K-2

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|---|---|
| **From:** | Hart, Mary |
| **To:** | Ullrich, Elizabeth |
| **Cc:** | Roberts, Mark; DeBoer, Briana; Gordon, Craig; Burritt, Arthur; Powell, Raymond; Grant, Carl; Ryan Fahey |
| **Subject:** | [External_Sender] RE: Decommissioning activities at BMS Wallingford, Ct site |
| **Date:** | Thursday, May 31, 2018 2:46:11 PM |
| **Attachments:** | Amendment letter to NRC May 31 2018.pdf<br>Bristol-Myers Squibb DD Plan May 2018 (002).pdf |

Per our phone conversation of 5/30/18, attached please find the Amendment Letter for License No. 06-27843-02 and the Decommissioning Plan for review. 03029266

Regards,
Mary

**From:** Ullrich, Elizabeth <Elizabeth.Ullrich@nrc.gov>
**Sent:** Wednesday, May 30, 2018 11:36 AM
**To:** Hart, Mary <mary.hart@bms.com>
**Cc:** Roberts, Mark <Mark.Roberts@nrc.gov>; DeBoer, Briana <Briana.DeBoer@nrc.gov>; Gordon, Craig <Craig.Gordon@nrc.gov>; Burritt, Arthur <Arthur.Burritt@nrc.gov>; Powell, Raymond <Raymond.Powell@nrc.gov>
**Subject:** telephone call today regarding decommissioning activities

Mary,

Thanks for calling back so quickly, because both Mark Roberts and Briana DeBoer were still in my office discussing what might be required under your license. As we discussed, we received a reciprocity request from your contractor, which included the decommissioning plan for your Bristol-Myers Squibb License No. 06-27843-02. The decommissioning plan (DP) referred to activities to be performed, such as cutting to remove sections of duct in order to remediate facilities (mostly in your synthesis facility, based on our conversation with you) that are beyond the normal decontamination and remediation activities authorized under your license. We believe that, in accordance with 10 CFR 30.36(g)(1), that you need to formally submit this plan as an amendment to your license so that we can review the DP prior to implementation. We cannot use the contractor's request to work under reciprocity to open an amendment of the license, but you may refer to the plan that was submitted with their reciprocity request.

Mark and Briana work in our Decommissioning branch and I work in our Commercial branch; depending on the complexity of the DP activities, it will be assigned to one of us, and likely we will work together on this.

Regarding your termination request: We have a metric that requires us to review amendments and termination request within 90 days. Depending on the complexity of the decommissioning activities, we may need all 90 days to complete the review of your results. It will likely be faster if we have been able to review the DP ahead of time, and if we can inspect the decommissioning activities while they are underway.

In addition, our fiscal year begins October 1. If your request for termination is submitted prior to October 1, you will not be require to pay a fee for your license in the next fiscal year.

Please contact me if you have any other questions.
Thanks,
Betsy

Betsy Ullrich, Senior Health Physicist
USNRC Region I
2100 Renaissance Boulevard, Suite 100
King of Prussia, PA 19406
610-337-5040 (office)
240-704-4575 (cell)
Elizabeth.ullrich@nrc.gov

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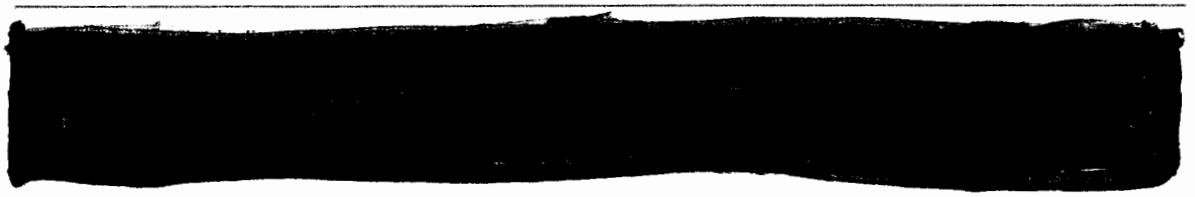

Bristol-Myers Squibb
U.S. Pharmaceuticals
P. O. Box 5100
Wallingford, CT 06492

May 31, 2018

U.S. Nuclear Regulatory Commission
Region 1
2100 Renaissance Boulevard, Suite 100
King of Prussia, PA 19406

Re: Bristol-Myers Squibb License No. 06-27843-02 Amendment

I am requesting the following amendment to License No. 06-27843-02, Bristol-Myers Squibb, 5 Research Parkway, Wallingford, CT. 06492.

- submit for NRC review, the Decommissioning Plan (DP). The activities covered under this DP will be performed by DDES in order to remove fixed contamination in the Radiosynthesis Chemistry suites located on 4th floor D wing and the Radioactive Waste storage areas.

Effective 12/31/18, BMS will be vacating this location and will terminate the license with a submittal of the NRC FORM 314 prior to the October 1, 2018 deadline.

