DCGL_W$ or > MDC

The principal purpose of an investigation level is to guard against the possible misclassification of the survey unit. They also serve as a QC check during the final survey process. A survey measurement that exceeds an investigation level may indicate that the survey unit has been improperly classified. It may also indicate a failing survey instrument or a localized area of elevated residual radioactivity where there was a failure in the remediation process. Large variations in background exposure rates may also result in investigative surveys.

Depending upon the results of the investigation, survey units may require no action, may be remediated, or may be reclassified, and /or re-surveyed. Initial administrative action or investigation level guidelines may be found in Table 5-3. For a Class 1 survey unit, while measurements above the DCGL are not necessarily unexpected, any measurement exceeding the DCGL is investigated. The release criteria allows individual measurements representing small areas of residual radioactivity to exceed the DCGL. However, any measurement that exceeds the DCGL is subject to the elevated measurement comparison (EMC). For a Class 2 survey unit, any measurement above the DCGL is unexpcted and is investigated. As there is a low expectation for residual radioactivity in a Class 3 survey unit, any above background static measurement, exceeding a small fraction of a DCGL is investigated. If the scanning MDC exceeds the DCGL, any indication of residual radioactivity during the scan is also investigated.

Table 5-3 Summary of Investigation/Action Levels

	SURVEY AREA TYPE		
	CLASS 1 AREA	**CLASS 2 AREA**	**CLASS 3 AREA**
Investigation or Action Level	Flag any measurement > $DCGL_W$.	Flag any measurement >50% of $DCGL_W$.	Flag any measurement >25% of $DCGL_W$.
Reclassification Level	N/A	If any measurement are ≥ $DCGL_W$, area should be reclassified as Class 1.	If any measurement ≥ $DCGL_W$, area should be reclassified as Class 1. If any measurement exceeds 50% of the $DCGL_W$, but are < the $DCGL_W$, area should be reclassified as Class 2 area.
Remediation Indication When:	Consider remediation when residual activity exceeds the $DCGL_W$ for any scan or discrete measurement averaged over 100 cm^2.	Not indicated for Class 2 or Class 3 survey areas unless above limits specified for Class 1 survey area. Reclassify and resurvey as necessary.	Not indicated for Class 2 or Class 3 survey areas unless above limits specified for Class 1 survey area. Reclassify and resurvey as necessary.

5.4.2 Investigation

Locations identified by scan or static measurements with residual radioactivity, which exceed an investigation level are marked and investigated. The elevated measurement is then confirmed to exceed the investigation level. The area around the elevated measurement is investigated to determine the extent of the elevated residual radioactivity and to provide reasonable assurance that other undiscovered areas of elevated radioactivity do not exist. Scan coverage of the area being investigated is increased to 100 percent (if not already at that level). Static measurements are also taken if scan measurements are not capable of providing sufficient data to characterize the elevated area. Depending on the results of the investigation, the survey unit may require remediation, reclassification, and/or resurveyed. Possible outcomes of the data investigation process are shown in Table 5-4 .

Static measurements above the investigation level that should have been, but were not identified by scan measurements may indicate that the scanning method is inadequate. In that case, the scanning method is evaluated and appropriate corrective actions are taken. Corrective actions may include re-scanning affected survey units using other survey protocol or survey instrumentation.

Table 5-4 Possible Actions Resulting from Data Analysis

No.	Data Results	Class 1	Class 2	Class 3
1	One or more data points > $DCGL_W$	Remediate and resurvey as necessary	Reclassify & resurvey	Reclassify & resurvey
2	All data points ≤ $DCGL_W$	Survey Unit Passes	Determine if reclassification is required.	Determine if reclassification is required.
3	One or more points > 50% of $DCGL_W$ but ≤ $DCGL_W$	Survey Unit Passes	Increase survey coverage or review & reclassify & resurvey as necessary	Reclassify & resurvey
4	One or more points > 25% of $DCGL_W$ but ≤ 50% $DCGL_W$	Survey Unit Passes	Survey Unit Passes	Reclassify & resurvey
5	All data points ≤ 25% DCGL	Survey Unit Passes	Survey Unit Passes	Survey Unit Passes

5.4.3 Remediation

Areas of elevated residual radioactivity above the $DCGL_w$ should be considered for remediation. Based on the survey data, it may be necessary to remediate all or a portion of a survey unit.

5.4.4 Reclassification

If survey measurements in a Class 2 or Class 3-survey unit exceed the DCGL, the survey unit is reclassified as a Class 1-survey unit. A Class 2 or Class 3-survey unit that is remediated is reclassified as a Class 1 survey unit. If survey measurements in a Class 3-survey unit exceed 25% of the DCGL, the survey unit is reclassified as a Class 2 survey unit. If a Class 2 survey unit exhibits measurements exceeding 0.5 x the DCGL it may be further investigated or reclassified as a Class 1 survey unit.

5.4.5 Resurvey

If a survey unit is reclassified or if remediation activities are performed, then a re-survey using the methods and frequency applicable to the new survey unit classification is performed. Where only a small fraction (<10%) of the area of a Class 1 survey unit is remediated, replacement measurements are collected within the remediated area. Their locations are determined using the random selection process.

5.5 Decision Error

There are two types of decision errors applied to analytical results: Type I (α) and Type II (β) errors. A Type I error, or false positive, is the probability that null hypothesis is rejected when it should be accepted. A Type II error, or false negative, is the probability of determining that null hypothesis is accepted when it should be rejected. The probability of making decision errors can be controlled by adopting an approach called hypothesis testing. The null hypothesis (H_0) is treated like a baseline condition and is defined by MARSSIM as:

H_0 = residual radioactivity in the survey unit exceeds the release criterion.

This means that the site or survey area is assumed contaminated until proven otherwise. For the purpose of this final survey, Type I or α error will be set at 0.05 or 5 percent and Type II or β error will be set at 0.05 or 5 percent.

5.6 Background Reference Areas

For the BMS site, the decision has been made based on evaluation of the characterization data that the contaminants of concern are assumed to be not present in the environment, or in the case of ^{137}Cs, to be present at such an insignificant level that it can be considered not present. Therefore, background reference areas are not required and the survey planning process and survey data assessment process will utilize the Sign test to determine if any residual contamination in a survey unit exceeds the DCGL.

5.7 Building Material Backgrounds

Material-specific background count rate information for input into the survey planning process will be obtained from the characterization survey report. The standard deviation in the background count rate will be calculated based on the data obtained. In the routine survey planning process, material-specific background information from the characterization report will be input into COMPASS where it is stored. COMPASS automatically calculates the standard deviation. The material-specific background information is stored as part of the general site information and not on a survey unit specific basis.

5.8 Anticipated Survey Unit Contamination Level

The anticipated contamination level for each survey unit for input into the survey planning process will be obtained from the characterization report. This same data will be used to calculate the standard deviation of the anticipated contamination level. These two manually calculated values will be input into COMPASS when prompted for "Gross Survey Unit Mean (cpm)" and the standard deviation. The data from the characterization report that is used to calculate the mean value and the standard deviation will be copied and included with the survey package or otherwise appropriately referenced.

5.9 Relative Shift

The relative shift is defined as Δ/σ where Δ is the DCGL - LBGR (Lower Bound of the Gray Region) and σ is the standard deviation of the contaminant distribution. In order to calculate the relative shift, the DCGL must be determined and two assumptions must be made to estimate the LBGR and the standard deviation of the measurement distribution. MARSSIM suggests that the LBGR be set at 50%, of the DCGL but can be adjusted later to provide a value for the relative shift between the range of 1 to 3. The standard deviation may be calculated from preliminary survey data, prior surveys of similar areas and materials or the standard deviation of a reference background area.

It should be noted that s represents the standard deviation prior to release after all area decontamination is thought to be complete. If no reference data is available to make a reasonable estimate of the background standard deviation, MARSSIM suggests using 30% of the mean survey unit background. For the BMS facility, data from the facility characterization or from post-remediation surveys will be used to calculate the standard deviation value for each survey unit. The value for LBGR is input into COMPASS. The relative shift is automatically calculated and reported by COMPASS.

5.10 Number of Samples/Measurements

Once the relative shift is determined the calculated value, Δ/σ, can be used to obtain the minimum number of measurements or samples necessary to reject the null hypothesis based upon the initial assumptions and justify that the survey unit meets the requirements for release for unrestricted use. MARSSIM Table 5-3 contains the number of samples or measurements necessary for the given decision errors, α and β, and the calculated relative shift, Δ/σ, when dealing with non-radionuclide specific measurements or when the radionuclide is present in the background. The value N/2 from Table 5-3 represents the number of samples or measurements to be collected in each the survey unit and the reference background area. MARSSIM Table 5-5 provides the number of measurements of samples for the case in which the radionuclide is not in the background.

5.11 Sample/Measurement Number Reasonableness

Once the number of samples/measurements is determined, it must be assessed whether or not that number is reasonable for the survey unit and the survey unit size. It is possible, even if MARSSIM guidance is strictly followed, that there are not enough samples to produce the desired level of "comfort" or the number becomes excessive. The number of samples is determined on a case-by-case basis and if the number of samples/measurements is not reasonable, then the data quality objectives or initial assumptions should be re-evaluated.

6.0 SURVEY IMPLEMENTATION

The purpose of the final status survey is to collect sufficient survey data to support release for unrestricted use of the former BMS radiopharmaceutical manufacturing operations facility and associated grounds and structures at New Brunswick, NJ. The project team will perform surveys according to project specific Duratek procedures and this Survey Plan. Implementation of this Survey Plan will include the following:

1) Survey instrumentation will be set up and source checked to ensure proper operation.
2) The Project Manager/Supervisor will perform preliminary inspections of the areas to identify additional specific survey requirements.
3) The Project Manager/Supervisor will develop survey packages for the survey areas.
4) The project team will mark the fixed point survey locations as applicable.
5) The project team will take survey measurements and collect samples as required using appropriate calibrated instruments and perform daily source and background checks before and after each day's work.
6) Direct survey data collected during the project will be downloaded from the survey instrument into a database for storage and processing.
7) The Project Manager will review the completed survey packages to ensure that all required surveys have been performed.
8) The Project Manager will review the survey results to identify any areas exceeding the specified release criteria.

