

Bristol-Myers Squibb  
Pharmaceutical Research Institute

Richard L. Gelb Center for Pharmaceutical Research and Development

5 Research Parkway P.O. Box 5100 Wallingford, CT 06492-7660

Q-5

Elizabeth Ullrich  
Commercial and R&D Branch  
Division of Nuclear Materials Safety  
Region I  
King of Prussia, Pennsylvania 19406

November 18, 2009

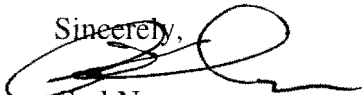
03029266

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

Dear Ms. Ullrich,

Based on your request for more information on our use of Cl-36 and Gd-153 I am supplying the additional information in this letter and attached. We never purchased, possessed or used Cl-36. We had added it to our license in anticipation but never needed it. We have not purchased, possessed or used Gd-153 since 1993 (25 half-lives). All the work with the gamma emitting microspheres was done in labs 111K and 112K. Those labs were used for other rad work after the microspheres work ended and were decommissioned in 2006. The attached decommissioning reports along with the letter from Antkowiak & Mahoney Enterprises, Inc. provide the information you requested. I have also attached my original request submitted on August 25, 2009. If you have any questions or concerns please call me at 203-677-6342. Thank you.

Sincerely,



Carl Noonan  
Associate Director  
Environment, Health & Safety

RECEIVED  
REGION I

2009 NOV 23 AM 11:26



A Bristol-Myers Squibb Company

144311

PHARMACEUTICAL MATERIALS-002

# Bristol-Myers Squibb Pharmaceutical Research Institute

Richard L. Gelb Center for Pharmaceutical Research and Development

5 Research Parkway P.O. Box 5100 Wallingford, CT 06492-7660

Elizabeth Ullrich  
Commercial and R&D Branch  
Division of Nuclear Materials Safety  
Region I  
King of Prussia, Pennsylvania 19406

August 25, 2009

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

Dear Ms. Ullrich,

By this letter I am requesting an amendment to license 06-27843-02, Bristol-Myers Squibb, Wallingford, CT 06492 to comply with the requirements for NARM. I am requesting changes to the BMS site license as described below.

- Add fluorine-18 at 600 mCi in any form to the license
- Add Remesh Padmanabha, Fiona McPhee and Jonathan O'Connell to the license as principal investigators (training/experience attached)
- Increase the site limit for carbon-14 from 3 curies to 5 curies
- Delete chlorine-36, scandium-46, selenium-75, strontium-85, rubidium-86, niobium-95, tin-113, iodine-131, xenon-133, cerium-141, and gadolinium-153 from the license as we do not use these isotopes.
- Delete Margie Goldstein and Hsu-Tso Ho as principal investigators from the license. They are no longer employed with BMS.

If you have any questions or concerns please call me at 203 677-6342, e-mail at [carl.noonan@bms.com](mailto:carl.noonan@bms.com) or write to the above address. Thank you.

Sincerely,



Carl Noonan

Associate Director  
Environment, Health & Safety





**Antkowiak and Mahoney  
Enterprises, Inc.**

36 Dawkins Drive  
East Earl, PA 17519

November 17, 2009

Mr. Carl Noonan  
Bristol Myers Squibb  
Pharmaceutical Research Institute  
5 Research Parkway  
Wallingford, CT 06492-7660

Subject: 2006 Decommissioning of Rooms 111K and 112K

Dear Mr. Noonan:

At your request, I have reviewed the decommissioning survey reports provided by Antkowiak and Mahoney Enterprises, Inc. (AME) in 2006 for the above referenced rooms with respect to the effectiveness of the surveys for the detection of Gd-153. Gd-153 is a low energy gamma emitter whose gamma radiations are also accompanied by electrons of four different energy levels. The lowest energy electron is 21KeV. Therefore, the liquid scintillation counting technique used to analyze the smear samples taken during those surveys would have been more than sufficient to detect these radiations. The minimum detectable activity of the scintillation counter used to analyze the samples was 102 dpm/100 cm<sup>2</sup> for tritium, which has a maximum beta energy of 18 KeV.

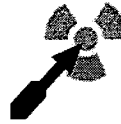
Similarly, the higher energy electrons would be detected by the survey meter (Ludlum Model 12 with model 43-68 probe) used to scan the rooms. While the meter was not calibrated at these energy levels, based on information provided by the manufacturer for detection efficiency at these energy levels, I estimate the scanning MDC to be about 20 percent higher than it was for carbon-14 at the time of the survey. This would make the scan MDC approximately 4,500 dpm/100 cm<sup>2</sup>, which is sufficient to decommission the rooms.

If you have any further questions, please feel free to contact me.

Sincerely,

Antkowiak and Mahoney Enterprises, Inc.

Joel Antkowiak, President



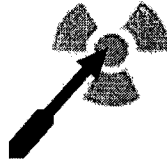
**Antkowiak and Mahoney  
Enterprises, Inc.**

## **DECOMMISSIONING SURVEY**

**Bristol Myers Squibb  
Wallingford, Connecticut**

**Rooms 112K**

Prepared by



**Antkowiak and Mahoney  
Enterprises, Inc.**

**3 Valley Court  
Chester, NY 10918  
845 406-1917**





Antkowiak and Mahoney  
Enterprises, Inc.

## DECOMMISSIONING SURVEY

Bristol Myers Squibb  
Wallingford, Connecticut

Rooms 112K

*Survey Date:*

August 23, 2006

*Surveys performed by:*

Joel Antkowiak  
Robert Mahoney

*Report prepared by:*

Joel Antkowiak

Reviewed and Approved by: Joel Antkowiak Date: \_\_\_\_\_

Digitally signed by Joel Antkowiak  
DN: CN = Joel Antkowiak, C =  
US, O = AME Inc.  
Date: 2006.09.08 15:46:00 -04'00'

---

## **Introduction**

On August 23, 2006 Antkowiak and Mahoney Enterprises, Inc. (AME) conducted decommissioning surveys for Bristol Myers Squibb at the facility in Wallingford, Connecticut. The intent of the survey was to document the radiological conditions in room 112K prior to its release for renovation. This survey report is based on the methods presented in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM provides guidance on determining the number of data points required in each survey unit, the interpretation of survey results, choice of instrumentation, and data reduction,. Values for activity to dose conversions are obtained from Regulatory Guide for Decommissioning (NUREG-1500). Much of the Quality Assurance plan is developed based on an EPA document, "Guidance for the Data Quality Objectives Process". (EPA /600/R-96)

## **Radionuclides of Concern**

Based on information provided by the Radiation Safety Officer for this site, the nuclides that were previously used in these rooms are tritium and carbon-14.

## **Release Criterion**

The TEDE value of 25 mrem/y has been set in Subpart E - Radiological Criteria for License Termination, 10 CFR 20.1402. However, that regulation also invokes the ALARA principle. In NUREG-1500, the statement is made, "...the NRC will consider that the licensee has complied with the ALARA requirement if the licensee can demonstrate that the TEDE to the average member of the critical group does not exceed 3 mrem per year".

This site will be decontaminated such that, at a maximum, the highest Total Effective Dose Equivalent (TEDE) received by an individual occupying the site after release would be 3 millirem. This predicted dose level is based on the building occupancy scenario/model of NUREG/CR5512, which in turn is used to calculate the surface contamination limits presented in Table B-1 of NUREG 1500. Those values for selected nuclides are presented in Table 2, below.

## Residual Radioactivity Limits

Residual radioactivity limits are called Derived Concentration Guideline levels (DCGL). These are values of surface contamination or soil concentrations that will deliver the TEDE over the next 1,000 years, under specific use scenarios.

Radionuclide	Surface Concentration dpm/100cm <sup>2</sup>
H-3	5,290,000
C-14	158,000

**Table 2 - Concentration values which deliver 3 mrem/y under the building occupancy scenario.**

Because the detection of surface contamination with current field instrumentation is essentially a "gross beta" measurement, the value of the most restrictive of the listed radionuclides would normally be selected as the DCGL for this project. However, the footnote to Table B-1 states "For most radionuclides, based on ALARA and best practice, it is not necessary to leave contamination in excess of 5,000 dpm/100cm<sup>2</sup>". Therefore the DCGL for this project will be 5,000 dpm/100cm<sup>2</sup>, with the knowledge that this value would deliver a TEDE well below 3 mrem/y.

## Survey Units

The survey units for this project were all designated as Class 2 per the MARSSIM terminology. Classification was based on the RSO's knowledge of the site. The survey units are as follows:

Room 112K

## Survey Design

The number of data points necessary for a given survey unit in this survey is based on using the one sample Sign test for analysis of the data. This statistical test is appropriate when the contaminant is not present in background, or is present at such a small fraction of the DCGL as to be insignificant. The likely contaminants as identified by Bristol Myers Squibb staff are H-3 and C-14, which fall into this category of radionuclides. In terms of data reduction, this means the survey units are not compared to a reference (i.e. non-impacted) area, but are compared directly to the DCGL. Equation 5-2 is then used to determine the number of data points in each survey unit as follows:

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

We define each "data point" as a measurement location for both an integrated surface activity count (beta and gamma) and wipe sample. These are in addition to the scanning surveys conducted in each survey unit. The contamination limits for this decommissioning project are less than 5,000 dpm/100 cm<sup>2</sup> for total (fixed and removable) radioactivity. The release limits are called Derived Concentration Guideline Levels (DCGL) in the MARSSIM document.