Sincerely,

Mary C. Hart, RSO
Associate Director, EHS
Bristol-Myers Squibb Company
5 Research Parkway
Wallingford Ct. 06492
mary.hart@bms.com
203-677-6071

Carl Grant
Site Director
Bristol-Myers Squibb Company
5 Research Parkway
Wallingford, Ct 06492
carl.grant@bms.com
203-677-7637

# Bristol-Myers Squibb

## Wallingford Campus

## Decontamination and Decommissioning Plan

### 5 Research Parkway

### Wallingford, CT 06492


May 22, 2018

Prepared by:


Decontamination Decommissioning and Environmental Services, LLC
4 Arrow Drive
Woburn, MA 01801

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# ACRONYM LIST

| | |
|---|---|
| ALARA | As Low As Reasonably Achievable |
| CTDEEP | Connecticut Department of Energy and Environmental Protection |
| D&D | Decontamination and Decommissioning |
| $DCGL_{EMC}$ | Derived Concentration Guideline Level – Elevated Measurement Comparison |
| $DCGL_W$ | Derived Concentration Guideline Level – Average Area Concentration |
| DOT | U.S. Department of Transportation |
| DQO | Data Quality Objective |
| DSV | Default Screening Value |
| GSF | Gross Square Feet |
| HSA | Historical Site Assessment |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MDC | Minimum Detectable Concentration |
| NRC | U.S. Nuclear Regulatory Commission |
| QAPP | Quality Assurance Project Plan |
| RSO | Radiation Safety Officer |
| TEDE | Total Effective Dose Equivalent |

# 1.0 Introduction

Bristol-Myers Squibb (BMS) is in the process of ceasing operations at its Wallingford Campus located at 5 Research Parkway in Wallingford, Connecticut. These spaces are scheduled for future use with non-radioactive material use. Radioactive Material use at the BMS campus has been performed under U.S. Nuclear Regulatory Commission (NRC) Broad Scope Radioactive Materials License No. 06-27843-02. This Decontamination and Decommissioning (D&D) Plan is to cover the performance of D&D services to effectively survey and remediate the radioactive material use and support areas on the Wallingford Campus and allow for unrestricted release of the space. Subsequently this will lead to license termination. This D&D Plan will demonstrate the techniques used to determine whether or not the interior of the impacted areas of facility will fall below the annual total effective dose equivalent (TEDE) of nineteen (19) millirem above background to an individual member of the public. Administrative limits, with ALARA in mind, will limit doses to fractions of that limit. The goal of this decommissioning is to achieve unrestricted release of the radioactive material areas and achieve license termination.

This plan was developed using the guidance provided in NUREG 1727, "NMSS Decommissioning Standard Review Plan"; NUREG 1757, "Consolidated NMSS Decommissioning Guidance"; and NUREG 1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM). This plan provides the approach, methods, and techniques for the radiological D&D of impacted areas of each facility. Final status surveys are designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with the default screening values generated using the default scenarios and parameters of the DandD Code v.2.4. These methods ensure technically defensible data is generated to aid in determining whether or not this facility meets the release criteria for unrestricted use.

D&D activities will be performed in accordance with this plan and the Decontamination Decommissioning and Environmental Services (DDES) Radiation Safety Protection Program. DDES will be performing this scope of work under DDES' Massachusetts Radioactive Materials License 56-0623.

# 2.0 Site Description

Bristol-Myers Squibb commenced operations at 5 Research Parkway in 1984. The main facility is one large building with five wings, A, B, C, D & F. There is also a Material Handling Building located on the north side of the campus. An 8,500

square foot caged area of this waste storage building was used for radioactive waste storage and decay. Radioactive material use was permitted in laboratories on the 3rd, 4th and 5th floors in each of the five wings of the facility for scientific research revolving around pharmaceutical development. Included in this decommissioning are waste rooms and supplementary facilities that supported the laboratories such as a waste building and penthouses. The facility operates under its NRC Radioactive Materials License No. 06-27843-02.

Radioactive Material use was limited to the interior of the facility, therefore surveys of the exterior of the facility are not warranted at this time.

# 3.0 Site History

## 3.1 Potential Contaminants

Table 3.1 is a list of radionuclides or authorized licensed materials used in sealed and unsealed form within the BMS facility. This list was compiled based on data obtained from a review of the facility's NRC Radioactive Materials License No. 06-27843-02.

**Table 3.1 Radionuclides Identified**

| Nuclide | Form | Possession Limit |
|---|---|---|
| Carbon-14 | Any | 5 Curies |
| Hydrogen-3 | Any | 6 Curies |
| Fluorine-18 | Any | 600 millicuries |
| Phosphorus-32 | Any | 750 millicuries |
| Phosphorus-33 | Any | 500 millicuries |
| Sulfur-35 | Any | 5 curies |
| Calcium-45 | Any | 100 millicuries |
| Copper-64 | Any | 30 millicuries |
| Gallium-68 | Any | 3 millicuries |
| Germanium-68 | Any | 3 millicuries |
| Zirconium-89 | Any | 20 millicuries |
| Iodine-125 | Any | 1 curie |
| Cesium-137 | Sealed Source | 300 microcuries |

# 4.0 Impacted Room Descriptions

A historical site assessment and scoping surveys were performed in March of 2018. This HSA identified that most of radioactive material use areas have been previously decommissioned by BMS. DDES reviewed decommissioning surveys and close out reports as part of the HSA. These areas will be included as Class 3

survey units as part of this decommissioning.

Only the radiosynthesis suites, PCO-Chemistry and waste storage rooms remain as active radioactive material use areas at the facility. Radiosynthesis stopped work on May 18, 2018. PCO-Chemistry is scheduled to stop use of radioactive material on July 13, 2018. The facility is of standard laboratory construction and the materials are of those typically found in a laboratory setting. All horizontal surfaces and vertical surfaces up to 2 meters in height will be considered impacted. These laboratories consist of fume hoods, associated fume hood ventilation, sink drains, vacuum lines and general room ventilation. All of these systems will be considered potentially impacted as part of this decommissioning and included in the surveys to terminate the facilities radioactive materials license.

