

FINAL STATUS SURVEY REPORT  
BUILDING 250 EXTERIOR

MALLINCKRODT, INC.  
COLUMBIUM- TANTULUM PROJECT- PHASE 1

MARCH 2004

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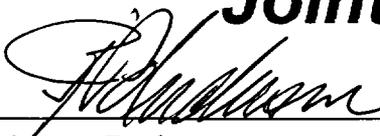
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**MALLINCKRODT, Inc.**  
**C-T PROJECT - PHASE I**  
**FINAL STATUS SURVEY REPORT**

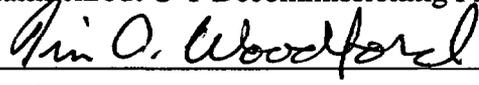
**Building 250 Exterior**  
**Survey Units 250E, 250S and 250R1 - R3**  
**Revision 0**

Prepared by

**BMNX**  
**Joint Venture**

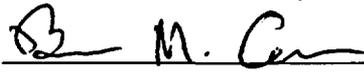
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**C-T PROJECT – PHASE I**

**FINAL STATUS SURVEY REPORT**

**Building 250 Exterior**  
**Survey Units 250E, 250S and 250R1 – R3**  
**Revision 0**

**1. INTRODUCTION**

**1.1. PURPOSE**

1.1.1. This Final Status Survey Report (FSSR) is being submitted by Mallinckrodt, Inc. to the U.S. Nuclear Regulatory Commission (NRC) for the exterior surfaces of Building 250 on the Mallinckrodt St. Louis site (designated as Survey Units (SU) 250E, 250S, and 250R1 – R3). This report is being provided in accordance with the Mallinckrodt C-T Project, Phase I Decommissioning Plan. This FSS was performed in accordance with the Field Instruction (FI) CT-FI-012<sup>1</sup> and the FSSP for Building 250 east wall to demonstrate that the established guidelines for unrestricted release have been met. The results of the FSS are presented in this FSSR as justification for release of this SU from License STB-401 for unrestricted use.

**1.2. HISTORICAL BACKGROUND**

1.2.1. From 1942 to 1961 Mallinckrodt was involved in radiological activities outside of the scope of this report which terminated in 1977. Mallinckrodt's facilities have either been released from the applicable license or are being remediated by the US Army Corps of Engineers in the affected areas. License STB-401 was issued to

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<sup>1</sup> CT-FI-012, *Final Status Survey Guide for Survey Units 250S and 250R1 – R3*

Mallinckrodt in 1961 by the Atomic Energy Commission (AEC), later the Nuclear Regulatory Commission (NRC), to allow extraction of columbium and tantalum (C-T) from natural ores and tin slag, since the ores and byproducts of processing contain uranium and thorium isotopes. Mallinckrodt has not performed C-T extraction since 1987. On July 12, 1993, NRC amended License STB-401 to possession-only for D&D and license termination.

## 2. SCOPE OF FINAL STATUS SURVEY

### 2.1. DEFINITION AND CLASSIFICATION OF SURVEY UNIT

- 2.1.1. The exterior walls and roof of Building 250 have been designated as five survey units, SU-250E, SU-250S, and SU-250R1 – SU-250R3. These survey units have been designated as Class 2. SU-250S was originally classified as Class 3. After initial FSS measurements were taken, the survey unit was found to be above background levels and was reclassified as Class 2.
- 2.1.2. Table 2.1 below contains the description provided in Appendix A of the D Plan for the areas referenced by this FSSR.

**Table 2.1<sup>2</sup>**  
***Survey Area Descriptions***

Area	Survey Unit	Location / Surface
318	250E	East Exterior Wall
319	250S	South Exterior Wall
320	250R1 – R3	Roof Decking

- 2.1.3. A summary report for the survey units listing all the surfaces and fixed apparatus assigned to SU-250E, SU-250S, and SU-250R1 – R3 is presented in Appendix 1. Because like items of installed apparatus appear in, or extend over, more than one survey unit, all such items are associated with SU-250S, and measurements taken on these items will be considered together. Drawings of the survey units are presented in Appendix 2, Figures 2.1 through 2.3.
- 2.1.4. A Section of the east wall measuring approximately 20 x 75 ft. was removed and disposed of as part of a maintenance project in 2001. The transite panels which replaced those removed are not affected and therefore are not included in the FSS. The area which has been repaired is depicted in Figures 2.1 and 4.1 of Appendix 2.

<sup>2</sup> Appendix A of D Plan.

## 2.2. IDENTIFICATION OF THE RADIOLOGICAL CONTAMINANTS

2.2.1. The radionuclides on the St. Louis site under license STB-401 are the uranium and thorium series. Both series are assumed to be in radioactive equilibrium and to exist in a uranium-to-thorium ratio of two to one.<sup>3</sup>

## 2.3. REFERENCE BACKGROUND LEVELS

2.3.1. When the initial characterization (CH) surveys were performed from 1992 through 1996, beta backgrounds were determined for several matrices. Where additional background measurements were required for the FSS, they were taken on unaffected surfaces nearby or offsite. Where background data were unavailable for a given matrix, a value of zero was used. All background levels were determined by taking direct readings on the specified matrix on unaffected surfaces using the same methods and type equipment as were used for the FSS. Available background data for the contaminants of interest in the survey units are presented in Table 2.2.

**Table 2.2**  
**Background Reference Data**

<b>Matrix</b>	<b>Mean (dpm<sub>p</sub>/100cm<sup>2</sup>)<sup>4</sup></b>	<b>Standard Deviation (dpm<sub>p</sub> /100cm<sup>2</sup>)</b>
Brick	192.4	16.0
Concrete	35.4	20.1
Metal	24.0	15.7
Wood	13.4	24.0

2.3.2. Gamma Background. The ambient background data collected before the surveys were performed on the roof were less than the NaI gamma background data collected on Building 25 Roof<sup>5</sup>, which had an average and standard deviation of 4,079 cpm and 196 cpm respectively. The most conservative ambient background reading taken when the direct measurements were performed was 3,254, and the ambient measurement taken when the scan surveys were performed was 4,071 cpm. These two ambient values were used as background for the gamma measurements on the roof rather than the less conservative backgrounds collected on Building 25.

## 2.4. RELEASE CRITERIA

2.4.1. Table 2.3 displays the Derived Concentration Guideline (DCGL<sub>w</sub>) for measurements on building surfaces and fixed equipment. This value is the

<sup>3</sup> Mallinckrodt C-T Project D Plan Appendix D.

<sup>4</sup> Dpm<sub>p</sub>/100 cm<sup>2</sup> refers to the disintegrations per minute per 100 cm<sup>2</sup> for the combined nuclide series.

<sup>5</sup> See Appendix A of NEXTEP Tech Memo 0230, *Technical Basis Document for Mallinckrodt Final Status Survey*. A.H. Thatcher, CHP. (included with FSSR 235 Roof).

primary release criterion from the D Plan and is applied net of background to building surfaces such as roofs. It also applies to items of installed apparatus such as vents, air handlers, and piping.

- 2.4.2. To limit the dose from residual materials as much as possible an Administrative Release Guideline (ARG)<sup>6</sup> was developed and was used during the FSS as if it were the DCGLw with certain exceptions.<sup>7</sup>

**Table 2.3**  
***Building Surface and Installed Apparatus Release Criteria***

Criterion	(dpm <sub>p</sub> /100 cm <sup>2</sup> )
DCGLw	13,000
ARG	2,600

2.4.3. Elevated Measurements Criteria (EMC).

- 2.4.3.1. Because the units surveyed in this FSS were Class 2, all measurements are required to be less than the DCGLw. Therefore, the EMC criteria do not apply.

2.5. SURVEY INSTRUMENTS

- 2.5.1. The instrumentation utilized to generate FSS data was maintained, calibrated, and tested according to the requirements of the D Plan. All procedures, responsibilities, and schedules for calibrating and testing equipment have been documented.
- 2.5.2. Maintenance information and use limitations provided in the vendor documentation of the instruments used during this FSS were adhered to. Measuring and analyzing equipment were tested and calibrated before initial use and were recalibrated periodically and whenever previous calibrations were invalidated. Field and laboratory equipment specifically used for obtaining final radiological survey data were calibrated based on standards traceable to NIST. Minimum frequencies for calibrating equipment have been established and documented.
- 2.5.3. Measuring equipment were tested at least once on each day the equipment was used for FSS. Test results were recorded in tabular or graphic form and compared to predetermined, acceptable performance ranges. Equipment not conforming to the performance criteria was promptly removed from service and any data gathered in the interim evaluated for quality until the deficiencies were resolved.

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<sup>6</sup> NEXTEP Tech Memo 0211, *Recommendation for an Administrative Release Guideline for the Mallinckrodt C-T Project*, A.H. Thatcher, CHP.

<sup>7</sup> Final Status Survey Design Guide (Phase I), Section 3.2, covers the rules governing use of the ARG.

- 2.5.4. All calibration and source check records were completed, reviewed, signed-off and retained in accordance with the Mallinckrodt Quality Assurance Program. Copies of the original Calibration Sheets for the instruments used in this FSS are provided in Appendix 3.
- 2.5.5. L2221/AB-100 – The primary instrument used for the detection of surface radioactivity was the AB-100 scintillation detector configured for beta detection. The AB-100 detector houses a ZnS/BC-408 organic scintillator and is paired with the Ludlum 2221 scaler/ratemeter for fixed and scan surveys. The window of the AB-100 was modified to increase the thickness of the mylar to 7-9 mg/cm<sup>2</sup> for the purpose of alpha attenuation<sup>8</sup>. The detector window was unshielded (open) for a time period during counting at each sample location, and shielded (closed) for the same time period at the same location<sup>9</sup>. The difference in the two readings is attributable to beta emissions above 80 KeV in energy.<sup>10</sup> The sensitivity of the AB-100 was derived from experiments by Lucas and Colyott which were reported in Attachment 3 to the D Plan.<sup>11</sup> The actual instruments used were calibrated and normalized to the reference instrument tested by Lucas and Colyott as prescribed in CT-QA-6.1<sup>12</sup>.
- 2.5.6. L2241-2/AB-100 – The AB-100 detector mentioned above paired with the Ludlum 2241-2 scaler/ratemeter was used in the same way for direct and/or scan beta measurements.
- 2.5.7. L43-89 – The Ludlum 43-89 scintillation detector is a newer design that is functionally and physically equivalent to the AB-100. It has a slightly lower efficiency as a rule, and it may be paired with the same ratemeters and scalers.
- 2.5.8. L3030 – The Ludlum Model 3030 alpha/beta scaler houses ZnS(Ag) and plastic scintillators and was used to count removable contamination collected on paper swipes. Smear papers were counted in the laboratory and results were reported in  $\beta$ pm/100 cm<sup>2</sup>. Removable contamination measurements were not compared with the release criteria for purposes of releasing the survey unit, but only to confirm that the removable fraction was less than 20% of the DCGLw.
- 2.5.9. L2221/3x3NaI - When beta measurements could not be taken, the 3"x3" Sodium Iodide (NaI) detector was used. This instrument was calibrated off site and no modification or normalization (as was required for the AB-100/ L43-89) was performed.

<sup>8</sup> As specified in Appendix D of the D Plan. Measurements taken with only the mylar covering the probe were "open window" measurements.

<sup>9</sup> The "closed window" reading was taken with a 1/8" soft Aluminum plate covering the face of the detector. It is sufficient to exclude  $\beta$  rays from the U and Th series.

<sup>10</sup> Internal Conversion Electrons (ICE) will also be included in this number but are a second order effect and may be ignored.

<sup>11</sup> *Energy Dependent Calibrations for the Bicron Model AB-100 Beta Ray Survey Probe*, A. Lucas, CHP and L. Colyott, Ph.D., submitted as Attachment 3 to the Mallinckrodt Phase I Decommissioning Plan.

<sup>12</sup> CT-QA-6.1 - *Calibration and Control of Measuring and Survey Equipment*.

## 2.6. LOWER LIMITS OF DETECTION

- 2.6.1. The terminology adopted to reflect the measurement (detection) capability of an instrument is the lower limit of detection (LLD) or the minimum detectable activity (MDA). It refers to the intrinsic detection capability of the entire measurement process. The LLD, or MDA, is the lowest level of radioactivity that will yield a net count, above system blank, that will be detected with at least 95% probability with no greater than a 5% probability of falsely concluding that a blank observation represents a real signal. It is desirable to express the MDA as minimum detectable areal density (MDAD) or minimum detectable concentration (MDC) in units comparable to a regulatory limit with which a measurement may be compared. For a more detailed discussion regarding LLD and equations involved in calculation of LLD, refer to CT-QA-6.1.<sup>13</sup>
- 2.6.2. The LLD requirements for the FSS have been developed in accordance with MARSSIM<sup>14</sup> Chapter 4 guidelines. They are contained in the Design Guide and are listed in Table 2.4. Since gamma survey measurements on the roof were known to exceed the ARG, the DCGL<sub>w</sub> was used to calculate the MDC and thresholds for all gamma measurements.

**Table 2.4**  
***MDC Requirements***

<b>Measurement Type</b>	<b>MDC Requirement</b>
Direct Beta	50% of ARG
Class 2 Beta Scans	ARG
Direct Gamma	50% of DCGL <sub>w</sub>
Class 2 Gamma Scans	DCGL <sub>w</sub>

- 2.6.3. The MDCs for the instruments used in the FSS were calculated according to Appendix D of the D Plan. A comparison of the MDCs calculated for the AB-100 and the NaI gamma detector with the requirements is provided in Table 2.5. Details of the MDC calculations are presented in NEXTEP Tech Memo 0230.<sup>15</sup>

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<sup>13</sup> CT-QA-6.1, Ibid.

<sup>14</sup> NUREG 1575, *Multi Agency Radiation Survey and Site Investigation Manual*.

<sup>15</sup> NEXTEP Tech Memo 0230, *Technical Basis Document for Mallinckrodt Final Status Surveys*, A.H. Thatcher, CHP (included with FSSR 235 Roof).

**Table 2.5**  
**Minimum Detectable Concentration (MDC) Comparison<sup>16</sup>**

<b>Measurement</b>	<b>Matrix</b>	<b>Calculated MDC (dpm<sub>v</sub>/100 cm<sup>2</sup>)</b>	<b>Required MDC (dpm<sub>v</sub>/100 cm<sup>2</sup>)</b>
<b>BETA DIRECT</b>	Brick	100	1,300
<b>BETA SCAN</b>	Brick	760	2,600
<b>GAMMA DIRECT</b>	Gravel	660	6,500
	Non-gravel	423	
<b>GAMMA SCAN</b>	Gravel	1,200	13,000
	Non-Gravel	830	

**2.7. ACTION THRESHOLDS**

2.7.1. Action thresholds based upon the release criteria were calculated for each type of instrument used in this FSS. The action threshold for beta scans is derived in NEXTEP Tech Memo 0230.<sup>17</sup>

2.7.2. Since any residual contamination on the roof of Building 250 was expected to be under a new layer of roofing material, only gamma measurements were used to survey the roof. The action thresholds for both direct and scan measurements were calculated using equations presented in NEXTEP Tech Memo 0230<sup>18</sup> and gamma conversion factors,  $F_g$ , from NEXTEP Tech Memo 0229<sup>19</sup>. Both calculations are based upon the  $DCGL_w$  since survey measurements exceeding the ARG were known to exist on the roof.

2.7.3. The calculation for the direct gamma action threshold is given by Equation 1.

**Equation 1**

$$T_{inv} = DCGL_w * F_g$$

*Where:*

$T_{inv}$  = The investigation threshold.

$F_g$  = The direct gamma conversion factor for a roof with or without gravel covering.  
(Listed in Table 2.6)

2.7.4. The calculation for the gamma scan action threshold is given by Equation 2.

<sup>16</sup> All Values given are net of background.