The first step in determining the number of samples is to define the gray region. The gray region is the range of values where the consequences of making a decision error are minor. Typically the lower boundary of the gray region (LBGR) is one half of the DCGL, therefore the shift or delta ( $\Delta$ ) is equal to DCGL-LBGR. For this project:

$$\Delta = 5,000 \text{ dpm}/100\text{cm}^2 - 2,500 \text{ dpm}/100\text{cm}^2$$

The next step is to estimate the standard deviation of the measurements of the contaminants. If results from characterization surveys are not available, it is reasonable to assume a relative standard deviation of 30%.

The DCGL and LBGR are expressed in counts per minute based on 3.2% efficiency for the detection of I-125 and a 126 cm<sup>2</sup> probe. This would make the gray region from 202 cpm to 101 cpm. Thirty percent of the DCGL would give a standard deviation of 60.6. The relative shift would then be:

$$\Delta/\sigma = (202-101)/60.6 = 1.67$$



The value of Sign p as obtained from Table 5.4 in the MARSSIM manual for a relative shift of 1.67 is 0.945201.

The acceptable error rates for this project are 0.10 for a Type I error and 0.05 for a Type II error. That is, there is a 5% chance of releasing a survey unit that, in reality does not meet the release criteria (Type I). Conversely, there is a 90% chance of not releasing a survey unit that truly does meet the release criteria.

The percentiles,  $Z_{1-\alpha}$  and  $Z_{1-\beta}$  represented by these decision errors are 1.645 and 2.326.

Substituting all the values determined above into equation 5.2 gives the number of data points, N as;

$$N = \frac{(1.645 + 2.326)^2}{4(0.945201 - 0.5)^2} = 20$$

The number of data points is increased by 20% to account for missing or unusable data, making

$$N = 20 \times 1.2 = 24$$

As a check on this calculation, the number of data points necessary based on the error rates and relative shift was also determined using Table 5.5 in MARSSIM. That value is 24 data points. Therefore, we obtained at least 24 data points in each survey unit. Not included in that number are biased measurements, obtained in areas where professional judgment would suggest contamination could be encountered.

Any contamination in the areas surveyed is most likely isolated spots. Section 5.5.2.4 of MARSSIM states that the preceding statistical tests are most appropriate for uniformly distributed contamination. Specifically, "systematic measurements and sampling, in conjunction with surface scanning, are used to obtain an adequate assurance level that small areas of elevated radioactivity will satisfy the release criterion." The method employed for this survey includes enough randomly located data points to satisfy the statistical test, as well as scanning and a systematic grid measurements to detect small areas of elevated activity.

## Equipment

This project will use the following instruments or their equivalent for verification of the presence or absence of radioactive contamination.

### *Beta/Gamma Surveying*

Ludlum Model 12 meter with 44-92 gas proportional probe or other appropriate detector designed to detect beta/gamma radiation. This probe has an active surface area of 126 cm<sup>2</sup> with an open area of 100 cm<sup>2</sup>. The floor was surveyed with the same instrument.

Based on the information in MARSSIM Chapter 6, section 6.7, the scanning minimum detectable concentration for these systems can be determined based on the following equation:

$$\text{Scan MDC} = \text{MDCR} / [p^{1/2} * e_i * e_s * (\text{probe area} / 100 \text{ cm}^2)]$$

where

MDCR = minimum detectable count rate

$e_i$  = instrument efficiency

$e_s$  = surface efficiency (typically = 0.5)

$p$  = surveyor efficiency (typically = 0.5)

Assuming a background count rate of 300 cpm, the MDCR for the model 43-68 probes for this project is 512 cpm. This is based on a scan rate of 1 probe width per second, with a requirement of 95% correct detections and an acceptable rate of false positives equal to 60%.

The Scan MDC is then as presented in Table 1, assuming typical values of 0.5 for both surveyor efficiency and surface efficiency, and efficiency for carbon-14 of 0.137.

Instrument	MDCR (cpm)	Scan MDC (dpm/100 cm <sup>2</sup> )
Ludlum Model 12 w/Model 43-68 probe	512	3,737

This is below the site specific DCGL of 5,000 dpm/100 cm<sup>2</sup> for a dose of 3 mRem/year.

*Instrument Scan MDCs*

For scaler readings, the minimum detectable activity for each meter-probe combination is dependent on several factors. These include count time, efficiency for each specific isotope, and the radiological content of each different material surveyed (i.e., ceramic tiles will have a higher background than dry wall). Table 2 shows typical MDAs for these survey systems for carbon-14. The actual MDAs will be determined at the time of the surveys. These are determined using the following formula:

$$MDA = \frac{2.71 + 4.65 \sqrt{Br \times t}}{t \times E \times A/100}$$

where:

MDA = activity in dpm/100 cm<sup>2</sup>

Br = background rate in counts per minute

t = counting time in minutes

E = detector efficiency in counts per disintegration (4π)

A = probe area or area wiped in cm<sup>2</sup>

*Instrument Scaler MDAs*

<b>Instrument</b>	<b>Minimum Detectable Activity</b>
Ludlum Model 12 w/Model 43-68 probe	500-600 dpm/100 cm <sup>2</sup>

Calibration certificates for each meter used are provided.

## Sample Analysis

Sampling for removable activity was conducted by wiping approximately 100 cm<sup>2</sup> area with a two inch diameter dry filter paper. The samples were then placed directly into a scintillation vial in a specific location of a uniquely identified rack or tray. The position numbers are then described on the scintillation counter log sheet. The samples remain in the specified container and position throughout sample preparation and analysis. This reduces the risk of mislabeling or cross contamination among the many samples taken during this project.

The samples were analyzed by setting three energy windows on the liquid scintillation counter. The low energy channel (channel 1) is set for optimal tritium efficiency, the second window (channel 2) is set for optimal carbon-14 efficiency, and the third window (channel 3) is set for higher energy beta emitters. Because of the potential for I-125 contamination, the samples were counted for 5 minutes to reduce the minimum detectable activity for the counter.

Each day samples are analyzed, NIST traceable tritium and carbon-14 sources are also analyzed at the end of each "batch". The daily counts for both tritium and carbon-14 were within the specified ranges. The minimum detectable activity (MDA) for the counter used (Beckman model 5000 TD; serial number 7040372) is as follows:

Channel 1 MDA = 102 dpm

Channel 2 MDA = 46 dpm

Channel 3 MDA = 33 dpm

For purposes of free release of the rooms, the removable activity exhibited in all three channels is combined to determine compliance with the release criteria. The results are presented in Appendix I.

**Statistical Test  
of  
Measurement Results**

Because all samples and readings indicated residual activity below the site specific DCGL, no statistical analysis is required.

## Quality Assurance Plan

Providing quality data for a decommissioning project is based on certain key elements as discussed in EPA guidance documents (EPA 504/G-93/071). These are known as PARRC (precision, accuracy, representativeness, completeness, and comparability) parameters. In addition, the sensitivity of measurements, expressed as the Minimum Detectable Activity (MDA) must be sufficiently low to detect contamination  $\leq 25\%$  of the release criteria (NRC, 1992). The processes for assessing these parameters are discussed below.

### Precision

Precision is a test of how closely one can replicate a measurement. Replicate measurements for total beta contamination will be made by obtaining two one minute counts in sequence at the same location. At least 5% of the total measurements will be duplicated in this manner. To replicate the removable activity analysis a second wipe sample will be obtained as close as possible to the original sample. Both the Item Release Survey Log and the Contamination Measurements Log have a reminder to perform this function on every twentieth line. The formula below will be used to determine the relative percent difference (RPD). One can expect measurements of contaminated areas at this site to be reproduced within  $\pm$  the RPD for each category (fixed and removable) with similar instrumentation and count times.

### Reproducibility of Fixed Location Measurements

$$\text{*Relative Percent Difference} = \frac{\text{Measurement} - \text{Replicate Meas.}}{(\text{Measurement} + \text{Replicate Meas.}) / 2} \times 100\%$$

## **Accuracy**

Accuracy is a test of how close the meters response is to a known value. The beta standard used for this project will be a Carbon-14 windowless source, (serial # E948) with a radioactivity level of 215,880 disintegrations per minute as certified by the National Institute of Standards and Testing. AME recognizes contamination on items may be in a geometry different from the calibration standard. (i.e. different size area, or not uniformly distributed). However, the difference between the meters efficiency for a point source and large areas of contamination is estimated to be less than 6% (NRC, 1995a).

To ensure continued accuracy in the field a check log was established at the beginning of the project. This is accomplished by counting the same source multiple times and plotting the average and two and three sigma values. A daily check of the meters, employing a radioactive source of known quantity, serves as the accuracy check. A source check "jig" will be used to ensure the source and meter are always in the same position relative to one another. The value will be plotted on the Quality Control chart against the average and standard deviations as determined previously. Instruments greater than plus or minus three standard deviations will be removed from use, and tagged "out of service" until repaired.