In addition, previously decommissioned laboratories, adjacent hallways, penthouses and office areas will be surveyed during decommissioning. A support building known as the Material Handling Building is a separate structure that houses waste operations for the 5 Research Parkway site. As radioactive waste was stored inside this building, it is also subject to decommissioning.

# 5.0 Radiological Status of Facility

The radiological status of the facility has been determined by a combination of historical records, scoping surveys and interviews with BMS project management. It has been determined that the nuclides of concern for this decommissioning are limited to C-14 and H-3. This is based on previous decommissioning surveys and time that has passed since last use of materials at the facility. A characterization survey shall be performed to determine the current status of the facility.

## 5.1 Characterization Survey

Typically, the survey protocol for building surfaces will consist of performing the scanning portion of the final status survey protocol, with judgmental smears and static measurements on the highest probability areas for residual radioactivity. Judgmental static measurements and smears shall also be taken, as needed, on vertical surfaces as part of potentially modified Class 2 and Class 3 final status survey protocols.

The purpose of scanning is to identify locations of elevated activity. Where elevated activity is identified, a static measurement and smear will be taken at the location of highest activity identified during the scan. Where elevated activity is identified, the boundary of the elevated area will be marked to aid in locating the area for remedial actions.

If the initial characterization survey results indicate that contamination is not present in excess of the release criteria or administrative limits, then data from the survey may be used as part of the final status survey. For areas that are partially contaminated, the characterization survey data may be used as part of the final status survey measurements provided that 1) the data used is only from areas with contamination levels below the release criteria, and 2) decontamination work is controlled such that the survey location could not have become cross-contaminated.

Each survey unit will have an independent survey package that has specific survey instructions. The survey package will contain, at a minimum:

- Survey Unit number (e.g., Building and Room Number, System Number, etc.)
- Percentage of surface requiring scan surveys
- Number of removable contamination measurements
- Instrumentation to be used with static count times and scan rates
- Any additional specific survey instruction
- Maps of the survey unit surfaces

## 6.0 Release Criteria

The radiological release criteria of 19 mrem per year will be used for decommissioning this facility. Specifically, the facility being released under this decommissioning effort will be surveyed in accordance with the guidance and protocols contained in MARSSIM to demonstrate compliance with the release criteria. The criteria include residual radioactivity results in a TEDE, that to an average member of the critical group, does not exceed 19 mrem per year and that the residual radioactivity has been released to levels that are as low as reasonably achievable (ALARA). Additionally, during decommissioning activities, the TEDE shall not exceed 19 mrem per year.

## 7.0 Derived Concentration Guideline Levels

The NRC has published default screening values in NUREG 1757 for commonly used radionuclides to a dose of 25 mrem. Connecticut Department of Energy and Environmental Protection (CTDEEP) regulations require that sites be decommissioned to 19 mrem. DandD v.2.4 software will be used to determine default screening values for isotopes or dose limits not listed in NUREG 1757. Surface contamination limits will be derived using the Building Occupancy scenario together with default parameter values. Screening values were selected such that the 0.9 quantile of projected doses was less than or equal to 19 mrem/y (i.e., when probabilistic dose assessment calculations were performed, there was a 90% probability that the calculated dose would be less than 19 mrem/y).

The default screening values are the basis for developing the derived concentration guideline levels (DCGL's) for the project. The DCGL is the radionuclide specific surface area concentration that could result in a dose equal to the release criterion. $DCGL_W$ is the concentration limit if the residual activity is essentially evenly distributed over a large area. For this project, $DCGL_W$ is equal to the DSV. Table 7.1 identifies the $DCGL_w$ for each of the limiting Nuclides of Concern (NOC) for this decommissioning.

**Table 7.1 $DCGL_w$ 19 mrem/year**

| Nuclide | Total (DPM/100 $cm^2$) | Removable (DPM/100 $cm^2$) |
|---|---|---|
| H-3 | $9.41 \times 10^7$ | $9.41 \times 10^6$ |
| C-14 | $2.79 \times 10^6$ | $2.79 \times 10^5$ |

Additionally BMS management has set administrative limits that are well below 19 mrem. These goals show BMS' commitment to ALARA. The administrative limits are presented in table 7.2.

**Table 7.2 BMS Administrative Limits**

| Nuclide | Total (DPM/100 $cm^2$) | Removable (DPM/100 $cm^2$) |
|---|---|---|
| H-3 | NA | 1,000 |
| C-14 | 5,000 | 1,000 |

In the case of non-uniform contamination, higher levels of activity are permissible over small areas. The $DCGL_{EMC}$ is derived separately for these small areas. The $DCGL_{EMC}$ is the $DCGL_W$ increased by an area factor depending on the size of the elevated area. For the Wallingford Campus decommissioning project, $DCGL_{EMC}$ is not expected to be used since after remediation, all areas will meet Administrative limits, which are a small percentage of the DSV.

# 8.0 ALARA Analysis

Due to the extremely low doses associated with the release criteria used for this D&D project, a quantitative ALARA analysis is not required. Administrative limits below default screening values are being used to establish DCGLs.

NUREG 1727 states in part: "In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the staff presumes, absent information to the contrary, that licensees or responsible

parties that remediate building surfaces or soil to the generic screening levels do not need to demonstrate that these levels are ALARA. However, licensees or responsible parties should remediate their facility below these levels through practices such as good housekeeping. In addition, licensees or responsible parties should provide a description in the final status survey report of how these practices were employed to achieve the final activity levels."