In order to support the final status surveys, the facility will be cleared of all loose equipment and materials to the maximum extent practicable. Surveys will then be performed as described in the following sections.

6.1 Instrumentation and Selection

Selection and use of instruments will ensure sensitivities are sufficient to detect the identified primary radionuclides at the minimum detection requirements. Table 6.1 provides a list of the instruments, types of radiation detected and calibration sources planned for use during the project. The hard-to-detect radionuclides that include low energy beta emitters cannot be measured using these field instruments. These radioisotopes will be quantified through off-site laboratory analysis on an as-needed basis. Scaling factors may be utilized to account for these nuclides during field surveys.

Duratek will use the Ludlum Model 2350-1 Data Logger with a variety of detectors for direct measurements of total beta surface activity as well as exposure rate measurements. The Data Logger is a portable microprocessor-based counting instrument capable of operation with NaI(Tl) gamma scintillation, gas-flow proportional, GM and ZnS scintillation detectors. The Data Logger is capable of

retaining in memory the survey results and instrument/detector parameters for up to 1000 measurements. This data is then downloaded to a personal computer for subsequent reporting and analysis.

Detector selection will depend on the survey to be performed, surface contour and survey area size. It is anticipated that most, if not all, of the final status survey scan and fixed point readings will be taken using a 126 cm^2 gas-flow proportional detector (Ludlum model no. 43-68) for direct beta measurements. (While scan and fixed point readings for alpha activity are not planned, this detector is also capable of performing these measurements should it become necessary.)

If required, removable contamination surveys will be performed using standard smear survey techniques and the smears counted on a Ludlum model no. 2929 scaler and a Ludlum model no. 43-10-1 phoswich detector.

In addition to the standard detector systems described above, a 1" x 1" Sodium Iodide (NaI) gamma scintillation detector will be used for in situ measurements at all soil sample locations. This detector is used with the Ludlum 2350 data logger. These measurements will be used for informational purposes and be available for use as part of an evaluation should any soil sample results require further evaluation of the area. Other detectors that may be used for direct surface measurements include the 50 cm^2 Zinc Sulphide (ZnS) alpha scintillator and the 15.5 cm^2 GM detector. Duratek also has a series of GM and gas-proportional detectors that are available if necessary for direct surface measurements of the interiors of system piping. These detectors, coupled to the Model 2350 Data Logger, have been used successfully during final status surveys at other sites, thus allowing clean piping to remain in place, and effectively separating clean from contaminated waste.

Soil samples will receive an onsite screening using a High Purity Germanium (HPGe) Gamma Spectroscopy System, or equivalent. Soil samples will be sent offsite to a New Jersey Department of Environmental Protection (NJDEP) certified laboratory for official analysis.

Table 6-1 Survey Instrumentation

Instrument/Detector	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2350/43-68	Gas-flow proportional ($126\ cm^2$)	Alpha or beta	^{99}Tc (ß) ^{230}Th (a)	Direct measurements and smear counting
Ludlum Model 2350/43-37	Gas-flow proportional ($550\ cm^2$)	Alpha or beta	^{99}Tc (ß) ^{230}Th (a)	Direct measurements
Ludlum Model 2350/43-94 or 43-98	Gas-flow proportional Pipe Detector	Alpha or beta	^{99}Tc (β) ^{230}Th (a)	Direct measurements
Ludlum Model 2350/ SP-113-3m or SP-175-3m	GM Pipe Detector	Beta	^{99}Tc (β)	Direct Beta measurements
Ludlum Model 2350/44-2	1" x 1" NaI scintillator	Gamma	^{137}Cs (?)	Gamma exposure rate
Ludlum Model 2350/44-40	Shielded GM ($15.5\ cm^2$)	Beta	^{99}Tc (β)	Direct Beta measurements
Ludlum Model 2929/43-10-1	Phoswich	Alpha & Beta	^{99}Tc (β) ^{230}Th (a)	Alpha and Beta smear counting
Canberra Gamma Spectroscopy System	High Purity Germanium	Gamma	Mixed Gamma	Nuclide identification and quantification

6.2 Detection Sensitivity

The data logger/gas-flow proportional counter has a scan MDC of ~620 dpm/100 cm^2 and fixed point MDC of ~250 dpm/100 cm^2 for measurements made on a flat even surface such as floors. Each of the MDCs are a factor of 2 higher when making measurements on uneven surfaces such as concrete walls. These MDCs are significantly less than the investigation levels (see section 5.4.1).The detection sensitivity of the Ludlum 2350-1 Data Logger with the 43-68 detector that will be routinely used for surface contamination measurements is estimated and the results summarized in Table 6.2. Count times are selected to ensure that the measurements are sufficiently sensitive with respect to the $DCGL_W$.

Table 6-2 Typical Detection Sensitivities

Instrument and Detector	Radiation	BKGND Count Time (min)	BKGND (cpm)	Instrument Efficiency[a] (cpm/dpm)	Count time (min)	MDC (dpm/100 cm^2)	Scan[a] MDC dpm/100 cm^2
Model 43-68	Beta-Gamma	1	250	0.24	1	250	620

[a] MDC_{scan} is calculated by assuming a scan rate of 5 cm/sec (unless otherwise marked), which is equivalent to a count time of 0.03 min, assuming an 8.9 cm detector width.

6.3 Instrument Calibration

Duratek calibrates the data loggers and associated detectors on a semi-annual basis using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment. The calibration includes:

- high voltage calibration,
- discriminator/threshold calibration,
- window calibration,
- alarm operation verification, and
- scaler calibration verification.

The detector calibration includes:

- operating voltage determination,
- calibration constant determination, and
- dead time correction determination.

Calibration labels showing the instrument identification number, calibration date and calibration due date are attached to all portable field instruments. The user will check the instrument calibration label before each use. Procedures for calibration, maintenance, accountability, operation and quality control of radiation detection instruments are listed in Attachment 5.

6.3.1 Calibration Sources

All sources used for calibration or efficiency determinations for the survey will be representative of the instrument's response to the identified nuclides and are traceable to NIST.

Health Physics Survey Specialists will control radioactive sources used for instrument response checks and efficiency determination. Sources will be stored securely and an inventory maintained onsite.

6.4 Survey Package Development

For each survey area/unit, the project team will develop a package, or portfolio, by performing a walk-down and preparing a worksheet/tracking sheet outlining the general survey instructions, location codes, and any specific survey instructions for any abnormal conditions within the survey area. Completion and review signature blocks will be used to track the progress of the surveys.

After the survey is completed, the project team will update the survey package(s) with the survey data and results of any special surveys or sample analyses performed.

6.5 Survey Protocols/Requirements

The final status survey of the facility will consist of beta/gamma surface scans and direct beta measurements. The survey of the facility grounds will consist of gamma scans and soil sampling for gamma spectroscopy analysis.

6.6 Surface Scans

6.6.1 Beta Scans

Beta scans will be performed over accessible floor, wall and ceiling interior surfaces and exterior walls, roof and asphalt and concrete paved areas using a gas-flow proportional detector while listening to the audible output of the instrument. The scan areas will be 100% for Class 1 survey units, 10% to 50% for Class 2 survey units, and 10% for Class 3 survey units. The beta scans will be performed using large area (126 cm^2) gas flow proportional detectors in combination with the Ludlum Model 2350 data logger. Beta scans of surfaces will be performed holding the detector approximately 1/4 inch from the surface and moving the detector at a rate of two inches per second over the area. The scan speeds will ensure that contamination at levels of less than the $DCGL_W$ will be detected if present. During the scanning process, the Ludlum Model 2350 data logger instruments' audible output will be monitored and the digital display readout observed for any elevated counts detected. Any areas exceeding the appropriate investigation level (section 5.4.1) will be identified for further investigation and potential decontamination.

6.6.2 Gamma Scans

Gamma scans will not be performed inside the facility as beta surveys are sufficient to detect the residual radionuclides at this facility. Gamma scans will be performed for informational purposes outside the building around the asphalt and concrete paved areas and in soil areas around the buildings. A NaI (Tl) gamma scintillation detector will be used with the Ludlum Model 2350 to help identify any areas of residual contamination in the soil or the building interior.

6.7 Direct Surface Activity Measurements/Sampling

Direct surface activity measurement for total beta activity, will be taken on the structural surfaces of the buildings and on concrete or asphalt paved areas within each survey area/unit. The direct beta measurements will be performed using large area (126 cm^2) gas flow proportional detectors in combination with the Ludlum

Model 2350 survey meter. The number of measurements and spacing will be determined in accordance with MARSSIM and this Plan.

6.7.1 Number of Measurements/Samples

The number of measurement/samples for each survey unit will be determined in accordance with section 5.10 of this plan. A relative shift of between 1 and 3 should be used, providing a minimum of 13 samples/measurements per survey unit, depending upon the measurement distribution and the size of the area.

For class 1 and 2 survey units, measurements will be taken using randomly generated coordinates for a starting point with a systematic spacing between survey points a described in 6.7.2 and 6.7.3 below. For class 3 survey units, the survey points will all be randomly generated.

