

**Final Radiological Status Report  
Room T-393B**

at

**Chemtura Corporation**

199 Benson Road  
Middlebury, CT 06749

**Final Report Date September 29, 2008**

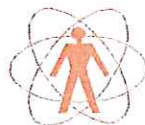
Performed by

**Radiation Safety Associates, Inc.**

19 Pendleton Drive, P.O. Box 107  
Hebron, CT 06248

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[www.radpro.com](http://www.radpro.com)



**Chemtura Middlebury**



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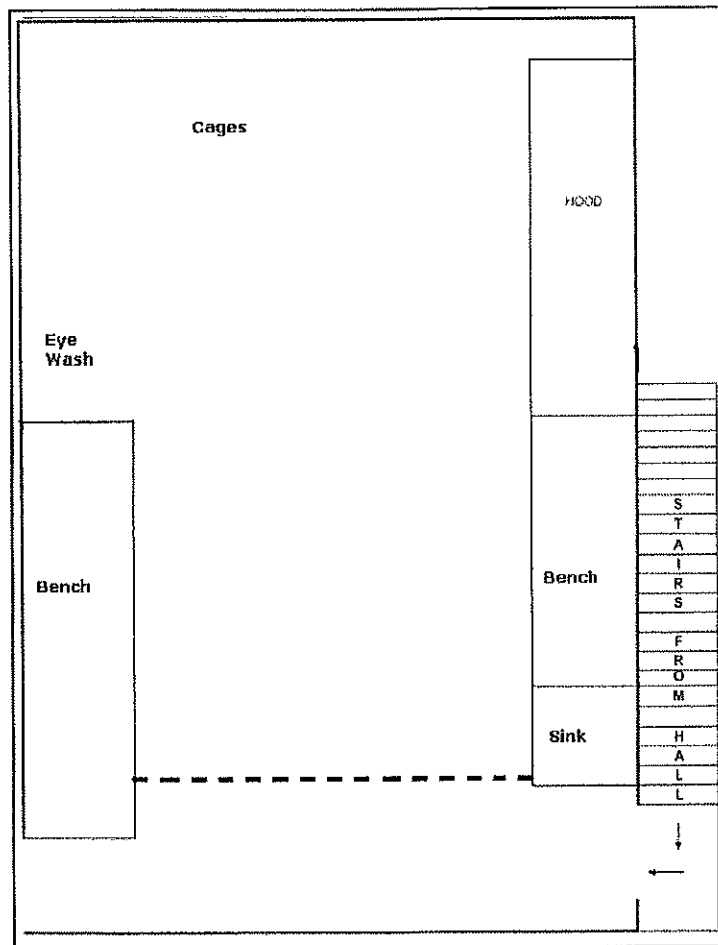
**Introduction**

Radiation Safety Associates, Inc. (RSA) was employed by Chemtura Corporation to perform a decommissioning survey of Room T-393B in the main building at its Middlebury site. Chemtura Corporation (Chemtura) is licensed by the U.S. Nuclear Regulatory Commission (NRC) to possess and use radioactive material at various locations on the Main Campus in Middlebury, Connecticut. Room T-393B was used for research under this license held by Chemtura. The Radiation Safety Officer identified one isotope of concern for decommissioning this room: Carbon-14 (C-14). This room is considered a MARSSIM<sup>1</sup> Class 1 area comprising a single survey unit for purposes of decommissioning planning. Chemtura has a long history of wipe survey results in this room, and the RSO anticipates that little contamination is present. Work was performed on site on August 5, 2008.

**Facility Description**

The basic floor plan of this room is shown in Figure 1 below.

*Figure 1. Floor plan of Room T393B.*



<sup>1</sup> Multi Agency Radiation Site Survey and Investigation Manual.



Figure2. Right side of Room T393B showing the fume hood, bench and sink.

Figure3 Left side of Room T393B showing a bench and cage racks.

### Data Quality Objectives (DQO)

As part of the DQO process the objective of the survey and the null and alternate hypotheses should be clearly stated. In demonstrating that this objective is met, the null hypothesis,  $H_0$ , tested is that residual contamination exceeds the release criterion; the alternative hypothesis,  $H_a$ , is that residual contamination meets the release criterion.

Since the beta-emitting contaminants that are presumed to be present in the facility are not presumed present in background, the Sign test is used to determine the number of data points needed for statistical tests. The acceptable decision error rates were determined during the DQO process described in MARSSIM. The Type I error ( $\alpha$ ) was specified as 0.05 and Type II decision error ( $\beta$ ) was set at 0.05. The shift,  $\Delta$ , also referred to as the lower bound of the gray region (LBGR), was set at 50% of the DCGL. The square roots of the DCGLs were taken as the standard deviation values used for calculation of the sample sizes for measurement of total contamination.

Carbon-14 is assigned a total contamination DCGL of  $3.7E+6$  dpm/100  $cm^2$ . The results of all measurements were compared to this limit. The removable contamination limit is set at 10% of the total contamination limit. These DQO data for Carbon-14 are summarized in Table 1 below.

Table 1. Carbon-14 DCGL and related data.

C-14	NRC DCGL (dpm/100 $cm^2$ )	$\Delta$ (LBGR) (dpm/100 $cm^2$ )	$\sigma$ (dpm/100 $cm^2$ )	$\Delta/\sigma$	Number of Samples required per survey unit by the Sign Test
Removable	3.7E+5	1.85E+5	608	304	14
Direct	3.7E+6	1.85E+6	1923	962	14

## Application of the DCGLs

All directly measured beta contamination will be considered to be from C-14, and will meet Chemtura ALARA goals described below.

## Acceptance Criteria

These surveys were accomplished in accordance with the requirements stated in 10 CFR 20.1402. Guidance for this decommissioning was taken from NUREG-1757, Vol. 1, Rev. 1 (Consolidated NMSS Decommissioning Guidance – Decommissioning Process for Materials Licensees) for Group 2: Unrestricted Release Using Screening Criteria; No Decommissioning Plan Required; and from MARSSIM (NUREG-1575 Rev. 1). Acceptance criteria were established based on the NRC recommendations<sup>2</sup> for release of facilities for unrestricted use following decommissioning, for the isotopes potentially present in the laboratories surveyed. Chemtura has reduced these release criteria to conform to ALARA principles. The release criteria used for this project are summarized in Table 3 below. The federal limits are the concentrations of each radionuclide that, if present in a building released for unrestricted use, could deliver a dose of 25 mrem per year to the person likely to receive the highest dose from all pathways. The State of Connecticut has determined that this release criterion should be 19 mrem per year instead of 25 mrem per year. Therefore the limits have also been reduced by a factor of  $19 \div 25 = 0.76$  to show compliance with State rules.

The direct survey (total contamination) DCGLs for the isotopes anticipated in this project are given in the table below, in dpm/100 cm<sup>2</sup>, along with Chemtura ALARA goals and the State limits. In all cases the Chemtura ALARA goals are smaller than the State limits.

**Table 2. Derived Concentration Guideline Levels (DCGLs) for total contamination (dpm/100 cm<sup>2</sup>).**

	NRC Value <sup>3</sup> dpm/100 cm <sup>2</sup>	Chemtura ALARA Goal dpm/100 cm <sup>2</sup>	State Limit dpm/100 cm <sup>2</sup>
C-14	3.7E+6	3.7E+4 (37,000)	2.8E+6

The DCGL's for removable contamination (wipe survey limits) are 10% of the values shown above and are given in Table 4 below.

**Table 3. Derived Concentration Guideline Levels (DCGLs) for removable contamination (dpm/100 cm<sup>2</sup>).**

	NRC Value <sup>4</sup> dpm/100 cm <sup>2</sup>	Chemtura ALARA Goal dpm/100 cm <sup>2</sup>	State Limit dpm/100 cm <sup>2</sup>
C-14	3.7E+5	3.7E+3 (3,700)	2.8E+5

The ALARA goals for total residual contamination are a factor of 100 lower than the NRC values, and the removable contamination criteria are a factor of 10 less than that.