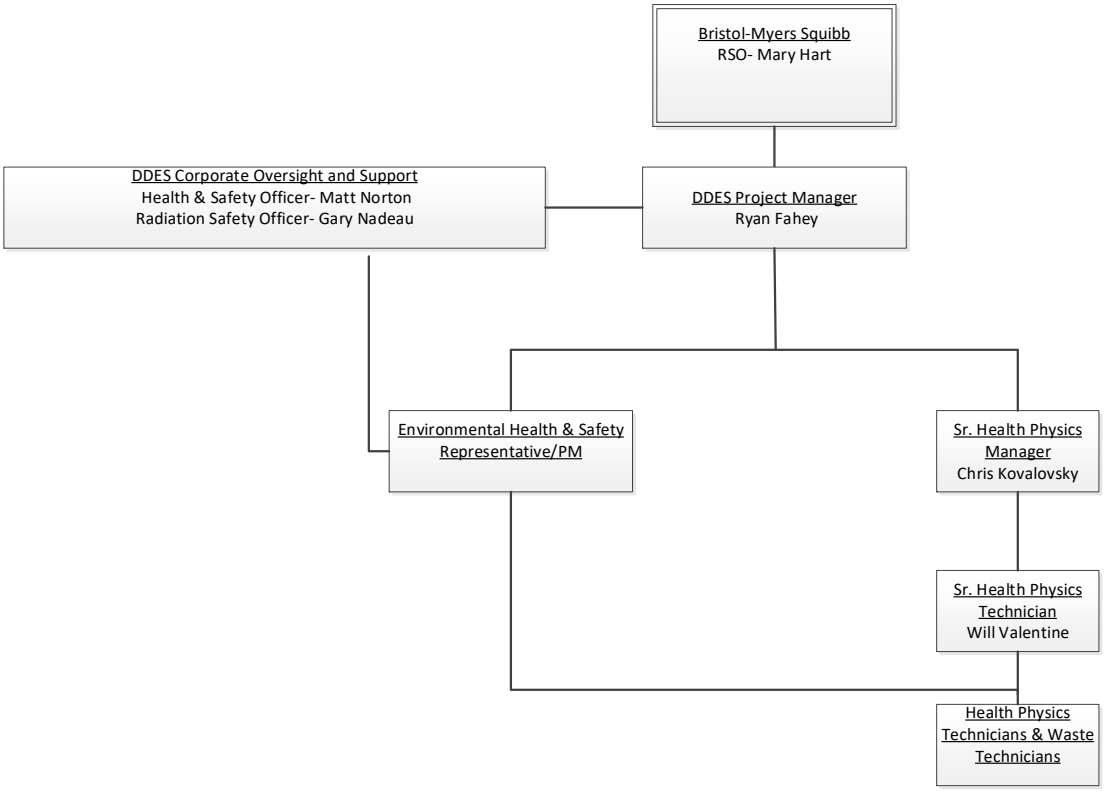
# 9.0 Planned Decommissioning Activities

Remediation methods that will be used include simple decontamination (i.e. wet wiping with a mild detergent) and removal of contaminated material by dismantling systems and structures and/or cutting contaminated sections from the material. Cutting may consist of the use of saws, band saws, high leverage shears, electric snips, tin snips and/or ratcheting cable cutters. HEPA-filter vacuums will be used to remove loose dry material from surfaces during remediation activities. A fixative agent will be applied to the interiors of fume hoods and ductwork prior to removal. All remediation activities will be conducted to control the spread of contamination and to maintain personnel exposures ALARA.

## 9.1 Contaminated Structures

Remediation methods that will be used include simple decontamination (i.e. wet wiping with a mild detergent) and removal of contaminated material. If it is likely that radioactive materials have migrated to inaccessible areas, such as under casework or tile, dismantlement will be required to assess the activity levels in these inaccessible areas.

# 10.0 Project Management and Organization




# 11.0 Radiation Safety and Health Program

Radiological work will be performed according to DDES' Radiation Safety Program under the management and supervision of the Project Radiation Safety Officer.

# 12.0 Radioactive Waste Management

An estimated 29,020 pounds of LLRW will be generated and disposed of during decommissioning activities. Waste will be accumulated in 1 cubic yard non-reusable containers while oversized waste will be wrapped in 6 mil plastic sheeting and shrink-wrapped. All waste packaged for shipment will be staged and surveyed prior to loading for off-site disposal. This will allow the project team to efficiently package all equipment and materials preventing external contamination of packaged waste. Live loading shipping campaigns will occur during non-operational hours to limit the disturbance to BMS employees and facility operations. All radioactive waste is scheduled to be disposed of at Alaron in Wampum, Pennsylvania. Table 12.1 identifies the waste that is anticipated to be generated under this scope.

**Table 12.1 Estimated LLRW Types and Weights**

| Contaminated Material Type | Approximate Weight (lbs.) |
|---|---|
| Ceiling | 1,700 |
| Flooring | 2,500 |
| Drywall | 400 |
| Hoods | 4,500 |
| Exhaust Ductwork | 5,500 |
| Filter Housings | 2,500 |
| Filters | 3,840 |
| Casework | 3,000 |
| Lab Trash & PPE | 1,000 |
| Marble Tables | 1,400 |
| Refrigerator/Dishwasher | 800 |
| Bench Tops | 1,800 |
| Compactor Plate | 80 |
| **Total** | **29,020** |

# 13.0 Quality Assurance Program

For the Final Status Survey Report, DDES, LLC will develop a Quality Assurance Project Plan (QAPP) utilizing the guidelines of MARSSIM Section 9. At a minimum, the QAPP will incorporate, the following:

- Description of the Quality Assurance and Quality Control goals, Data Quality Objectives (DQO), procedures, and plans to be implemented for all D&D activities.
- Description of the methodology to ensure that all radiological survey data meet the 95% confidence level.