6.7.2 Sample/Measurement Grid Spacing

The grid spacing for the measurement and samples is estimated in two ways depending upon the shape of the grid (either triangular or rectangular grid). If a triangular grid is used, the grid spacing is estimated as follows:

$$L = \sqrt{\frac{A}{0.866N}}$$

Where:

L = Distance between measurement locations

A = Survey unit Area

N = Number of measurements

If a square grid is used, the spacing is estimated as follows:

$$L = \sqrt{\frac{A}{N}}$$

6.7.3 Starting Location

Once the number of measurements and the grid spacing are determined, a starting point for the survey must be established for each class 1 and 2 survey unit. This will be performed by selecting a reference point for the survey unit, such as the corner of the room, and using a random number generator to

provide a random number between 0 and 1, for an initial offset from the reference point in both the x and y coordinates. The random number pair will be multiplied by the calculated grid spacing, providing the offset from the reference point for the first grid location.

Upon establishing the first grid location, the calculated grid spacing will be used to establish a grid system throughout the survey unit. If the survey unit includes the floor, walls and ceiling, the grid will be extended to all surfaces from the initial point.

Once gridded, a check to ensure that the number of grid locations satisfies the calculated number of measurements will be performed. If not, a smaller grid spacing will be used to ensure the minimum number of measurements/samples are obtained.

6.7.4 Soil Sampling

A surface soil sample (0-15 cm) will be obtained at each grid node for the facility grounds immediately around buildings and any other survey unit/area determined to be necessary. A total of approximately 1 quart of soil will be collected, dried, homogenized and sieved to minus 1/4-inch mesh. All soil samples will be sent offsite to an independent laboratory approved by the New Jersey Department of Environmental Protection (NJDEP).

6.7.5 Minimum Detectable Concentration

Minimum Detectable Concentration (MDC) is defined as the smallest amount or concentration of radioactive material that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDC is dependent upon the counting time, geometry, sample size, detector efficiency and background count rate. As a Data Quality Objective, the MDCs must be less than 50% of the applicable Derived Concentration Guideline Level. There are two different MDCs that will be utilized, one for direct beta surface activity measurements and one for field scanning.

These are calculated differently as follows. The equation used for calculating the MDC for direct field instrumentation is:

$$MDC = \frac{\frac{2.71}{t_s} + 3.29\sqrt{\frac{R_b}{t_s} + \frac{R_b}{t_b}}}{E\left(\frac{A}{100}\right)}$$

Where:

MDC	=	Minimum Detectable Concentration (dpm/100 cm^2)
R_b	=	Background Count Rate (cpm)
t_b	=	Background Count Time (min)
t_s	=	Sample Count Time (min)
A	=	Detector Area (cm2)
E	=	Detector Efficiency (c/d)

The equation for the scanning MDC is:

$$MDC = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$

Where:

MDC	=	Minimum Detectable Concentration (dpm/100 cm2)
d'	=	Decision error taken from Table 6-5 of MARSSIM
i	=	Observation counting interval (scan speed divided by the detector width)
b_i	=	Background count per observation interval
E_i	=	Detector Efficiency (c/d)
E_s	=	Surface Efficiency (typically around 50% for beta contamination on concrete)
p	=	Surveyor Efficiency (typically 50%)
A	=	Detector Area (cm2)

The MDC for the offsite gamma spectral analysis of soil will be sufficient to detect at 50% or less of the $DCGL_w$ for ^{60}Co.

6.8 Survey Records

The project team will maintain records of surveys in the survey packages for each area. The survey package may include the following records depending upon the survey design and protocols:

- Survey Package Worksheet giving the package identification, survey location information, general survey instructions and any specific survey instructions.
- Survey Comment Addendum containing comments from the survey technician regarding any unusual situation encountered while surveying.
- The Survey Unit Diagram of the area to be surveyed as available.
- Photographs of the survey area, as necessary, to show special or unique conditions.
- Printout of laboratory analysis results (if performed).
- Ludlum Model 2350-1 data files and Microsoft Access® database converted values for all radiation survey measurements.

The survey team will take direct measurements for total alpha and beta surface activity using the Ludlum Model 2350-1 Data Logger system. Upon completion of a survey, the contents of the Data Logger's memory will be downloaded to a database.

Duratek will use a proprietary computer program to generate a survey report that presents all raw data, converted data, and information by survey location. The survey technician and supervisor will review these reports for completeness, accuracy, and suspect entries and compare the data to the guideline values.

Any changes to the database tables such as detector efficiency and background, which could affect survey results, will require supervisor approval. In addition, changes to data in the primary table will require a written explanation on a change request. The change request will be attached to the survey report and maintained as a permanent record.

Data and document control will include the maintenance of the raw data files, translated data files (Microsoft Access® database files) and documentation of all corrections made to the data. The databases will be backed up on a daily basis. Duratek will then turn all original survey records over to BMS with the final report.

7.0 SURVEY PACKAGE CONTENT

A survey package will be prepared for each survey unit prior to the performance of the final status survey for that unit. A typical survey package will include a survey package worksheet,

a copy of the COMPASS computer code data quality objective printout (DQO Wizard), a map of the survey unit showing the fixed survey points, and additional documentation as necessary that provides the inputs used for the COMPASS computer code. The survey package worksheet lists the package ID number, survey unit location and description, unit classification, historical information, and survey instructions. After the survey of the unit is completed, a copy of the survey results will be added to the package (normally, in the form of the Ludlum 2350 printout) as well as a copy of the COMPASS computer code data quality assessment printout (DQA printout).

Attachments 3 and 4 provide examples of two typical survey packages prepared for performing the final status survey for a class 3 outside area requiring soil samples (attachment 3) and a floor in a room where the floor has been designated class 1 and the walls and ceiling have been designated class 2 (attachment 4). Each of the attachments is an example of a survey package ready to be issued for final status survey.

8.0 DATA QUALITY ASSESSMENT AND EVALUATION

Once all the surveys are complete, the data will be assessed and evaluated to ensure that the $DCGL_W$ was met. If no single measurement exceeded the $DCGL_W$, no statistical test is required and the survey unit can be unconditionally released. All areas exceeding the $DCGL_W$ will be evaluated for remediation. Once complete, the data will be evaluated following the methodology specified in MARSSIM and this Plan to re-calculate the number of measurements based on the survey standard deviation to ensure that the proper number of measurements were taken. If it is determined that enough data was not collected, the measurement location spacing will be reduced and the area and re-surveyed.

Direct beta measurements collected during the final status surveys will be compared against the ^{60}Co DCGL in Table 4.1. The soil sample analysis results will also be compared against the ^{60}Co DCGL in Table 4.2. In both cases, the $DCGL_W$ for ^{60}Co will be used unless specifically authorized by the Duratek Project Manager. A non-parametric statistical test will be performed in cases where residual radioactivity, relative to the criteria for release for unrestricted use, is encountered. If survey results in excess of the $DCGL_W$ are not obtained, non-parametric statistical tests on the survey results will not be performed. Individual survey results exceeding the appropriate investigation level will be identified for additional investigation.

Final survey data are reviewed to verify they are of adequate quantity and quality. An assessment is performed to verify the data. If the quantity or quality of the data is called into question, previous survey steps will be re-evaluated and additional data will be collected as necessary prior to further statistical analysis

8.1 Data Verification and Validation

The final survey data will be reviewed to verify they are authentic, appropriately documented, and technically defensible. The review criteria for data acceptability are:

- The instruments used to collect the data are capable of detecting the radiation of interest at or below the investigation level. If not, acceptable compensatory measures have been taken.
- The calibration of the instruments used to collect the data is current and radioactive sources used for calibration are traceable to recognized standards or calibration organizations.
- Instrument response is checked before and, where required, after instrument use each day data are collected.
- Survey team personnel are properly trained in the applicable survey techniques.
- The MDCs and the assumptions used to develop them are appropriate for the instruments and the survey methods used to collect the data.
- The survey methods used to collect the data are appropriate for the media and types of radiation being measured.
- Special measurement methods used to collect data are applied as warranted by survey conditions.
- The custody of samples that are to be sent for off-site laboratory analysis, are tracked from the point of collection until the final results have been obtained.
- The final survey data set consists of qualified measurement results representative of current facility status that were collected as prescribed by the survey design package.

A discrepancy exists where one or more criteria are not met. The discrepancy will be reviewed and corrective actions taken as appropriate.

8.2 Statistical Testing

The Sign or the Wilcoxon Rank Sum (WRS) statistical test, may be applied to the final survey data set where one or more measurements exceed the $DCGL_w$. The statistical test is based on the hypothesis that the level of residual radioactivity in the survey unit exceeds the $DCGL_w$. There must be sufficient survey data with levels of residual radioactivity at or below the $DCGL_w$ to reject this statistical hypothesis and to conclude the survey unit meets the release criteria.

8.2.1 Application of Statistical Tests

The statistical test does not need to be performed when the survey data clearly show that the survey unit meets the release criteria. The survey unit clearly meets the criterion if every measurement in the survey unit is less than or equal to the $DCGL_w$.

The statistical test is applied where one or more measurements exceed the $DCGL_w$. Survey results and the corresponding conclusions for when a background reference area is not used, are shown in Table 8-1.

Table 8-1 Initial Survey Results and Conclusions When A Background Reference Area Is Not Used

Survey Result (Class 1 Areas)	Conclusion: Survey unit meets site release dose criteria	
	Yes	No
All measurements less than or equal to $DCGL_W$	✓	
Mean greater than $DCGL_W$		✓
Any measurement greater than $DCGL_W$ with mean less than or equal to $DCGL_W$ which passes Sign test	✓	
Any measurement greater than $DCGL_W$ with mean less than or equal to $DCGL_W$ which fails Sign test		✓

8.2.2 Sign Test

The one-sample Sign statistical test is used if the radionuclide of concern is not present in background and radionuclide-specific measurements are made. The Sign test may also be used if one or more radionuclides are present in background at such small fractions of the $DCGL_W$ as to be considered insignificant. In this case, background concentrations of the radionuclides are included with the residual radioactivity. This option is only used if it is expected that ignoring the background concentration does not affect the outcome of the statistical test. The advantage of ignoring a small background concentration is that no background reference area is necessary.