<sup>2</sup> Federal Register / Vol. 63, No. 222 / Wednesday, November 18, 1998, page 64134 table I

<sup>3</sup> Ibid.

<sup>4</sup> Federal Register / Vol. 63, No. 222 / Wednesday, November 18, 1998, page 64134 table I, footnote 1.

In the calculation of all survey results, background was subtracted from the sample count rate before results were calculated and compared to the release criteria.

### **Instrumentation**

The instruments used for direct contamination measurements were calibrated within one year prior to the final survey measurements, and their operability was checked daily prior to use. The minimum detectable activity (MDA) of these devices was determined at the 95% confidence level using standard equations (Attachment A) and typical background counting rates.

The Chemtura liquid scintillation counter (LSC) was used to count all the wipe samples, and calibration data for that machine is on file in the Chemtura Radiation Safety Office. The calibration information for the portable instruments used during this decommissioning is contained in Attachment B.

Table 4 and Attachment A contain complete information about the instruments used during this decommissioning.

Table 4. Equipment available for use during this project.

Detector	Window	Electronics	Application	<sup>14</sup> C Eff.	R <sub>b</sub>	t <sub>b</sub>	t <sub>s</sub>	Minimum Detectable Activity
G-M pancake-type, Figure 2	1.7 ± 0.3 mg/cm <sup>2</sup> mica	Ludlum Model 3	Locate contamination in areas inaccessible to the other detectors	3.5%	65 cpm	Rate	Rate	See Attachment A
Ludlum 44-68 hand held 126 cm <sup>2</sup> gas proportional, Figure 3	0.8 mg/cm <sup>2</sup> aluminized Mylar	Ludlum 2224 scaler-rate meter	Scans and direct measurements on counters, hoods, shelves, drawers	7.5%	560 cpm β	5 min	1 min	See Attachment A
Ludlum 43-37 cart-mounted, 584 cm <sup>2</sup> , gas-flow proportional, Figure 4	0.8 mg/cm <sup>2</sup> aluminized Mylar	Ludlum 2224 scaler-rate meter	Scans and direct measurements on floors	3.6%	590 cpm β	5 min	1 min	See Attachment A





Figure 4. Ludlum 44-9 G-M frisker.

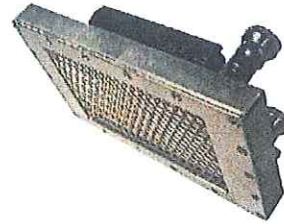


Figure 5. Ludlum 43-68 gas proportional detector.



Figure 6. Ludlum Model 239-1F Floor monitor (43-37 + 2224).

## Scoping Survey

The Scoping Survey for this project consisted of a floor scan and direct surveys of numerous suspect components and locations. The plan was to ensure that wipes and direct measurements were taken at any location where the scoping survey indicated the presence of radioactive contamination.

A nearly 100% scan survey of the floor of this room was accomplished as part of the preliminary survey to ensure that no contamination was available on the floor to be spread during the final status survey. This was done with a thin-window gas proportional floor monitor (described below).

Benches, the fume hood and other laboratory surfaces where radioactive materials were known or were likely to have been used were also scanned. Locations where the gas proportional detector would not fit were scanned with a G-M thin-window pancake-type detector as part of the preliminary survey. This would have identified areas of significant contamination.

If any direct measurement exceeded twice the local background count rate, action would have been taken as soon as practical to reduce the contamination to below these guideline values.

## Final Status Survey

### A. Wipe Samples

The minimum number of wipe samples to be taken in this single survey unit was determined using the MARSSIM (Sign test) method to be 14 samples or measurements. Survey locations within the survey unit are shown in Attachment C-1. The maximum area of a survey unit is 10,760 ft<sup>2</sup>. Actual area of Room T-393B is approximately 500 ft<sup>2</sup>.

1. Selected floor and wall locations;
2. Selected drawers, shelves and cabinets at random;
3. The sink;
4. Sink drain using a 6-inch cotton-tipped swab;
5. Fume hood sill, inside surface of window, work surface (base), sides and back and air outlet duct.

More than 150 wipes were taken as part of this decommissioning effort. Wipe tests were evaluated in a calibrated liquid scintillation counter (LSC) and were reported as both cpm and dpm Carbon 14.

### B. Scan Surveys and Direct Gross Beta Measurements on Surfaces and Components

A scan survey was performed on all countertops using a calibrated Ludlum 43-68 thin-window proportional counter combined with a Ludlum 2224 scaler-rate meter. A scan survey was also performed on hood interiors, inside selected drawers, on selected shelves, in selected cabinets and in other selected areas. This same instrument was used to make a series of direct contamination measurements on selected countertops using a 1-minute sample count time and a 5-minute background count time.

### C. Direct Gross Beta Measurements on Floors

Direct contamination measurements were performed on selected floor areas with the Ludlum Model 239-1F floor monitor using a 1-minute sample count time and a 5-minute background count time. This is a gas-proportional detector, Ludlum Model 43-68 combined with a Ludlum 2224 scaler-ratemeter.

## Final Survey Results

The results of all wipe samples and all direct contamination measurements are contained in Attachment C to this report. With the exception of four areas/components, the results of the wipe tests and direct measurements indicated that no detectable radioactive material was present. Even in the areas where some contamination was identified, the detected activity was less than the CHEMTURA ALARA goal for C-14 for direct beta measurements. There was measurable contamination in two locations (wipes #76 and #79), so the decision was made to decontaminate these two components as an ALARA measure. Post-decontamination wipes were counted and are included in the Attachment C results (wipes #164 and #165).

Direct measurements showed two relatively small areas of contamination, one of which approached the ALARA goal (#28 = 29852 dpm/100 cm<sup>2</sup>) and one that exceeded it (#39 = 42563 dpm/100 cm<sup>2</sup>). These areas were decontaminated several times, including (in the case of #39)

removal of some surface concrete. The final readings on both of these areas (#28 = 2,103 dpm/100 cm<sup>2</sup> and #39 = 3619 dpm/100 cm<sup>2</sup>) were at least a factor of 10 less than the ALARA goal of 3.7E+4 (37,000) dpm/100 cm<sup>2</sup>, and all were less than twice local background.

### Radioactive Waste

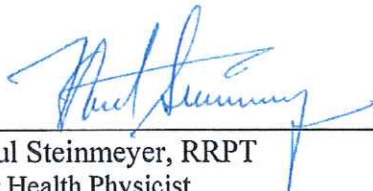
Prior to performing the final radiological status survey, the RSO had removed all stock solutions, radioactive samples and radioactive waste from the laboratory, and all equipment labeled "Caution Radioactive Material" had been removed from the lab. Radioactive waste produced during decontamination operations was turned over to the Radiation Safety Office for disposition.

### Conclusion

Based on the results of the radiological surveys described above, and in compliance with the criteria established in 10 CFR 20.1402 and the associated guidance documents, for the isotope potentially present in the laboratories surveyed, Room T-393B contains no licensed radioactive material requiring further action or control.

### Certification

I certify that this document is prepared in conformity with applicable federal and state regulations and that all statements and information contained herein, including any supplements attached hereto, are true and correct to the best of my knowledge and belief. Based on the results of these measurements, the most highly exposed person in the critical group will not receive an annual radiation dose in excess of 19 mrem from any potential licensed radioactive material remaining in these buildings.