<sup>17</sup> NEXTEP Tech Memo 0230, *ibid.*

<sup>18</sup> NEXTEP Tech Memo 0230, *ibid.*

<sup>19</sup> NEXTEP Tech Memo 0229, *MCNP Gamma Modeling of Mallinckrodt Roof Surfaces*, N. Zhang. (provided with FSSR 101 External).

**Equation 2**

$$T_{inv} = DCGL_W * F_g * \sqrt{p}$$

Where:

$F_g$  = The gamma conversion factor for scans over a roof with or without gravel covering. (Listed in Table 2.6)  
 $p$  = surveyor efficiency (assumed to be = 0.50)

2.7.5. A summary of the action thresholds calculated for this FSS is presented in Table 2.6.

**Table 2.6**  
**Action Thresholds<sup>20</sup>**

Measurement	Matrix	Conversion Factor, $F_g$ (cpm/dpm <sub>p</sub> /100 cm <sup>2</sup> )	Class 2 Action Threshold (cpm)
BETA SCAN	Brick	N/A	2,000
GAMMA DIRECT	Gravel	0.48	6,240
	Non-gravel	0.75	9,750
GAMMA SCAN	Gravel	0.44	4,040
	Non-gravel	0.64	5,880

2.8. INSTRUMENT SENSITIVITY, BACKSCATTER AND PAINT ATTENUATION

2.8.1. Beta direct measurements taken in the field were converted to dpm<sub>p</sub>/100 cm<sup>2</sup> of the parent nuclide series in accordance with Section 9 of the Design Guide using the following equation:

**Equation 2**

$$AD = \frac{Co - Cc}{PAF * S_i * S_b(m) * t}$$

Where:

- AD = Areal Density in dpm<sub>p</sub>/100 cm<sup>2</sup> for the parent nuclides
- Co = Counts measured in the open window configuration
- Cc = Counts measured in the closed window configuration
- PAF = Paint attenuation factor derived from the number of coats of paint applied to the surface since C-T operations ceased.
- S<sub>i</sub> = Normalized Instrument sensitivity without backscatter.
- S<sub>b</sub>(m) = Backscatter factor (a function of matrix)

<sup>20</sup> The Class 3 action threshold is always equal to the greater of the T<sub>BK</sub> or the MDC of the instrument used. T<sub>BK</sub> is defined for each matrix as mean background plus two standard deviations (2σ) as described in Section 3.5.4.

t = Integration time in minutes.

2.8.2. Justification and calculations for separation of backscatter (as a function of the matrix) and instrument sensitivity were presented in NEXTEP Tech Memo 0215.<sup>21</sup> Reference backscatter coefficients for several matrices were generated using an MCNP model and are described in NEXTEP Tech Memo 0213.<sup>22</sup> These coefficients were stored in the Matrix table in the Database and were used in the calculations according to the matrix upon which the measurement was taken.

### 3. SURVEY METHODS

#### 3.1. SURVEY PROCEDURES

3.1.1. The FSS conformed to the procedures and plans listed in Table 3.1. The primary guidance for the FSS is contained in the Design Guide and the FI.

**Table 3.1**

<b>Survey Procedures and Documents</b>
CT Decommissioning Plan (Phase I)
CT Decommissioning Project, Final Status Survey Design Guide (Phase I)
CT-FI-012, Final Status Survey Guide for Survey Units 250S and 250R1-250R3
FSSP 250E – Building 250
CT-QA-6.1: Calibration and Operation of Measuring and Survey Equipment
CT-RP-66: Operation of Scalers, Rate Meters, and Contamination Detectors
CT-RP-39: Performance of Radiation and Contamination Surveys
CT-RP-40: Survey Documentation and Review

3.1.2. All FSS data recorded in the field were submitted to the Quality Assurance Manager (or designee) for processing and review. The data collection forms and annotated drawings were signed by the technician taking the data and reviewed by the Radiation Protection, Health & Safety (RPHS) Manager (or designee) overseeing the survey. After data entry and review, QA approved the data sheets and filed them with the permanent Mallinckrodt records. The QA checklist<sup>23</sup> developed for quality verification of FSS data was used as a guide to data verification.

<sup>21</sup> NEXTEP Tech Memo 0215, *Separation of Backscatter & Derivation of Instrument Sensitivity*, A.H. Thatcher CHP. (Included with FSSR 2501).

<sup>22</sup> NEXTEP Tech Memo 0213, *Beta Backscatter Factors for Several Materials at the Mallinckrodt Site*, N. Zhang and D. Wilson. (Included with FSSR 2501).

<sup>23</sup> NEXTEP Tech Memo 0206, *QA Data Verification for MI CT Final Status Survey Data*, B. Anderson, (Included with FSSR 2501).

3.1.3. All the data generated by the surveys were entered into the C-T Radiation Database (RDB) and analyzed as outlined in Section 4.4 of the D Plan.

## 3.2. SURVEY MEASUREMENTS

### 3.2.1. Beta Measurements:

3.2.1.1. *Direct* – A systematic grid of direct measurements was obtained on the wall surfaces as described in the FI for SU-250S and in the FSSP for SU-250E. Bias measurements were taken on building surfaces and fixed apparatus at locations determined by the surveyor and to fully characterize the fixed apparatus.

3.2.1.2. *Scans* - Beta scans were performed using the same instruments used for the direct beta measurements. Beta Scans were performed on the wall surfaces. Scans were performed at a scan rate of less than one detector width per second with a probe height less than one inch from the surface being scanned.

### 3.2.2. Gamma Measurements:

3.2.2.1. *Direct* - Because it is the roof decking of Building 250 that is affected, it was not possible to detect residual contaminants beneath the surface with beta detectors. Instead, a 3"x3" Sodium Iodide (NaI) gamma detector was used in both the direct and scan modes to survey the roof in SU-250R1 – SU-250R3. For direct measurements the detector was placed on the roof surface and counts were taken for one minute. Wherever possible, the gravel covering on the roof was brushed aside and the measurements were taken on the asphalt binder roofing material. For that case, the non-gravel gamma threshold in Table 2.6 was used to evaluate the data.

3.2.2.2. *Scans* - Gamma Scans were performed in straight lines 5 cm above the surface of the roof in SU-250R1 – SU-250R3 with each scan line separated from the next by 1 meter. The scan rate did not exceed 1 ft/s.

### 3.2.3. Removable Contamination Measurements:

3.2.3.1. *Swipes* - Removable contamination samples were collected at 100% of all regular grid locations on the south wall and the roof. Because SU-250E was surveyed in 2001, no smear data were taken on the east wall as part of the FSS.<sup>24</sup> The swipes were counted in the laboratory and recorded in the database. Sampling of removable contamination was performed to confirm the assumption, used in derivation of the

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<sup>24</sup> The NRC requested smear data be included beginning with the survey of SU 2501 in 2002.

DCGLw, that the removable fraction measures less than 20% of the DCGLw<sup>25</sup>.

### 3.3. MEASUREMENT LOCATIONS

#### 3.3.1. Statistical Grid Data Points

3.3.1.1. The *Visual Sample Plan*® (VSP)<sup>26</sup> software was used to develop a MARSSIM grid for all five survey units. The minimum number of points required and their spacing were calculated in accordance with the statistical guidance given in MARSSIM Sections 5.5.2.2 and 5.5.2.5.

3.3.1.2. VSP uses the Data Quality Objective (DQO) input values to calculate the minimum number of measurement points, N, required to satisfy MARSSIM statistical guidance. A summary of all the input parameters used with VSP for this Report is presented in Table 3.2.

**Table 3.2**  
*VSP Inputs for Building 250 Exterior*

<b>DQO</b>	<b>250 Walls</b>	<b>250 Roof</b>
<b>Type I error rate</b>	5%	5%
<b>Type II error rate</b>	5%	5%
<b>Width of Gray Region</b>	200 dpm <sub>p</sub> /100cm <sup>2</sup>	200 dpm <sub>p</sub> /100cm <sup>2</sup>
<b>Level (ARG)</b>	2,600 dpm <sub>p</sub> /100cm <sup>2</sup>	13,000 dpm <sub>p</sub> /100cm <sup>2</sup>
<b>Estimated Std Deviation</b>	200 dpm <sub>p</sub> /100cm <sup>2</sup>	200 dpm <sub>p</sub> /100cm <sup>2</sup>

3.3.1.3. The minimum required number of grid measurements for all survey units was 24. Up to 25% excess grid points were used in survey planning to account for inaccessible or unusable locations. The actual number of measurements recorded also varied due to geometric considerations and the random origin provided by VSP.

3.3.1.4. A rectangular grid pattern was used for all five survey units. The number of grid point measurements actually recorded for each survey unit is presented in Table 3.3.

<sup>25</sup> Section 3.3 of the C-T Design Guide.

<sup>26</sup> NEXTEP Tech Memo 0008, *Verification and Validation of Applicable Portions of VSP Software*, A. H. Thatcher, CHP.

**Table 3.3**  
**Grid Points Recorded by Survey Unit**

<b>Survey Unit</b>	<b>Class</b>	<b>N (actual)</b>
SU-250E	2	25
SU-250S	2	31
SU-250R1	2	31
SU-250R2	2	36
SU-250R3	2	31

**3.3.2. Bias Measurement Locations**

3.3.2.1. Bias direct measurements (gamma on SU-250R1-250R3 surfaces, beta on SU-250E and SU-250S surfaces, and beta on fixed apparatus) were taken at the discretion of the HP technician performing the survey.

3.3.2.2. Bias surveys were also taken at hot spot locations identified by scans as directed in the Hot Spot Protocol<sup>27</sup>.

**3.4. REFERENCE COORDINATE SYSTEM**

3.4.1. A unified reference system was prescribed for the location of all data points taken on all building surfaces and on the surface of installed apparatus. A description of the reference coordinate system is provided below.

3.4.2. A data point's unique location is specified by a combination of the following data elements: building, room, surface ID, X, and Y. The surface ID refers to the four walls, floor, ceiling and roof as shown in Table 3.4. X and Y are distances from the origin measured as shown in the table. An example of X and Y axes for floors and walls is presented in Appendix 2, Figure 3.1.

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<sup>27</sup> CT-FI-004, *Final Status Survey Guide for Survey Unit 2504*.

**Table 3.4**  
***Coordinate System Locators***

<b>Location</b>	<b>Identifier</b>	<b>X</b>	<b>Y</b>
North Wall	N	Feet right from leftmost edge of the wall surface	Feet up from floor or the lowest point in the room
South Wall	S		
East Wall	E		
West Wall	W		
Floor	F	Feet east from western most edge of the surface	Feet North of southernmost edge
Ceiling	C		
Roof	R		

- 3.4.3. The surface ID for a roof applies only in the case when measurements are being made on the exterior surface of a building. In this unique case the “room” assigned has the special number “999”.
- 3.4.4. Systematic grid data points which fell on external surfaces of installed apparatus were located with the primary coordinate system. The ID code of the apparatus was recorded in the remarks. For example: Let Q2 be identified as a large air conditioning unit located on the roof. Any systematic grid measurement points for the roof surface which landed on the air conditioner would have been identified using the X and Y coordinates from the southwest corner of the roof. “Q2 – A/C unit” would be noted in the remarks. The surface ID would be “R”.
- 3.4.5. All bias data points taken on installed apparatus were numbered and located on the drawings provided. This number was recorded as the X coordinate on the data sheet and amplifying information was entered in the remarks section.

### 3.5. DATA EVALUATION

- 3.5.1. All of the direct, swipe and scan data were entered into the C-T Radiation Database (RDB) for easy access and analysis. The direct beta measurements are normally the primary means for documenting the survey unit and justifying its release. Therefore, a special report was programmed to perform all the tests specified in Section 4.4.8 of the D Plan and to provide a clear report of the results for evaluation. The calculations in this report have been validated and verified as described in NEXTEP Tech Memo 0231<sup>28</sup>.
- 3.5.2. The purpose of the screening software is to compare each direct beta reading taken in the survey unit with specified threshold levels, to apply the statistical tests called for in MARSSIM when appropriate, and to present the results in a clear and useful manner so that an analyst can accurately assess the action to be taken or declare that the survey unit meets the requirements for release.

<sup>28</sup> NEXTEP Tech Memo 0231, *Validation and Verification of the C-T Database Analysis Report*, B. Anderson, (included with FSSR 2501).

3.5.3. Some of the screening tests apply to each record in the survey unit and failure of one data point results in failure of the survey unit. Other tests do not apply to each survey record but generate a single PASS/FAIL verdict for the entire data set. The tests are described in the following paragraphs<sup>29</sup>. An abbreviated summary of these tests is presented in Table 3.5.

3.5.4. *Background Screen.*

3.5.4.1. For each MATRIX code in the database, calculate the mean background reading, its standard deviation, and its minimum value. Calculate and store the Background Threshold,  $T_{bk}$ , with its matrix code according to the following equation:

Equation 3

$$T_{bk}(m) = \overline{BK}(m) + 2 * \sigma_{bk}(m)$$

3.5.4.2.  $T_{bk}$  is equal to the mean of the background readings ( $\overline{BK}$ ) for a given matrix plus two times its standard deviation ( $2\sigma$ ).

3.5.4.3. Compare each data point in the filtered survey unit with  $T_{bk}$ . If the survey reading  $> T_{bk}$  the data point fails the test. One data point failure implies failure of the background screen test for the survey unit.

3.5.5. *Min/Max Test.*

3.5.5.1. Find the maximum direct survey result, in  $\text{dpm}_p/100\text{cm}^2$ , for the survey data set.

3.5.5.2. Find the minimum background reading among all the background data points having MATRIX codes that match those in the data set.

3.5.5.3. If the difference between these two values is greater than DCGLw the MIN/MAX test fails for the survey unit.

3.5.6. *DCGLw Screen.*

3.5.6.1. For each matrix code calculate and store a DCGLw Threshold ( $T_d$ ).  $T_d$  is calculated by adding the value of DCGLw to  $T_{bk}$ .

Equation 4

$$T_d(m) = T_{bk} + DCGLw$$

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<sup>29</sup> A more detailed explanation is provided in the Design Guide.

3.5.6.2. Compare each data point in the survey unit with  $T_d$ . If the survey reading  $> T_d$  the data point fails the test. One data point failure implies failure of the DCGLw screen test for the survey unit.

3.5.7. *EMC Screen.*

3.5.7.1. For each matrix code calculate and store an EMC Threshold ( $T_e$ ).  $T_e$  is calculated by adding the value of EMC to  $T_{bk}$ . The EMC value selected is normally dependent upon the area involved. However, if no specific area was known, the EMC was normally set to the a priori  $DCGL_{EMC}$ .

**Equation 5**

$$T_e(m) = T_{bk}(m) + DCGL_w$$

3.5.7.2. Compare each data point in the filtered survey unit with  $T_e$ . If the survey reading  $> T_e$  the data point fails the test. One data point failure implies failure of the EMC test for the survey unit.

3.5.8. *DCGL Average Test.*

3.5.8.1. For each matrix material in the survey unit, calculate the mean gross activity density, (in  $dpm_p/100cm^2$ ), in the survey data set. Subtract from this value, the mean value of background activity for the same matrix. If the remainder is greater than DCGLw for any matrix in the survey unit, the test fails.

**Equation 6**

$$\overline{AD}(m) - \overline{BK}(m) > DCGL_w$$

3.5.9. *Statistical Tests.*

3.5.9.1. The statistical tests prescribed by MARSSIM operate only on the data points of MEASUREMENT TYPE = RG (Regular Grid) or PG (Post-remediation Grid). The program narrows the filter to include only these points before proceeding.

3.5.9.2. The Wilcoxon Rank Sum Test<sup>30</sup> is applicable for survey units with measurements on a single matrix type or on matrices with similar background characteristics. Where more than one matrix was present, the Sign Test for Paired Data<sup>31</sup> was used.

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<sup>30</sup> Described in Appendix I of MARSSIM.

<sup>31</sup> Described in NEXTEP Tech Memo 0231, Ibid.