8.3 Data Conclusions

The results of the statistical test allow one of two conclusions to be drawn. The first conclusion is that the survey unit meets the release criteria. The data have provided statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the release criteria. The decision that the survey unit is acceptable for unrestricted release can be made with sufficient confidence and without further analysis.

The second conclusion that is that the survey unit fails to meet the release criteria. The data does not provide sufficient statistically significant evidence that the level of

The second conclusion that is that the survey unit fails to meet the release criteria. The data does not provide sufficient statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the release criteria . The data is analyzed further to determine why the statistical test result led to this conclusion.

Possible reasons the survey unit fails to meet the release criteria are:

- It is in fact true.
- It is a random statistical fluctuation.
- The test did not have sufficient power to detect that it is not true. The power of the test is primarily based on the actual number of measurements obtained and their standard deviation. A retrospective power analysis for the test may be performed. If the power of the test is insufficient due to the number of measurements additional data may be collected. If it appears that the failure may be due to statistical fluctuations the survey unit may be resurveyed and another set of discrete measurements collected for statistical analysis. A larger number of measurements increases the probability of passing if the survey unit actually meets the release criteria. If it appears that the failure was caused by the presence of residual radioactivity in excess of the release criteria, the survey unit is remediated and resurveyed.

8.4 Use Of Compass

The COMPASS computer program (Ref. 11.4) is a program developed the Oak Ridge Institute for Science and Education (ORISE) to assist in the development MARSSIM survey packages and the assessment of final status survey data. This section generally describes the use of the COMPASS program and provides information as to the expected sources of inputs to COMPASS and the documentation to be included in survey packages describing these inputs. It assumes the Site Wizard function has already been run. The Site Wizard establishes the list of potential contaminants and their screening DCGLs for surface soil and building surfaces. A unique name is given to the site in COMPASS and once established, it cannot be edited or revised. If revisions are necessary, the Site Wizard must be run again and a new name assigned to the site. (If this becomes necessary, consider using the old site name and adding, "Rev. 1". Increment the revision number in the site name each time a revision is necessary.)

The COMPASS program has four basic routines. The first two address survey package development for surface soil and building surfaces. The second two address survey data assessment for surface soil and building assessment.

8.4.1 Use of the DQO Wizard for Surface Soil Assessment

(a) Select the site.

(b) On the *Survey Unit Details* page, a unique name for the survey unit is entered in the *Survey Unit Description* window. The name will normally be the letter and number combination assigned to the survey unit as provided in Attachment 2. The second window contains a list of survey unit names already established. The program will not allow you to proceed to the next page if a survey unit name is entered that has already been established.

NOTE:

If it is necessary to revise any of the information entered for a survey unit after the COMPASS run has been completed, it will be necessary to assign a new name to the survey unit. Consider assigning the new name using the old name plus a revision number in a manner similar to that described above for revising the site name.

(c) Survey Unit Area (m^2) and Class: from attachment 2.

(d) In the third window, labeled *Comments*, a brief description of the survey unit is entered such as, *B-124 Outside Areas, Soil Samples*.

(e) The next window provides a list of the potential contaminants for the site and their screening DCGLs. Click on ^{137}Cs. (^{54}Mn was also detected in a small percentage of characterization samples and may also be selected. These are the only two non-naturally occurring isotopes detected during the characterization survey in the soil samples taken in the area around Building 124 and the Building 83 tanks.)

(f) The next window lists ^{137}Cs and ^{54}Mn if they were both selected. Click on the box next to each of them as they will each be measured directly. If only ^{137}Cs was selected as the contaminant, this window will not appear.

(g) The next window requests estimated mean specific activity and standard deviation for each of the contaminants in the survey area and the reference area. No entries will be made in the sections for the reference

area. The estimated mean specific activity and standard deviation of each contaminant in the survey area is manually calculated from characterization survey data for that area. The characterization survey data used to perform the calculations should be included in the survey package.

(h) The next window requests the Lower Boundary of the Gray Region (LBGR) acceptable Alpha (type I) and Beta (type II) error rate. For the LBGR, a value approximately three standard deviations less than the anticipated mean specific activity is entered. For both the Alpha and Beta errors, 0.05 is entered.

(i) COMPASS will then calculate the sample size and generate a power curve. The COMPASS results should be printed and included in the survey package.

8.4.2 Use of the DQO Wizard for Building Surface Assessment

(a) Select the site.

(b) On the *Survey Unit Details* page, the user enters the survey unit description, survey unit area (in m^2), the survey unit classification, and the material to be surveyed. Below is given the source for each information category to be entered.

(c) *Survey Unit Description* - a unique name for the survey unit. The name will normally be the letter and number combination assigned to the survey unit as provided in Attachment 2. The COMPASS display contains a list of survey unit names already established. The program will not proceed if a survey unit name is entered that has already been established.

NOTE:

If it is necessary to revise any of the information entered for a survey unit after the COMPASS run has been completed, it will be necessary to assign a new name to the survey unit. Consider assigning the new name using the old name plus a revision number in a manner similar to that described above for revising the site name.

(d) Survey Unit Area (m^2) and Class - from Attachment 2.

(e) *Comments* - a brief description of the survey unit such as *B-124 Room 146 Walls and Ceilings.*

(f) *Background Materials* – Select one of the materials in *Previous Entries*. If the material to be surveyed is not present in the list, it will be entered in *New Material.*

(g) *Instrument Efficiency* – the $\underline{2\pi}$ instrument efficiency is entered. This can be assumed to be twice the efficiency posted on the instrument (as it is normally the 4π efficiency that is posted on the instrument). The value entered should be in the range of 0.4-0.5.

(h) *Surface Efficiency* – Typically for floors and other smooth surfaces, this value is 0.5. For concrete and other rough uneven surfaces, this value is 0.25.

(i) *Count Time* – Typically one minute

(j) *Background Material Summary* – If the background material selected earlier was one of the *previous entries*, then the average background count rate, standard deviation, and minimum detectable concentration (MDC) is displayed. If a new material was entered earlier, background count rate information will have to be entered. Normally, background count rate information obtained on that material or a similar material during the characterization survey is entered. As each new background count rate for a material is entered, the display above it showing the average background count rate, standard deviation, and minimum detectable concentration (MDC) is updated.

(k) *Gross Survey Unit Mean (cpm)* $\underline{+}$ *1*σ – Both the survey unit mean and the standard deviation are manually calculated values. These values are normally calculated using characterization survey data from the same area. A copy of the data used to calculate these values should be included in the survey package. COMPASS will automatically calculate the *Sign Test Sigma* value.

(l) The next window provides a list of the potential contaminants for the site and their screening DCGLs. ^{60}Co will be selected. (The Project

Manager may specify additional contaminants, but the typical building surface survey package will be prepared based on ^{60}Co being the only contaminant.)

(m) The next window allows the user to select either the Sign Test or the Wilcoxon Rank Sum (WRS) Test. It is currently planned to use the Sign Test for all final status surveys.

(n) The next window requests estimated mean specific activity and standard deviation for the contaminant in the survey area and the reference area. No entries will be made in the sections for the reference area. The estimated mean specific activity and standard deviation of ^{60}Co in the survey area is manually calculated from characterization survey data for that area. It will be assumed that all activity identified during the characterization survey is the result of ^{60}Co contamination. The characterization survey data used to perform the calculations should be included in the survey package.

(o) The next window requests the Lower Boundary of the Gray Region (LBGR) acceptable Alpha (type I) and Beta (type II) error rate. For the LBGR, a value approximately three standard deviations less than the anticipated mean specific activity is entered. For both the Alpha and Beta errors, 0.05 is entered.

(p) COMPASS will then calculate the sample size and generate a power curve. The COMPASS results should be printed and included in the survey package.

8.4.3 DQA Wizard for Surface Soil Assessment

(a) Select the Site.

(b) Select the Survey Unit.

(c) *Systematic Samples* – Enter the number of samples collected.

(d) Select whether the data entry will be either *Manual Entry* or *Import from Excel File.*

(e) The sample data is entered based on the laboratory results. A value must be entered for each isotope for each sample. If the results in a given sample for a given isotope are <MDA, enter 0.

(f) COMPASS will then guide the user through a series of windows that assist in the evaluation of the survey data and a determination as to whether or not the null hypothesis is to be accepted or rejected.

(g) After completing the COMPASS run, the results should be printed out and included in the survey package.

8.4.4 DQA Assessment for Building Surface Assessment

(a) Select the site.

(b) Select the Survey Unit.

(c) *Systematic Samples* – Enter the number of samples collected.

(d) Select whether the data entry will be either *Manual Entry* or *Import from Excel File.*

(e) The sample data is then entered. For each survey point, the following is entered:

- Survey point number.
- Material surveyed.
- Gross count rate.

(f) COMPASS will then guide the user through a series of windows that assist in the evaluation of the survey data and a determination as to whether or not the null hypothesis is to be accepted or rejected.

(g) After completing the COMPASS run, the results should be printed out and included in the survey package.

9.0 QUALITY ASSURANCE AND QUALITY CONTROL

Duratek's Quality Assurance/Quality Control Programs ensure that all quality and regulatory requirements are satisfied. Procedures and the Quality Assurance/Quality Control Plan control all activities affecting quality. These documents include the following Quality Control measures as an integral part of the survey process.

9.1 Selection of Personnel

Project management and supervisory personnel are required to have extensive experience with Duratek procedures and the QA/QC plan and be familiar with the requirements of this Final Status Survey Plan. Management must have prior experience with the radionuclide(s) of concern and a working knowledge of the instruments used to detect the radionuclides on site.

Duratek will select supervisory personnel to direct the survey based upon their experience and familiarity with the survey procedures and processes. Likewise, Health Physics Survey Specialists who will perform the surveys will be selected based upon their qualifications and experience.