K. Paul Steinmeyer, RRPT  
Senior Health Physicist  
Radiation Safety Associates, Inc.

September 29, 2008

Date

# **Attachment A**

## **Counting Statistics**

## Attachment A—Counting Statistics

## Minimum Detectable Activity (MDA)

MDA is the minimum detectable (*quantifiable*) activity in dpm at a specified confidence level. Additional conversion factors (C) may be applied to convert dpm to any other activity units that may be desired (e.g.,  $\mu\text{Ci}$ , kBq, etc.). MDA depends on the counting device, counting times (controllable by procedure) and background counting rate. It is not specific to an individual sample. The MDA of a detection system can be prospectively established in the sample collection and counting procedure by specifying sample and background counting times, and by specifying some maximum acceptable background counting rate. Detector efficiency is established during calibration.

$$\text{MDA} = \frac{k_1^2 + 2k_1 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s)(E)(C)}$$

Where:

$R_b$  = background count rate in cpm

$t_s$  = sample count time in minutes

$t_b$  = background count time in minutes

E = detector efficiency in counts per disintegration

A = area wiped

C = conversion factor from dpm to other desired activity unit, if applicable

$k_1$  = the one-sided confidence factor = 1.645 at 95% confidence

In nuclear counting programs, MDA is usually calculated at the 95% confidence level ( $k_1 = 1.645$ ).

MARSSIM sets the first term of the numerator equal to 3 instead of 2.71.

$$\text{MDA}_{95\%} = \frac{3 + 3.29 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s)(E)(C)}$$

Where:

$R_b$  = background count rate in cpm

$t_s$  = sample count time in minutes

$t_b$  = background count time in minutes

E = detector efficiency in counts per disintegration

C = conversion factor from dpm to other desired activity unit, if applicable. For these calculations, C = 1.

## Attachment A-Counting Statistics

**LLD for Wipe Samples (Chemtura's LSC)**

When assaying samples, including wipe samples, the more correct term to use is lower limit of detection (LLD) because sample parameters (e.g., area wiped in this case), in addition to detector and procedural variables, are now part of the equation. For wipe samples, the equation is modified as follows:

$$LLD_{95\%} = \frac{3 + 2k_1 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s)(E) \left(\frac{A}{100}\right)(C)}$$

This extra term in the denominator accounts for the actual area wiped. A sample area of 100 cm<sup>2</sup> (~4"×4" or 10 cm×10 cm) was used for these samples.

$$k_1 = 1.645 \text{ at CL}=95\%$$

$$R_b = 31 \text{ cpm}$$

$$t_s = 1 \text{ minutes}$$

$$t_b = 1 \text{ minutes}$$

$$E = 93\%$$

$$A = 100 \text{ cm}^2$$

$$C = 1 \text{ (i.e., no unit conversion factor used)}$$

$$\frac{3 + 3.29 \sqrt{0.31 * 1 \left(1 + \frac{1}{1}\right)}}{(1)(0.93) \left(\frac{100}{100}\right)(1)} = \frac{5.59}{0.93} = 6 \text{ dpm} / 100 \text{ cm}^2$$

An LLD of 6 dpm shows that we can easily detect the DCGL concentration of total contamination with 95% certainty.

## Attachment A-Counting Statistics

## LLD for Direct Surface Measurements (Ludlum Model 43-68 + Model 2224-1)

Performing direct contamination measurements is the same as counting wipe samples, except the sample is the floor or component being measured. Detector area (A) now comes into play, instead of the area wiped. The area of the Ludlum Model 43-68 is 126 cm<sup>2</sup>. The LLD will be in terms of dpm/100 cm<sup>2</sup>.

$$LLD = \frac{k_1^2 + 2 k_1 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s) (E) \left(\frac{A}{100}\right) (C)}$$

Given:

$$k_1 = 1.645 \text{ at CL}=95\%$$

$$R_b = 560 \text{ cpm}$$

$$t_s = 1 \text{ minutes}$$

$$t_b = 5 \text{ minutes}$$

$$E = 6.4\%$$

$$A = 126 \text{ cm}^2$$

$$C = 1 \text{ (i.e., no unit conversion factor used)}$$

At 95% confidence this becomes

$$LLD_{95\%} = \frac{3 + 3.29 \sqrt{560 * 1 \left(1 + \frac{1}{5}\right)}}{(1)(0.064) \left(\frac{126}{100}\right) (1)} = \frac{88.29}{0.08} = 1095 \text{ dpm/100 cm}^2$$

An LLD of 1095 shows that we can detect the ALARA goal DCGL concentration of total contamination (37,000 dpm/100 cm<sup>2</sup>) with 95% certainty.

## Attachment A-Counting Statistics

## LLD for Direct Surface Measurements (Ludlum Model 43-37 + Model 2224-1)

Performing direct contamination measurements is the same as counting wipe samples, except the sample is the floor or component being measured. Detector area (A) now comes into play, instead of the area wiped. The area of the Ludlum Model 43-37 is 425 cm<sup>2</sup>. The LLD will be in terms of dpm/100 cm<sup>2</sup>.

$$LLD = \frac{k_1^2 + 2 k_1 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s) (E) \left(\frac{A}{100}\right) (C)}$$

Given:

$$k_1 = 1.645 \text{ at CL}=95\%$$

$$R_b = 590 \text{ cpm}$$

$$t_s = 1 \text{ minutes}$$

$$t_b = 5 \text{ minutes}$$

$$E = 4.7\%$$

$$A = 425 \text{ cm}^2$$

$$C = 1 \text{ (i.e., no unit conversion factor used)}$$

At 95% confidence this becomes

$$LLD_{95\%} = \frac{3 + 3.29 \sqrt{590 * 1 \left(1 + \frac{1}{5}\right)}}{(1)(0.047) \left(\frac{425}{100}\right) (1)} = \frac{90.54}{0.2} = 453 \text{ dpm/100 cm}^2$$

An LLD of 453 shows that we can detect the ALARA goal DCGL concentration of total contamination (37,000 dpm/100 cm<sup>2</sup>) with 95% certainty.



## Attachment A—Counting Statistics

## LLD for Direct Surface Measurements (Ludlum Model 44-9 + Model 2224-1)

Performing direct contamination measurements is the same as counting wipe samples, except the sample is the floor or component being measured. Detector area (A) now comes into play, instead of the area wiped. The area of the Ludlum Model 44-9 is 15 cm<sup>2</sup>. The LLD will be in terms of dpm/100 cm<sup>2</sup>.

$$LLD = \frac{k_1^2 + 2 k_1 \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{(t_s) (E) \left(\frac{A}{100}\right) (C)}$$

Given:

$$k_1 = 1.645 \text{ at CL}=95\%$$

$$R_b = 65 \text{ cpm}$$

$$t_s = 5 \text{ minutes}$$

$$t_b = 5 \text{ minutes}$$

$$E = 3.5\%$$

$$A = 15 \text{ cm}^2$$

$$C = 1 \text{ (i.e., no unit conversion factor used)}$$

At 95% confidence this becomes

$$LLD_{95\%} = \frac{3 + 3.29 \sqrt{65 * 1 \left(1 + \frac{5}{5}\right)}}{(5)(0.035) \left(\frac{15}{100}\right) (1)} = \frac{40.51}{0.03} = 1350 \text{ dpm/100 cm}^2$$

An LLD of 1350 shows that we can detect the ALARA goal DCGL concentration of total contamination (37,000 dpm/100 cm<sup>2</sup>) with 95% certainty.