**Table 3.5**  
**Threshold Screening Tests**

<b>Test</b>	<b>Test Criteria for PASS</b>
Min/Max	Difference between minimum background measurement and maximum survey value less than DCGL <sub>w</sub>
Background	All samples must be less than the background threshold <sup>a</sup>
DCGL <sub>w</sub>	All samples must be no more than DCGL <sub>w</sub> + the background threshold
DCGL <sub>avg</sub>	The average of all net survey values must be less than DCGL <sub>w</sub>
EMC	All samples must be less than DCGL <sub>EMC</sub> + the background threshold
Sign Test for Paired Data	The Sign Test for Paired Data is described in detail in NUREG 1505 <sup>32</sup>
Wilcoxon Rank Sum Test	This statistical test is described in detail in MARSSIM, Appendix I.

<sup>a</sup> The background threshold is equal to the mean background value plus twice  $\sigma_{BK}$ .

3.5.10. The output of the Threshold Comparison Test Report (TCTR) was used for analysis of the data for each survey unit and the results are presented in Appendix 4. The TCTR is divided into eight sections which are briefly described in the following paragraphs to assist the unfamiliar reader.

3.5.10.1. General: date, survey unit number, class, and grid information.

3.5.10.2. Survey Unit Table: building surfaces included, affected fixed apparatus, and total surface area of the survey unit.

3.5.10.3. Initialization Data: On startup of the analysis report program, the analyst must tell the program which parameters to use while running the tests described in this section. The *Initialization Data* section of the report output displays the options that were chosen for the run. The measurement types listed are those chosen by the analyst to be included in the report. The date range chosen is also listed. The default value is "All Dates". Values for DCGL<sub>w</sub> (ARG) and DCGL<sub>EMC</sub> are also specified at the start of the run and are listed in this section. If remediated data points are included in the run, it will be noted in this section. Normally they will be excluded.

3.5.10.4. Values for DCGL<sub>w</sub> (ARG) and DCGL<sub>EMC</sub> are also specified at the start of the run and are listed in this section. Normally, the values for

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<sup>32</sup> NUREG 1505, *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*.

DCGL<sub>w</sub> and DCGL<sub>EMC</sub> are initialized to 2,600 and 13,000 dpm<sub>p</sub>/100cm<sup>2</sup> respectively. If, however, measurements within the survey unit excluded the ARG value of 2,600 dpm<sub>p</sub>/100cm<sup>2</sup>, the DCGL<sub>w</sub> initialization value was increased up to 13,000 dpm<sub>p</sub>/100cm<sup>2</sup>, the actual limit stipulated in the D Plan.

- 3.5.10.5. Survey Unit Test Status: Lists Pass/Fail status of all tests and gives a high level summary of key activity levels in the SU.
- 3.5.10.6. Points that failed tests: Lists all points that failed each specified threshold test (EMC, DCGL, and Background).
- 3.5.10.7. Points that passed all the tests: This includes the remainder of all the points in the data set. These data points have passed all the tests.
- 3.5.10.8. Summary of background data used in the calculations. This table includes the matrix materials included in the survey and the thresholds calculated for each of the tests discussed in this section.
- 3.5.10.9. Statistical Test Results: This page lists the results of the Sign Test for Paired Data or the Wilcoxon Rank Sum test, whichever is selected. If the Test Status line reads Pass then the survey unit passes the Sign Test for Paired Data. The Data Summary section lists the number of background points and the number of survey points used from the data set. If the operator selects the option to show all data, a table of all data points used in the test is printed out.
- 3.5.11. Provided all additional considerations such as scan data, swipes, sampling of removable contamination or sludge from traps, etc. indicate that the survey unit meets the release criteria, the release of the survey unit can be determined from the test report according to Table 3.6.

**Table 3.6**  
**Requirements for SU Release<sup>33</sup>**

Test	Class 1	Class 2	Class 3
Min/Max	not required <sup>a</sup>	not required <sup>a</sup>	PASS
Background	not required	not required	PASS
DCGL <sub>w</sub>	not required	PASS	PASS
DCGL <sub>avg</sub>	PASS	PASS	PASS
EMC	PASS	PASS	PASS
Sign Test for Paired Data	PASS	PASS	PASS

<sup>a</sup> Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

<sup>33</sup> See MARSSIM, Chapter 8, Table 8.2

## 4. FSS RESULTS AND DISCUSSION

### 4.1. CHARACTERIZATION DATA

4.1.1. Sixty-three direct beta measurements taken in SU-250E during characterization surveys in 1995 were included in this final status survey. Since most of the characterization data for the other survey units were taken with an HP-210 instrument, they cannot be normalized to the AB-100 calibration standards and therefore are not included in the data set.

### 4.2. SURVEY UNIT 250E

#### 4.2.1. Direct Beta Measurements on Building Surfaces

4.2.1.1. SU-250E was surveyed in April 2001. Eighty-eight direct beta measurements were taken on the wall surfaces. 25 of these were included in the systematic grid.<sup>34</sup> A diagram of the survey unit layout of the east wall with the beta measurements taken is presented in Appendix 2, Figure 4.1.

4.2.1.2. A summary of the direct measurement results is presented in Table 4.1 and shows that the maximum activity measured, net of background, was 139 dpm<sub>p</sub>/100cm<sup>2</sup>. The average value for the survey unit was 14 dpm<sub>p</sub>/100cm<sup>2</sup>.

**Table 4.1**  
***SU-250E Direct Measurements Summary***

Matrix	Points	Avg Net Activity <sup>a</sup> (dpm <sub>p</sub> /100cm <sup>2</sup> )	Max Net Activity (dpm <sub>p</sub> /100cm <sup>2</sup> )
Brick	39	-9.3	51.5
Concrete	5	43.9	138.6
Metal	5	15.1	77.3
Other Non Metal	28	34.6	90.1
Transite Wall	10	31.4	80.4
Wood	1	-11.6	-11.6

<sup>a</sup> Net values are survey measurements less average matrix background.

#### 4.2.2. Direct Beta Measurements on Installed Apparatus

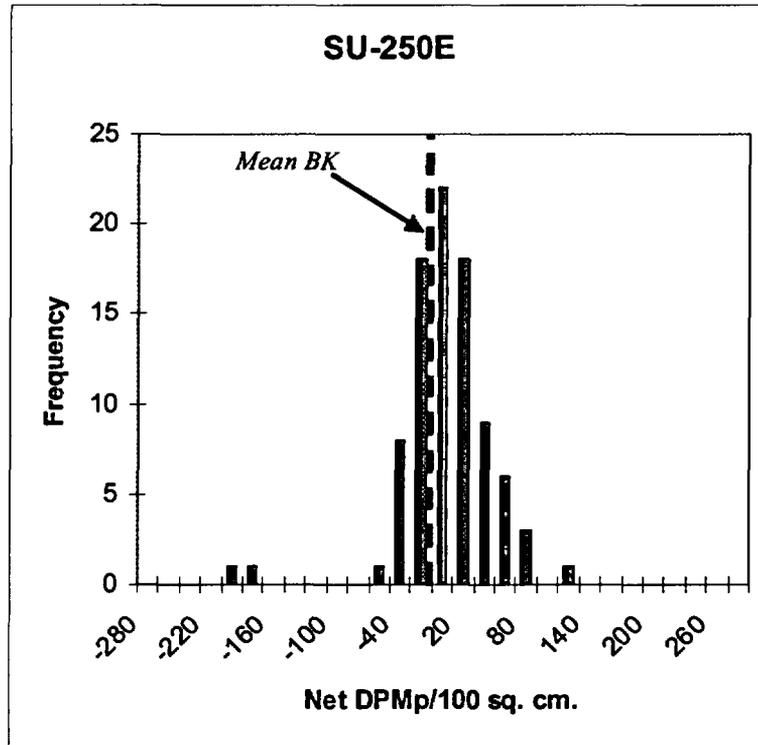
4.2.2.1. The installed apparatus for SU-250E was included in SU-250S.

#### 4.2.3. Direct Beta Measurement Distribution and Threshold Tests

4.2.3.1. A histogram of all the beta direct net activity values found in SU-250E is provided in Figure 4.1. The distribution appears to have a single mode with the majority of the data centered at approximately

<sup>34</sup> Offsets of up to 15% of the grid spacing was allowed in case of obstructions.

10 dpm<sub>p</sub>/100cm<sup>2</sup>. This is consistent with a normal distribution of background radioactivity.



**Histogram of Net Direct Beta Measurements**  
**Figure 4.1**

4.2.3.2. All the direct measurements in the survey unit were analyzed using the Threshold Comparison Test Report (TCTR) and the results are presented in Appendix 4 for SU-250E. The TCTR report contains a complete listing of all the beta direct measurements taken in the Final Status Survey within SU-250E sorted by room, surface, and activity. The summary pages indicate that all tests described in the D Plan passed except for the background test. A comparison of test results and requirements for release of the survey unit is presented in Table 4.2. All tests required for release of a Class 2 survey unit passed.

**Table 4.2**  
**Requirements for SU Release<sup>a</sup>**

Test	Class 2	SU-250E
Min/Max	not required <sup>a</sup>	P
Background	not required	F
DCGL <sub>w</sub>	PASS	P
DCGL <sub>avg</sub>	PASS	P
EMC	PASS	P
Sign Test for Paired Data	PASS	P

<sup>a</sup> Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

**4.2.4. Beta Scan Measurements**

4.2.4.1. Beta scans were performed on about 10% of the surface of the wall not including the transite wall panels that were removed. The scan threshold used for these surveys was 2,000 cpm (net of background) which corresponds to the ARG of 2,600 dpm<sub>p</sub>/100cm<sup>2</sup>.

4.2.4.2. The background values used for beta scans on the east wall of Building 250 was the average open window reading on each matrix in the background data set. Where no background data were on file for a given matrix, a value of zero was used for background. A list of the backgrounds used is presented by matrix in Table 4.3.

**Table 4.3**  
**Beta Scan Backgrounds for SU-250E**

Matrix	Background (cpm)
B	550
C	330
M	170
W	160

4.2.4.3. No net scan measurements were observed in SU-250E that exceeded the beta scan threshold listed in Table 2.6.

**4.3. SURVEY UNIT 250S**

**4.3.1. Direct Beta Measurements on Building Surfaces**

4.3.1.1. SU-250S was surveyed in October 2003. Thirty-one direct beta measurements were taken on the wall surface. All of these were included in the systematic grid. A diagram of the survey unit layout

with the beta measurements taken is presented in Appendix 2, Figure 4.2.

4.3.1.2. A summary of the direct measurement results is presented in Table 4.4 and shows that the maximum activity measured, net of background, was 157 dpm<sub>p</sub>/100cm<sup>2</sup>. The average value for the survey unit was 28 dpm<sub>p</sub>/100cm<sup>2</sup>. No direct beta measurements were observed on the wall surfaces of SU-250S that exceeded 6% of the ARG.

**Table 4.4**  
***SU-250S Direct Measurements Summary***

<b>Matrix</b>	<b>Points</b>	<b>Avg Net Activity<sup>a</sup></b> <b>(dpm<sub>p</sub>/100cm<sup>2</sup>)</b>	<b>Max Net Activity</b> <b>(dpm<sub>p</sub>/100cm<sup>2</sup>)</b>
Brick	13	31.5	105.5
Metal	4	24.0	157.3
Transite Wall	14	24.8	76.9

<sup>a</sup> Dpm<sub>p</sub> refers to disintegrations per minute of the parent nuclide series.

#### 4.3.2. Direct Beta on Installed Apparatus

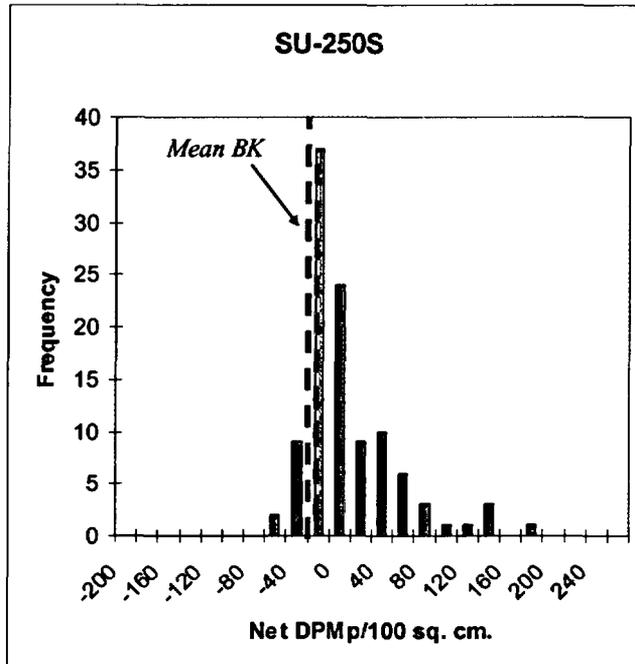
4.3.2.1. All 18 items of installed apparatus assigned to SU-250S (listed in Appendix 1) were surveyed by direct beta measurements. A summary of the measurements taken is provided in Table 4.5 sorted by matrix. The net values observed ranged from -35 to 185 dpm<sub>p</sub>/100cm<sup>2</sup>. All measurements taken on installed apparatus in SU-250S were less than 8% of the ARG.

**Table 4.5**  
***SU-250S Fixed Equipment Direct Measurements Summary***

<b>Matrix</b>	<b>Points</b>	<b>Avg Net Activity</b> <b>(dpm<sub>p</sub>/100cm<sup>2</sup>)</b>	<b>Max Net Activity</b> <b>(dpm<sub>p</sub>/100cm<sup>2</sup>)</b>
Fiberglass	1	29.5	29.5
Metal	74	14.6	184.7

#### 4.3.3. Direct Beta Measurement Distribution and Threshold Tests

4.3.3.1. A histogram of all the beta direct net activity values found in SU-250S is provided in Figure 4.2. The data are skewed to the right. This is consistent with a normal distribution of background radioactivity and another distribution of residual activity just above background.



**Histogram of Net Direct Beta Measurements**  
**Figure 4.2**

4.3.3.2. All the direct measurements in the survey unit were analyzed using the Threshold Comparison Test Report (TCTR) and the results are presented in Appendix 4 for SU-250S. The TCTR report contains a complete listing of all the beta direct measurements taken in the Final Status Survey within SU-250S sorted by activity. The summary pages indicate that all tests described in the D Plan passed except for the background test. A comparison of test results and requirements for release of the survey unit is presented in Table 4.6. SU-250S passed all the tests required of a Class 2 survey unit.

**Table 4.6**  
**Requirements for SU Release<sup>a</sup>**

Test	Class 2	SU-250S
Min/Max	not required <sup>a</sup>	P
Background	not required	F
DCGL <sub>w</sub>	PASS	P
DCGL <sub>avg</sub>	PASS	P
EMC	PASS	P
Sign Test for Paired Data	PASS	P

<sup>a</sup> Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

4.3.3.3. As the histogram in Figure 4.2 shows, the data show background levels with some residual activity. These results are consistent with a survey unit that passes all tests except background.

4.3.4. Measurements of removable contamination

4.3.4.1. Swipes were taken at each location where a direct grid measurement was performed. The results of the measurements are presented in Table 4.7.

**Table 4.7**  
***SU-250S Removable Contamination Summary***

Surface	Points	Avg Net Beta ( $\beta\text{pm}/100\text{cm}^2$ )	Max Net Beta ( $\beta\text{pm}/100\text{cm}^2$ )	Avg Net Activity <sup>a</sup> ( $\text{dpm}_p/100\text{cm}^2$ )	Max Net Activity ( $\text{dpm}_p/100\text{cm}^2$ )
S	31	-6.2	25.0	-1.3	5.2

<sup>a</sup> Activity was converted to  $\text{dpm}_p/100\text{cm}^2$  from  $\beta\text{pm}/100\text{cm}^2$  using an approximate figure of 4.8 betas per disintegration.

4.3.4.2. The results show that removable contamination averages near zero  $\text{dpm}_p/100\text{cm}^2$  and varies between  $-6.5$  and  $+5.2\text{ dpm}_p/100\text{cm}^2$ . The data confirm that virtually no removable contamination is present within SU-250S.