9.2 Training

All project personnel will receive site specific training to identify the specific hazards present in the work and survey areas. Training will also include a briefing and review of this Plan, applicable Duratek procedures, the QA Plan (ref. 11.8) and the Site Safety and Health Plan (ref. 11.9). Copies of all training records will be maintained on site through the duration of on-site activities.

During site orientation and training, survey personnel will become familiar with site emergency procedures. In the event of emergency, personnel will act in accordance with all applicable site emergency procedures and the Site Safety and Health Plan.

9.3 Written Procedures

Procedures and this plan will control all survey tasks that are essential to survey data quality. A list of plans and procedures is provided in the Project Quality Assurance Project Plan (ref. 11.8).

9.4 Instrumentation Selection, Calibration and Operation

Duratek has selected instruments proven to reliably detect the radionuclides present at the BMS facility. Duratek will calibrate instruments or use qualified vendors under approved procedures using calibration sources traceable to the National Institute of Standards and Technology (NIST). All detectors are subject to daily response checks when in use.

Procedures for calibration, maintenance, accountability, operation and quality control of radiation detection instruments implement the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.

9.5 Survey Documentation

The survey packages will be the primary method of controlling and tracking the hard copy records of survey results. Records of surveys will be documented and maintained in the survey package for each area according to Duratek procedures. Each survey measurement will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and Quality Control (QC) sample number, as applicable.

9.6 Chain of Custody

Procedures establish responsibility for the custody of samples from the time of collection until results are obtained. All samples shipped off site for analysis will be accompanied by a chain-of-custody record to track each sample.

9.7 Records Management

Generation, handling and storage of survey data packages are controlled by an approved procedure.

9.8 Review of Survey Results

The completed survey package and survey data from each survey unit be reviewed by the Project Manager/Surpervisor to verify all documentation is complete and accurate.

10.0 SURVEY REPORT

Duratek may begin preparing the Final Status Survey Report during the surveys. General information can be drafted early to expedite report preparation when work is completed. The report will contain brief descriptions of the site and the surveys performed, sketches of the survey units and sample locations as necessary and survey results in tabular and graphical form.

Duratek will submit a draft report to BMS for comment after completing site activities and receiving all sample analyses. The final report will be submitted to the NRC and NJDEP following resolution of all internal comments. The final report will contain the following information as a minimum.

- An overview of the results of the final status survey.

- A discussion of any changes that were made in the final status survey from what was proposed in the Decommissioning Plan.
- A description of the method by which the number of samples and a justification for these values.
- A summary of the values used to determine the numbers of samples and a justification for these values.
- The survey results for each survey unit.
- A description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity.
- If a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for final radiological surveys.
- If a survey unit fails, a discussion of the impact that the reason for the failure has on other survey unit information.

The Final Status Survey Report will serve as the basis for a formal request that the NRC and the NJDEP release the former manufacturing facilities from license restrictions. It is anticipated that these agencies may perform radiological surveys of selected areas to confirm the facilities satisfy the release criteria.

11.0 REFERENCES

11.1 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, August 2000.

11.2 NUREG-1727, *MNSS Decommissioning Standard Review Plan*, September 2000.

11.3 *Bristol-Myers Squibb Former Radiopharmaceutical Production Facility Characterization Survey Report*, Duratek, Inc., July 2002.

11.4 *COMPASS Code* Version 1.0.0 was developed under the sponsorship of the U.S. Nuclear Regulatory Commission for implementation of MARSSIM in support of the decommissioning license termination rule (10 CFR Part 20, Subpart E).

11.5 NRC screening computer code *DandD* Version 2.1.0

11.6 NRC, 63 FR 64132, *Table 1-Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination*, Nov. 18, 1998.

11.7 NRC, 64 FR 68395, *Table 3-Interim Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels*, December 7, 1999

11.8 PL-DTK-01-029, *Quality Assurance Project Plan for Bristol-Myers Squibb*, Rev 0.

11.9 PL-DTK-01-028, *Site Safety & Health Plan for Bristol-Myers Squibb*, Rev 0.

11.10 Draft NUREG-1549, *Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.*

11.11 10 CFR20, *Standards for Protection Against Radiation.*

12.0 ATTACHMENTS

Attachment 1: NUREG 1727 Compliance Matrix

Attachment 2: Survey Package List

Attachment 3: Sample Survey Package - E0200, Soil Samples Under B-83 Tanks

Attachment 4: Sample Survey Package - A0100, B-124 Rooms 146 & 147

Attachment 5: Procedures

Attachment 1

COMPLIANCE MATRIX FOR NUREG 1727, NMSS DECOMMISSIONING STANDARD REVIEW PLAN AND THE BMS FINAL STATUS SURVEY PLAN

Below is given a compliance matrix that demonstrates that the BMS Final Status Survey (FSS) Plan meets the review criteria given in NUREG 1727, NMSS Decommissioning Standard Review Plan. The left-hand column lists each of the bulleted items that should be included in the Final Status Survey Plan (NUREG 1727, section 14.4, p. 14.8), and the right hand column indicates the section(s) of the FSS Plan that addresses that item.

NRC NMSS Standard Review Criteria	FSS Plan Section(s)
1. A brief overview describing the final status survey design.	Section 1.4, 4.0 and 5.0
2. A description and map or drawing of impacted areas of the site, area, or building classified by residual radioactivity levels (Class 1, Class 2, or Class 3) and divided into survey units, with an explanation of the basis for division into survey units. Maps should have compass headings indicated.	Sections 2.1, 2.2, 4.4, Attachments 2, 3, and 4
3. A description of the background reference areas and materials, if they will be used, and a justification for their selection.	Sections 5.6 and 5.7
4. A summary of the statistical tests that will be used to evaluate the survey results, including the elevated measurement comparison, if Class 1 survey units are present, a justification for any test methods not included in MARSSIM, and values for the decision errors (a and ß) with a justification for a values greater than 0.05.	Section 5.5, 8.2, and 8.3
5. A description of scanning instruments, methods, calibration, operational checks, coverage, and sensitivity for each media and radionuclide.	Sections 6.1, 6.2, 6.3, 6.6, and 6.7

NRC NMSS Standard Review Criteria	FSS Plan Section(s)
6. For in-situ sample measurements made by field instruments, a description of the instruments, calibration, operational checks, sensitivity, and sampling methods, with a demonstration that the instruments, and methods, have adequate sensitivity.	Informational measurements only.
7. A description of the analytical instruments for measuring samples in the laboratory, including the calibration, sensitivity, and methodology for evaluation, with a demonstration that the instruments and method have adequate sensitivity.	All soil samples will be analyzed by an offsite laboratory certified by the NJDEP.
8. A description of how the samples to be analyzed in the laboratory will be collected, controlled, and handled.	Section 9.6
9. A description of the final status survey investigation levels and how they were determined.	Section 5.4
10. A summary of any significant additional residual radioactivity that was not accounted for during site characterization.	Section 1.3.
11. A summary of direct measurement results and/or soil concentration levels in units that are comparable to the DCGL and, if data is used to estimate or update the survey unit.	Section 1.2, 2.3 Attachment 2
12. A summary of the direct measurements or sample data used to both evaluate the success of remediation and to estimate survey unit variance.	Section 5.8 Attachment 2

Attachment 2 - Survey Package List

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m²	Characterization Elevated Activity Summary: Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
A0100 Class 1	124	146 & 147	Floor	90	Rm 146 Work bench drawer 12,905 **[REMOVED]**		
					Rm 147 Fume hood 5,455 **[REMOVED]**		
A0200 Class 1	124	148 & 149	Floor	87			
A0300 Class 1	124	150 & 151	Floor	90	Rm 151 Fume hood 45,515 **[REMOVED**	Fume Hood 28.3 **[REMOVED]**	Fume hood 14,980 β **[REMOVED]**
					Rm 151Fume hood 41,092 **[REMOVED]**		Fume hood 57,630 β **[REMOVED]**
					Rm 151Fume hood 14,980 **[REMOVED]**		
					Rm 151 Fume Hood 111,510 **[REMOVED]**		
A0400 Class 1	124	152 & 153	Floor	86		Rm 152 False ceiling 20.2	

					Characterization Elevated Activity Summary		
Survey Package/Survey Unit Class	**Building**	**Room/Area Description**	**Surface**	**Area m²**	**Direct Beta Activity (β/γ dpm/100 cm2)**	**Direct Alpha Activity (α dpm/100 cm2)**	**Removable Activity (dpm/100 cm2)**
A0500 Class 1	124	Former Tank Area	Floor	43			
A0600 Class 1	124	Stack Base	Base	41			
A0700 Class 1	124	180 & 181	Floor	95			
A0800 Class 1	124	Minitec Cave & Decay Pit	Cave	77	Minitec Tank Pit Drain 55,587		Minitec Tank Pit Drain 36,812 β
A0900 Class 1	124	172, 174, 175, 176, 177	Floor	89	Rm 172 Small spot on floor inside services doors beneath lead glass window 6,560		
		172			Vent duct 5,748 **[REMOVED]**	Table top in cave 20.2 **[REMOVED]**	
		172			Table top in cave 24,785 **[REMOVED]**		
		172			Cave Floor 138,651		
		172			Cave Structure 16,870		
		172			Cave Wall 11,722		

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
		172			Shield door track 31,724 **[REMOVED]**		
		174			Electrical conduit in service panel beneath lead glass window 30,682 **[REMOVED]**	Floor in front of shield door 28.3	Floor in front of shield door 11,358 β
		174			Floor in front of shield door 1,014,820	Cave Wall 28.3	
		174			Cave Structure 137,714		
		174			Vent duct 63,365 **[REMOVED]**		
		174			Cave Wall 20,849		
		174			Shield door track 63,183 **[REMOVED]**		
		175			Top of transfer table 22,078 **[REMOVED]**		Above false ceiling 28.3 α
		175			Cave floor 133,388		
		175			Cave Structure 15,922		
		175			Vent duct 5,853 **[REMOVED]**		