## **Attachment B**

# **Instrument Calibration Certificates**

Attachment B  
Instrument Calibration Certificates

**CERTIFICATE  
OF CALIBRATION**  
(COUNT-RATE INSTRUMENT)



**RSA Laboratories, Inc.**  
19 Pendleton Drive, P.O. Box 61  
Hebron, Connecticut 06248  
(860) 228-0721 Fax (860) 228-4402

Customer and Contact: Radiation Safety Associates, Inc., Attn: K. Paul Steinmeyer (860) 228-0487

Customer Address: P.O. Box 107, 19 Pendleton Drive, Hebron, CT 06248

Inst. Mfr. & Model Ludlum Model 2224-1

Inst. Type Scaler/Ratemeter

Inst. s/n 129459

Det. Mfr. & Model Ludlum Model 43-68

Det. Type Gas Proportional

Det. s/n 111315

Cal. Date 04 August 2008

Due Date 04 August 2009

Cal. Interval 1 year

Environmental conditions: Temperature: 72°F Relative Humidity: 44% Atmospheric Pressure: 29.60 inches Hg

Pre-calibration Checks:

Contamination survey

Battery check

Slow response check

Det. volty 1550 Vdc

Mechanical check

Audio check

Window operation

Plateau check

Input sens. \*See comments

Meter zero

Reset check

Fast response check

Alarm set

Pulse generator s/n 94926

Oscilloscope s/n 171-04928

Voltmeter s/n 57410002

HV Readout (2 points) Ref./Inst. 900 V/ 900 V Ref./Inst. 1700 V/ 1700 V

Comments: \* Alpha threshold = 140 mV; Beta threshold = 3.6 mV; Beta window = 3.6 mV to 30 mV.

Local background = 2 cpm alpha, 557 cpm beta. Th-230 efficiency measured on contact.

S/N of source used for precision check #6 Isotope Cs-137 Dedicated Source?  Yes  No  
Reading #1 23,000 cpm Reading #2 23,000 cpm Reading #3 23,000 cpm Mean 23,000 cpm  
Precision:  ± < 10%  ± 10-20%  Out of tolerance

Range Multiplier	Reference Calibration Point	Instrument Indication
x 100	400,000 cpm	400,000 cpm
x 1000	100,000 cpm	100,000 cpm
x 100	40,000 cpm	40,000 cpm
x 100	10,000 cpm	10,000 cpm
x 10	4000 cpm	4000 cpm
x 10	1000 cpm	1000 cpm
x 1	400 cpm	400 cpm
x 1	100 cpm	100 cpm
1 min count	100,000 cpm	100,000 cpm

All ranges calibrated electronically.

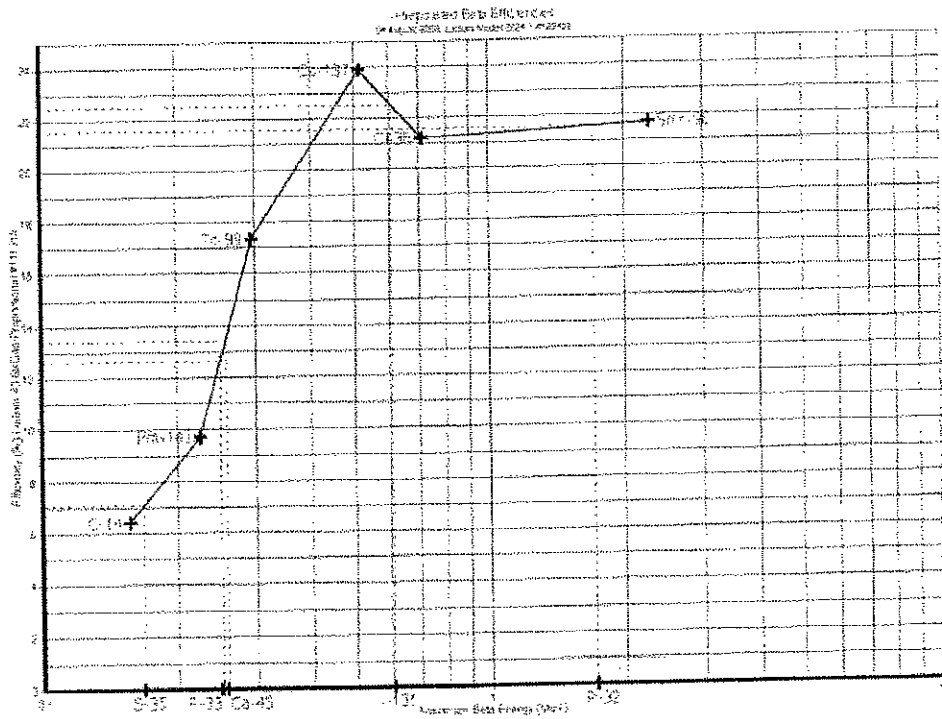
Range Multiplier	Cal. Source Used (isotope and S/N)	Source Activity (dpm)	Instrument Reading (cpm)	4π Instrument Efficiency (%)
1 min count	C-14 #4456	202,100	7 (cp) 13,516 (cp)	0.0% 6.4%
1 min count	Pm-147 #5381	3,064	3 (cp) 843 (cp)	0.0% 9.7%
1 min count	Tc-99 #D702	23,664	4 (cp) 4,528 (cp)	0.0% 17.3%
1 min count	Cs-137 #2886	16,275	3 (cp) 4,440 (cp)	0.0% 23.9%
1 min count	C-14 #D700	25,498	3 (cp) 4,576 (cp)	0.0% 21.2%
1 min count	Sr-90 #D711	40,542	5 (cp) 9,377 (cp)	0.0% 21.7%
1 min count	Th-230 #91101200210	36,999	3,035 (cp) 2,108 (cp)	12.8% 4.0%

RSA Laboratories ID# 12065. Instrument indicates within ± 10% of calibration points unless otherwise indicated. Source to detector entry window distance for efficiency determinations is 1 cm unless otherwise specified. RSA Laboratories, Inc. certifies that the above instrument has been calibrated with standards traceable to the National Institute of Standards and Technology, or have been derived from accepted values of natural physical constants, or have been derived by the ratio type of calibration techniques.

Calibrated by: Kurt D. Newton

Date: 04 August 2008

Attachment B  
Instrument Calibration Certificates



RSA Laboratories ID# 12065.

Calibrated by: Kurt D. Newton

Date: 04 August 2008

Attachment B  
Instrument Calibration Certificates

**CERTIFICATE  
OF CALIBRATION**  
(COUNT-RATE INSTRUMENT)



**RSA Laboratories, Inc.**  
19 Pendleton Drive, P.O. Box 61  
Hebron, Connecticut 06248  
(860) 228-0721 Fax (860) 228-4402

Customer and Contact: Radiation Safety Associates, Inc., Attn: K. Paul Steinmeyer (860) 228-0487  
Customer Address: P.O. Box 107, 19 Pendleton Drive, Hebron, CT 06248  
Inst. Mfr. & Model Ludlum Model 2224-1 Inst. Type Sealer/Ratemeter  
Det. Mfr. & Model Ludlum 43-37 Det. Type Gas-Proportional  
Cal. Date 04 August 2008 Due Date 04 August 2009

Inst. s/n 129459  
Det. s/n 103776  
Cal. Interval 1 year

Environmental conditions: Temperature: 72°F Relative Humidity 44% Atmospheric Pressure 29.60 inches Hg

Pre-calibration Checks:

- Contamination survey
- Mechanical check
- Meter zero
- Geoposition check
- Battery check
- Autos check
- Reset check
- Fast response check
- Slow response check
- Window operation
- Plateau check
- Alarm set
- Det. volts 1550 Vd
- Input sens. "See comments"

- Pulse generator s/n 94926
- HV Readout (2 points) Ref./Inst. 900 V/ 900 V Ref./Inst. 1700 V/ 1700 V
- Oscilloscope s/n 171-04928
- Voltmeter s/n 57410002

Comments: \* Alpha threshold = 140 mV; Beta threshold = 3.6 mV; Beta window = 3.6 mV to 30 mV. Local background = 1 cpm alpha, 438 cpm beta. Th-230 efficiency measured on contact.