## **Representativeness**

Representative data would be that data which accurately reflects the environment where the measurement was obtained. One measurement of this parameter is to simply compare the number of times the premise the data is intended to show fails, compared to the number of times the premise is tested. For this project, the premise is elevated count rates with the meter indicates contamination. The equation used is:

$$\text{Representativeness} = (1-F/N) \times 100\%$$

For this project the goal is for data to be 100% representative. To achieve this goal, all hot spots identified during the scanning survey will be verified by a second technician prior to reporting.

## **Completeness**

Completeness is a measure of the amount of valid data obtained compared to the amount that was specified. For the purposes of evaluation, data defined as invalid through a QA review is subtracted from the complete data set to determine the number of valid data points. For this project, completeness greater than 95% is desirable.

## **Comparability**

Comparability is a non quantitative evaluation of the agreement between different types of data sets which should be, intuitively, related to each other. For example, on this project, all metal locations exhibiting elevated fixed beta contamination would also exhibit some removable beta contamination. For firebrick, areas exhibiting elevated beta count rates would show positive beta results for volumetric analysis.

## **Sensitivity**

To determine a meters suitability for a measurement, the minimum detectable activity (MDA) is compared with the project specific release limits. The minimum detectable activity will be calculated using an equation from NUREG-5849, and the average of the daily background and source checks. Meters and count times will be adjusted so that the fixed activity MDA's are less than 20% of the release limits, and removable activity measurements are less than 10% of the release limits. Typical MDA's are presented in the Attachments, which also illustrates the equation used to determine the MDA.

## **Data Reduction**

All data is to be reported at the 95% confidence level. Data will be reviewed by the QA manager and Project Manager before being reported. Basic parameters such as efficiency and background will be evaluated from instrument check logs to determine if the values are within expected ranges. When several transformations of the data is required, a few values will be traced from raw data to reported value to ensure continuity of data, and absence of transcription errors.

All reported data will bear an approval signature. All values of radioactivity (concentration or contamination levels) will be reported with an estimate of the statistical uncertainty. Both values will have the same number of decimal places. Results in disintegration per minute (dpm) will only be reported as a whole number. Surface and removable activity values will be reported in dpm/100 cm<sup>2</sup>. Volumetric analysis will be reported in picocuries per gram (pCi/g). Concentrations will only be reported to one decimal place. The radioactive decay process is assumed to be normally distributed, so the standard deviation will be estimated using standard statistical methods. Values below the calculated minimum detectable activity (MDA) will be reported as "less than" or " $\leq$ " the MDA.

Computer data reduction will have several values confirmed by hand calculations. Rounding off will not change the reported value from the original by more than 20%. For example, if 0.1635 is reported as 0.16, it differs by 2%. However if the value of 0.2 is reported the difference is 22%. All fractional quantities will be reported as a decimal, preceded by a zero. Commas will be used to separate the 1,000s units for values of 10,000 or greater.



## **Understanding the Appendices**

The appendices presenting the results of the removable contamination surveys show diagrams of each area surveyed. On each diagram, if two smears are shown to be taken on one item (drawers, cabinet, etc.), the odd numbered smear was taken on the outside of the item. The inside is represented by the even numbered smear.

The appendices that present the data from the scaler measurements refer to the numbers of the smear on the pictures of Appendix I as appropriate. For example, reading number one taken in Room 310A Main View corresponds to the location represented in the picture for the removable activity. There is a scalar reading for each location noted on the main view of the room. If the number of locations was not sufficient to meet the 20 point minimum on the main view, then additional readings were taken on the additional views for that room. Where readings or samples are indicated on drawers and cabinets, the odd numbered reading/sample was taken on the outside of the item, and the even numbered reading represents the inside. For drawers and cabinets, the inside reading was taken inside the drawer, or on the shelf nearest, the location of the number on the diagram.

## **Survey Results – Final Status**

No removable radioactive contamination was found in the rooms surveyed that exceeded 10% of the site specific DCGL of 5,000 dpm/100 cm<sup>2</sup>.

No direct radioactive contamination was found in the room surveyed after final cleaning of the room.

No samples for removable activity showed levels above the DCGL for this project. In addition, no readings showed activity above the DCGL for this project. Therefore, no statistical analysis is required.

The final survey results for each of the surveyed areas are presented in Appendices I and II. Appendix III consists of copies of the meter calibration certificate.

## References

U.S. Nuclear Regulatory Commission (NRC), NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination*. Draft Report for Comment, June 1992

U.S. Nuclear Regulatory Commission (NRC), NUREG-1500 *Working Draft Regulatory Guide on Release Criteria for Decommissioning*.. Draft Report for Comment, August 1994

U.S. Nuclear Regulatory Commission (NRC), NUREG-1505 *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*. Draft Report for Comment, August 1995

U.S. Nuclear Regulatory Commission (NRC), NUREG-1506 *Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria*. Draft Report for Comment, August 1995

U.S. Nuclear Regulatory Commission (NRC), NUREG-1507 *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. Draft Report for Comment, August 1995

U.S. Nuclear Regulatory Commission (NRC) *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material.*, Policy and Guidance Directive FC 83-23. November 1983

Environmental Protection Agency (EPA) EPA 540/G-93/071 *Data Quality Objectives Process for Superfund*. Washington, DC 1994

## **Appendix I**

### **Diagrams and Smear Results**

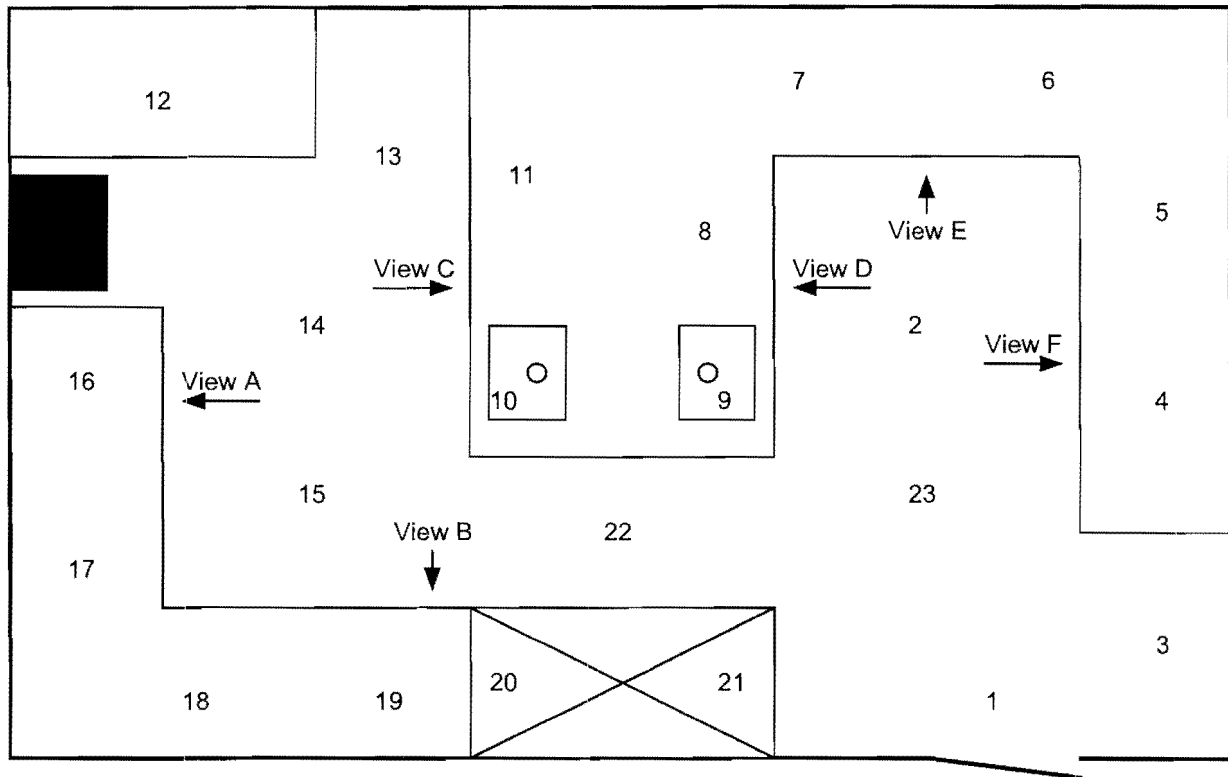
Room: 112K Main View

Name:

Notes: Part 1. Smears 1-20.



Antkowiak and Mahoney  
Enterprises, Inc.