The QAPP will be developed and organized with emphasis given to maximizing worker safety, minimizing/eliminating off-site releases and minimizing overall project costs. The quality control program will control all quality documents during the performance of D&D operations. Quality documents include, but are not limited to:

- Training Records
- Survey Records
- Instrument Records

- Shipping Records
- Work Procedures and Plans

# 14.0 Survey Instrumentation

## 14.1 Instrument Calibration

Laboratory and portable field instruments will be calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources, where feasible, and to radiation emission types and energies that will provide detection capabilities similar to the nuclides of concern.

## 14.2 Functional Checks

Functional checks will be performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation will be specified by procedure to ensure measurements are statistically valid. Background readings will be taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions. If an instrument fails a functional check, all data obtained with the instrument since the last satisfactory check will be invalidated.

## 14.3 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination will be chosen to provide a minimum detectable concentration (MDC) that meets the criteria specified in this Plan. MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100cm$^2$. Count times and scanning rates are determined using the following equations:

### 14.3.1 Static Counting

Static Counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is an expansion of NUREG 1507, “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions”, Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{Static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{E_{tot} \cdot \frac{A}{100\,cm^2}}$$

Where:

| | | |
|---|---|---|
| $MDC_{Static}$ | = | Minimum detectable concentration level in dpm/100cm$^2$ |
| *Br* | = | background count rate in counts per minute |
| $t_b$ | = | Background count time in minutes |
| $t_s$ | = | Sample count time in minutes |
| $E_{tot}$ | = | Total detector efficiency for radionuclide emission of interest (includes combination of instrument survey 2π efficiency and 0.25 surface efficiency) |
| A | = | Detector probe area in cm$^2$ |

### 14.3.2 Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation that is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

| | | |
|---|---|---|
| $MDC_{scan}$ | = | Minimum detectable concentration level in dpm/100 cm$^2$ |
| *d'* | = | desired performance variable (1.38) |
| *bi* | = | background counts during the residence interval |
| *i* | = | residence interval |
| *p* | = | surveyor efficiency (0.5) |
| $E_{tot}$ | = | total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency) |
| *A* | = | detector probe area in cm$^2$ |

### 14.3.3 Smear Counting

Smear counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{smear} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E}$$

Where:

| | | |
|---|---|---|
| $MDC_{Smear}$ | = | Minimum detectable concentration level in dpm/smear |
| *Br* | = | background count rate in counts per minute |
| $t_b$ | = | Background count time in minutes |
| $t_s$ | = | Sample count time in minutes |

## 14.4 Instrumentation Specifications

The instrumentation, or equivalent, used for facility decommissioning surveys is summarized in the following tables. Table 14.1 lists the standard features of each instrument such as probe size and efficiency. Table 14.2 lists the typical operational parameters such as scan rate, count time, and the associated Minimum Detectable Concentrations (MDC). Alternate or additional instrumentation with similar detection capabilities may be utilized as needed for survey requirements with DDES LLC Project RSO approval.

**Table 14.1 Instrumentation Specifications**

| Detector Model | Detector Type | Detector Area | Meter Model | Window Thickness | Typical Total Efficiency |
|---|---|---|---|---|---|
| Ludlum 43-37 Floor Monitor | Gas Flow Proportional | 582 $cm^2$ | Ludlum 2221 | 0.4 $mg/cm^2$ | 13 % (C-14) |
| PerkinElmer TriCarb | LSC | 2" x 2" | Tri-Carb | N/A | 92% (C-14) 55% (H-3) |
| Ludlum 43-93 | Alpha Beta Scintillation | 100 $cm^2$ | Ludlum 2224 | 0.8 $mg/cm^2$ | 10% ($^{14}C$) |
| Ludlum 19 | Gamma Scintillation | 1" x 1" | Ludlum | N/A | N/A |

**Table 14.2 Typical Instrument Operating Parameters and Sensitivities**

| Measurement Type | Detector Model | Meter Model | Scan Rate | Count Time | Background (cpm) | MDC (dpm/100cm$^2$) |
|---|---|---|---|---|---|---|
| Surface Scans | Ludlum 43-37B Floor Monitor | Ludlum 2221 | 4 in./sec. | N/A | 740 | 441 ($^{14}$C) |
| Surface Scans | Ludlum 43-93 | Ludlum 2224 | 2 in./sec. | N/A | 235 | 2,317 ($^{14}$C) |
| Total Surface Activity | Ludlum 43-68B | Ludlum 2221 | N/A | 1 Min | 285 | 582 ($^{14}$C) |
| Total Surface Activity | Ludlum 43-93 | Ludlum 2224 | N/A | 1 Min | 235 | 558($^{14}$C) |
| Removable Activity | PerkinElmer Tri-Carb | N/A | N/A | 60 sec. | 10 ($^{3}$H)<br>15 ($^{14}$C) | 22 ($^{3}$H)<br>17 ($^{14}$C) |

# 15.0 Characterization Surveys

Typically, the survey protocol for building surfaces will consist of performing the scanning portion of the final status survey protocol, with judgmental smears and static measurements on the highest probability areas for residual radioactivity. Judgmental static measurements and smears shall also be taken on vertical surfaces as part of the modified Class 2 and Class 3 final status survey protocols.