S/N of source used for precision check #91TH4700000 isotope Th-230 Dedicated Source? BYES RNO  
Reading #1 1,028 cpm Reading #2 1,078 cpm Reading #3 1,072 cpm Mean 1,059 cpm  
Precision:  ± < 10%  ± 10-20%  Out of tolerance

Range Multiplier	Reference Calibration Point	Instrument Indication
x 000	400,000 cpm	400,000 cpm
x 100	100,000 cpm	100,000 cpm
x 10	40,000 cpm	40,000 cpm
x 100	10,000 cpm	10,000 cpm
x 10	400 cpm	400 cpm
x 10	100 cpm	100 cpm
x 1	40 cpm	40 cpm
x 1	10 cpm	10 cpm
1/min count	100,000 cpm	100,001 cpm

All ranges calibrated electronically.

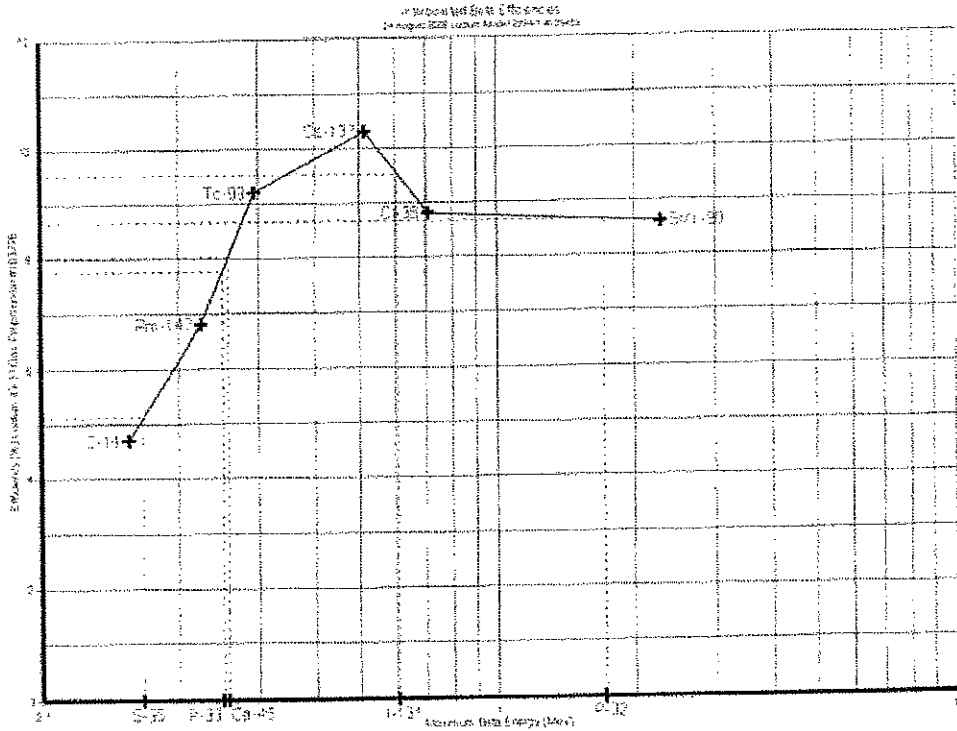
Range Multiplier	Cal. Source Used (isotope and S/N)	Source Activity (dpm)	Instrument Reading (cpm)	± Instrument Efficiency (%)
1/min count	C-14 14456	202,300	1 (c) 9,960 (f)	0.0% 4.7%
1/min count	Po-210 45381	3,064	0 (c) 648 (f)	0.0% 8.3%
1/min count	Tc-99 #1702	23,064	0 (c) 2,863 (f)	0.0% 9.2%
1/min count	Co-137 42886	16,275	0 (c) 2,120 (f)	0.0% 10.3%
1/min count	Co-60 #1700	23,598	1 (c) 2,722 (f)	0.0% 8.3%
1/min count	Am-241 #1711	40,542	7 (c) 1,094 (f)	0.0% 8.6%
1/min count	Th-230 #91TH4700001	22,000	1,078 (c) 1,053 (f)	3.2% 3.7%

RSA Laboratories ID# 12065 Instrument indicates within ±10% of calibration points unless otherwise indicated. Source-to-detector entry window distance for efficiency determinations is 1 cm unless otherwise specified. RSA Laboratories, Inc. certifies that the above instrument has been calibrated with standards traceable to the National Institute of Standards and Technology, or have been derived from accepted values of natural physical constants, or have been derived by the ratio-type of calibration techniques.

Calibrated by: Kurt D. Newton

Date: 04 August 2008

Attachment B  
Instrument Calibration Certificates



RSA Laboratories ID# 12065

Calibrated by: Kurt D. Newton

Date: 04 August 2008

Attachment B  
Instrument Calibration Certificates

**CERTIFICATE  
OF CALIBRATION  
(COUNTER/SCALER)**



**RSA Laboratories, Inc.**  
19 Pendleton Drive, P.O. Box 61  
Hebron, Connecticut 06248  
(860) 228-0721 Fax (860) 228-4402

Customer and Contact: Radiation Safety Associates, Inc., Attn: K. Paul Steinmeyer (860) 228-0487  
Customer Address: P.O. Box 107, 19 Pendleton Drive, Hebron, CT 06248  
Inst. Mfr. & Model Ludlum Model 2224-1 Inst. Type Scaler/Ratemeter Inst. s/n 129459  
Det. Mfr. & Model Ludlum Model 44-9 Det. Type Pancake G-M Det. s/n 116450  
Cal. Date 08 August 2008 Due Date 08 August 2009 Cal. Interval 1 year

Environmental conditions: Temperature: 72°F Relative Humidity 51% Atmospheric Pressure 29.42 inches Hg

Pre-calibration Checks:

- Contamination survey
- Mechanical check
- Meter zero
- Geotrapism check
- Battery check
- Audio check
- Reser check
- Fast response check
- Slow response check
- Window operation
- Plateau check
- Alarm set
- Det. volts 900 Vdc
- Input sens. \*See comments

- Pulse generator s/n 94926
- HV Readout (2 points) Ref./Inst. 900 V/ 900 V
- Oscilloscope s/n 171-04928
- Voltmeter s/n 57410002
- Ref./Inst. 1700 V/ 1700 V

Comments: \* Alpha threshold = 80 mV; Beta threshold = 2.5 mV; Beta window = 2.5 mV to 20 mV. Local background = 59 cpm beta. For beta efficiency, meter was set to alpha setting.

S/N of source used for precision check 4456 Isotope C-14 Dedicated Source?  Yes  No  
Reading #1 7,030 cpm Reading #2 7,124 cpm Reading #3 7,043 cpm Mean 7,066 cpm  
Precision:   $\pm <10\%$    $\pm 10-20\%$   Out of tolerance

Range Multiplier	Reference Calibration Point	Instrument Indication
x 1000	400,000 cpm	400,000 cpm
x 1000	100,000 cpm	100,000 cpm
x 100	40,000 cpm	40,000 cpm
x 100	10,000 cpm	10,000 cpm
x 10	4000 cpm	4000 cpm
x 10	1000 cpm	1000 cpm
x 1	400 cpm	400 cpm
x 1	100 cpm	100 cpm
1 min count	100,000 cpm	100,001 cpm

All ranges calibrated electronically

Cal. Source Used (isotope and S/N)	Source Activity (dpm)	Instrument Reading (cpm)	4 $\sigma$ Instrument Efficiency (%)
C-14 #4456	202,100	7,066	3.5%

RSA Laboratories ID# 12067. Instrument indicates within  $\pm 10\%$  of calibration points unless otherwise indicated. Source-to-detector entry window distance for efficiency determinations is 1 cm unless otherwise specified. RSA Laboratories, Inc. certifies that the above instrument has been calibrated with standards traceable to the National Institute of Standards and Technology, or have been derived from accepted values of natural physical constants, or have been derived by the ratio-type of calibration techniques.