### Smear Analysis Results - Analysis by Liquid Scintillation Counting

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA	16	<MDA	<MDA	<MDA
7	<MDA	<MDA	<MDA	17	<MDA	<MDA	<MDA
8	<MDA	<MDA	<MDA	18	<MDA	<MDA	<MDA
9	<MDA	<MDA	<MDA	19	<MDA	<MDA	<MDA
10	<MDA	<MDA	<MDA	20	<MDA	<MDA	<MDA



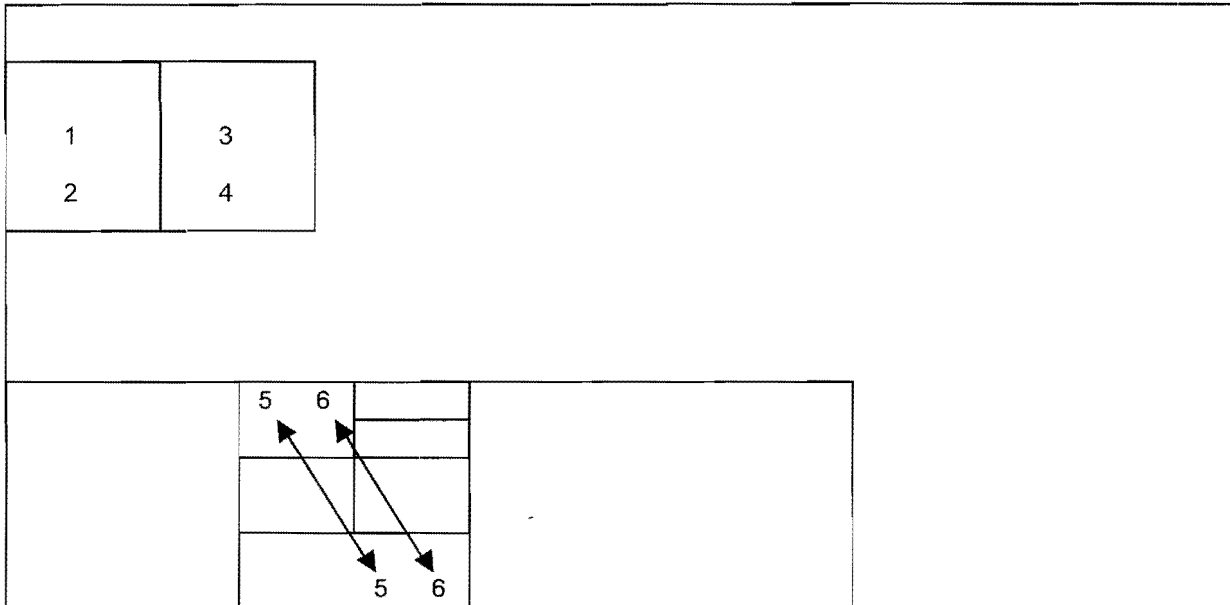
Room: 112K View A

Name:

Notes:



Antkowiak and Mahoney  
Enterprises, Inc.



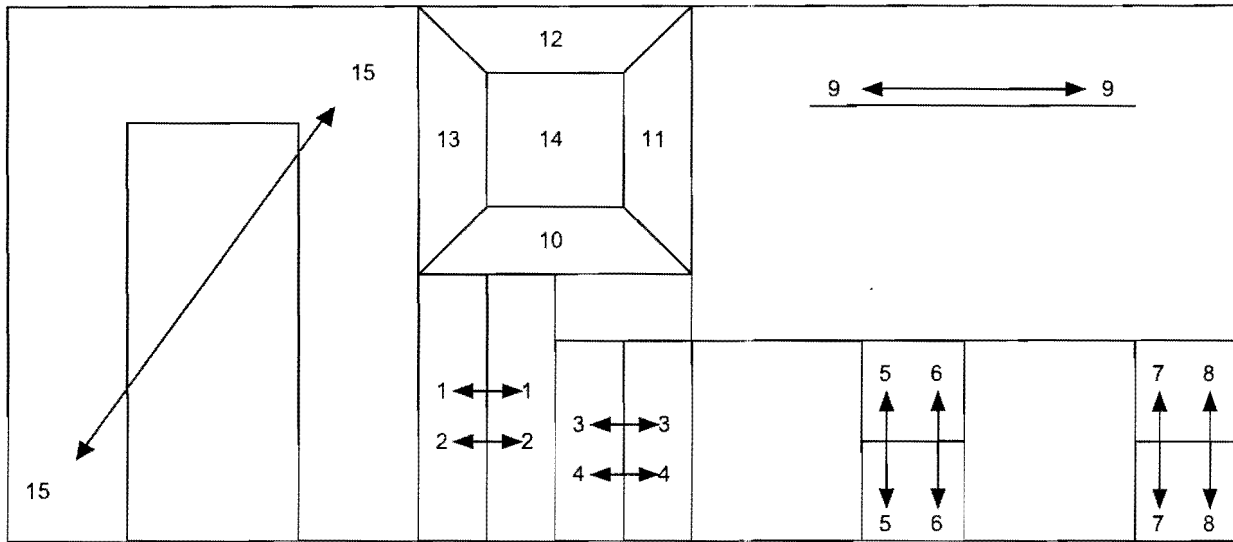
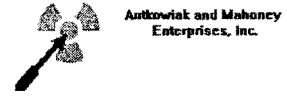
### Smear Analysis Results - Analysis by Liquid Scintillation Counting

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA				
2	<MDA	<MDA	<MDA				
3	<MDA	<MDA	<MDA				
4	<MDA	<MDA	<MDA				
5	<MDA	<MDA	<MDA				
6	<MDA	<MDA	<MDA				

Room: 112K View B

Name:

Notes:



**Smear Analysis Results - Analysis by Liquid Scintillation Counting**

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA				
7	<MDA	<MDA	<MDA				
8	<MDA	<MDA	<MDA				
9	<MDA	<MDA	<MDA				
10	<MDA	<MDA	<MDA				

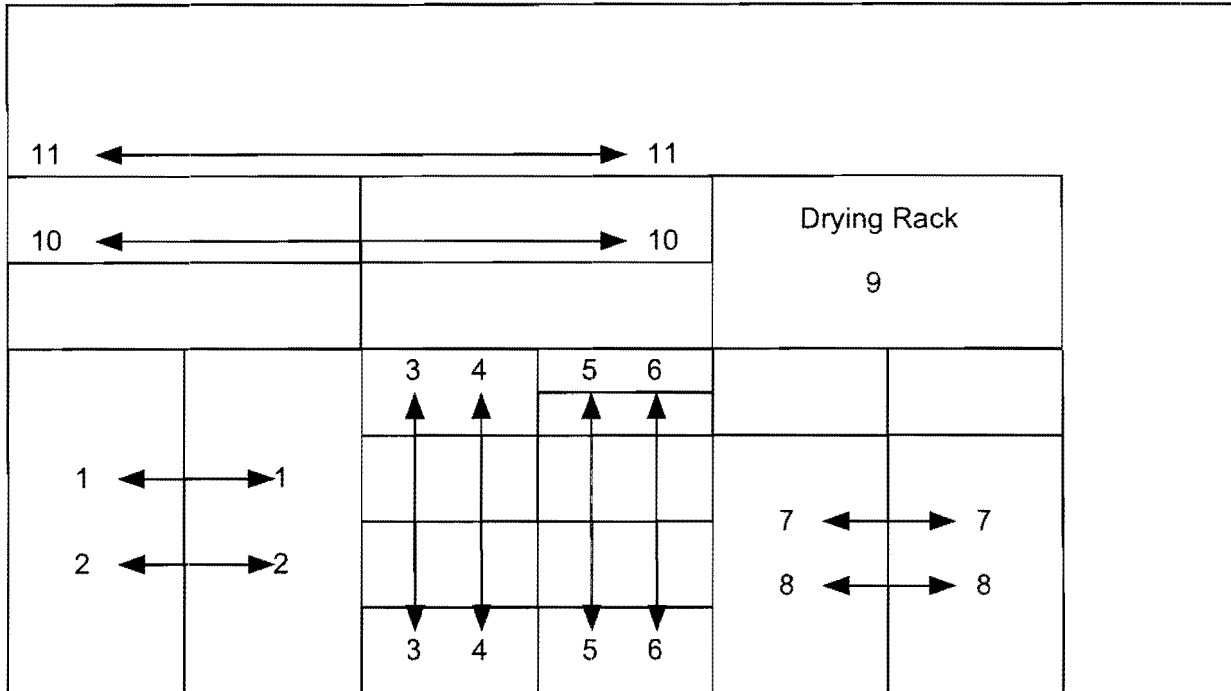
Room: 112K View C

Name:

Notes:



Antkowiak and Mahoney  
Enterprises, Inc.