The purpose of scanning is to identify locations of elevated activity. Where elevated activity is identified, a static measurement and smear will be taken at the location of highest activity identified during the scan. Where elevated activity is identified, the boundary of the elevated area will be marked to aid in locating the area for remedial actions.

If the initial characterization survey results indicate that contamination is not present in excess of the release criteria, then data from the survey may be used as part of the final status survey. For areas that are partially contaminated, the characterization survey data may be used as part of the final status survey measurements provided that 1) the data used is only from areas with contamination levels below the release criteria, and 2) decontamination work is controlled such that the survey location could not have become cross-contaminated.

Each survey unit will have an independent survey package that has specific survey instructions. The survey package will contain, at a minimum:

- Survey Unit number (e.g., Building and Room Number, System Number, etc.)
- Percentage of surface requiring scan surveys

- Number of removable contamination measurements
- Instrumentation to be used with static count times and scan rates
- Any additional specific survey instruction
- Maps of the survey unit surfaces

# 16.0 Remedial Action Surveys

Remediation will be conducted to control the spread of contamination and keep personnel exposures ALARA. Remedial action surveys are conducted in support of remediation activities to help determine when the area is ready for a final status survey and to provide updated estimates for final status survey planning. Remedial action surveys serve to monitor the effectiveness of decontamination efforts and ensure that surrounding areas are not cross-contaminated from remediation actions.

Remedial action surveys will consist of scan surveys, direct measurements and removable contamination measurements. These will be conducted following remediation activities in order to establish the success or failure of the efforts to decontaminate the applicable survey area. Results of the survey will be the decision basis for either continued remediation or the conduction of final status surveys.

Remedial action surveys will be designed to meet the objectives of the final status surveys. To the extent allowed by MARSSIM, the results of the remedial action surveys will be used to supplement the final status survey.

# 17.0 Design and Performance of Final Status Surveys

Final status surveys are performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. The final status survey will be conducted using the Data Quality Objective (DQO) process. Characterization and remedial action survey data will be used as final status survey data to the maximum extent possible in order to minimize overall project costs.

Final status surveys will be conducted by performing required scan surveys, total direct surveys, and removable contamination measurements as discussed further in this section. All survey data shall be documented on survey maps and associated data information sheets.

## 17.1 Background Determination

The use of reference background areas or paired background comparisons is not

necessary for the purposes of this plan. Material and ambient background values are not expected to be present at a significant level in comparison to the DCGLs. Surface background will be determined for each material type to calculate the actual survey MDCs and associated count errors.

## 17.2 Area Classifications

Based on the results of the historical site assessment and previous survey results, facility areas have been classified as impacted areas or non-impacted areas.

### 17.2.1 Non-Impacted Area

Non-impacted areas are areas without residual radioactivity from licensed activities and are not surveyed during final status surveys. The following areas are classified as non-impacted:

- Surfaces above a two-meter height.
- Building Exterior
- Campus Grounds

### 17.2.2 Impacted Areas

Impacted areas are those areas that have potential residual radioactivity from licensed activities. Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined, for the purposes of this plan are as follows:

#### 17.2.2.1 Class 1 Area

Areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support classification as Class 2 or Class 3.

#### 17.2.2.2 Class 2 Area

Areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

#### 17.2.2.3 Class 3 Area

Areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

## 17.3 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision will be made as to whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated, and released as a single unit. For the purposes of this plan, areas of similar construction and composition will be grouped together as survey units and tested individually against the DCGLs and the null hypothesis to show compliance with the release criteria. Survey units will be homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small-elevated areas of residual radioactivity. Survey units will be sized according to the potential for small-elevated areas of residual radioactivity.

Survey units will be established to meet MARSSIM recommendations.

**Table 17.1 MARSSIM Recommended Maximum Survey Unit Sizes**

| Type of Survey Unit | Class 1 | Class 2 | Class 3 |
|---|---|---|---|
| Structures | Up to 100 $m^2$ | 100 $m^2$ to 1,000 $m^2$ | No limit |

Table 17.2 below summarized the initial classifications of each survey unit at the BMS facility based upon the site meeting and historical use.

**Table 17.2 Initial Area Classifications**

| Wing | Room # | Isotope(s) | Class |
|---|---|---|---|
| D | 360B | H-3, C-14 | 1 |
| D | 486A | H-3, C-14 | 1 |
| D | 486E | H-3, C-14 | 1 |
| D | 486F | H-3, C-14 | 1 |
| D | 486G | H-3, C-14 | 1 |
| D | 488A | H-3, C-14 | 1 |
| D | 490D | H-3, C-14 | 1 |
| D | 490E | H-3, C-14 | 1 |
| D | 490F | H-3, C-14 | 1 |
| D | 134E | H-3, C-14 | 1 |
| D | 1st Floor | H-3, C-14 | 3 |
| D | 2nd Floor | H-3, C-14 | 3 |
| D | 3rd Floor | H-3, C-14 | 3 |
| D | 4th Floor | H-3, C-14 | 3 |
| D | Penthouse | H-3, C-14 | 3 |
| C | 1st Floor | H-3, C-14 | 3 |
| C | 2nd Floor | H-3, C-14 | 3 |
| C | 3rd Floor | H-3, C-14 | 3 |
| C | 4th Floor | H-3, C-14 | 3 |
| C | Penthouse | H-3, C-14 | 3 |
| B | 1st Floor | H-3, C-14 | 3 |
| B | 2nd Floor | H-3, C-14 | 3 |
| B | 3rd Floor | H-3, C-14 | 3 |
| B | 4th Floor | H-3, C-14 | 3 |
| B | Penthouse | H-3, C-14 | 3 |
| B | Penthouse | H-3, C-14 | 3 |
| A | 1st Floor | H-3, C-14 | 3 |
| A | 2nd Floor | H-3, C-14 | 3 |
| A | 3rd Floor | H-3, C-14 | 3 |
| A | 4th Floor | H-3, C-14 | 3 |
| A | Penthouse | H-3, C-14 | 3 |
| F | 1st Floor | H-3, C-14 | 3 |
| F | 2nd Floor | H-3, C-14 | 3 |
| F | 3rd Floor | H-3, C-14 | 3 |
| F | 4th Floor | H-3, C-14 | 3 |
| F | 5th Floor | H-3, C-14 | 3 |
| F | Penthouse | H-3, C-14 | 3 |