Calibrated by: Kurt D. Newton

Date: 08 August 2008

# **Attachment C**

## **Survey Results**



Attachment C-1  
Wipe Sample Locations

RADIATION SAFETY ASSOCIATES

19 Pendleton Drive  
Hebron, CT 06248  
(860) 228-0487

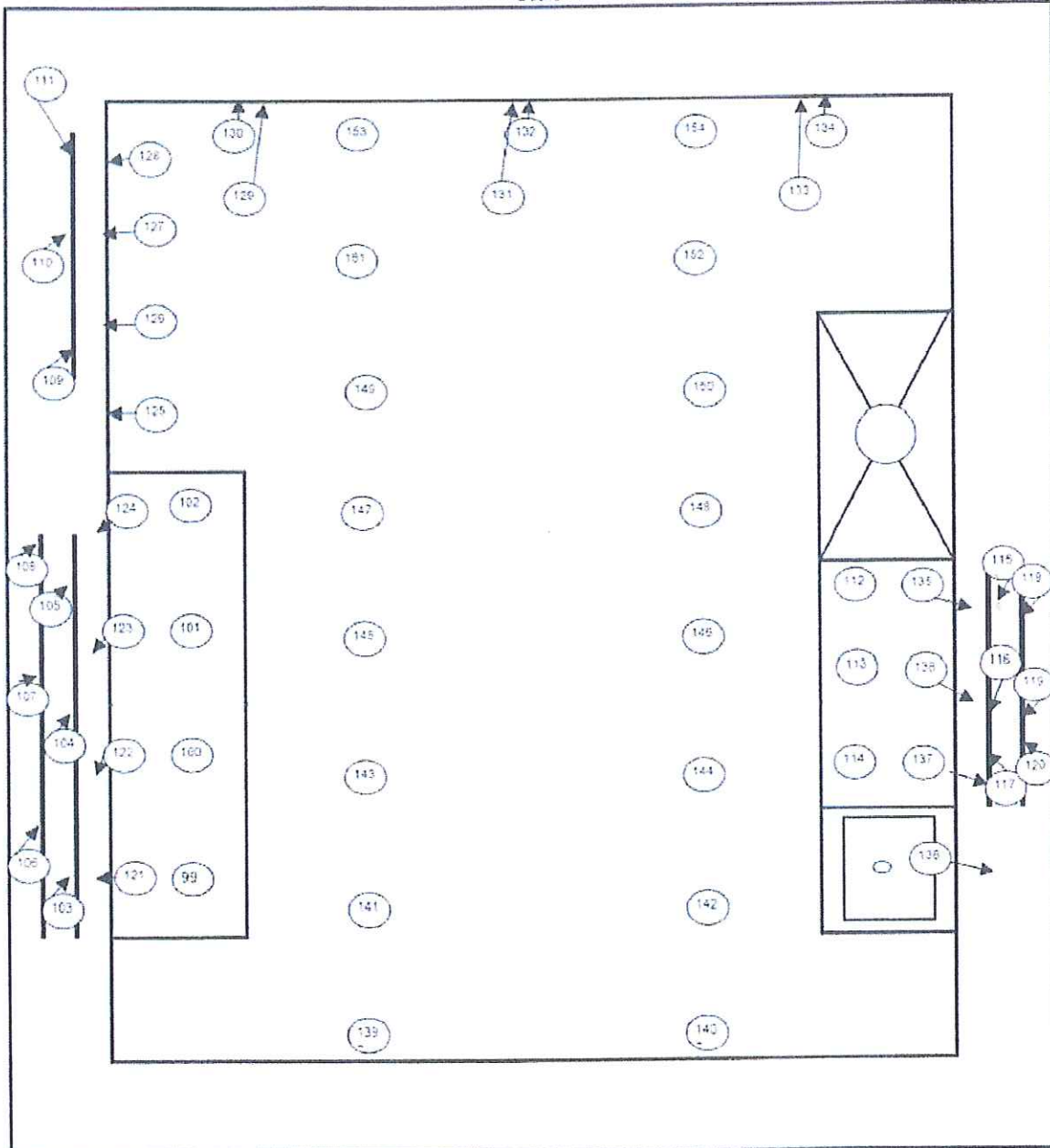
Job Chemtura Rat Room T-393B

Sheet No 1 of 2

Calculated by \_\_\_\_\_ Date \_\_\_\_\_

Checked By \_\_\_\_\_ Date \_\_\_\_\_

Scale \_\_\_\_\_



Attachment C-1  
Wipe Sample Results

RSA Laboratories  
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Radiochemistry Analysis Data Sheet

Page 1 of 5

Report No. Report 3 Customer: Radiation Protection Services  
Customer Samp No. Various Location: Rat Room/lab T-393  
RSA Lab Sample No. N/A Project: Chemtura Decommissioning  
Date Collected: 8/05/08, 8/12/08 Samp. Description: Wipes  
Date Counted: 8/5/2008 Matrix: Wipes  
H-3 LLD dpm= 9.02  
C-14 LLD dpm= 29.35

RSA ID#	CUST. ID#	Location	C-14 CPM	C-14 DPM		
BACKGROUND		BLANK	31.3			
W-1		Hood	10.7	11.5		
W-2		Hood	13.9	14.9		
W-3		Hood	13.0	13.9		
W-4		Hood	15.1	16.2		
W-5		Hood	22.9	24.7		
W-6		Hood	8.2	8.9		
W-7		Hood	13.0	13.9		
W-8		Hood	19.4	20.8		
W-9		Hood	13.3	14.3		
W-10		Hood	9.7	10.4		
W-11		Hood	9.6	10.3		
W-12		Hood	12.5	13.4		
W-13		Cage 1	30.3	32.7		
W-14		Cage 2	33.8	36.4		
W-15		Cage 3	117.3	126.4		
W-16		Cage 4	48.6	52.4		
W-17		Cage 5	15.1	16.3		
W-18		Cage 6	18.1	19.7		
W-19		Cage 7	18.9	20.6		
W-20		Cage 8	12.7	13.8		
W-21		Cage 9	34.8	37.6		
W-22		Cage 10	35.5	39.1		
QCCS		QCCS, C-14	123472.0	134927.3		
W-23		Cage 11	21.2	23.2		
W-24		Cage 12	15.6	17.0		
W-25		Cage 13	120.7	131.7		
W-26		Cage 14	154.5	171.6		
W-27		Cage 15	26.2	28.9		
W-28		Cage 16	65.1	73.0		
W-29		Cage 17	16.3	17.6		
W-30		Cage 18	12.8	14.0		
W-31		Drawer	49.7	54.0		
W-32		Drawer	24.0	26.1		
W-33		Drawer	7.5	8.1		
QCCS		QCCS, Blank	1.1	1.2		