**Smear Analysis Results - Analysis by Liquid Scintillation Counting**

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA				
3	<MDA	<MDA	<MDA				
4	<MDA	<MDA	<MDA				
5	<MDA	<MDA	<MDA				
6	<MDA	<MDA	<MDA				
7	<MDA	<MDA	<MDA				
8	<MDA	<MDA	<MDA				
9	<MDA	<MDA	<MDA				
10	<MDA	<MDA	<MDA				





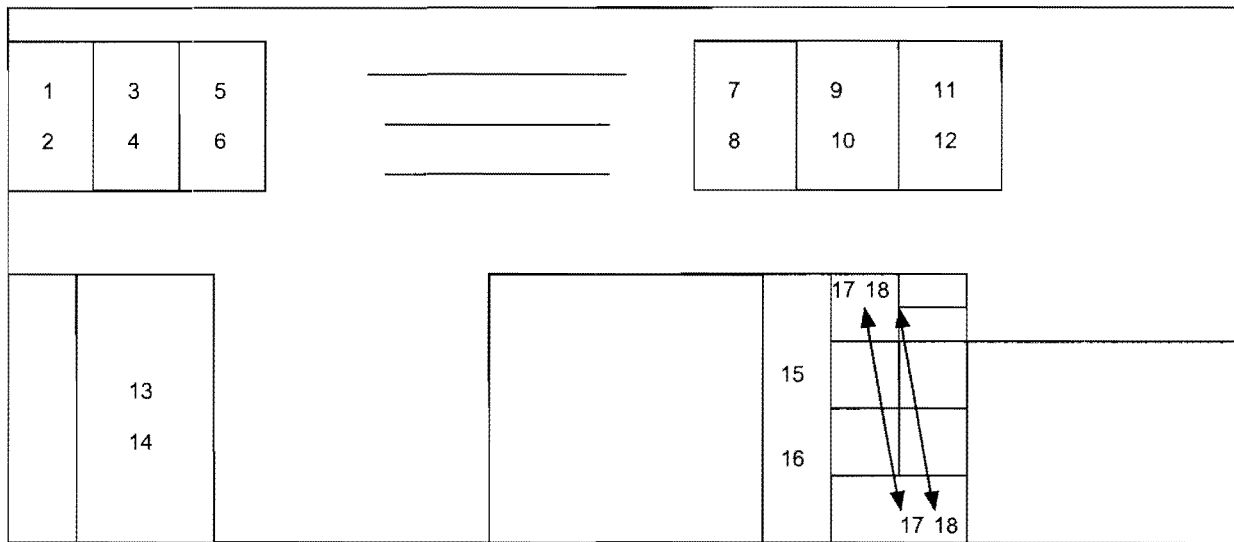
Room: 112K View E

Name:

Notes:



Antkowiak and Mahoney  
Enterprises, Inc.



**Smear Analysis Results - Analysis by Liquid Scintillation Counting**

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA	16	<MDA	<MDA	<MDA
7	<MDA	<MDA	<MDA	17	<MDA	<MDA	<MDA
8	<MDA	<MDA	<MDA	18	<MDA	<MDA	<MDA
9	<MDA	<MDA	<MDA				
10	<MDA	<MDA	<MDA				



## **Appendix II**

### **Scalar Measurements Results**

# Scalar Measurements - Room 112K Main View

Ludlum Model 12, serial no. 193772

Limiting MDA (C-14) = 536 dpm/100 cm<sup>2</sup>

Location	Smear Number	Reading (cpm)	Activity (dpm/100 cm <sup>2</sup> )
112K Main View	1	240	<MDA
112K Main View	2	191	<MDA
112K Main View	3	249	<MDA
112K Main View	4	257	<MDA
112K Main View	5	237	<MDA
112K Main View	6	263	<MDA
112K Main View	7	224	<MDA
112K Main View	8	311	<MDA
112K Main View	9	238	<MDA
112K Main View	10	243	<MDA
112K Main View	11	284	<MDA
112K Main View	12	221	<MDA
112K Main View	13	227	<MDA
112K Main View	14	217	<MDA
112K Main View	15	225	<MDA
112K Main View	16	212	<MDA
112K Main View	17	215	<MDA
112K Main View	18	252	<MDA
112K Main View	19	301	<MDA
112K Main View	20	229	<MDA
112K Main View	21	237	<MDA
112K Main View	22	215	<MDA
112K Main View	23	222	<MDA

## **Appendix III**

### **Calibration Certificates**

# Certificate of Calibration



Antkowiak and Mahoney  
Enterprises, Inc.

3 Valley Court  
Chester, NY 10918

Ri

**Company** Antkowiak and Mahoney Enterprises, Inc.      **Certificate Number:** 1327

**Manufacturer** Ludlum

**Model** 12

**Serial Number** 196772

**Probe Model** 43-68

**Serial Number** AME4368

**Calibration Type** Linearity and Efficiency Check      **Calibration Geometry** 2 Pi

**Battery Check** Pass      **High Voltage** 1650 v      **Background Reading** 160 cpm

**Pulse Generator:** Ludlum Model 500, serial number 189500 , calibrated September 13, 2005

Scale	Calibration Point (cpm)	As Found (cpm)	Meter Reading (cpm)	Correction Factor
x100	340,000	360,000	340,000	N/A
x100	170,000	180,000	170,000	N/A
x10	34,000	34,000	34,000	N/A
x10	17,000	17,000	17,000	N/A
x1	3,400	3,600	3,300	N/A
x1	1,700	2,100	1,800	N/A
x0.1	340	400	310	N/A
x0.1	170	280	195	N/A

Source Isotope	Source Activity	Source Serial Number	Source Reading	Efficiency
Carbon-14	1.793 kBq	1010-66-2	11,000	0.101
Silicon-32	1.870 kBq	1010-66-3	34,000	0.303

Calibrated by Joel Antkowiak

Calibration Date July 19, 2006

Approved by Joel Antkowiak

Digitally signed by Joel Antkowiak  
DN: CN = Joel Antkowiak, C = US, O = AME Inc  
Date: 2006.09.08 15:46:09 -04'00'

Approval Date July 19, 2006

Comments



**Antkowiak and Mahoney  
Enterprises, Inc.**

## **DECOMMISSIONING SURVEYS**

**Bristol Myers Squibb  
Wallingford, Connecticut**

**Rooms 111K**

Prepared by



**Antkowiak and Mahoney  
Enterprises, Inc.**

**3 Valley Court  
Chester, NY 10918  
845 406-1917**

---





Antkowiak and Mahoney  
Enterprises, Inc.

## DECOMMISSIONING SURVEYS

Bristol Myers Squibb  
Wallingford, Connecticut

Rooms 111K

*Survey Date:*

July 19, 2006

*Surveys performed by:*

Joel Antkowiak  
Robert Mahoney

*Report prepared by:*

Joel Antkowiak

Reviewed and Approved by: Joel Antkowiak Date: \_\_\_\_\_

Digitally signed by Joel Antkowiak  
DN: CN = Joel Antkowiak, C =  
US, O = AME Inc,  
Date: 2006.08.03 15:19:11 -  
04'00'

## **Introduction**

On July 19, 2006 Antkowiak and Mahoney Enterprises, Inc. (AME) conducted decommissioning surveys for Bristol Myers Squibb at the facility in Wallingford, Connecticut. The intent of the survey was to document the radiological conditions in room 111K prior to its release for renovation. This survey report is based on the methods presented in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM provides guidance on determining the number of data points required in each survey unit, the interpretation of survey results, choice of instrumentation, and data reduction. Values for activity to dose conversions are obtained from Regulatory Guide for Decommissioning (NUREG-1500). Much of the Quality Assurance plan is developed based on an EPA document, "Guidance for the Data Quality Objectives Process". (EPA /600/R-96)

## **Radionuclides of Concern**

Based on information provided by the Radiation Safety Officer for this site, the nuclides that were previously used in these rooms are tritium and carbon-14.

## **Release Criterion**

The TEDE value of 25 mrem/y has been set in Subpart E - Radiological Criteria for License Termination, 10 CFR 20.1402. However, that regulation also invokes the ALARA principle. In NUREG-1500, the statement is made, "...the NRC will consider that the licensee has complied with the ALARA requirement if the licensee can demonstrate that the TEDE to the average member of the critical group does not exceed 3 mrem per year".

This site will be decontaminated such that, at a maximum, the highest Total Effective Dose Equivalent (TEDE) received by an individual occupying the site after release would be 3 millirem. This predicted dose level is based on the building occupancy scenario/model of NUREG/CR5512, which in turn is used to calculate the surface contamination limits presented in Table B-1 of NUREG 1500. Those values for selected nuclides are presented in Table 2, below.

## Residual Radioactivity Limits

Residual radioactivity limits are called Derived Concentration Guideline levels (DCGL). These are values of surface contamination or soil concentrations that will deliver the TEDE over the next 1,000 years, under specific use scenarios.

Radionuclide	Surface Concentration dpm/100cm <sup>2</sup>
H-3	5,290,000
C-14	158,000

**Table 2 - Concentration values which deliver 3 mrem/y under the building occupancy scenario.**

Because the detection of surface contamination with current field instrumentation is essentially a “gross beta” measurement, the value of the most restrictive of the listed radionuclides would normally be selected as the DCGL for this project. However, the footnote to Table B-1 states “For most radionuclides, based on ALARA and best practice, it is not necessary to leave contamination in excess of 5,000 dpm/100cm<sup>2</sup> “. Therefore the DCGL for this project will be 5,000 dpm/100cm<sup>2</sup>, with the knowledge that this value would deliver a TEDE well below 3 mrem/y.

## Survey Units

The survey units for this project were all designated as Class 2 per the MARSSIM terminology. Classification was based on the RSO's knowledge of the site. The survey units are as follows:

Room 111K

## Survey Design

The number of data points necessary for a given survey unit in this survey is based on using the one sample Sign test for analysis of the data. This statistical test is appropriate when the contaminant is not present in background, or is present at such a small fraction of the DCGL as to be insignificant. The likely contaminants as identified by Bristol Myers Squibb staff are H-3 and C-14, which fall into this category of radionuclides. In terms of data reduction, this means the survey units are not compared to a reference (i.e. non-impacted) area, but are compared directly to the DCGL. Equation 5-2 is then used to determine the number of data points in each survey unit as follows:

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

We define each "data point" as a measurement location for both an integrated surface activity count (beta and gamma) and wipe sample. These are in addition to the scanning surveys conducted in each survey unit. The contamination limits for this decommissioning project are less than 5,000 dpm/100 cm<sup>2</sup> for total (fixed and removable) radioactivity. The release limits are called Derived Concentration Guideline Levels (DCGL) in the MARSSIM document.