4.3.5. Beta Scan Measurements

4.3.5.1. Beta scans were performed on about 15% of the surface of the wall. Diagrams of the areas surveyed are presented in Appendix 2, Figure 4.4.

4.3.5.2. The scan threshold used for these surveys was 2,000 cpm (net of background) which corresponds to the ARG of  $2,600\text{ dpm}_p/100\text{cm}^2$  as shown in Table 2.6.

4.3.5.3. All scans performed on the wall surface were taken on brick and transite. The average background value used for analysis of the brick raw data was obtained from the open window, direct beta readings (in cpm) taken in the survey unit. This value was 363 cpm. The average of all open window survey readings taken on brick in the background data set was 552 cpm. The Background used for transite was zero since no data for transite exist in the background data set.

4.3.5.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. The beta scan data are summarized for SU-250S and presented in Table 4.8.

**Table 4.8**  
***SU-250S Scan Measurements Summary***

<b>Matrix</b>	<b>Areas</b>	<b>Maximum (cpm)</b>	<b>Average (cpm)</b>	<b>Max Net (cpm)</b>	<b>Avg Net (cpm)</b>
Brick	5	400	315.0	36.8	-48.2
Transite	1	200	170.0	200.0	170.0

4.3.5.5. The maximum net scan value of 170 cpm is well below the scan threshold of 2000 cpm. No beta scan data were observed in SU-250S above the scan threshold.

**4.4. SU-250R1 – SU-250R3**

4.4.1. The original roof of SU-250R1 – SU-250R3 affected by C-T operations has been covered with new roofing material. Therefore, beta detection methods are not adequate to characterize the survey unit and gamma methods were employed instead.

**4.4.2. Direct Gamma Measurements on Building Surfaces**

4.4.2.1. A total of ninety-eight direct gamma measurements were taken on the roof of SU-250R1 – SU-250R3. All of these were included in the systematic grid. A diagram of the roof layout with the gamma measurements taken in each survey unit is presented in Appendix 2, Figure 4.3.

4.4.2.2. Gamma direct measurements were converted to  $\text{dpm}_p/100\text{cm}^2$  using the conversion factors listed in Table 2.6 and were compared with thresholds listed in the same table. These thresholds were based upon the  $\text{DCGL}_w$  rather than the ARG since survey values in excess of the ARG were known to exist within the survey unit.

4.4.2.3. A summary of the direct measurement results for SU-101R1 – SU-101R3 is presented in Table 4.9 and shows that the maximum activity measured, net of background, was  $5,400 \text{ dpm}_p/100\text{cm}^2$ . The average for the roof was  $937 \text{ dpm}_p/100\text{cm}^2$ . A complete listing of all the direct gamma measurements taken on the roof is presented in Appendix 5.

**Table 4.9**  
***SU-250R1 – SU-250R3 Direct Gamma Measurements Summary***

<b>Survey Unit</b>	<b>Matrix</b>	<b>Points</b>	<b>Avg Net Activity<sup>a</sup> (<math>\text{dpm}_p/100\text{cm}^2</math>)</b>	<b>Max Net Activity (<math>\text{dpm}_p/100\text{cm}^2</math>)</b>
250R1	Tar	31	402	3,530
250R2	Tar w/ Gravel	36	226	2,850
250R3	Tar w/ Gravel	31	2,300	5,400

<sup>a</sup>  $\text{Dpm}_p$  refers to disintegrations per minute of the parent nuclide series.

4.4.2.4. Since all the direct gamma measurements were less than the DCGL<sub>w</sub>, the data set must automatically pass the DCGL<sub>w</sub>, DCGL<sub>AVG</sub>, and EMC tests and the Sign Test for Paired Data. A comparison of the maximum survey reading (5,900 cpm) in Appendix 5 with the minimum background reading (3,254 cpm) shows that the survey unit also passed the Min/Max test. A comparison of test results and requirements for release of SU-250R1 – SU-250R3 is presented in Table 4.10.

**Table 4.10**  
**Requirements for SU Release**

Test	Class 2	SU-250R1-3
Min/Max	not required <sup>a</sup>	P
Background	not required	N/A
DCGL <sub>w</sub>	Pass	P
DCGL <sub>avg</sub>	Pass	P
EMC	Pass	P
Sign Test for Paired Data	Pass	P

<sup>a</sup> Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

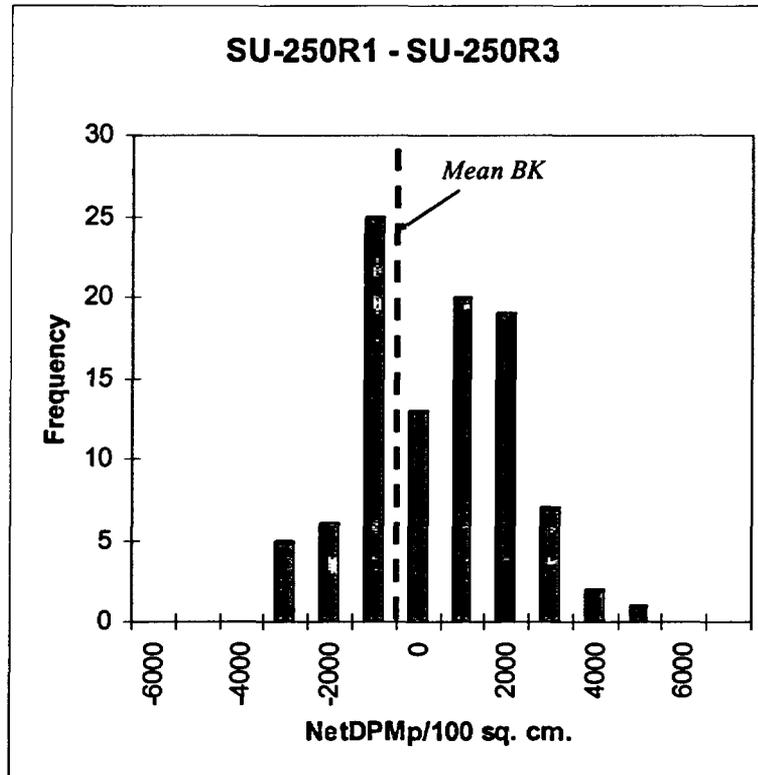
4.4.2.5. The direct gamma measurements show that SU-250R1 – SU-250R3 passed all the tests required for release of a Class 2 survey unit.

4.4.3. Direct Beta Measurements on Installed Apparatus

4.4.3.1. The installed apparatus on the roof surface was included in the survey of SU-250S.

4.4.4. Direct Gamma Measurement Distribution and Threshold Tests

4.4.4.1. A Histogram of all the gamma direct net activity values found in SU-250R1 – SU-250R3 is provided in Figure 4.3. The distribution is grouped between -1,000 and +5,000 dpm<sub>p</sub>/100 cm<sup>2</sup> and appears to be either a single background distribution or background with some residual contamination above background. All measurements were below the DCGL<sub>w</sub>.



**Histogram of Net Gamma Measurements**  
Figure 4.3

4.4.5. Measurements of Removable Contamination

4.4.5.1. Swipes were taken at all of the locations where a direct grid measurement was performed. The results of these measurements are presented in Table 4.11. The results show that removable contamination in SU-250R1 – SU-250R3 ranges between –7 and +12 dpm<sub>p</sub>/100cm<sup>2</sup>. The average for the roof is 1 dpm<sub>p</sub>/100cm<sup>2</sup>. No significant removable contamination is present in SU-250R1 – SU-250R3.

**Table 4.11**  
**SU-250R1 – SU-250R3 Removable Contamination Summary**

Survey Unit	Surface	Points	Avg Net Beta (βpm/100cm <sup>2</sup> )	Max Net Beta (βpm/100cm <sup>2</sup> )	Avg Net Activity <sup>a</sup> (dpm <sub>p</sub> /100cm <sup>2</sup> )	Max Net Activity (dpm <sub>p</sub> /100cm <sup>2</sup> )
250R1	R	31	5.8	56.0	1.2	11.7
250R2	R	36	-4.8	41.0	-1.0	8.5
250R3	R	31	15.2	44.0	3.2	9.2

<sup>a</sup> Activity was converted to dpm<sub>p</sub>/100 cm<sup>2</sup> from βpm/100 cm<sup>2</sup> using an approximate figure of 4.8 betas per disintegration.

#### 4.4.6. Gamma Scan Measurements

- 4.4.6.1. Gamma scans were performed on a total of about 15% of SU-250R1 – SU-250R3. At least 15% of each survey unit was scanned. A diagram of the areas surveyed is presented in Appendix 2, Figure 4.5.
- 4.4.6.2. The scan thresholds used for these surveys are listed in Table 2.6.
- 4.4.6.3. The average background value used for analysis of the raw data was 4,071 cpm as described in paragraph 2.3.
- 4.4.6.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. The gamma scan data for SU-250R1 – SU-250R3 are summarized and presented in Table 4.12.

**Table 4.12**  
***SU-250R1 – SU-250R3 Scan Measurements Summary***

<b>Survey Unit</b>	<b>Matrix</b>	<b>Points</b>	<b>Maximum (cpm)</b>	<b>Average (cpm)</b>	<b>Max Net (cpm)</b>	<b>Avg Net (cpm)</b>
250R1	Tar/Roofing	4	6000	3875.0	1929.0	-196.0
250R2	Tar/Roofing	3	5000	4433.3	929.0	362.3
250R3	Tar/Roofing	3	5500	4366.7	1429.0	295.7

- 4.4.6.5. No gamma scan data were observed in SU-250R1-R3 which exceeded the scan threshold.

## 5. CONCLUSIONS

### 5.1. SU-250E

- 5.1.1. SU-250E passed all the tests described in the D Plan except background. All tests required for release of a Class 2 survey unit were passed. (Par. 4.2.3.2)
- 5.1.2. No beta scan data were observed in SU-250E above the scan threshold of 2,000 cpm. (Par. 4.2.4.3)
- 5.1.3. SU-250E meets all the requirements of the D Plan for unconditional release.

### 5.2. SU-250S

- 5.2.1. SU-250S passed all the tests described in the D Plan except background. All tests required of a Class 2 survey unit were passed. (Par. 4.3.3.2)
- 5.2.2. No residual activity above 8% of the ARG was measured on the installed apparatus of SU-250S. (Par. 4.3.2.1)

- 5.2.3. No significant removable contamination was measured in SU-250S. (Par. 4.3.4.2)
- 5.2.4. No beta scan data were observed in SU-250S above the scan threshold. (Par. 4.3.5.5)
- 5.2.5. SU-250S meets all the requirements of the D Plan for unconditional release.

### 5.3. SU-250 ROOF

- 5.3.1. SU-250R1 – SU-250R3 passed all the tests described in the D Plan which are required of a Class 2 survey unit. (Par. 4.4.2.4 & 4.4.2.5)
- 5.3.2. No significant removable contamination was measured in SU-250R1 – SU-250R3. (Par. 4.4.5.1)
- 5.3.3. No gamma scan data were observed in SU-250R1 – SU-250R3 which exceeded the gamma scan thresholds. (Par. 4.4.6.5)
- 5.3.4. SU-250R1 – SU-250R3 meet all the requirements of the D Plan for unconditional release.

## 6. RECOMMENDATIONS

- 6.1. The external surfaces of Building 250 should be released from the license.

**Appendix 1**  
**Building Survey Unit Listing for**  
**Building 250 Exterior**

## *Building Survey Unit Listing*

<i>SurfaceCode</i>	<i>Xmax</i>	<i>Ymax</i>	<i>Area (sq.ft.)</i>	<i>Paint (Coats)</i>	<i>Description</i>
<b><i>SurveyUnitID: 250E</i></b>					<b><i>Class: 2</i></b>
<b><i>Room 999</i></b>					
E	238.5	48.6	7.700	0.0	
<b><i>Summary for Room 999 (1 detail record)</i></b>				<b><i>7,700 Sq. Feet</i></b>	
<b><i>TOTAL for Survey Unit 250E</i></b>				<b><i>7,700 Sq. Feet</i></b>	

## *Building Survey Unit Listing*

<i>SurfaceCode</i>	<i>Xmax</i>	<i>Ymax</i>	<i>Area (sq.ft.)</i>	<i>Paint (Coats)</i>	<i>Description</i>
<b>SurveyUnitID: 250S</b>					<b>Class: 2</b>
<b>Room 999</b>					
S	93	48.6	4,350	0.0	Includes S wall of stairwell
Q1				0.0	Drains (5)
Q2				0.0	Blowers (26) and associated ducting
Q3				0.0	Parapet Wall
Q4				0.0	Vent, air handler foundation
Q5				0.0	Glass vents (10)
Q6				0.0	Access Ladders (4)
Q7				0.0	Exhaust Vents (9)
Q8				0.0	Air handlers (3) and associated ducting
Q9				0.0	Hatches (3)
Q10				0.0	Small Vents on middle and south sections (~28)
Q11				0.0	Piping runs
Q12				0.0	Large blower and associated ducting
Q13				0.0	Lighting (2) on south wall
Q14				0.0	Vertical Ducting on south wall
Q15				0.0	Piping (2) on south wall
Q16				0.0	Vent on south addition
Q17				0.0	Piping and brackets
Q18				0.0	Piping (4) vertical runs on south wall

*Summary for Room 999 (19 detail records)*

**4,350 Sq. Feet**

**TOTAL for Survey Unit 250S**

**4,350 Sq. Feet**

# *Building Survey Unit Listing*

<i>SurfaceCode</i>	<i>Xmax</i>	<i>Ymax</i>	<i>Area (sq.ft.)</i>	<i>Paint (Coats)</i>	<i>Description</i>
<b><i>SurveyUnitID: 250R1</i></b>			<b><i>Class: 2</i></b>		
<b><i>Room 9991</i></b>					
R	84	57.5	4,030	0.0	Incl south extension rm.
<b><i>Summary for Room 9991 (1 detail record)</i></b>				<b><i>4,030 Sq. Feet</i></b>	
<b><i>TOTAL for Survey Unit 250R1</i></b>				<b><i>4,030 Sq. Feet</i></b>	

## *Building Survey Unit Listing*

<i>SurfaceCode</i>	<i>Xmax</i>	<i>Ymax</i>	<i>Area</i> <i>(sq.ft.)</i>	<i>Paint</i> <i>(Coats)</i>	<i>Description</i>
<b>SurveyUnitID: 250R2</b>			<b>Class: 2</b>		
<i>Room 9992</i>					
R	84	88	7,390	0.0	
<b>Summary for Room 9992 (1 detail record)</b>				<b>7,390 Sq. Feet</b>	
<b>TOTAL for Survey Unit 250R2</b>				<b>7,390 Sq. Feet</b>	

## *Building Survey Unit Listing*

	<i>SurfaceCode</i>	<i>Xmax</i>	<i>Ymax</i>	<i>Area</i> <i>(sq.ft.)</i>	<i>Paint</i> <i>(Coats)</i>	<i>Description</i>
<b><i>SurveyUnitID: 250R3</i></b>		<b><i>Class: 2</i></b>				
<b><i>Room 9993</i></b>						
	R	93	93	8,000	0.0	Includes Stairwell Roof
<b><i>Summary for Room 9993 (1 detail record)</i></b>					<b><i>8,000 Sq. Feet</i></b>	
<b><i>TOTAL for Survey Unit 250R3</i></b>					<b><i>8,000 Sq. Feet</i></b>	

**APPENDIX 2**

**Figures**

PARTIAL SITE PLAN  
SCALE: 1" = 20'