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary: Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
		175			Cave Wall 7,374		
		175			Shield door tracks 7,170 **[REMOVED]**		
A1000 Class 1	124	171 & 178	Floor	80	Rm171 Storage cabinets opposite caves: spots up to 123,000 **[REMOVED]**		
A1100 Class 1	124	Iodine Caves	Cave	95	Cave Drain Room 172 199,065 **[REMOVED]**		
					Cave Drain Room 174 158,707 **[REMOVED]**		
					Cave Drain Room 175 5,583 **[REMOVED]**		
A1200 Class 1	124	142	Floor	108	Floor area up to 307,757		Floor up to 257,129 β
							Floor up to 23 α
A1300 Class 1	124	143	Floor	57	Floor area Up to 9,915		Floor area up to 32.9 α
							Pass-thru 32.9 α
A1400 Class 1	.124	190	Floor	57			
A1500	124	Valve Pit	All	60			

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary		
					Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
Class 1							
A1600 Class 1	122	222	Floor	68			
A1700 Class 1	83	Tank Vault	All	55			
B0100 Class 2	124	Tank Vault	All	582			
B0200 Class 2	124	144 &145	All	725			
B0300 Class 2	124	146-153	Walls & Ceiling	1,076			
B0400 Class 2	124	142 & 143	Walls & Ceiling	438			
B0500 Class 2	124	143A	All	207			
B0600 Class 2	124	154	All	560			Ceiling 28.0 α
B0700 Class 2	124	155-168	All	752	Rm 164 Stall 24,776		Rm 156 Floor 37.7 α
		156					Equipment 28.0 α [REMOVED}
		163					Men's Shower Area Drain 27.9 α
		163C					Structure 23.0 α
		165					Sink/Counter 37.7 α

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary		
					Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
		168					Equipment 23.2 α **[REMOVED}**
B0800 Class 2	124	170	All	375	Counter/Sink Area 37,899	Fume hood 6,935	Counter/Sink Area 27.9 α **[REMOVED]**
					Fume hood 260,861		Floor 37.7 α
							Pass-thru 42.6 α **[REMOVED}**
B0900 Class 2	124	171-178, 180 - 181	Walls & Ceiling	980	Rm180 Floor near Minitec tank pit 6,134		Rm180 Minitec tank pit floor 24,264 β
		180			Minitec tank pit floor 2,899,134		
		180			Capped pipe in shallow pit 12,907		
		181			Counter/Sink area 36,824 **[REMOVED}**		
B1000 Class 2	124	179 & 212	All	934			Rm179 Ceiling 23.2 α
B1100 Class 2	124	182-184	All	590			Rm182 Wall 23.4 α
B1200 Class 2	124	190	Walls & Ceiling	144	Floor under hood 11,642		Glove Box 19,348 β **[REMOVED}**

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary		
					Direct Beta Activity (β/γ dpm/100 cm2)	**Direct Alpha Activity (α dpm/100 cm2)**	**Removable Activity (dpm/100 cm2)**
					Fume hood 621,177 **[REMOVED}**		Fume hood 15,296 β **[REMOVED}**
					Glove box 181,890 **[REMOVED}**		
B1300 Class 2	124	191-199	All	620			
B1400 Class 2	124	200	All	471			
B1500 Class 2	124	201-204, 204A	All	459			Rm204 Floor 28.0 α
		204					Equip/Table 32.9 α **[REMOVED}**
		204					Drain 23.0 α **[REMOVED}**
B1600 Class 2	124	205-207	All	798			Rm206A Floor 37.7 α
		206					Drain 23.0 α
B1700 Class 2	124	208-210	All	1,088			Rm208 Floor 23.2 α
		209					False Ceiling 23.4 α
		209					Equipment 23.2 α **[REMOVED}**
B1800	124	211, 212A, 213	All	661			

					Characterization Elevated Activity Summary		
Survey Package/Survey Unit Class	**Building**	**Room/Area Description**	**Surface**	**Area m^2**	**Direct Beta Activity (β/γ dpm/100 cm2)**	**Direct Alpha Activity (α dpm/100 cm2)**	**Removable Activity (dpm/100 cm2)**
Class 2							
B1900 Class 2	124	Duct Level in Old Section-South	All	644		Blower EFG3 24.1	Filter GB-9 24.1 α [REMOVED}
B2000 Class 2	124	Duct Level in Old Section-North	All	644			
B2100 Class 2	124	Duct Level in New Section-South	All	851	Filter EFC5: 7,920 [REMOVED}	Intake grill 49.3 [REMOVED}	Filter RGB-1 24.1 α [REMOVED}
					Filter EFC9: 13,894 [REMOVED}		
					Filter EFC8: 7,142 [REMOVED}		
B2200 Class 2	124	Duct Level in New Section-Center	All	851			Floor 24.1 α
B2300 Class 2	124	Duct Level in New Section-North	All	851			Filter FH10 24.1 α [REMOVED]
B2400 Class 2	124	Hot Barn, 219-221	All	965			Room 219 Floor 24.1 α
B2500 Class 2	124	222	Walls & Ceiling	220			
D0100 Class 2	124	Building 124 Vault Area Soils	Soil	303			
D0200 Class 2	124	Building 124 South Soil Areas	Soil	2,020			

Survey Package/Survey Unit Class	Building	Room/Area Description	Surface	Area m^2	Characterization Elevated Activity Summary		
					Direct Beta Activity (β/γ dpm/100 cm2)	Direct Alpha Activity (α dpm/100 cm2)	Removable Activity (dpm/100 cm2)
C0100 Class 3	124	Above 1st Floor False Ceilings - Old Section	All	4,669			
C0200 Class 3	124	Above 1st Floor False Ceilings - New Section	All	4,124			
C0300 Class 3	124	Offices, Conf Room, Canteen	All	1,558		Electrical Room Wall 20.6	
C0400 Class 3	124	185-189 & 214-216	All	2,201		Room 214 vent 40.5 [REMOVED}	Floor 23.4 α
		214					Ceiling 23.4 α
		214					Ceiling 23.4 α
C0500 Class 3	124	Building 122 & 124 Exteriors	All	8,016		Roof up to 195.4	Wall 24.1 α
						Wall 28.5	Roof 29.1 α
E0100 Class 3	83	Building 83 Tank Area Soils	Soil	61			
E0200 Class 3	124	All Other Building 124 Soils	Soil	7,071			

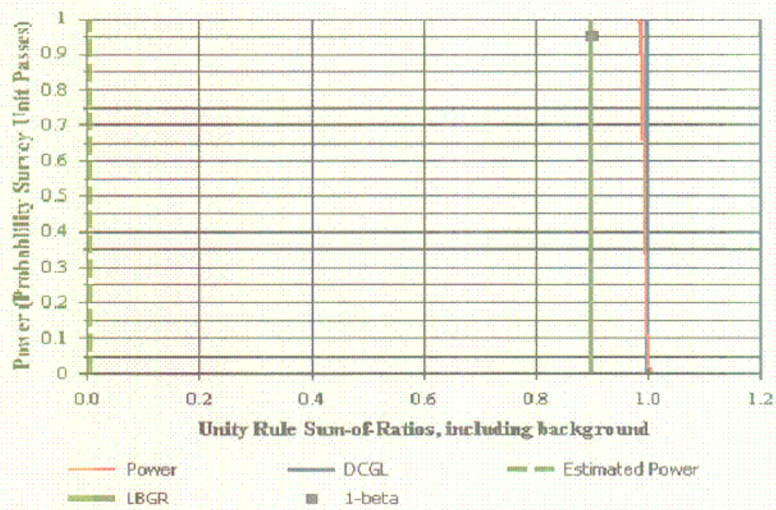
Attachment 3
Sample Survey Package
E0200, Soil Samples Under B-83 Tanks

Surface Soil Survey Plan

Survey Plan Summary

Site:	Bristol-Meyers Squibb Decommissioning		
Planner(s):	William R. Hoey		
Survey Unit Name:	E0200 Rev. 1		
Comments:	B-83. Soil Under Tanks		
Area (m²):	56	Classification:	3
Selected Test:	Sign	Estimated Sigma (SOR):	0.01
DCGL (SOR):	1	Sample Size (N):	13
LBGR (SOR):	0.9	Estimated Conc. (SOR):	0
Alpha:	0.050	Estimated Power:	1
Beta:	0.050		

Prospective Power Curve



Surface Soil Survey Plan

Contaminant Summary

Contaminant	DCGLw (pCi/g)	Inferred Contaminant	Ratio	Modified DCGLw (pCi/g)	Scan MDC (pCi/g)
Cs-137	11.00	N/A	N/A	N/A	N/A
Mn-54	9.00	N/A	N/A	N/A	N/A

Contaminant	Survey Unit Estimate (Mean ± 1-Sigma) (pCi/g)	Reference Area Estimate (Mean ± 1-Sigma) (pCi/g)
Cs-137	0.014 ± 0.028	N/A
Mn-54	0.0234 ± 0.04	N/A

Duratek Inc.
Survey Package Worksheet for Package E0200
Bristol-Myers Squibb Soils Below Building 83 Tanks

Package Identification No.: E0200	Prepared by: Paul C. Ely
Location: Building 83 Buried Wastewater Tank Area	Date prepared: 10/14/2002
Area Classification: Class 3	

Area Description
The survey is for the soils below the Building 83 tanks between Building 83 and Building 115.

Historical Information
There is no history of spills to the soil around the Building 83 buried tank area. The characterization report indicates that the soils up to 20 feet deep around the tank vault were not contaminated.

General Survey Instructions

The COMPASS program was utilized to generate a minimum sample requirement for this area of 13 samples (see attached). Fifteen random sample locations in the tank area were determined and laid out as indicated on the attached survey map.