The first step in determining the number of samples is to define the gray region. The gray region is the range of values where the consequences of making a decision error are minor. Typically the lower boundary of the gray region (LBGR) is one half of the DCGL, therefore the shift or delta ( $\Delta$ ) is equal to DCGL-LBGR. For this project:

$$\Delta = 5,000 \text{ dpm}/100\text{cm}^2 - 2,500 \text{ dpm}/100\text{cm}^2$$

The next step is to estimate the standard deviation of the measurements of the contaminants. If results from characterization surveys are not available, it is reasonable to assume a relative standard deviation of 30%.

The DCGL and LBGR are expressed in counts per minute based on 3.2% efficiency for the detection of I-125 and a 126 cm<sup>2</sup> probe. This would make the gray region from 202 cpm to 101 cpm. Thirty percent of the DCGL would give a standard deviation of 60.6. The relative shift would then be:

$$\Delta/\sigma = (202-101)/60.6 = 1.67$$

The value of Sign p as obtained from Table 5.4 in the MARSSIM manual for a relative shift of 1.67 is 0.945201.

The acceptable error rates for this project are 0.10 for a Type I error and 0.05 for a Type II error. That is, there is a 5% chance of releasing a survey unit that, in reality does not meet the release criteria (Type I). Conversely, there is a 90% chance of not releasing a survey unit that truly does meet the release criteria.

The percentiles,  $Z_{1-\alpha}$  and  $Z_{1-\beta}$  represented by these decision errors are 1.645 and 2.326.

Substituting all the values determined above into equation 5.2 gives the number of data points, N as;

$$N = \frac{(1.645 + 2.326)^2}{4 (0.945201 - 0.5)^2} = 20$$

The number of data points is increased by 20% to account for missing or unusable data, making

$$N = 20 \times 1.2 = 24$$

As a check on this calculation, the number of data points necessary based on the error rates and relative shift was also determined using Table 5.5 in MARSSIM. That value is 24 data points. Therefore, we obtained at least 24 data points in each survey unit. Not included in that number are biased measurements, obtained in areas where professional judgment would suggest contamination could be encountered.

Any contamination in the areas surveyed is most likely isolated spots. Section 5.5.2.4 of MARSSIM states that the preceding statistical tests are most appropriate for uniformly distributed contamination. Specifically, "systematic measurements and sampling, in conjunction with surface scanning, are used to obtain an adequate assurance level that small areas of elevated radioactivity will satisfy the release criterion." The method employed for this survey includes enough randomly located data points to satisfy the statistical test, as well as scanning and a systematic grid measurements to detect small areas of elevated activity.

## Equipment

This project will use the following instruments or their equivalent for verification of the presence or absence of radioactive contamination.

### *Beta/Gamma Surveying*

Ludlum Model 12 meter with 44-92 gas proportional probe or other appropriate detector designed to detect beta/gamma radiation. This probe has an active surface area of 126 cm<sup>2</sup> with an open area of 100 cm<sup>2</sup>. The floor was surveyed with the same instrument.

Based on the information in MARSSIM Chapter 6, section 6.7, the scanning minimum detectable concentration for these systems can be determined based on the following equation:

$$\text{Scan MDC} = \text{MDCR} / [p^{1/2} * e_i * e_s * (\text{probe area} / 100 \text{ cm}^2)]$$

where

MDCR = minimum detectable count rate

e<sub>i</sub> = instrument efficiency

e<sub>s</sub> = surface efficiency (typically = 0.5)

p = surveyor efficiency (typically = 0.5)

Assuming a background count rate of 300 cpm, the MDCR for the model 43-68 probes for this project is 512 cpm. This is based on a scan rate of 1 probe width per second, with a requirement of 95% correct detections and an acceptable rate of false positives equal to 60%.

The Scan MDC is then as presented in Table 1, assuming typical values of 0.5 for both surveyor efficiency and surface efficiency, and efficiency for carbon-14 of 0.137.

<b>Instrument</b>	<b>MDCR (cpm)</b>	<b>Scan MDC (dpm/100 cm<sup>2</sup>)</b>
Ludlum Model 12 w/Model 43-68 probe	512	3,737

This is below the site specific DCGLof 5,000 dpm/100 cm<sup>2</sup> for a dose of 3 mRem/year.

*Instrument Scan MDCs*

For scaler readings, the minimum detectable activity for each meter-probe combination is dependent on several factors. These include count time, efficiency for each specific isotope, and the radiological content of each different material surveyed (i.e., ceramic tiles will have a higher background than dry wall). Table 2 shows typical MDAs for these survey systems for carbon-14. The actual MDAs will be determined at the time of the surveys. These are determined using the following formula:

$$MDA = \frac{2.71 + 4.65 \sqrt{Br \times t}}{t \times E \times A/100}$$

where:

MDA = activity in dpm/100 cm<sup>2</sup>

Br = background rate in counts per minute

t = counting time in minutes

E = detector efficiency in counts per disintegration (4π)

A = probe area or area wiped in cm<sup>2</sup>

*Instrument Scaler MDAs*

<b>Instrument</b>	<b>Minimum Detectable Activity</b>
Ludlum Model 12 w/Model 43-68 probe	500-600 dpm/100 cm <sup>2</sup>

Calibration certificates for each meter used are provided.

## Sample Analysis

Sampling for removable activity was conducted by wiping approximately 100 cm<sup>2</sup> area with a two inch diameter dry filter paper. The samples were then placed directly into a scintillation vial in a specific location of a uniquely identified rack or tray. The position numbers are then described on the scintillation counter log sheet. The samples remain in the specified container and position throughout sample preparation and analysis. This reduces the risk of mislabeling or cross contamination among the many samples taken during this project.

The samples were analyzed by setting three energy windows on the liquid scintillation counter. The low energy channel (channel 1) is set for optimal tritium efficiency, the second window (channel 2) is set for optimal carbon-14 efficiency, and the third window (channel 3) is set for higher energy beta emitters. Because of the potential for I-125 contamination, the samples were counted for 5 minutes to reduce the minimum detectable activity for the counter.

Each day samples are analyzed, NIST traceable tritium and carbon-14 sources are also analyzed at the end of each "batch". The daily counts for both tritium and carbon-14 were within the specified ranges. The minimum detectable activity (MDA) for the counter used (Beckman model 5000 TD; serial number 7040372) is as follows:

Channel 1 MDA = 102 dpm

Channel 2 MDA = 46 dpm

Channel 3 MDA = 33 dpm

For purposes of free release of the rooms, the removable activity exhibited in all three channels is combined to determine compliance with the release criteria. The results are presented in Appendix I.



**Statistical Test  
of  
Measurement Results**

Because all samples and readings indicated residual activity below the site specific DCGL, no statistical analysis is required.

## Quality Assurance Plan

Providing quality data for a decommissioning project is based on certain key elements as discussed in EPA guidance documents (EPA 504/G-93/071). These are known as PARRC (precision, accuracy, representativeness, completeness, and comparability) parameters. In addition, the sensitivity of measurements, expressed as the Minimum Detectable Activity (MDA) must be sufficiently low to detect contamination  $\leq 25\%$  of the release criteria (NRC, 1992). The processes for assessing these parameters are discussed below.

### Precision

Precision is a test of how closely one can replicate a measurement. Replicate measurements for total beta contamination will be made by obtaining two one minute counts in sequence at the same location. At least 5% of the total measurements will be duplicated in this manner. To replicate the removable activity analysis a second wipe sample will be obtained as close as possible to the original sample. Both the Item Release Survey Log and the Contamination Measurements Log have a reminder to perform this function on every twentieth line. The formula below will be used to determine the relative percent difference (RPD). One can expect measurements of contaminated areas at this site to be reproduced within  $\pm$  the RPD for each category (fixed and removable) with similar instrumentation and count times.

### Reproducibility of Fixed Location Measurements

$$\text{*Relative Percent Difference} = \frac{\text{Measurement} - \text{Replicate Meas.}}{(\text{Measurement} + \text{Replicate Meas.}) / 2} \times 100\%$$

## **Accuracy**

Accuracy is a test of how close the meters response is to a known value. The beta standard used for this project will be a Carbon-14 windowless source, (serial # E948) with a radioactivity level of 215,880 disintegrations per minute as certified by the National Institute of Standards and Testing. AME recognizes contamination on items may be in a geometry different from the calibration standard. (i.e. different size area, or not uniformly distributed). However, the difference between the meters efficiency for a point source and large areas of contamination is estimated to be less than 6% (NRC, 1995a).

To ensure continued accuracy in the field a check log was established at the beginning of the project. This is accomplished by counting the same source multiple times and plotting the average and two and three sigma values. A daily check of the meters, employing a radioactive source of known quantity, serves as the accuracy check. A source check "jig" will be used to ensure the source and meter are always in the same position relative to one another. The value will be plotted on the Quality Control chart against the average and standard deviations as determined previously. Instruments greater than plus or minus three standard deviations will be removed from use, and tagged "out of service" until repaired.