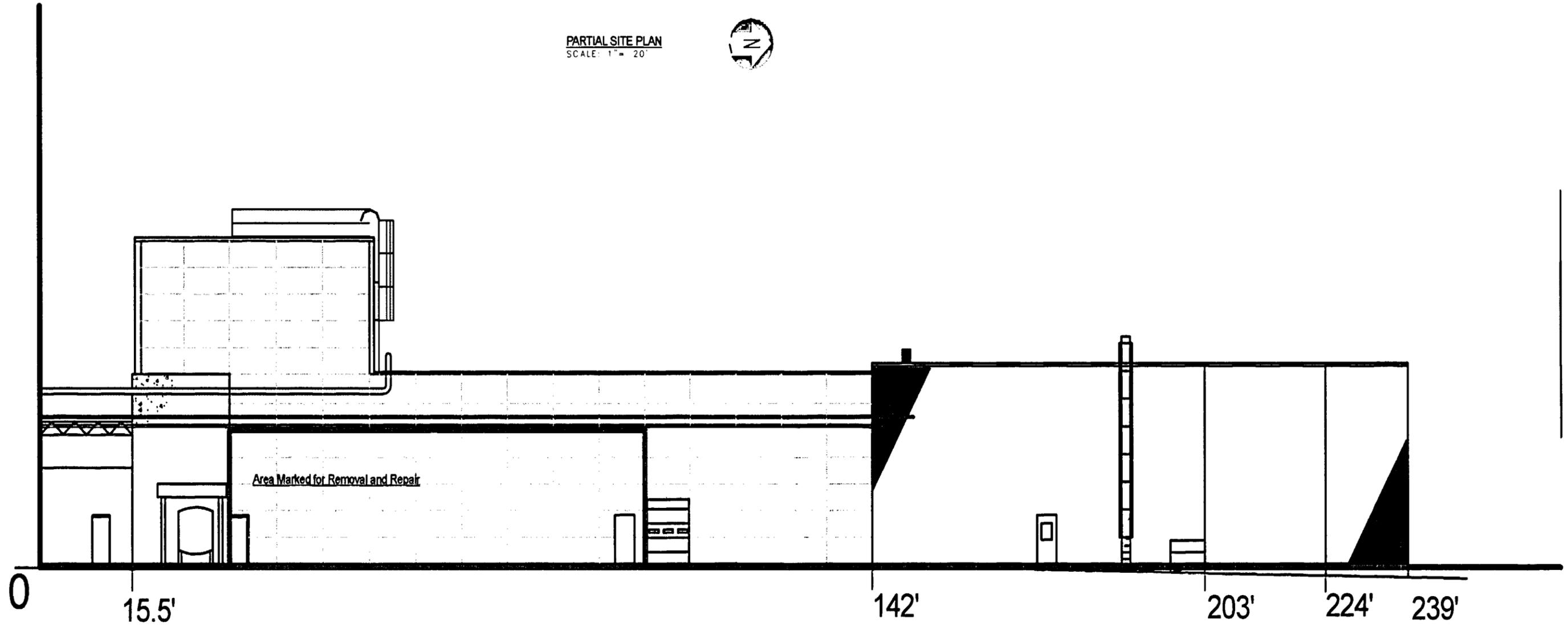
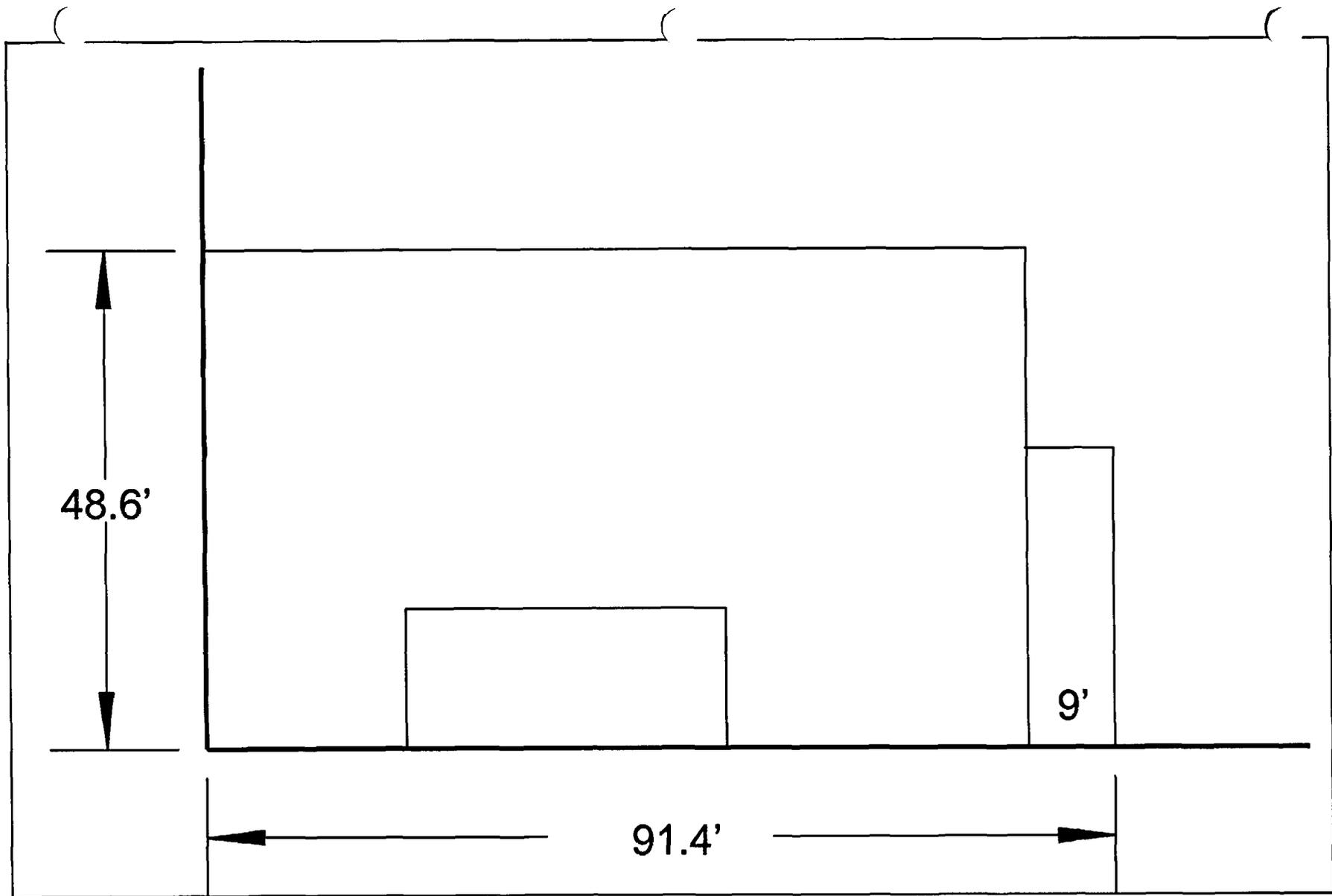
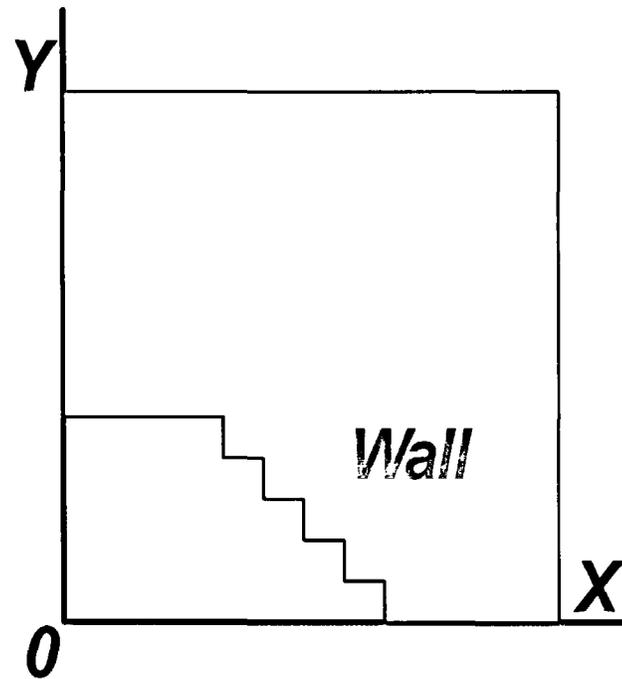
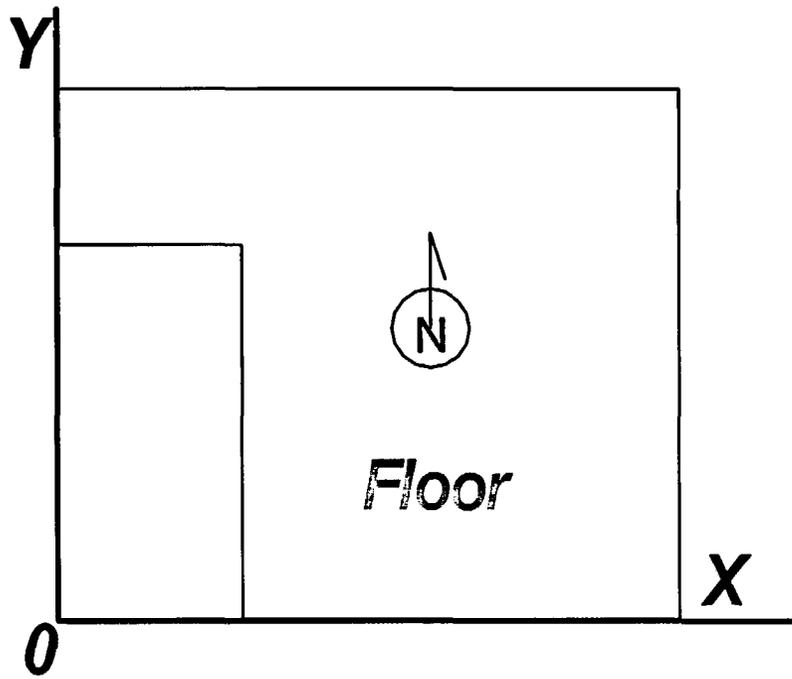


Figure 2.1  
SU-250E



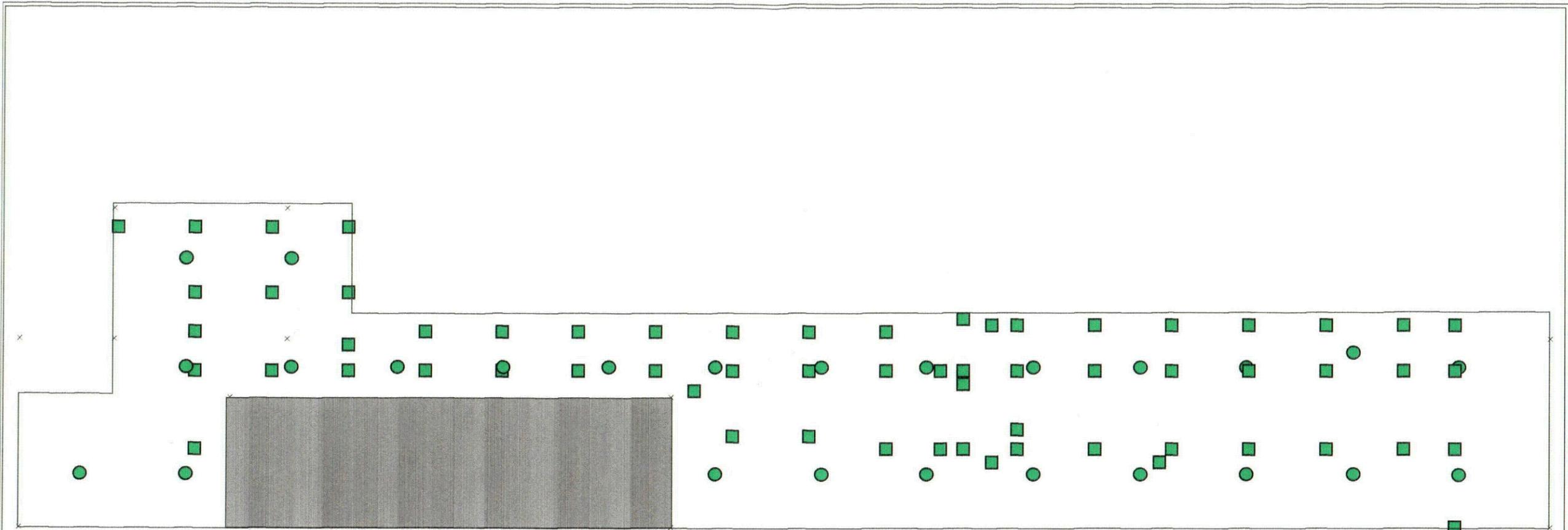
**Figure 2.2**  
*SU-250S*

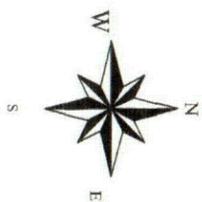
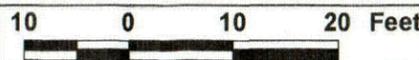