1. **The tanks and concrete slab under the tanks will be removed prior to obtaining the soil samples. Shoring will be in place to keep the excavation open for sampling.**
2. Mark the location of the sample location with a survey flag in the soil at the locations indicated on the survey map.
3. Obtain 1 exposure rate measurement on contact with the surface and another at 1 meter above the surface at each survey measurement location with M2350-1.
4. Obtain approximately one gallon of soil from each sample location at a depth of 0 to 6-inches.
5. Obtain a 100 ml or larger liquid sample from each location for tritium analysis. The sample locations are below the water table and water for sampling will be readily available.
6. Use only the L1 and L8 codes and sample depth when labeling samples for analysis.

Survey Package Completion.

1. When all measurements, samples or scans are collected, initial and date the "MEASUREMENT TYPE" block on the survey package to indicate the measurements or samples were collected.
2. Note any problems, comments, or other information pertinent to the data or sample collection under the "FIELD NOTES" section.

Use all location codes provided below when taking measurements.

Special Instructions
Use the sodium iodide detector model number 44-2 for gamma survey measurements.

Survey performance (Initial and date as each survey is complete)													
Location Code					General Description	Beta Scan	Direct Beta	Contact Gamma	1 meter Gamma	Smear Gross	LS Water Sampler	Media Sample
L1	L2	L6	L7	L8								
Bristol Myers Squibb Building 83 Soils Under Tanks												
E0200	NA	NA	NA	1 thru 15	**Soil Under Tanks**	NA	NA	(15)	(15)	NA	(15)	15

Package Review
Date Package Completed:
Package Reviewed by and Date:

Survey Comments

SURVEY PACKAGE E0200

B-83 CONCRETE PAD DIMENSIONS

Conversion Factor: $1\ ft^2 = 9.29E\text{-}2\ m^2$

Pad Dimensions:

22.5' x 27'

A = 22.5 * 27 * 9.29E-2

= 56 square meters

B-83 TANKS SOIL SAMPLES COORDINATES

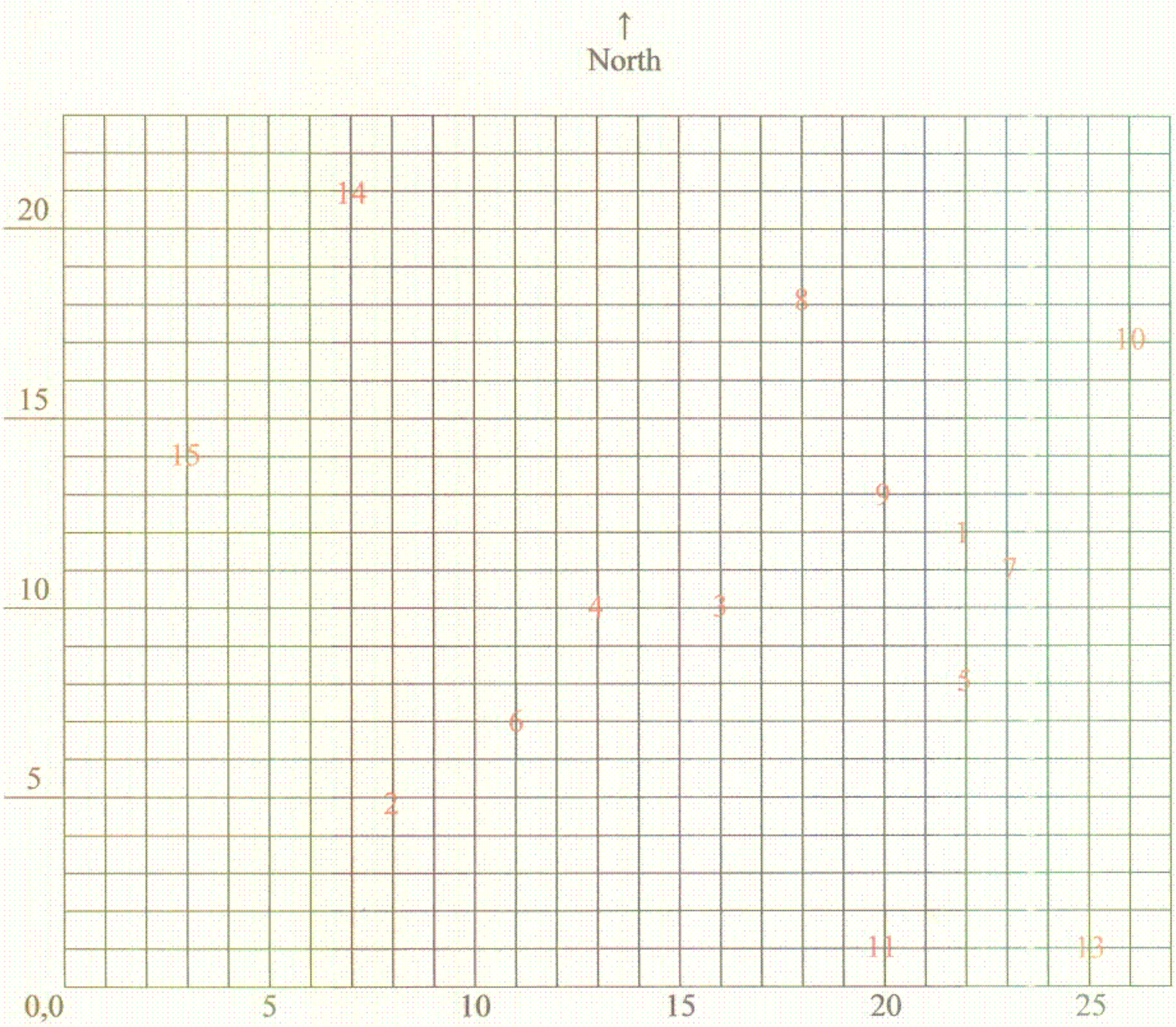
N = 15

X is random between 0 & 27, Y is random between 0 & 22. Each value was truncated at the decimal point to make coordinates.

	X	Y
1	22	12
2	8	5
3	16	10
4	13	10
5	22	8
6	11	7
7	23	11
8	18	18
9	20	13
10	26	17
11	20	1
12	7	9
13	25	1
14	7	21
15	3	14

SURVEY PACKAGE E0200
B-83 TANKS SOIL SAMPLES

The B-83 tanks sat on a concrete pad that was 22.5' x 27'. The reference point for the grid below is the southwest corner of the pad's former location. Each grid line represents 1 foot.



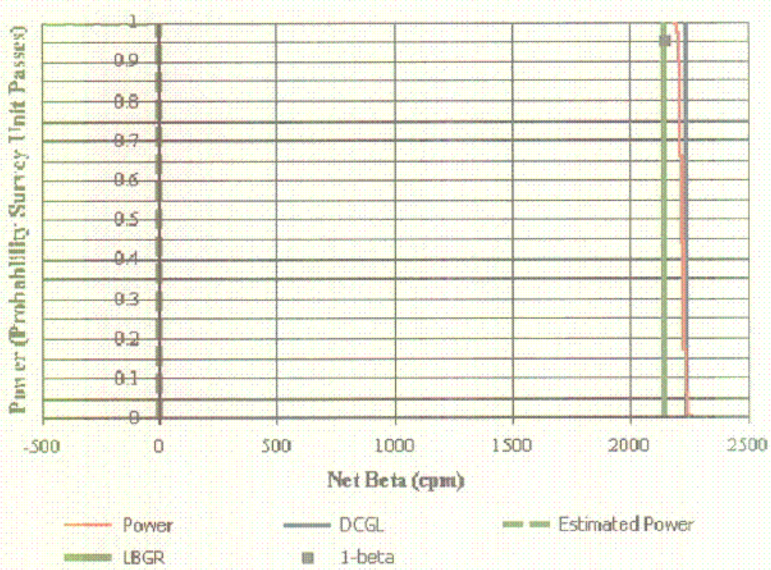
Attachment 4
Sample Survey Package
A0100, B-124 Rooms 146 & 147

Building Surface Survey Plan

Survey Plan Summary

Site:	Brtistol-Meyers Squibb Decommissioning. Rev. 1		
Planner(s):	Paul Ely		
Survey Unit Name:	Building 124 Rooms 146 & 147 Floors		
Comments:	Survey Package A0100		
Area (m²):	90	Classification:	1
Selected Test:	Sign	Estimated Sigma (cpm):	29.4
DCGL (cpm):	2,237	Sample Size (N):	13
LBGR (cpm):	2,147	Estimated Conc. (cpm):	-0.6
Alpha:	0.050	Estimated Power:	1.00
Beta:	0.050	EMC Sample Size (N):	13

Prospective Power Curve



Building Surface Survey Plan

Contaminant Summary

Contaminant	DCGLw (dpm/100 cm²)
Co-60	7,100

Beta Instrumentation Summary

Gross Beta DCGLw (cpm/100 cm²): 7,100
Total Efficiency: 0.25
Gross Beta DCGLw (cpm): 2,237

ID	Type	Mode	Area (cm²)
3	Ludlum Model 2350 & Model 43-68 Detector	Beta	126

Contaminant	Energy[1]	Fraction[2]	Inst. Eff.	Surf. Eff.	Total Eff.
Co-60	96.09	1.0000	0.50	0.50	0.2500

[1] Average beta energy (keV) [N/A indicates alpha emission]
[2] Activity fraction

Gross Survey Unit Mean (cpm): 234 ± 21 (1-sigma)
Count Time (min): 1

Material	Number of BKG Counts	Average (cpm)	Standard Deviation (cpm)	MDC (dpm/100 cm²)
Linoleum	28	234.6	20.6	236

Duratek Inc.
Survey Package Worksheet for Package A0100
Bristol-Myers Squibb Building 124, Rooms 146 & 147 Floors

Package Identification No.: A0100	Prepared by: William R. Hoey
Location: Building 124 Rooms 146 and 147 Floors	Date prepared: 11/6/02
Area Classification: Class 1	

Area Description
This survey unit is Building 124, rooms 146 & 147 floors.