| Wing | Room # | Isotope(s) | Class |
|---|---|---|---|
| D | 360B | H-3, C-14 | 1 |
| Material Handling Building | Rad Waste | H-3, C-14 | 1 |
| Material Handling Building | Non-Rad Use Areas | H-3, C-14 | 3 |

*A minimum number fourteen (14) survey locations will be met for each survey unit. The survey points only account for horizontal surfaces only. Survey points for each survey unit will increase when vertical surface area (up to 2.0 meters in height) are added to obtain the total area for each survey unit.

## 17.4 Surface Scans

Typically, scanning is used to identify locations within the survey unit that exceed the investigation level. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination. Scanning surveys are designed to detect small areas of elevated activity that are not detected by the measurements using the systematic pattern. Table 17.3 summarizes the percentage of accessible building structural surfaces to be scanned based on classification.

**Table 17.3 Scan Survey Coverage by Classification**

| Classification | Percentage of Surface Area Requiring Scan Coverage (MARSSIM) | Services Surface Area Scan Coverage |
|---|---|---|
| 1 | 100% | 100% |
| 2 | 10 – 100% (Judgmental) | 50% |
| 3 | Judgmental | 20% |

The percentage of survey area scan surveyed may be increased based on suspected elevated activity. For Class 2 and Class 3 areas, the surfaces to be scan surveyed will be those with the highest potential to contain residual contamination.

Floor areas near laboratory entrances and exits will receive a 100% scan survey regardless of the area classification. These surveys will provide indications of potential migration of residual contamination to outside areas.

If elevated activity is detected during the scan surveys, then the location shall be

marked and total and removable surface activity measurements will be taken to quantify the activity. However, total surface activity measurements are in addition to the static measurements required for the statistical test.

## 17.5 Total Surface Activity Measurements

Direct surveys (static measurements) will be performed. If elevated measurements are detected, static measurements will be taken on surfaces to the extent practical, in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey will require detailed survey measurements.

### 17.5.1 Determining the Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples will depend on the Relative Shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration).

The minimum number of samples is obtained from MARSSIM tables or calculated using equations in Section 5 of MARSSIM.

### 17.5.2 Determination of the Relative Shift

The number of required samples will depend on the ratio involving the activity level to be measured relative to the variability in the concentration. The ratio to be used is called the Relative Shift and is defined in MARSSIM as:

$\sigma_s$= An estimate of the standard deviation of the residual radioactivity in the survey unit.

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL = Derived concentration guideline level
LBGR = Concentration at the lower bound of the gray region

The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test

### 17.5.3 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by failing a unit that should pass (ß decision error) or passing a unit that should fail (α decision error). MARSSIM uses the terminology α and ß decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The decision errors are 0.05 for Type I errors and 0.05 for Type II errors.

### 17.5.4 Determination of Number of Data Points (Sign Test)

The number of direct measurements for a particular survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(Sign\ p - 0.5\right)^2}$$

Where:

| | | |
|---|---|---|
| N | = | number of samples needed in the survey unit |
| Z1-α | = | percentile represented by the decision error □□ |
| Z1-β | = | percentile represented by the decision error □□ |
| *SignP* | = | estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR |

*Note: SignP* is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include an increase of 20% of the calculated value.

### 17.5.5 Determination of Sample Locations

Determination of Class 1 survey unit sample locations is accomplished by first determining sample spacing and then systematically plotting the

sample locations from a randomly generated start location. The random starting point of the grid provides an unbiased method for obtaining measurement locations to be used in the statistical tests. Class 1 survey units have the highest potential for small areas of elevated activity, so the areas between measurement locations may be adjusted to ensure that these areas can be detected by scanning techniques.

Similar systematic spacing methods are used for Class 2 survey units because there is an increased probability of small areas of elevated activity. The use of a systematic grid allows the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

Class 3 survey locations are determined from computer selected randomly generated x and y coordinates. Survey protocols for all areas are summarized in Table 17.4

**Table 17.4 Survey Sample Placement Overview**

| **Survey Unit Classification** | | **$DCGL_w$ Comparison** | **Elevated Measurement Comparison** | **Measurement Locations** |
|---|---|---|---|---|
| Impacted | Class 1 | Yes | N/A | Systematic random |
| | Class 2 | Yes | N/A | Systematic random |
| | Class 3 | Yes | N/A | Random |
| Non-Impacted | | None | None | None |

Permanent counter tops and other horizontal surfaces, which block floor surfaces, will be included as a replacement to the blocked floor surface. Likewise, fixed cabinetry faces and other permanent equipment will replace blocked wall surfaces. Permanent equipment, which does not actually block floor or wall surfaces, will be folded out 2-dimensionally and attached to the room overview so as to be included in the grid plot.