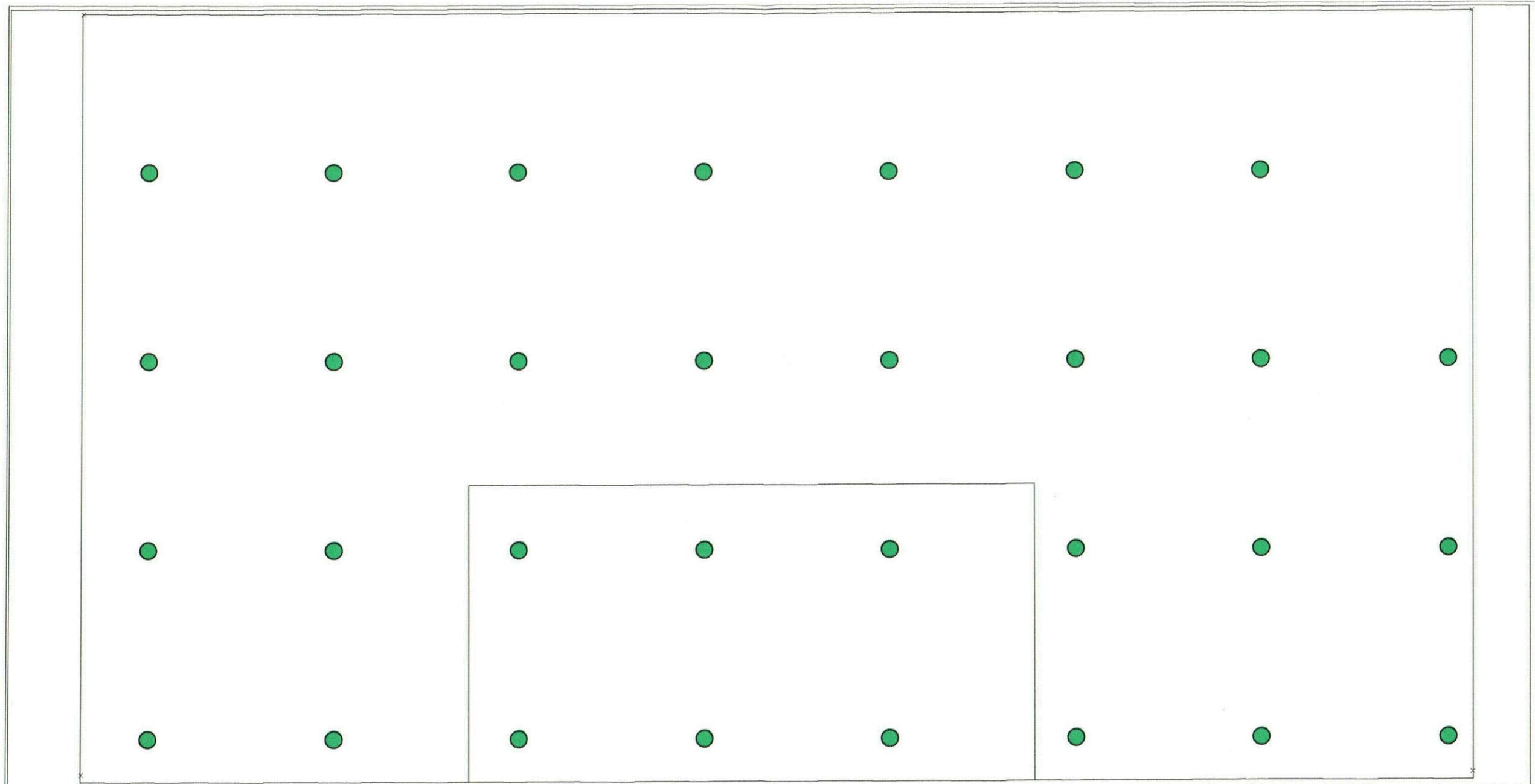


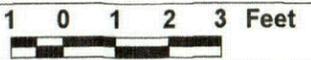
**Coordinate System**

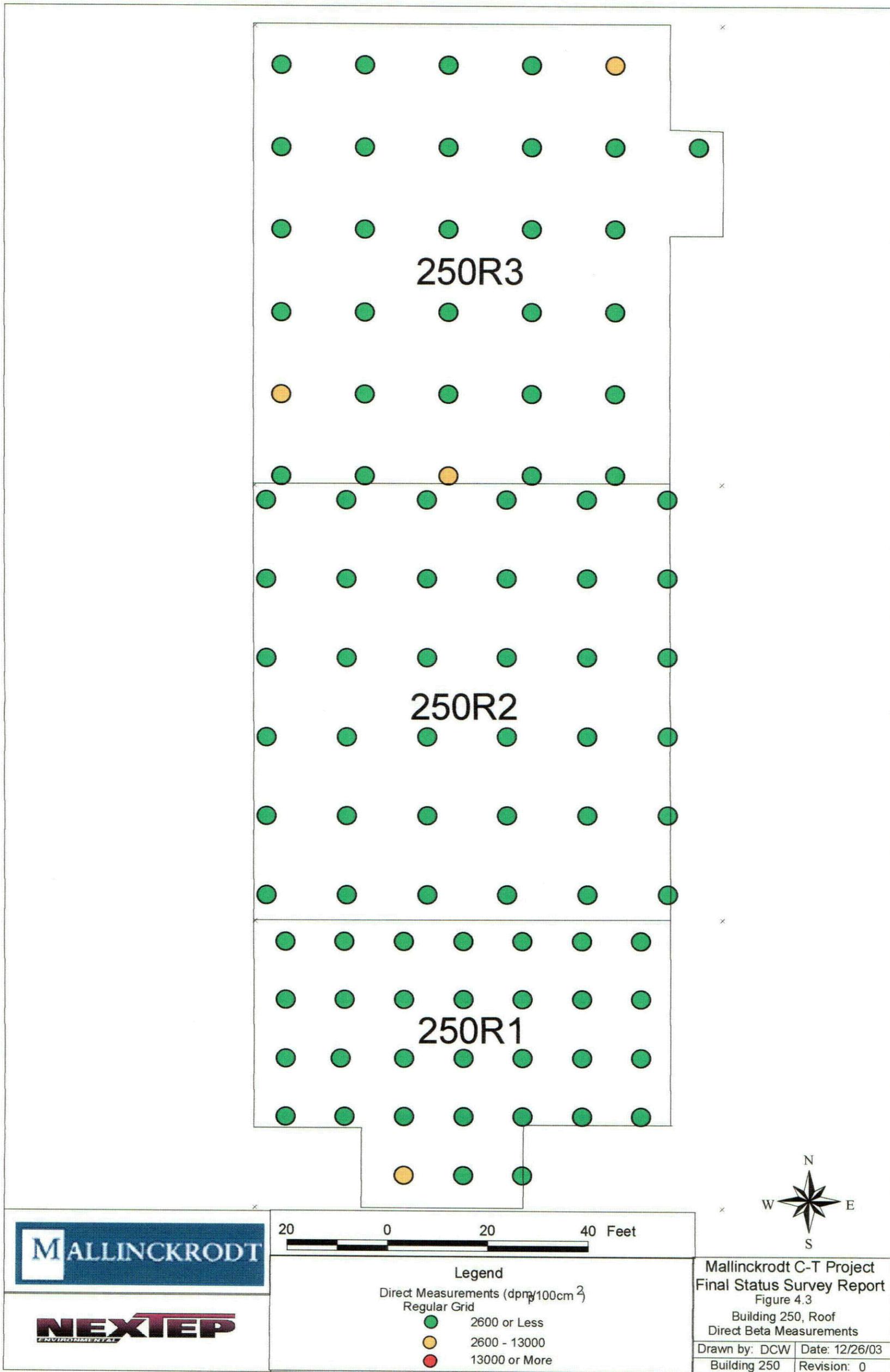
**Figure 3.1**

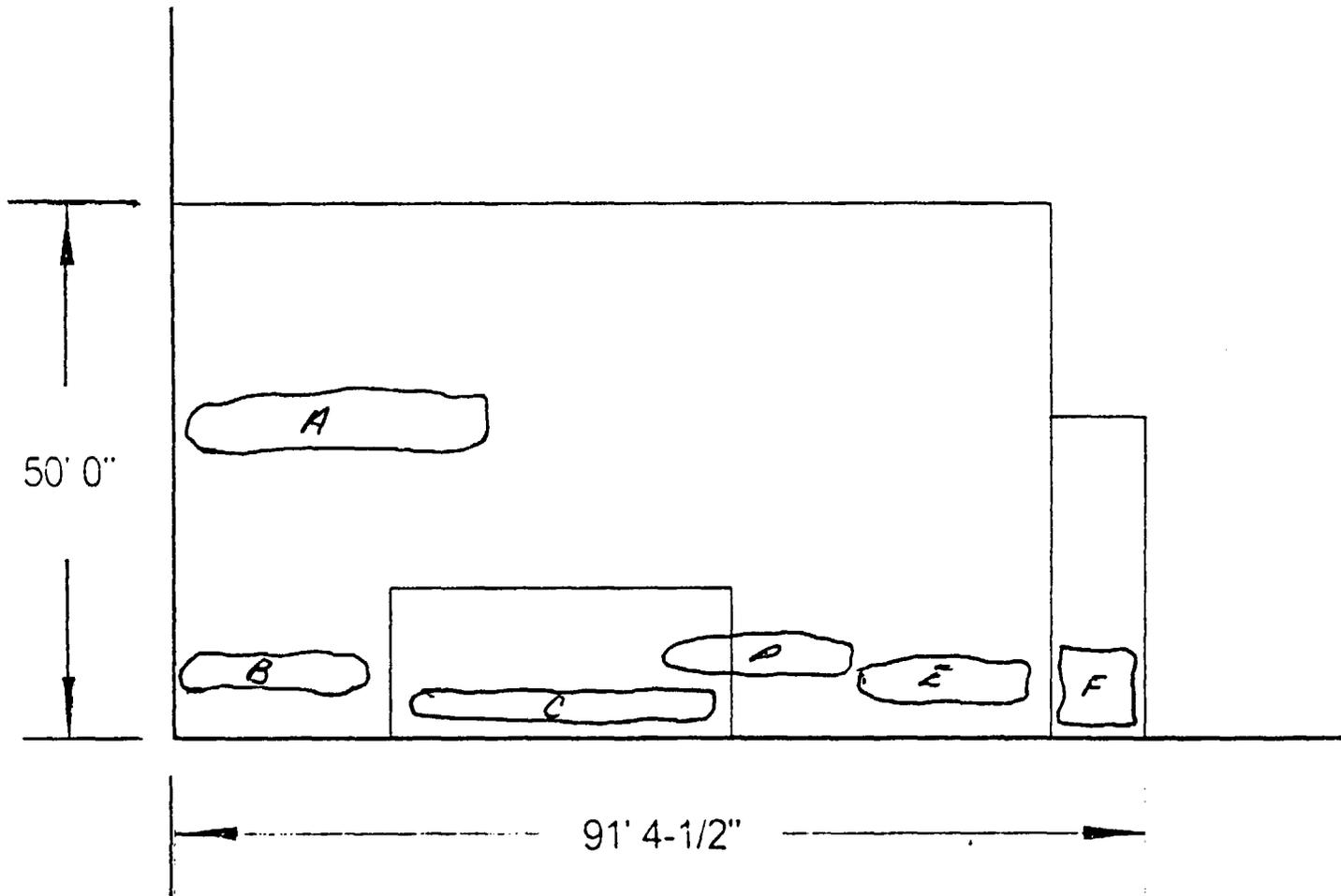


  	<p><b>Legend</b></p> <p>Direct Beta Measurements (dpm/100 cm<sup>2</sup>)</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="width: 20px;">■</td> <td>Not in Survey Unit</td> <td style="width: 20px;">●</td> <td>RG</td> <td style="width: 20px;">■</td> <td>CH</td> <td style="width: 100px;"></td> </tr> <tr> <td></td> <td></td> <td style="color: green;">●</td> <td style="color: green;">■</td> <td></td> <td></td> <td>Under 2000</td> </tr> <tr> <td></td> <td></td> <td style="color: orange;">●</td> <td style="color: orange;">■</td> <td></td> <td></td> <td>2000 - 2600</td> </tr> <tr> <td></td> <td></td> <td style="color: red;">●</td> <td style="color: red;">■</td> <td></td> <td></td> <td>2600 or More</td> </tr> </table>	■	Not in Survey Unit	●	RG	■	CH				●	■			Under 2000			●	■			2000 - 2600			●	■			2600 or More	  	<p><b>Mallinckrodt C-T Project Final Status Survey Report</b></p> <p>Figure 4.1 SU-250E Direct Beta Measurements</p> <table style="width: 100%; border: none;"> <tr> <td style="border: none; width: 50%;">Drawn by: DCW</td> <td style="border: none; width: 50%;">Date: 12/26/2003</td> </tr> <tr> <td style="border: none;">Building: 250</td> <td style="border: none;">Revision: 0</td> </tr> </table>	Drawn by: DCW	Date: 12/26/2003	Building: 250	Revision: 0
■	Not in Survey Unit	●	RG	■	CH																														
		●	■			Under 2000																													
		●	■			2000 - 2600																													
		●	■			2600 or More																													
Drawn by: DCW	Date: 12/26/2003																																		
Building: 250	Revision: 0																																		

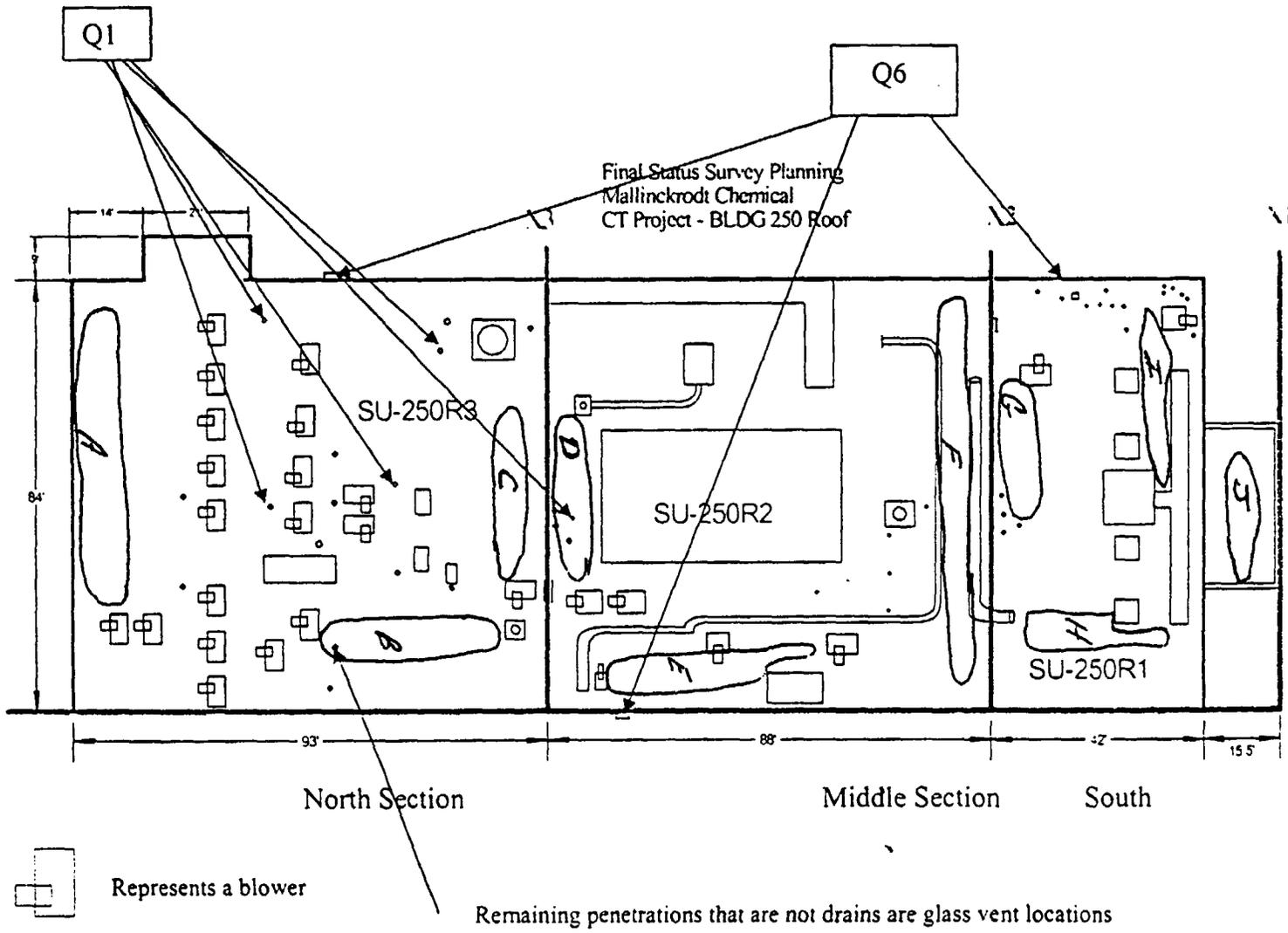


  	<p><b>Legend</b></p> <p>Direct Beta Measurements (dpm/100 cm<sup>2</sup>)</p> <p>RG BI</p> <p>● ▲ Under 2000</p> <p>● ▲ 2000 - 2600</p> <p>● ▲ 2600 or More</p>	 	<p><b>Mallinckrodt C-T Project Final Status Survey Report</b></p> <p>Figure 4.2</p> <p>SU-250S</p> <p>Direct Beta Measurements</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Drawn by: DCW</td> <td style="width: 50%;">Date: 12/26/2003</td> </tr> <tr> <td>Building: 250</td> <td>Revision: 0</td> </tr> </table>	Drawn by: DCW	Date: 12/26/2003	Building: 250	Revision: 0
Drawn by: DCW	Date: 12/26/2003						
Building: 250	Revision: 0						





**Figure 4.4**  
*Survey Unit 250S Scans*



**Figure 4.5**  
**Survey Unit 250R1 – R3 Scans**

## APPENDIX 3

### Calibration Sheets

Type	S/N	Cal Date	Sensitivity
Beta	106729/A0281	1/5/1995	0.78
	131415/426W	4/11/2001	1.10
	131415/188704	6/17/2003	0.61
Gamma	157020/020429-6	4/26/2003	
Swipe	179562	7/22/2003	

**Thermo Analytical**

TMA/Eberline  
601 Scarboro Rd.  
Oak Ridge, TN 37830  
(615) 481-0683 Fax (615) 483-1621

Site: \_\_\_\_\_  
Job #: \_\_\_\_\_

ABP-100  
AC 57  
CALIBRATION DATA SHEET

ABP-100

AC 57 SN: A 0281 Property of: EBERLINE INST.

Readout Inst.: 200 2200 SN: 106729 Cal. Exp. Date: 4-4-95

BETA  
Alpha Source: RSRY-90 SN: 1239/92 Activity: 22800 DPM

Date of Cal.: 10-3-94

PLATEAU: \* CALIBRATED @ 35mV I.S.