Historical Information

- Room 146 was used for Rubratope (Co-57) manufacturing, other capsule manufacturing and filling, and R&D. Isotopes used were Co-57, Ir-192, P-32, and I-125.
- Room 147 was used for Rubratope (Co-60) manufacturing, QC testing (Co-60, I-131, Sr-82 & 85). At one time, it was a sample prep room.
- No contamination levels >5,000 dpm/100 cm^2 were identified during the characterization survey except on equipment that was removed during the D&D phase.

General Survey Instructions

1) Perform a 100% scan of the floor for beta activity in both rooms. Scan speed should not exceed 2" per second.
2) Immediately notify the Project Manager if any reading greater than the equivalent of 7,100 dpm/100 cm^2.
3) Perform direct beta measurements at the 16 points given on the survey map that is part of this survey package.

Special Instructions
Perform a one minute count each of the C-14 and Tc-99 check source for beta measurements at the beginning and end of the survey. Use gas flow proportional detector model numbers 43-68 and 43-106 for surveys. Perform a field background measurement (FLDBK) and a field count (FLDCT) for a minimum of one minute at each fixed survey point.

Survey performance (Initial and date as each survey is complete)

Location Code					General Description	Beta Scan	Direct Beta	Direct Alpha	1 meter Gamma	Smear Gross	LS Smear	Media Sample
L1	L2	L6	L7	L8								
Bristol Myers Squibb Building 124 Rooms 146 & 147 Floors												
A0100	01F01		ZZZZZ	1-16	Floors		X					

Survey performance (Initial and date as each survey is complete)													
Location Code					General Description	Beta Scan	Direct Beta	Direct Alpha	1 meter Gamma	Smear Gross	LS Smear	Media Sample
L1	L2	L6	L7	L8								

Package Review
Date Package Completed:
Package Reviewed by and Date:

Survey Comments

Survey Package A0100
B-124 Rooms 146 & 147 Floors

Survey Grid Worksheet

One set of coordinates randomly generated by Excel for starting point. Values were truncated. X coordinate will be generated between 0 and 11. Y coordinate generated between 0 and 8.

X	Y
1	5

For the triangular method, the distance between measurement points is given by:

$$L = [A/0.866N]^{1/2}$$

where:

L = distance between measurement points in meters
A = area of survey unit in m^2
N = number of survey points

For 146 & 147:

$$L = [90/[0.866*15]]^{1/2}$$
$$= (6.93)^{1/2} \text{ m}$$
$$= 2.6 \text{ m}$$

The distance between measurement rows is given by:

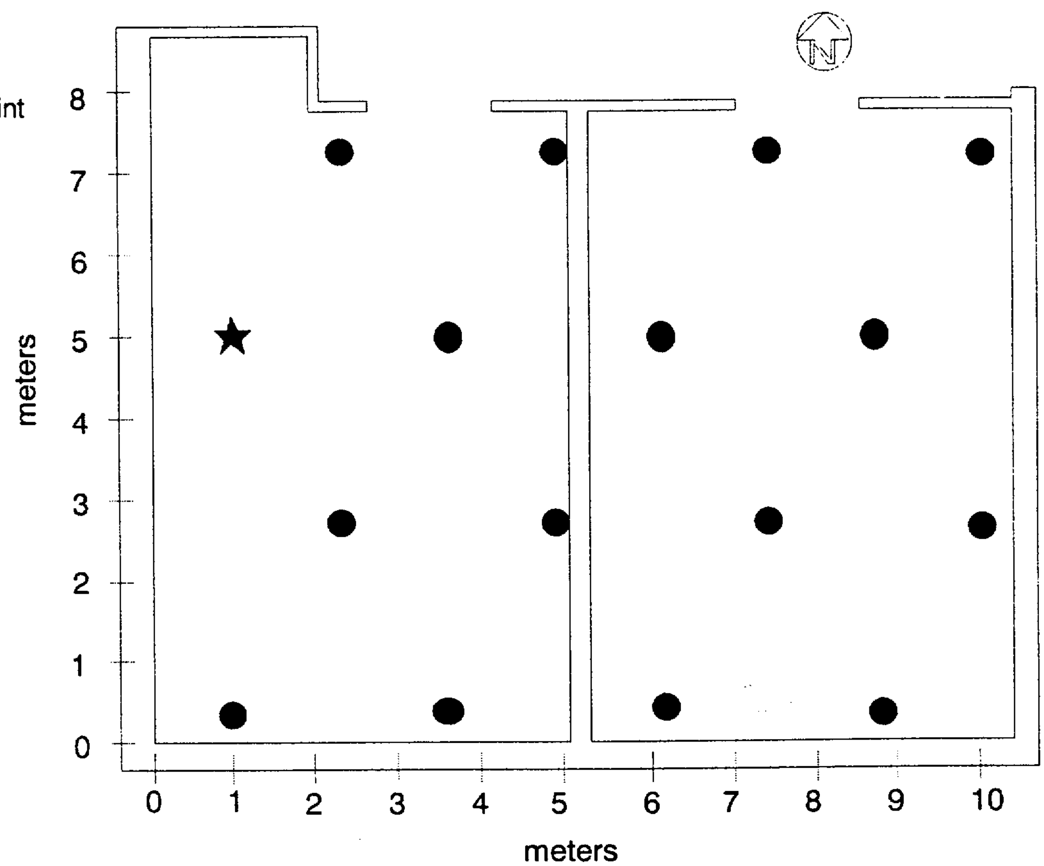
$$D = 0.866 * L$$
$$= 2.3 \text{ m}$$

The measurement points for successive rows shall be offset from the previous row by L/2 or 1.3 m.

SURVEY PACKAGE A0100

★ Starting Point

Survey Point	Survey X	Location Y
1	1	5
2	3.6	5
3	6.2	5
4	8.8	5
5	7.5	7.3
6	4.9	7.3
7	2.3	7.3
8	2.3	2.7
9	4.9	2.7
10	7.5	2.7
11	1.0	0.4
12	3.6	0.4
13	6.2	0.4
14	8.8	0.4
15	10.1	7.3
16	10.1	2.7



Attachment 5
Duratek Commercial Services Operating Procedures

Procedure Number	Procedure Title
REDS-ADM-102	Radiological Occurrence Reports
REDS-CHM-101	Sample Identification and Chain-of-Custody
REDS-CHR-106	Surface Soil Sampling
REDS-CHR-107	Subsurface Soil Sampling
DTK-AD-002	Document Storage and Control
DTK-AD-029	Personnel Training Policy and Implementation Procedure
DTK-QA-001	Commercial Services Quality Plan
DTK-AD-005	First Notification Procedure
REDS-CSA-203	Ludlum Model 2350 Series Data Logger Download Operation
DTK-SF-001	Office Safety
DTK-SF-002	Personal Protective Equipment Program
DTK-SF-003	Safety Harnesses, Lifelines/Lanyards General Fall Protection
DTK-SF-005	Equipment Lockout and Tagout
DTK-SF-006	Portable Electrical Equipment Inspection
DTK-SF-008	Ladder Inspection and Use
DTK-SF-009	Care and Use of Hand Tools and Portable Electric Power Tools
DTK-SF-012	Compressed Gas Storage and Use
DTK-SF-013	Flammable Liquid Storage and Handling
DTK-SF-016	Confined Space Entry Policy
DTK-SF-019	Management, Reporting, and Recordkeeping of Occupational Injuries and Illnesses
DTK-SF-020	Minimum Industrial Safety Standards for Radioactive Field Solutions
DTK-SF-023	Hearing Conservation Program
DTK-SF-024	Hazard Communication Program
REDS-INST-100	Radiation Protection Instrumentation Program
REDS-INST-101	Issue, Control, and Accountability of Radiation Protection Instrumentation
REDS-INST-102	Quality Control of Counting Systems and Portable Counters
REDS-INST-104	Calibration and Test Requirements for Radiation Protection Instrumentation

Attachment 5 (cont.)

Duratek Commercial Services Operating Procedures

Procedure Number	Procedure Title
REDS-INST-201	Operation of Ludlum Model 2350 Data Logger
REDS-INST-206	Operation of the Ludlum Model 19 Micro-R Meter
REDS-INST-211	Operation of Eberline BC-4 Portable Beta Counter
REDS-INST-311	Calibration of Eberline BC-4 Portable Beta Counter
REDS-OPS-202	Selection and Use of Protective Clothing
REDS-OPS-206	Personnel Survey and Decontamination
REDS-OPS-208	Radiation/Hazardous Work Permit
REDS-OPS-301	Performance of Surveys
REDS-OPS-302	Survey Documentation and Review
REDS-RAM-103	Unconditional Release of Tools, Equipment and Waste Materials
REDS-RAM-104	Radioactive Source Inventory, Leak Testing and Control
REDS-RAM-106	Shipment of Radioactive Material
REDS-RAM-107	Packaging of Radioactive Material

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

12/16/2002, and to inform you that the initial processing which includes an administrative review has been performed.

☑ AMEND. 29-00139-02
There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

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

______________________________________.

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

Your action has been assigned **Mail Control Number** 132495.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader

(FOR LFMS USE)
INFORMATION FROM LTS

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

Program Code: 03610
Status Code: 0
Fee Category: 3A
Exp. Date: 20080930
Fee Comments: ____________
Decom Fin Assur Reqd: Y

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED
   Applicant/Licensee: E. R. SQUIBB & SONS, INC.
   Received Date: 20021217
   Docket No: 3005222
   Control No.: 132495
   License No.: 29-00139-02
   Action Type: Amendment

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

3. COMMENTS

Signed M. A. Perkins
Date 12/18/2002

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

1. Fee Category and Amount: ____________

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

3. OTHER ____________
   ____

Signed ____________
Date ____________