Jay R. Dockendorff  
Laboratory Director

Attachment C-1  
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RSA ID#	CUST. ID#	LOCATION			C-14 CPM	C-14 DPM		
W-34		Drawer			5.9	5.4		
W-35		Drawer			15.6	16.8		
W-36		Drawer			19.4	21.1		
W-37		Drawer			12.4	13.3		
W-38		Drawer			12.5	13.4		
W-39		Drawer			10.2	11.1		
W-40		Drawer			44.1	47.7		
W-41		Drawer			15.2	16.4		
W-42		Drawer			20.9	22.5		
W-43		Drawer			31.1	34.2		
W-44		Drawer			0.1	0.8		
QCCS		QCCS, C-14			81718.6	132123.9		
W-45		Drawer			84.0	91.6		
W-46		Drawer			20.4	22.1		
W-47		Drawer			14.7	15.8		
W-48		Drawer			3.0	3.3		
W-49		Drawer			8.4	9.1		
W-50		Drawer			15.7	17.2		
W-51		Drawer			9.0	9.8		
W-52		Drawer			24.6	26.6		
W-53		Drawer			19.3	20.8		
W-54		Drawer			9.4	10.1		
W-55		Drawer			1.2	1.3		
QCCS		QCCS, Blank			9.2	8.8		
W-56		Drawer			15.7	17.1		
W-57		Drawer			8.9	8.6		
W-58		Drawer			53.6	58.2		
W-59		Drawer			13.7	14.7		
W-60		Drawer			77.8	84.1		
W-61		Drawer			13.4	14.5		
W-62		Drawer			19.2	20.8		
W-63		Drawer			20.6	22.3		
W-64		Drawer			4.2	4.5		
W-65		Drawer			6.7	7.3		
W-66		Hood, L Exhaust Duct			22.0	25.8		
QCCS		QCCS, C-14			116991.9	134380.7		
W-67		Hood, R Exhaust Duct			11.3	14.2		
W-68		Hood Trough L			16.7	18.2		
W-69		Hood Trough R			18.1	19.7		
W-70		Rolling Cart Top Shelf			8.5	7.1		
W-71		Rolling Cart Top Shelf			15.1	16.3		
W-72		Rolling Cart Bottom Shelf			11.5	12.4		
W-73		Rolling Cart Bottom Shelf			15.3	16.6		
W-74		Glass Metab Chamber B-4			19.4	20.8		
W-75		Glass Metab Chamber B-5			18.2	19.7		
W-76		Microscope Light			608.9	656.1		
W-77		Wire Suture Clips			15.9	17.1		




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Laboratory Director

Attachment C-1  
Wipe Sample ResultsRSA Laboratories  
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Radiochemistry Analysis Data Sheet

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RSA ID#	CUST. ID#	LOCATION	C-14 CPM	C-14 DPM		
QCCS		QCCS, Blank	14.2	15.2		
W-78		Silk Sutures	15.9	17.0		
W-79		Animal Scale	1238.4	1329.9		
W-80		Olympus Microscope	18.9	20.3		
W-81		Microscope Slides	30.6	32.7		
W-82		Hygrometer	7.5	8.1		
W-83		Bausch & Lomb Scope	12.4	13.4		
W-84		Olympus Varimagnifier	17.2	18.5		
W-85		Large Hygrometer	37.9	40.7		
W-86		Box BH2-CD 0683	12.2	13.0		
W-87		Olympus Camera Body	21.2	22.7		
W-88		Photomicro Adapter	12.7	13.6		
QCCS		QCCS, C-14	122389.4	133700.4		
W-89		Tape Dispenser	5.8	6.2		
W-90		Olympus Wood Box	11.4	12.2		
W-91		Paperwork Folder	10.7	11.4		
W-92		Remote Shutter chord	11.1	11.9		
W-93		Focusing screen	6.9	7.4		
W-94		Box LS-20H-2	21.7	23.3		
W-95		Coverslips	15.0	16.1		
W-96		Pipette Tips	13.2	14.3		
W-97		Black Metal Plates	7.6	8.1		
W-98		Animal Feeding Needles	16.5	17.6		
W-99		Counter top	12.6	13.5		
QCCS		QCCS, Blank	19.5	20.9		
W-100		Counter top	11.0	11.8		
W-101		Counter top	8.7	9.3		
W-102		Counter top	13.1	14.0		
W-103		Lower Shelf	11.2	12.1		
W-104		Lower Shelf	9.4	10.2		
W-105		Lower Shelf	12.3	13.5		
W-106		Upper Shelf	16.2	17.6		
W-107		Upper Shelf	13.9	15.3		
W-108		Upper Shelf	17.1	18.8		
W-109		Shelf	10.1	10.9		
W-110		Shelf	11.1	12.0		
QCCS		QCCS, C-14	82327.2	132785.7		
W-111		Shelf	13.3	14.3		
W-112		Counter Top	2.1	2.3		
W-113		Counter top	11.8	12.6		
W-114		Counter top	30.4	32.6		
W-115		Lower Shelf	10.5	11.2		
W-116		Lower Shelf	9.8	10.5		
W-117		Lower Shelf	16.9	18.2		
W-118		Upper Shelf	20.4	22.1		
W-119		Upper Shelf	16.8	18.1		
W-120		Upper Shelf	18.6	20.0		



Jay R. Dockendorff  
Laboratory Director

Attachment C-1  
Wipe Sample Results

RSA Laboratories  
A Division of Radiation Safety Associates  
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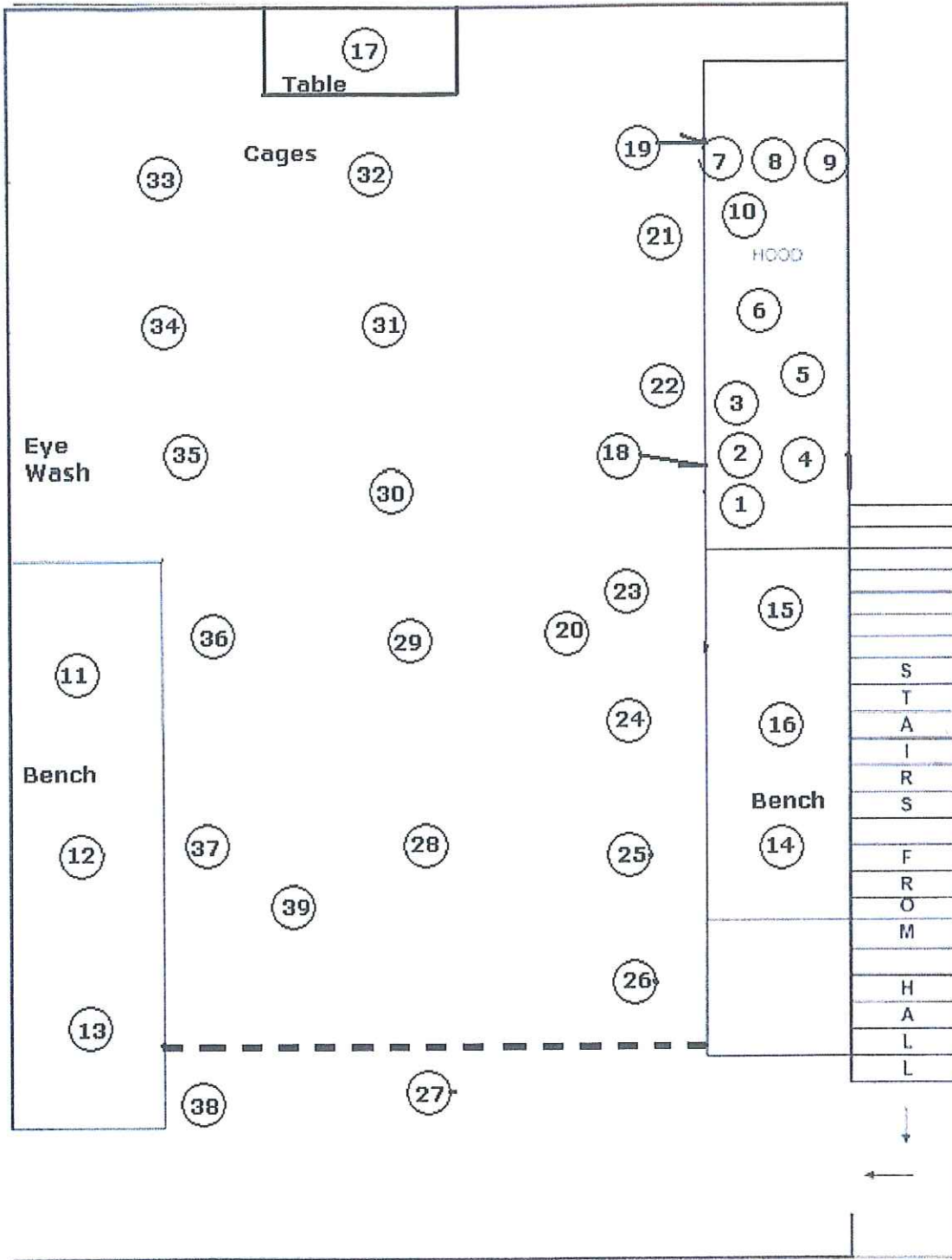
RSA ID#	CUST ID#	LOCATION			C-14 CPM	C-14 DPM		
W-121		Wall			15.40	16.50		
QCCS		QCCS, Blank			13.1	14.5		
W-122		Wall			26.8	28.7		
W-123		Wall			26.0	27.8		
W-124		Wall			7.1	7.5		
W-125		Wall			14.6	15.6		
W-126		Wall			9.9	10.6		
W-127		Wall			14.1	15.1		
W-128		Wall			15.2	16.3		
W-129		Wall			50.8	54.4		
W-130		Wall			12.9	13.9		
W-131		Wall			12.4	13.2		
W-132		Wall			14.4	15.5		
QCCS		QCCS, C-14			97749.1	133028.2		
W-133		Wall			18.2	19.5		
W-134		Wall			6.3	6.7		
W-135		Wall			11.5	12.3		
W-136		Wall			4.9	5.3		
W-137		Wall			10.9	11.7		
W-138		Wall			9.4	10.0		
W-139		Floor			15.0	16.1		
W-140		Floor			11.8	12.7		
W-141		Floor			23.2	24.8		
W-142		Floor			23.9	25.7		
W-143		Floor			11.9	12.8		
W-144		Floor			20.7	22.3		
QCCS		QCCS, Blank			13.0	13.9		
W-145		Floor			21.3	22.9		
W-146		Floor			10.7	11.5		
W-147		Floor			19.2	20.5		
W-148		Floor			14.0	15.0		
W-149		Floor			23.3	25.1		
W-150		Floor			14.8	15.9		
W-151		Floor			16.1	17.3		
W-152		Floor			9.0	9.6		
W-153		Floor			14.0	15.3		
W-154		Floor			3.9	4.4		
QCCS		QCCS, C-14			119459.0	133862.0		
W-155		Eye Wash Station			5.6	6.4		
W-156		Shower			11.6	12.4		
W-157		Sink			0.0	0.0		
W-158		Drain			19.2	21.2		
W-159		Post Decon, Floor			28.2	30.2		
W-160		Sink			14.3	15.4		
W-161		Sink Drain			3.2	3.4		
W-162		Animal cage rack 1			14.8	16.0		
W-163		animal cage rack 2			12.1	13.1		