## **Representativeness**

Representative data would be that data which accurately reflects the environment where the measurement was obtained. One measurement of this parameter is to simply compare the number of times the premise the data is intended to show fails, compared to the number of times the premise is tested. For this project, the premise is elevated count rates with the meter indicates contamination. The equation used is:

$$\text{Representativeness} = (1 - F/N) \times 100\%$$

For this project the goal is for data to be 100% representative. To achieve this goal, all hot spots identified during the scanning survey will be verified by a second technician prior to reporting.

## **Completeness**

Completeness is a measure of the amount of valid data obtained compared to the amount that was specified. For the purposes of evaluation, data defined as invalid through a QA review is subtracted from the complete data set to determine the number of valid data points. For this project, completeness greater than 95% is desirable.

## **Comparability**

Comparability is a non quantitative evaluation of the agreement between different types of data sets which should be, intuitively, related to each other. For example, on this project, all metal locations exhibiting elevated fixed beta contamination would also exhibit some removable beta contamination. For firebrick, areas exhibiting elevated beta count rates would show positive beta results for volumetric analysis.

## **Sensitivity**

To determine a meters suitability for a measurement, the minimum detectable activity (MDA) is compared with the project specific release limits. The minimum detectable activity will be calculated using an equation from NUREG-5849, and the average of the daily background and source checks. Meters and count times will be adjusted so that the fixed activity MDA's are less than 20% of the release limits, and removable activity measurements are less than 10% of the release limits. Typical MDA's are presented in the Attachments, which also illustrates the equation used to determine the MDA.

## **Data Reduction**

All data is to be reported at the 95% confidence level. Data will be reviewed by the QA manager and Project Manager before being reported. Basic parameters such as efficiency and background will be evaluated from instrument check logs to determine if the values are within expected ranges. When several transformations of the data is required, a few values will be traced from raw data to reported value to ensure continuity of data, and absence of transcription errors.

All reported data will bear an approval signature. All values of radioactivity (concentration or contamination levels) will be reported with an estimate of the statistical uncertainty. Both values will have the same number of decimal places. Results in disintegration per minute (dpm) will only be reported as a whole number. Surface and removable activity values will be reported in dpm/100 cm<sup>2</sup>. Volumetric analysis will be reported in picocuries per gram (pCi/g). Concentrations will only be reported to one decimal place. The radioactive decay process is assumed to be normally distributed, so the standard deviation will be estimated using standard statistical methods. Values below the calculated minimum detectable activity (MDA) will be reported as "less than" or " $\leq$ " the MDA.

Computer data reduction will have several values confirmed by hand calculations. Rounding off will not change the reported value from the original by more than 20%. For example, if 0.1635 is reported as 0.16, it differs by 2%. However if the value of 0.2 is reported the difference is 22%. All fractional quantities will be reported as a decimal, preceded by a zero. Commas will be used to separate the 1,000s units for values of 10,000 or greater.

## **Understanding the Appendices**

The appendices presenting the results of the removable contamination surveys show diagrams of each area surveyed. On each diagram, if two smears are shown to be taken on one item (drawers, cabinet, etc.), the odd numbered smear was taken on the outside of the item. The inside is represented by the even numbered smear.

The appendices that present the data from the scaler measurements refer to the numbers of the smear on the pictures of Appendix I as appropriate. For example, reading number one taken in Room 310A Main View corresponds to the location represented in the picture for the removable activity. There is a scalar reading for each location noted on the main view of the room. If the number of locations was not sufficient to meet the 20 point minimum on the main view, then additional readings were taken on the additional views for that room. Where readings or samples are indicated on drawers and cabinets, the odd numbered reading/sample was taken on the outside of the item, and the even numbered reading represents the inside. For drawers and cabinets, the inside reading was taken inside the drawer, or on the shelf nearest, the location of the number on the diagram.

### **Survey Results – Final Status**

No removable radioactive contamination was found in the rooms surveyed that exceeded 10% of the site specific DCGL of 5,000 dpm/100 cm<sup>2</sup>.

No direct radioactive contamination was found in the room surveyed after final cleaning of the room.

No samples for removable activity showed levels above the DCGL for this project. In addition, no readings showed activity above the DCGL for this project. Therefore, no statistical analysis is required.

The final survey results for each of the surveyed areas are presented in Appendices I and II. Appendix III consists of copies of the meter calibration certificate.

## References

- U.S. Nuclear Regulatory Commission (NRC), NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination*. Draft Report for Comment, June 1992
- U.S. Nuclear Regulatory Commission (NRC), NUREG-1500 *Working Draft Regulatory Guide on Release Criteria for Decommissioning*.. Draft Report for Comment, August 1994
- U.S. Nuclear Regulatory Commission (NRC), NUREG-1505 *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*. Draft Report for Comment, August 1995
- U.S. Nuclear Regulatory Commission (NRC), NUREG-1506 *Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria*. Draft Report for Comment, August 1995
- U.S. Nuclear Regulatory Commission (NRC), NUREG-1507 *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. Draft Report for Comment, August 1995
- U.S. Nuclear Regulatory Commission (NRC) *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material.*, Policy and Guidance Directive FC 83-23. November 1983
- Environmental Protection Agency (EPA) EPA 540/G-93/071 *Data Quality Objectives Process for Superfund*. Washington, DC 1994

## **Appendix I**

### **Diagrams and Smear Results**

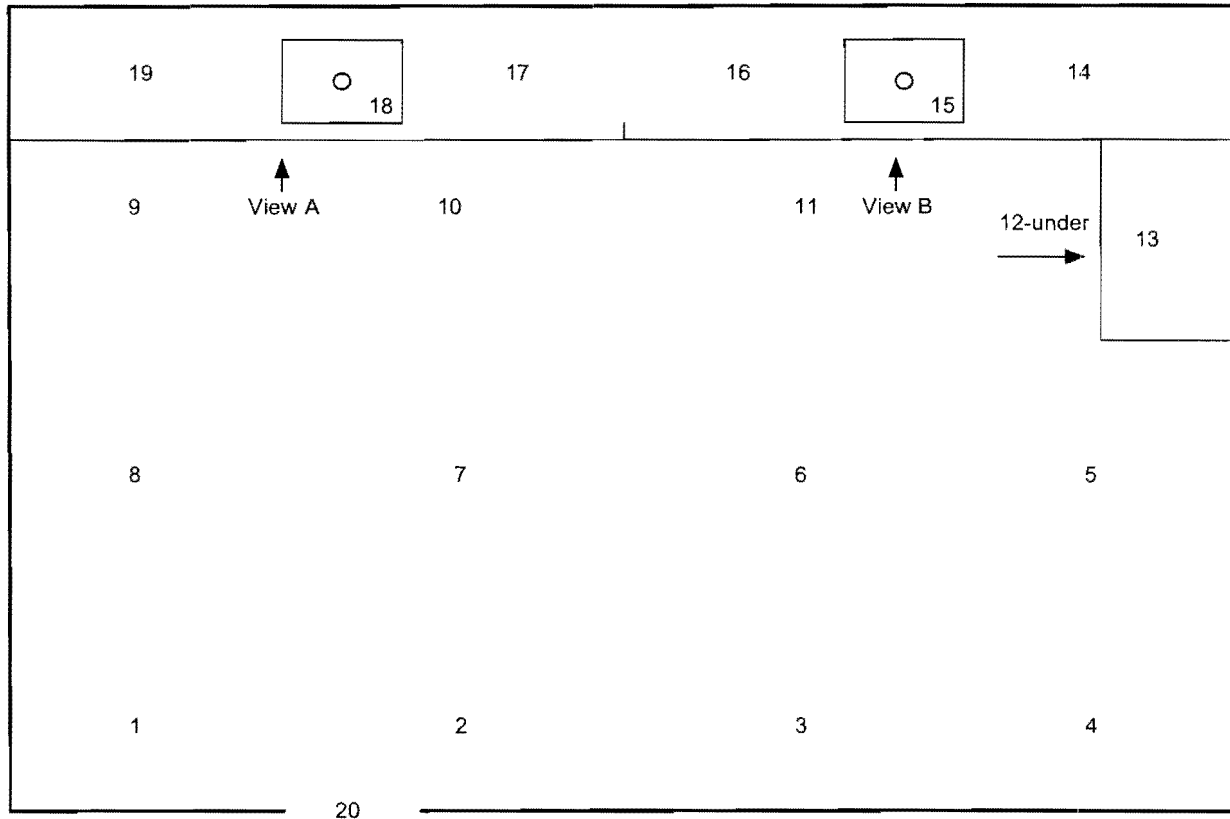
Room: 111K Main View

Name:

Notes:



Antkowiak and Mahoney  
Enterprises, Inc.