Internal surfaces of permanent furnishings (i.e., drawer or cabinetry interior surfaces) are not included in the systematic measurement location placement. However, these surfaces will be included in the scan surveys and judgmental measurements may be taken.

Additional total surface activity measurements will be collected at each area of elevated activity identified during the scan surveys.

### 17.5.5.1 Determining Class 1 Sample Locations

For this survey, all impacted areas (below 2 meter elevation) will be considered Class 1. In Class 1 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

N = number of samples needed in the survey unit
L = sample spacing interval
A = the survey unit area

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests (floors, walls, ceilings, fixed cabinetry, etc.) and folded out in a 2-dimensional view. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.

### 17.5.5.2 Determining Class 2 Sample Locations

In Class 2 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

N = number of samples needed in the survey unit

L = sample spacing interval
A = the survey unit area

Maps of the survey unit's permanent surfaces included in the statistical tests will be generated. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.

### 17.5.5.3 Determining Class 3 Sample Locations

For Class 3 areas, maps will be generated of the survey unit floor surfaces and applicable permanent equipment and/or furnishings. Sample locations will be chosen on floor, lower wall (<2m) and permanent equipment surfaces at the discretion of the survey technician. Measurement locations will be biased towards areas with the highest potential of residual contamination. Each chosen location will be plotted on the applicable survey map.

## 17.6 Removable Contamination Measurements

Removable contamination measurements (smears) will be collected on surfaces at each sample location. Removable contamination measurements will be used to determine if hard to detect nuclides are present within the survey units. These smears will be analyzed by a liquid scintillation counter. Additionally, removable contamination measurements will be collected for building system internals. An area of approximately 100 $cm^2$ shall be wiped if possible. If an area of less than 100 $cm^2$ is wiped, a comment shall be added to the survey data sheet estimating the surface area wiped to allow for area correction of the results. Swabs may be used when system or component access points are not large enough to allow for a wipe of a 100 $cm^2$ surface area.

## 17.7 Survey Documentation

A survey package will be developed for each survey unit containing the following:

- Survey Instruction Sheets
- General survey requirements
- Instrument requirements with associated MDCs, count times and scan rates
- Survey Maps

- Overview maps detailing survey locations and placement methodology
- Survey sub-unit maps with additional sample location information, as needed
- Survey Data Sheets
- Signature of Data Collector and Reviewer

### 17.8 Data Validation

Field data will be reviewed and validated to ensure:

- The completeness of forms and that the type of survey has correctly been assigned to the survey unit.
- That the MDCs for measurements meet the established data quality objectives and that independent calculations will be performed for a representative sample of data sheets and survey areas.
- That instrument calibrations and daily functional checks have been performed accurately and at the required frequency.

## 18.0 Data Quality Assessment (DQA) and Interpretation of Survey Results

The statistical guidance contained in Section 8 of MARSSIM will be used to determine if areas are acceptable for unrestricted release, and whether additional surveys or sample measurements are needed.

### 18.1 Preliminary Data Review

A preliminary data review will be performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data is reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity and to confirm the correct classification of survey units. If an area is misclassified with a less restrictive classification, the area will be upgraded and surveyed accordingly.

The following preliminary data reviews will be performed for each survey unit:

- Calculations of the survey unit mean, median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements. If the actual standard deviation is greater than estimated, the minimum number of samples shall be calculated using the actual standard deviation to ensure a

sufficient number of samples have been obtained.
- Comparison of survey data with applicable investigation levels.

### 18.2 Determining Compliance

For Class 1 areas, if it is determined that all total activity results are less than the applicable DCGL, then no further statistical tests are required. If any of the total activity measurements are greater than the $DCGL_W$, then the survey unit fails but the null hypothesis is not rejected. The survey unit is determined to meet the release criterion provided that the application of any unity rules result in values less than 1.

The Sign test is used to determine the minimum number of sample locations. However, the Sign test is not performed in this survey design because the total activity DCGL is used as a maximum. If all measurements are less than the DCGL, performance of the Sign test is not necessary because the survey unit will pass the Sign test by definition.

Removable contamination measurements will be compared directly to the applicable DCGL. No contingency is established for elevated removable contamination. Therefore, if any removable contamination is detected which exceeds the removable contamination DCGL, the survey unit is determined not to meet the release criterion. However, if all removable contamination measurements are less than the removable contamination DCGL, then compliance shall be determined based on total activity measurements.

Compliance will be determined for each applicable type of total activity measurement performed in each survey unit (i.e., gross beta total activity measurements and gross gamma total activity measurements). Locations with multiple isotopes present will be evaluated by the unity rule.

A Final Report summarizing D&D activities performed at the Bristol-Myers Squibb Facility at 5 Research Parkway in Wallingford, Connecticut shall be prepared and submitted to NRC. The guidance provided in NUREG 1727 will be used to prepare the final report.

## 19.0 References

- NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM)
- NUREG-1505, “A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys"
- NUREG 1507, “Minimum Detectable Concentrations with Typical Radiation

Survey Instruments for Various Contaminants and Field Conditions"
- NUREG 1727, "NMSS Decommissioning Standard Review Plan," September 2000.
- NUREG 1757, Volume 1 "Consolidated NMSS Decommissioning Guidance," September, 2002