Jay R. Dockendorff  
Laboratory Director



Attachment C-2  
Direct Measurement Locations



Attachment C-2  
Direct Measurement Results

Sample count time = 1 minute

Detector: Ludlum 2224-1 s/n 129459 w/43-68 s/n 111315

Detector Area: 100 cm<sup>2</sup>

MDA: 3297 dpm/100 cm<sup>2</sup>

C-14 efficiency (%): 6.4

Background (5 min. count): Beta = 560 cpm

Sample calculation (#2 below)

$$\frac{\text{gross cpm} - \text{bkgd cpm}}{\text{Eff} \times \left(\frac{A}{100}\right)} = \frac{565 \text{ cpm} - 560 \text{ cpm}}{0.064 \times \left(\frac{100}{100}\right)} = 78 \text{ dpm}$$

#	Location	Survey Point	Gross Beta cpm	Beta dpm
1	base - left	Hood	518	-656
2	base - middle	Hood	565	78
3	base - right	Hood	571	172
4	side - right	Hood	592	500
5	back - right	Hood	591	484
6	back - middle	Hood	549	-172
7	back - left	Hood	581	328
8	side - left	Hood	616	875
9	ceiling - left	Hood	547	-203
10	ceiling - right	Hood	535	-391
11	right side	Counter top	499	-953
12	middle	Counter top	496	-1000
13	left side	Counter top	503	-891
14	right side	Counter top	580	313
15	left side	Counter top	564	63
16	middle	Counter top	595	547
17	middle	Counter top	528	-500
18	inside cabinet - right	Hood	592	500
19	inside cabinet - left	Hood	545	-234
20	inside cabinet - left	Counter	551	-141



## Attachment C-2

## Direct Measurement Results

Sample count time = 1 minute

Detector: Ludlum 2224-1 s/n 129459 w/43-37 s/n 103776

Detector Area: 425 cm<sup>2</sup>MDA: 1053 dpm/100 cm<sup>2</sup>

C-14 efficiency (%): 4.7

Background (5 min. count): Beta = 590 cpm

Sample calculation (#21 below)

$$\frac{\text{gross cpm} - \text{bkgd cpm}}{\text{Eff} \times \left(\frac{A}{100}\right)} = \frac{1088 \text{ cpm} - 590 \text{ cpm}}{0.047 \times \left(\frac{425}{100}\right)} = 2493 \text{ dpm}/100 \text{ cm}^2$$

#	Location	Survey Point	Gross Beta cpm	Beta dpm
21	hood - left	Floor	1088	2493
22	hood - right	Floor	1050	2303
23	counter - left	Floor	789	996
24	counter - middle	Floor	825	1176
25	counter - right	Floor	1050	2303
26	sink	Floor	1383	3970
27	middle of floor	Floor	1276	3434
28	middle of floor	Floor	6553	29852
29	middle of floor	Floor	1357	3840
30	middle of floor	Floor	998	2043
31	middle of floor	Floor	954	1822
32	middle of floor	Floor	1031	2208
33	rat cage racks - rear	Floor	591	5
34	rat cage racks - rear	Floor	942	1762
35	eyewash station	Floor	713	616
36	counter - right	Floor	1025	2178
37	counter - middle	Floor	2418	9151
38	counter - left	Floor	1172	2914
39	hot spot (before decon)	Floor	9092	42563

Room T-393B Decommissioning Report

Attachment Y

Chemtura Room T-393B Decommissioning  
September 29, 2008

**Post decon #1 (scrub pad & spray wipe)**

26	sink	Floor	922	1662
27	middle of floor	Floor	630	200
28	middle of floor	Floor	1010	2103
29	middle of floor	Floor	652	310
37	counter - middle	Floor	1586	4986
39	hot spot	Floor	6254	28355

**Post decon #2 (scrub pad & spray wipe)**

37	counter - middle	Floor	1025	2178
39	hot spot (1 cm <sup>2</sup> )	Floor	5204	23099

**Post decon #3 (chisel & spray wipe)**

			Gross Beta cpm	Beta dpm
39	hot spot (1 cm <sup>2</sup> )	Floor	2073	7424

39 hot spot (1 cm<sup>2</sup>) Floor 84<sup>1,2</sup> 36 dpm/cm<sup>2</sup>

Calculation for #39 above

$$\frac{\text{gross cpm} - \text{bkgd cpm}}{\text{Eff} \times A_{\text{Det}}} = \text{dpm/cm}^2$$

$$\frac{84 \text{ cpm} - 65 \text{ cpm}}{0.035 \times 15 \text{ cm}^2} = 36 \text{ dpm/cm}^2$$

<sup>1</sup> Using Ludlum 44-9 G-M (A = 15 cm<sup>2</sup>) with Ludlum Model 2224-1 scalere/ratemeter: t<sub>b</sub> = 5 min, t<sub>s</sub> = 5 min, E = 3.5%, MDA = 3,310 dpm/100 cm<sup>2</sup>, background 65 cpm.

<sup>2</sup> Less than twice local background.