High Voltage	Source (CPM)	High Voltage	Source (CPM)	Background Check
600	ALPHA   BETA   BKGD	1050	203	6979 187 High Voltage CPM
650	SEC NOTE: -	1100	225	7123 219 Op. Voltage -50 NA
700	-	1150	286	7183 264 Op. Voltage =
750	-	1200	355	7382 339 Op. Voltage +50
800	1164 12	1250	8116 483	NOTE: MYLAR SHEET ADDED TO ATTENUATE ALPHA RESPONSE TO "0" CPM CONTRIBUTION. ALPHA SOURCE @ 7500 DPM NOM.
850	2172 23	1300	9863 902	
900	4111 78	1350	-	
950	5439 125	1400	-	
1000	6426 147	High Voltage set at: <u>1100</u> volts		

Efficiency:

A pos @ FORWARD CNTR POS.  
5 Minute Gross Counts: B pos @ REAR CNTR POS.

Pos "A": 34932 Pos "B": 32230  
Average (A + B)/2: 33481.0 Gross CPM: 6696.2  
Background: CPM: 296.2 Net CPM: 6400.0  
1481

Efficiency =  $\frac{\text{Net CPM}}{\text{DPM}} \times 100 = 28.1\%$

Date of Calibration: 1-5-95 Expiration Date: 7-5-95

Calibrated by: KENNETH MURPHY Kenneth Murphy  
(Print Name) (Signature)

Reviewed by: P.W. Roane Date: 1/5/95

EA4.10  
Rev: 1  
Date: 23 Jan 88

EA4.10 rev

L2200/ABP-100  
S/N: 106729/A0281  
1/5/95



Bicron  
AB-100

AG-37  
CALIBRATION DATA SHEET

AB-100

AG-37 SN: B426W

Property of: ES

(423) 481-0683 Phone  
(423) 481-0121 Fax  
www.thermoretec.com

Readout Inst.: 2241-Z

SN: 131415

Cal. Exp. Date: 4/11/02

Beta  
Alpha Source: Sr-90  
Sr-90

SN: 8-955

Activity: 6420 DPM

Date of Cal.: 10/24/00

\* @ 35 mV

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)	Background Check	
600	<u>85</u>	1060	<u>725</u>	High Voltage	<u>CPM</u>
650	<u>557</u>	1400	<u>750</u>	Op. Voltage $\pm 50$	<u>165</u>
700	<u>1429</u>	1450	<u>775</u>	Op. Voltage	<u>181</u>
750	<u>2574</u>	1200	<u>800</u>	Op. Voltage $\pm 50$	<u>218</u>
800	<u>3167</u>	1250	_____	Geometry @ Contact @ Center of Detector	
850	<u>3484</u>	1300	_____		
900	_____	1350	_____		
950	_____	1400	_____		
1000	_____	High Voltage set at: <u>775</u> volts			

Efficiency:

5 Minute Gross Counts:

Pos "A": \_\_\_\_\_  
Average (A + B)/2: \_\_\_\_\_  
Background: CPM: \_\_\_\_\_  
990

Pos "B": 286  
Gross CPM: \_\_\_\_\_  
Net CPM: \_\_\_\_\_

$14706/5 = 2941.2$  Net cpm  
 $990/5 = -198$  Net Bkg  
 $2743.2$   
 $= 6420$  dpm  
• 36 dms  
• 596 eff

Efficiency =  $\frac{\text{Net CPM}}{\text{DPM}} \times 100 = \text{_____} \%$

Date of Calibration: 4/11/01

Expiration Date: 4/11/02

Calibrated by: Randall H. Sells

Randall H. Sells

Reviewed by: [Signature]

Date: 4/12/01

EA4.10  
Rev: 2  
Date: 25 Feb 99

Page 4 of 4

A subsidiary of Thermo TerraTech Inc.,  
a Thermo Electron company

L2241-2/AB-100  
S/N: 131415/B426W  
4/11/01

CALN100A

Thermo NUtech  
For Mallinckrodt Chemical, Inc

NATIONAL NUCLEAR ABP-100

MATERIAL SPECIFIC CALIBRATION DATA SHEET

B426W  
ABP-100 SN: 131415 R45 HIGH VOLTAGE: 4MS V PROPERTY OF: ES  
READOUT INST: Lud 2241-2 SN: 131415 CAL EXPIRE DATE: 4/11/02  
ABP-100 EFFICIENCY TO SrY-90 ON 47 mm DISK: 0.376% CAL DATE: 4/11/01

SURFACE MATERIAL	BACKGROUND		BR	SOURCE		SR	Source #	SA	Efficiency SR-BR/SA
	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM		Source Activity	
Concrete	558	396	162	7989	228	7761	6-A	34000	0.224
↓	↓	↓	↓	7740	248	7492	↓	↓	0.216
↓	↓	↓	↓	7790	266	7524	↓	↓	0.217
↓	↓	↓	↓	7880	252	7628	↓	↓	0.220
272 x 125 = 34000									Average = 0.219
									Std Dev = 0.004

Wood	0	0	0	6142	237	5905	M-2	22750	0.260
↓	0	0	0	6163	271	5892	↓	↓	0.259
↓	0	0	0	6096	260	5836	↓	↓	0.257
↓	0	0	0	6233	274	5959	↓	↓	0.262
182 x 125 = 22750									Average = 0.260
									Std Dev = 0.002

Masonite	0	0	0	6011	242	5769	M-2	22750	0.254
↓	0	0	0	6145	250	5887	↓	↓	0.259
↓	0	0	0	6080	224	5856	↓	↓	0.257
↓	0	0	0	6137	240	5897	↓	↓	0.259
182 x 125 = 22750									Average = 0.255
									Std Dev = 0.007

Aluminum	0	0	0	6871	229	6642	M-2	22750	0.292
↓	0	0	0	6779	230	6549	↓	↓	0.288
↓	0	0	0	6888	254	6634	↓	↓	0.292
↓	0	0	0	6789	227	6562	↓	↓	0.288
182 x 125 = 22750									Average = 0.29
									Std Dev = 0.002

DATE OF CALIBRATION: 4/11/01 EXPIRATION DATE: 4/11/02  
 CALIBRATED BY: Randall H. Sells *Randall H. Sells*  
Print Name Signature  
 REVIEWED BY: Alan J. Grogan DATE: 4/12/01

L2241-2/AB-100  
S/N: 131415/B426W  
4/11/01

Scaler Timing @ 1 Min. Count Time			Function Check	
MP-2 @	2241-2 Response		Speaker:	<u>OK</u>
100 cpm ± 1	<u>100</u> cpm		Light:	<u>OK</u>
1000 cpm ± 1	<u>1000</u> cpm		Reset:	<u>OK</u>
10000 cpm ± 2	<u>10000</u> cpm			
100000 cpm ± 10	<u>100005</u> cpm			
<b>Rateometer</b>				
MP-2 @	2241-2	+/- 10%		
CPM	Pre	Post		
20	<u>20</u>	<u>20</u>		
80	<u>80</u>	<u>80</u>		
200	<u>200</u>	<u>200</u>		
800	<u>800</u>	<u>800</u>		
2K	<u>2.0K</u>	<u>2.0 K</u>		
8K	<u>8.0 K</u>	<u>8.0 K</u>		
20 K	<u>20.0</u> <u>80.0 K</u> EHS	<u>20.0</u> <u>80.0 K</u> EHS		
80 K	<u>80.0 K</u>	<u>80.0 K</u>		
200 K	<u>200 K</u>	<u>200 K</u>		
800 K	<u>799 K</u>	<u>799 K</u>		
Date of Calibration: <u>4/11/01</u>		Expiration Date: <u>4/11/07</u>		
Calibrated By: <u>Randall H. Sells</u> (Print Name)		<u>Randall H. Sells</u> (Signature)		
Reviewed By: <u>Alan Srigley</u>		Date: <u>4/12/01</u>		

ES 4.49  
 Rev 1:0  
 Date: 21 Feb 2001

2

L2241-2/AB-100  
 S/N: 131415/B426W  
 4/11/01

Ludlum  
43-89  
AG-3-T  
CALIBRATION DATA SHEET

43-89  
AG-3-T SN: 188704  
Readout Inst.: L2241-2  
~~Set~~  
Alpha Source: FF-514-90  
RHS  
Date of Cal.: 10-24-00

Property of: EAALT

SN: 131415 Cal. Exp. Date: 6-12-04  
SN: 2158/96 Activity: 16700 DPM

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)	Background Check	
600	<u>N/A</u>	<del>1050</del> <del>850</del>	<u>1598</u>	High Voltage	CPM
650	<u>f</u>	<del>1100</del> <del>875</del>	<u>2165</u>	Op. Voltage <del>-25</del>	<u>131</u>
700	<u>f</u>	<del>1150</del> <del>900</del>	<u>2631</u>	Op. Voltage	<u>169</u>
750	<u>f</u>	<del>1200</del> <del>925</del>	<u>3251</u>	Op. Voltage <del>+50</del>	<u>239</u>
800	<u>1552</u>	<del>1250</del> <del>950</del>	<u>3698</u>		
850	<u>2771</u>	<del>1300</del> <del>975</del>	<u>4235</u>		
900	<u>3737</u>	1350	<u>—</u>		
950	<u>4542</u>	1400	<u>—</u>		
1000	<u>5755</u>				

High Voltage set at: 900 RHS volts  
925

Efficiency:  
5 Minute Gross Counts:

Pos "A":                       
Average (A + B)/2:                       
Background: CPM:                     

Pos "B":                       
Gross CPM:                       
Net CPM:                     

1 min Qt. 3213  
1 min BKG 185  
3030 / 16700  
18.1%

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = \underline{18.1} \%$$

Date of Calibration: 6-17-03 Expiration Date: 12-17-03  
Calibrated by: Randall N. Sells                       
(Print Name) (Signature)  
Reviewed by:                      Date: 6/18/03

EA4.10  
Rev: 2  
Date: 25 Feb 99

L2241-2/L43-89  
S/N: 131415/188704  
6/17/03

CALN100A

**Thermo NUtech**  
For Mallinckrodt Chemical, Inc

**NATIONAL NUCLEAR ABP-100**  
**MATERIAL SPECIFIC CALIBRATION DATA SHEET**

43-89  
ABP-100 SN: 188704 HIGH VOLTAGE: 925 V PROPERTY OF: MALT  
READOUT INST: 2241-2 SN: 131415 CAL EXPIRE DATE: 12-12-03  
ABP-100 EFFICIENCY TO Sr-90 ON 47 mm DISK: 18.1 % CAL DATE: 6-17-03

SURFACE MATERIAL	BACKGROUND		BR	SOURCE		SR	Source #	SA	Efficiency SR-90
	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM		Source Activity	
Concrete	396	308	88	5005	181	4824	6-A	25900	18.5
↓	↓	↓	↓	4945	179	4766	↓	↓	18.1
↓	↓	↓	↓	4951	210	4741	↓	↓	18.0
↓	↓	↓	↓	5113	184	4929	↓	↓	18.7
								Average =	18.3
								Std Dev =	0.3
								259 x 100 = 25900	

SURFACE MATERIAL	BACKGROUND		BR	SOURCE		SR	Source #	SA	Efficiency SR-90
	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM		Source Activity	
Wood	0	0	0	4007	226	3781	M-2	17400	21.3
↓	0	0	0	3876	216	3660	↓	↓	21.3
↓	0	0	0	3971	211	3760	↓	↓	21.3
↓	0	0	0	3887	240	3647	↓	↓	21.0
								Average =	21.3
								Std Dev =	0.4
								174 x 100 = 17400	

SURFACE MATERIAL	BACKGROUND		BR	SOURCE		SR	Source #	SA	Efficiency SR-90
	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM		Source Activity	
Masonite	0	0	0	3964	249	3715	M-2	17400	21.4
↓	0	0	0	3889	191	3698	↓	↓	21.3
↓	0	0	0	3853	234	3619	↓	↓	21.3
↓	0	0	0	3946	198	3748	↓	↓	21.5
								Average =	21.4
								Std Dev =	0.3

SURFACE MATERIAL	BACKGROUND		BR	SOURCE		SR	Source #	SA	Efficiency SR-90
	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM		Source Activity	
Aluminum	0	0	0	4362	224	4138	M-2	17400	23.8
↓	0	0	0	4594	211	4186	↓	↓	24.1
↓	0	0	0	4358	257	4101	↓	↓	23.6
↓	0	0	0	4390	280	4160	↓	↓	23.9
								Average =	23.5
								Std Dev =	0.3

DATE OF CALIBRATION: 6-17-03 EXPIRATION DATE: 12-17-03

CALIBRATED BY: Randall H. Sells Randall H. Sells  
Print Name Signature

REVIEWED BY: Alex Jorgensen DATE: 6/18/03

@ Contact Geometry

L2241-2/L43-89  
S/N: 131415/188704  
6/17/03

# CT-RP-66 Chi Squared Test

Instrument Model #	2241	Date:	06/24/2003
Instrument Serial#	131415	Source Nuclide:	SrY90
Probe Model #	43-89	Source Serial #	2178-96
Probe Serial #	188704	Source dpm (4π):	66039 <span style="margin-left: 20px;">OK</span>
Window Setting:		Efficiency (cpm/dpm):	0.19
Threshold Setting:		Background cpm:	135.2
High Voltage:	925	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Counts	Expected	Background Counts
1	10358	10449	121
2	10405	10449	130
3	10502	10449	122
4	10336	10449	148
5	10281	10449	155
6	10198	10449	
7	10620	10449	
8	10468	10449	
9	10454	10449	
10	10328	10449	
11	10525	10449	
12	10403	10449	
13	10382	10449	
14	10418	10449	
15	10471	10449	
16	10669	10449	
17	10552	10449	
18	10690	10449	
19	10392	10449	
20	10525	10449	

sample mean (xbar) =	10449	Multiplier to convert	
sample variance (s^2) =	15903	to dpm:	5.4
background variance (b^2) =	239.7		
sample sigma (s) =	127		
(95% Confidence) 2.752 s =	350		
(99% Confidence) 3.615 s =	459		

df = n-1 =	19	MDA(cpm) =	57
chitest = p(x<χ^2) =	6.727E-02	MDA(dpm) =	306
chi-square (χ^2) =	28.919		

Acceptable χ^2 min =	8.907
Acceptable χ^2 max =	32.852
χ^2 test passes (yes/no)?	YES

99% Conf. Interval Test min =	9854
95% Conf. Interval Test min =	9964
Daily Source Check Mean Net Counts	10313
95% Conf. Interval Test max =	10663
99% Conf. Interval Test max =	10773

Test performed by: Steve Struck

Checked by:

Date:

L2241-2/L43-89  
S/N: 131415/188704  
6/17/03



Designer and Manufacturer  
of  
Scientific and Industrial  
Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.  
POST OFFICE BOX 810 PH. 325-235-5494  
501 OAK STREET FAX NO. 325-235-4572  
SWEETWATER, TEXAS 79556 U.S.A.

CUSTOMER TYCO/MALLINCKRODT ST LOUIS ORDER NO. 296103/271822

By Ludlum Measurements, Inc. Model 2221 Serial No. 157020

Mfg. Ludlum Measurements, Inc. Model 3x3 Serial No. 020429-6

Cal. Date 26-Apr-03 Cal Due Date 26-Apr-04 Cal. Interval 1 Year Meterface 202-159

Check mark  applies to applicable instr. and/or detector IAW mfg. spec. T. 77 °F RH 31 % Alt 693.6 mT (AG)

New Instrument  Instrument Received  Within Toler.  $\pm 10\%$   10-20%  Out of Tol.  Requiring Repair  Other-See comments

Mechanical ck.  Meter Zeroed  Background Subtract  Input Sens. Linearity

F/S Resp. ck.  Reset ck.  Window Operation  Geotransp.