### Smear Analysis Results - Analysis by Liquid Scintillation Counting

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA	16	<MDA	<MDA	<MDA
7	<MDA	<MDA	<MDA	17	<MDA	<MDA	<MDA
8	<MDA	<MDA	<MDA	18	<MDA	<MDA	<MDA
9	<MDA	<MDA	<MDA	19	<MDA	<MDA	<MDA
10	<MDA	<MDA	<MDA	20	<MDA	<MDA	<MDA



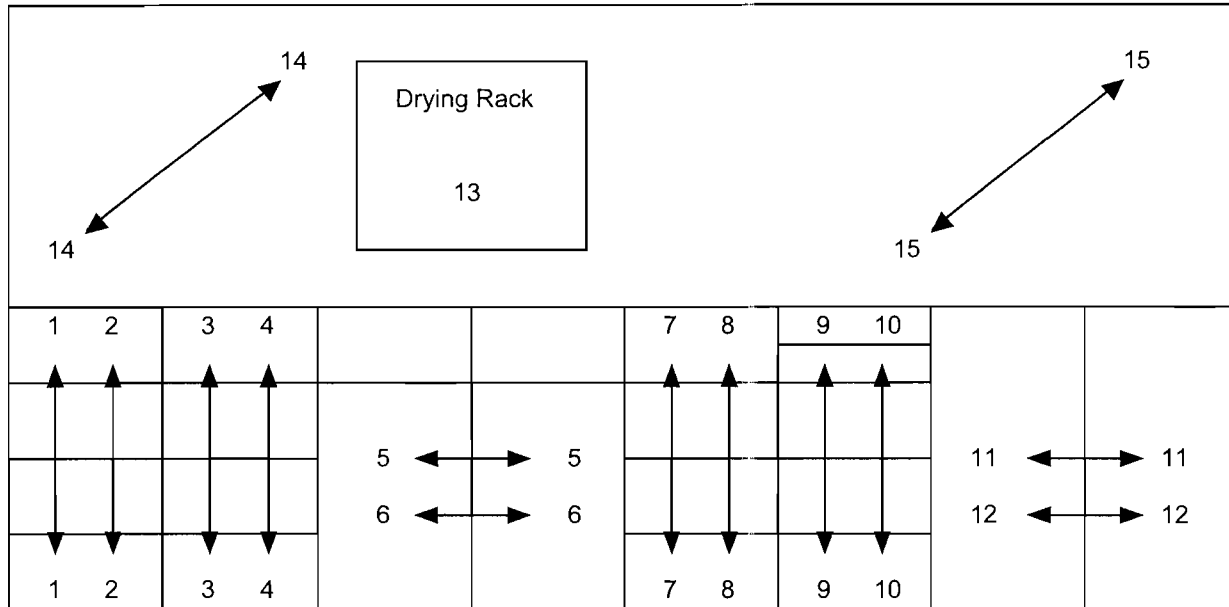
Room: 111K View A

Name:

Notes:



Antkowiak and Mahoney  
Enterprises, Inc.



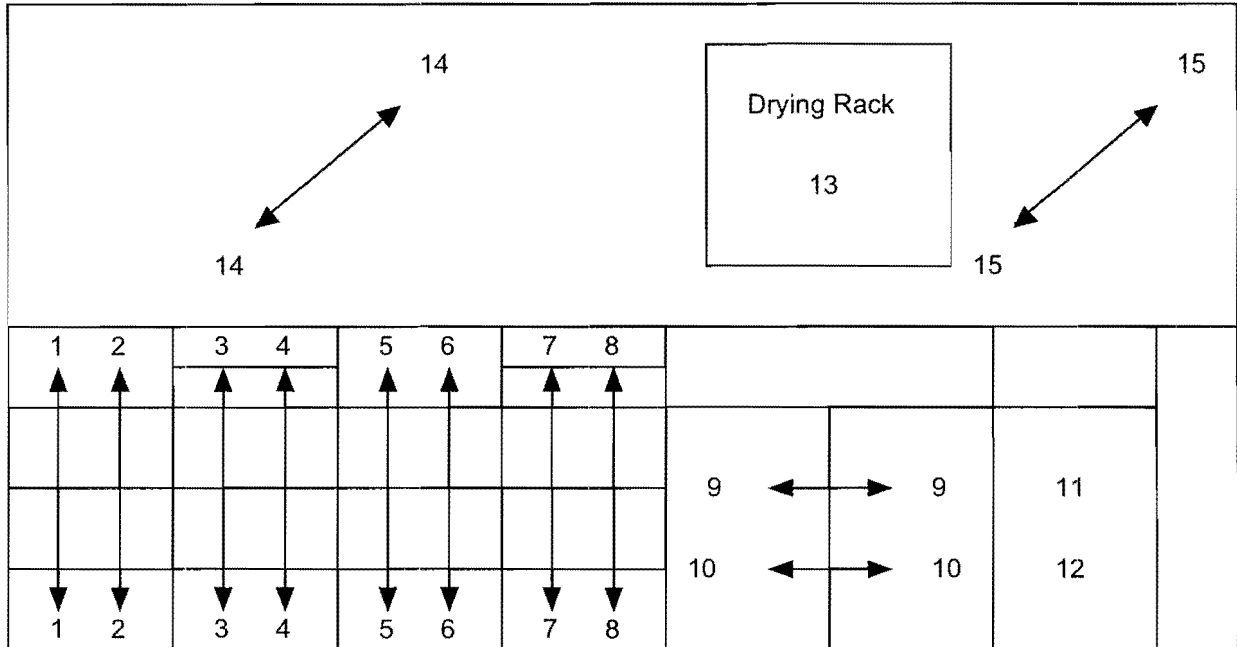
**Smear Analysis Results - Analysis by Liquid Scintillation Counting**

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA				
7	<MDA	<MDA	<MDA				
8	<MDA	<MDA	<MDA				
9	<MDA	<MDA	<MDA				
10	<MDA	<MDA	<MDA				

Room: 111K View B

Name:

Notes:



**Smear Analysis Results - Analysis by Liquid Scintillation Counting**

Smear ID	Channel 1	Channel 2	Channel 3	Smear ID	Channel 1	Channel 2	Channel 3
1	<MDA	<MDA	<MDA	11	<MDA	<MDA	<MDA
2	<MDA	<MDA	<MDA	12	<MDA	<MDA	<MDA
3	<MDA	<MDA	<MDA	13	<MDA	<MDA	<MDA
4	<MDA	<MDA	<MDA	14	<MDA	<MDA	<MDA
5	<MDA	<MDA	<MDA	15	<MDA	<MDA	<MDA
6	<MDA	<MDA	<MDA				
7	<MDA	<MDA	<MDA				
8	<MDA	<MDA	<MDA				
9	<MDA	<MDA	<MDA				
10	<MDA	<MDA	<MDA				

## **Appendix II**

### **Scalar Measurements Results**

## Scalar Measurements – Room 111K Main View

Ludlum Model 12, serial no. 193772

Limiting MDA (C-14) = 578 dpm/100 cm<sup>2</sup>

Location	Smear Number	Reading (cpm)	Activity (dpm/100 cm <sup>2</sup> )
111K Main View	1	300	<MDA
111K Main View	2	281	<MDA
111K Main View	3	306	<MDA
111K Main View	4	295	<MDA
111K Main View	5	299	<MDA
111K Main View	6	311	<MDA
111K Main View	7	288	<MDA
111K Main View	8	276	<MDA
111K Main View	9	291	<MDA
111K Main View	10	303	<MDA
111K Main View	11	312	<MDA
111K Main View	12	303	<MDA
111K Main View	13	309	<MDA
111K Main View	14	325	<MDA
111K Main View	15	225	<MDA
111K Main View	16	303	<MDA
111K Main View	17	356	<MDA
111K Main View	18	262	<MDA
111K Main View	19	348	<MDA
111K Main View	20	258	<MDA

## **Appendix III**

### **Calibration Certificates**

# Certificate of Calibration



Antkowiak and Mahoney  
Enterprises, Inc.

**Company** Antkowiak & Mahoney Enterprises

**Certificate Number:** AMEIH 006

**Manufacturer** Ludlum

**Model** 12

**Serial Number** 193772

**Probe Model** 43-68

**Serial Number** PR178433

**Calibration Type** Linearity and Efficiency Check

**Calibration Geometry** 2 Pi

**Battery Check** Pass

**High Voltage** 1600 v

**Background Reading** 200 cpm

**Pulse Generator:** Ludlum Model 500, serial number 174393, calibrated 7/30/04

Scale	Calibration Point (cpm)	As Found (cpm)	Meter Reading (cpm)	Correction Factor
x1000	340,000	320,000	340,000	N/A
x1000	170,000	160,000	170,000	N/A
x100	34,000	34,000	34,000	N/A
x100	17,000	17,000	17,000	N/A
x10	3,400	3,200	3,300	N/A
x10	1,700	1,600	1,700	N/A
x1	340	250	340	N/A
x1	170	100	170	N/A

Source Isotope	Source Activity	Source Serial Number	Source Reading	Efficiency
Carbon-14	1.793 kBq	1010-66-2	14,000	0.128
Silicon-32	1.870 kBq	1010-66-3	34,000	0.303

**Calibrated by** Joel Antkowiak

**Calibration Date** July 22, 2005

**Approved by** \_\_\_\_\_

**Approval Date** July 22, 2005

**Comments**

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

11/10/04, and to inform you that the initial processing which includes an administrative review has been performed.

Amendment (06-27813-00)  
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** 144311.  
When calling to inquire about this action, please refer to this control number.  
You may call us on (610) 337-5398, or 337-5260.