Audio ck.  Alarm Setting ck.  Batt. ck. (Min. Volt) 5.0 VDC

Calibrated in accordance with LMI SOP 14.8 rev 12/05/89.  Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comments mV Def. Oper. Comments V at Comments Threshold Dial Ratio 100=10 mV

HV Readout (2 points) Ref./Inst. 500 / 499 V Ref./Inst. 2000 / 1990 V

COMMENTS:

Peak settings	Gross Counts	Model 2221 currently set for Gross counts
High Voltage: <u>434 v</u>	<u>650v</u>	High voltage set with detector connected.
Threshold dial: <u>642</u>	<u>100 (10mv)</u>	
Window dial: <u>40</u>	<u>n/a</u>	
Window Position: <u>"IN"</u>	<u>"OUT"</u>	
Resolution for Cs137: <u>= 10</u>	<u>n/a</u>	Firmware: <u>26 10 10</u>

Gamma Calibration: GM detector positioned perpendicular to source except for M 44-B in which the front of probe face is aimed.

RANGE/MULTIPLIER	REFERENCE CAL POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1000	400 Kcpm	390	390
X 1000	100 Kcpm	100	100
X 100	40 Kcpm	390	390
X 100	10 Kcpm	110	110
X 10	4 Kcpm	390	390
X 10	1 Kcpm	110	110
X 1	400 cpm	400	400
X 1	100 cpm	100	100

\*Uncertainty within  $\pm 10\%$  C.F. within  $\pm 20\%$

ALL Range(s) Calibrated Electronically

REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital readout	400 K cpm	39810 (e)	Log Scale	500 K cpm	450K
	40 K cpm	3984 (e)		60 K cpm	50K
	4 K cpm	398 (e)		6 K cpm	4.5K
	400 cpm	40 (e)		500 cpm	500
	40 cpm	4 (e)		50 cpm	55

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of their International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LC-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N  1162  G112  M565  6105  T1008  T879  E562  E551  Neutron Am-241 So S/N 6524

Alpha S/N \_\_\_\_\_  Beta S/N \_\_\_\_\_  Other \_\_\_\_\_

1 m 500 S/N 81084  Oscilloscope S/N \_\_\_\_\_  Multimeter S/N 80042300

Calibrated By: Michael J Thomas Date 26-April-03

Reviewed By: Robert Harris Date 30 Apr 03

The certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc. FORM C22A 04/09/2003

AC Inst. Only  Passed Dielectric (Hi-Pot) and Continuity Test  Failed: \_\_\_\_\_

L2221/3x3  
S/N: 157020/020429-6  
4/26/03



# CT-RP-66

## Chi Squared Test

Instrument Model #	2221	Date:	05/07/2003
Instrument Serial#	157020	Source Nuclide:	Cs137
Probe Model #	Nal 3x3	Source Serial #	2558
Probe Serial #	020429-6	Source dpm (4 $\pi$ ):	21534000
Window Setting:	3700 <del>3480</del>	Efficiency (cpm/dpm):	0.01
Threshold Setting:	100mV <del>104</del>	Background cpm:	3676.2
High Voltage:	850V	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	<u>Gross Counts</u>	<u>Expected</u>	<u>Background Counts</u>
	<u>Observed</u>		
1	226801	227689	3624
2	227278	227689	3830
3	228251	227689	3610
4	227614	227689	3701
5	228344	227689	3616
6	228847	227689	
7	227269	227689	
8	227708	227689	
9	227138	227689	
10	227004	227689	
11	227520	227689	
12	227819	227689	
13	228808	227689	
14	228889	227689	
15	227778	227689	
16	227078	227689	
17	227572	227689	
18	227573	227689	
19	227841	227689	
20	227443	227689	

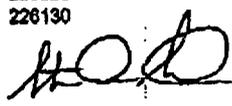
sample mean ( $\bar{x}$ ) =	227689	Multiplier to convert	
sample variance ( $s^2$ ) =	334344	to dpm:	94.8
background variance ( $b^2$ ) =	8750.2		
sample sigma ( $s$ ) =	588		
(95% Confidence) $2.752 s =$	1612		
(99% Confidence) $3.615 s =$	2117		

df = n-1 =	19	MDA (cpm) =	285
chitest = $p(x^2)$ =	8.637E-02	MDA (dpm) =	26948
chisquare ( $x^2$ ) =	27.800		

Acceptable $x^2$ min =	8.907
Acceptable $x^2$ max =	32.852
$x^2$ test passes (yes/no)?	YES

99% Conf. Interval Test min =	221895
95% Conf. Interval Test min =	222401
Daily Source Check Mean Net Counts	224013
95% Conf. Interval Test max =	225625
99% Conf. Interval Test max =	226130

Test performed by: S Struck

 5-7-2003

Checked by:

Date:

L2221/3x3  
S/N: 157020/020429-6  
4/26/03

# CT-RP-66 Chi Squared Test

Instrument Model #	2221	Date:	06/04/2003
Instrument Serial#	157020	Source Nuclide:	Cs137
Probe Model #	NaI 3x3	Source Serial #	2538-99
Probe Serial #	020429-6	Source dpm (4π):	2288600
Window Setting:	3680	Efficiency (cpm/dpm):	0.01
Threshold Setting:	104mV	Background cpm:	3985.8
High Voltage:	650V	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Observed	Expected	Background Counts
1	28742	28492	4019
2	28702	28492	4066
3	28477	28492	3976
4	28166	28492	3904
5	28711	28492	3964
6	28701	28492	
7	28491	28492	
8	28304	28492	
9	28412	28492	
10	28867	28492	
11	28084	28492	
12	28349	28492	
13	28087	28492	
14	28460	28492	
15	28454	28492	
16	28682	28492	
17	28441	28492	
18	28716	28492	
19	28608	28492	
20	28592	28492	

sample mean ( $\bar{x}$ ) =	28492	Multiplier to convert	
sample variance ( $s^2$ ) =	44336	to dpm:	80.3
background variance ( $b^2$ ) =	3699.2		
sample sigma ( $s$ ) =	219		
(95% Confidence) $2.752 s =$	603		
(99% Confidence) $3.815 s =$	792		

df = n-1 =	19	MDA (cpm) =	297
chitest = $p(x < \chi^2)$ =	5.759E-02	MDA (dpm) =	23801
chisquare ( $\chi^2$ ) =	29.866		

Acceptable $\chi^2$ min =	8.907
Acceptable $\chi^2$ max =	32.852
$\chi^2$ test passes (yes/no)?	YES

99% Conf. Interval Test min =	23714
95% Conf. Interval Test min =	23903
Daily Source Check Mean Net Counts	24508
95% Conf. Interval Test max =	25110
99% Conf. Interval Test max =	25299

Test performed by: S Struck 6-4-03

Checked by: \_\_\_\_\_ Date: \_\_\_\_\_

L2221/3x3  
S/N: 157020/020429-6  
4/26/03



Designer and Manufacturer  
of  
Scientific and Industrial  
Instruments

### CERTIFICATE OF CALIBRATION

**LUDLUM MEASUREMENTS, INC.**  
POST OFFICE BOX 810 PH. 325-235-6494  
501 OAK STREET FAX NO. 325-235-4672  
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER TYCO/MALLINCKRODT ORDER NO. 2005461274002  
Mfg. Ludlum Measurements, Inc. Model 3030 Serial No. 179562

Cal. Date 22-Jul-03 Cal Due Date 22-Jan-04 Cal. Interval 6 Months

Check mark  applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 39 % Alt 703.8 mm Hg  
 New Instrument  Instrument Received  Within Toler. +10%  10-20%  Out of Tol.  Requiring Repair  Other-See comments  
 Mechanical ck.  Window Operation  
 Audio ck.

Alpha Sensitivity 120 mV Beta Sensitivity 4 mV Beta Window 50 mV

Calibrated in accordance with LMI SOP 14.8 rev 12/05/89.

Instrument Volt Set 650 V High Voltage set with detector connected.

HV Readout (2 points) Ref./Inst. 501 / 500 V Ref./Inst. 1512 / 1500 V

(EEPROM Settings)

(PC) Count Time: 1.0

Alpha Alarm: 999999 cpm

Beta Alarm: 999999 cpm

Alpha/Beta Alarm: 999999 cpm

Calibration Due Date: 01/22/2004

LOC (Loss of Count) time = 30 minutes (default)

EC mode turned OFF.

Firmware version: 3901340

Overload set at 1/4 turn past OFF.

Battery voltage measured at 1.36 Vdc.

6.4 Efficiency = 7.1 % (4 pt) Net

Alpha Channel	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	<u>400K cpm</u>	<u>399903</u>	<u>399903</u>
	<u>40K cpm</u>	<u>39992</u>	<u>39992</u>
	<u>4K cpm</u>	<u>3995</u>	<u>3995</u>
	<u>400 cpm</u>	<u>400</u>	<u>400</u>
	<u>40 cpm</u>	<u>40</u>	<u>40</u>

Beta/Gamma Channel	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	<u>400K cpm</u>	<u>399507</u>	<u>399507</u>
	<u>40K cpm</u>	<u>39952</u>	<u>39952</u>
	<u>4K cpm</u>	<u>3997</u>	<u>3997</u>
	<u>400 cpm</u>	<u>400</u>	<u>400</u>
	<u>40 cpm</u>	<u>40</u>	<u>40</u>

\*Counts per minute within ± 10% C.F. within ± 20%

(0) Indicates 0.1 minute count

COMMENTS:

EC5. For Th-230 s/n 2748-00, 3070cpm read 2377 in 1 minute = 77% 2pi

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. This calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LD-1963

Reference Instruments and/or Sources:

Alpha S/N \_\_\_\_\_  Beta S/N \_\_\_\_\_  Other \_\_\_\_\_  
 m 500 S/N 134709  Oscilloscope S/N \_\_\_\_\_  Multimeter S/N 57390613

Calibrated By: Conrad Johnson Date 22 Jul 03

Reviewed By: WJ Rubin Date 22 July 03

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FORM C23-3 04/29/2003

AC Int.  Passed Dielectric (Hi-Pot) and Continuity Test  
Only  Failed:

L3030  
S/N: 179562  
7/22/03

Radium Measurements, Inc.  
 Model 3030 Plateau Data

7/22/03  
 8:48:42 AM

Header 1: John Q Public  
 Header 2: Serial#179562  
 Header 3: Site:Building 1  
 Header 4: Room 7 EastWall  
 Header 5: More Comments?  
 Header 6: More Comments?

Calibration Due Date: 5/8/03

Model 3030 Date: 7/19/04  
 Model 3030 Time: 8:32:16 AM

User PC Time: 1.0

Alpha Isotope: Pu-239  
 Alpha Source Size (dpm): 25200  
 Alpha Source Size (uCi): 0.011351351

Beta Isotope: Tc-99  
 Beta Source Size (dpm): 22600  
 Beta Source Size (uCi): 0.01018018

Starting High Voltage: 600  
 Starting High Voltage: 750  
 High Voltage Increment: 25

Platform Count Mode: SCALER  
 Source Count Time (min): 0001.0  
 Background Count Time (min): 1.0

EVT	Source (Beta)	ALPHA			BETA			
		Background	Eff	Crosstalk	Source (Alpha)	Background	Eff	Crosstalk
100	9387 (383)	0	37.3%	3.7%	4580 (2)	32	20.1%	0.0%
625	9455 (358)	1	37.5%	3.5%	5493 (3)	29	24.2%	0.0%
550	9483 (363)	0	37.6%	3.5%	6502 (3)	33	28.6%	0.0%
575	9586 (357)	1	38.0%	3.3%	7454 (3)	36	32.8%	0.0%
90	9537 (343)	0	37.8%	3.2%	8354 (0)	34	36.8%	0.0%
25	9618 (305)	0	38.2%	2.5%	9100 (6)	63	40.0%	0.1%
750	9666 (356)	1	38.4%	0.8%	10029 (5)	276	43.2%	0.0%

L3030  
 S/N: 179562  
 7/22/03

Ludlum Measurements, Inc.  
Model 3030 MDA Calculation Data

7/22/03

9:42:57 AM

Alpha Background(cpm): 0.0

Beta Background(cpm): 33.0

Alpha Efficiency %: 37.6

Beta Efficiency %: 28.6

Confidence Level: 95%

Count Time	Alpha MDA(dpm)	Beta MDA(dpm)
0.1	72.1	313.9
0.5	14.4	133.4
1.0	7.2	102.9
2.0	3.6	85.7
5.0	1.4	74.3
10.0	0.7	70.3
30.0	0.1	66.8
60 (1.0)	7.2	102.9

L3030  
S/N: 179562  
7/22/03

**APPENDIX 4**  
**Threshold Comparison Test Reports (TCTR)**

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

Run Date: Thursday, March 04, 2004

Survey Unit Number: 250E      Class: 2      Data Points: Beta      Grid Type: R

### SURVEY UNIT TABLE

<u>Bldg</u>	<u>Rm</u>	<u>Surface</u>	<u>Surface Area</u>		<u>Remarks</u>
			<u>Fixed</u>	<u>Included</u>	
			<u>Equipment</u>	<u>(sq. ft)</u>	
B250	999	E		7700	Does not include appendages on the west side.
Total Area				7700	

### INITIALIZATION DATA

Measurement Types Selected: RG, PG, BI, CH

Date Range: All

Thresholds:

EMC: 13,000      DCGLw: 2,600

### SURVEY UNIT TEST STATUS

<u>Test Performed</u>	<u>Status</u>	<u>dpm<sub>p</sub>/100 cm<sup>2</sup></u>		
Min/Max	Pass	Maximum Survey Value	B	244.0
Background	Fail	Minimum Background	W	-25.0
DCGLw	Pass	Difference		268.0
DCGLavg	Pass	Average Activity		102.5
EMC	Pass	Average Below DCGL		102.5
Wilcoxon Rank Sum Test	N/A	Average Background		66.6
Sign Test for Paired Data	Pass			

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

THE FOLLOWING DATA POINTS FAILED THE EMC TEST:

NONE

THE FOLLOWING DATA POINTS FAILED THE DCGLw TEST:

NONE

THE FOLLOWING DATA POINTS FAILED THE BACKGROUND TEST:

Survey Unit # 250E

Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas.		Gross Activity		Remarks	Exc	Res.
					Type	Min	SID	(dpm/100cm <sup>2</sup> )			
999	E	156.0	24.0	B	CH	2	2383	243.9		C	
999	E	224.0	12.0	B	CH	2	2404	231.7		C	
999	E	27.5	30.0	C	CH	2	2410	173.9		C	
999	E	224.0	0.0	C	CH	2	2403	118.1		C	
999	E	156.0	15.0	M	CH	2	2382	101.3		C	
999	E	87.5	30.0	O	CH	2	2431	90.1		C	
999	E	42.6	41.3	TS	RG	1	7921	80.4		C	
999	E	178.0	10.0	O	CH	2	2388	77.2		C	
999	E	135.5	30.0	O	CH	2	2444	74.0		C	
999	E	27.5	36.0	O	CH	2	2409	66.9		C	
999	E	27.5	46.0	O	CH	2	2408	62.4		C	
999	E	51.5	36.0	O	CH	2	2420	60.5		C	
999	E	26.1	41.3	TS	RG	1	7919	58.4		C	
999	E	51.5	28.0	O	CH	2	2419	56.0		C	
999	E	111.5	14.0	O	CH	2	2435	54.7		C	
999	E	92.3	24.7	TS	RG	1	7925	53.9		C	
999	E	42.6	24.7	TS	RG	1	7922	52.1		C	
999	E	75.7	24.7	TS	RG	1	7924	51.1		C	
999	E	123.5	14.0	O	CH	2	2439	44.4		C	
999	E	123.5	24.0	O	CH	2	2440	42.5		C	
999	E	51.5	24.0	O	CH	2	2418	35.4		C	
999	E	125.4	24.7	TS	RG	1	7927	32.9		C	
999	E	87.5	24.0	O	CH	2	2430	32.8		C	
999	E	75.5	24.0	O	CH	2	2427	32.8		C	
999	E	15.5	46.0	O	CH	2	2407	31.5		C	
999	E	39.5	24.0	O	CH	2	2414	29.0		C	
999	E	99.5	24.0	O	CH	2	2433	28.3		C	
999	E	99.5	30.0	O	CH	2	2434	26.4		C	
999	E	111.5	30.0	O	CH	2	2437	21.9		C	
999	E	39.5	46.0	O	CH	2	2416	21.2		C	
999	E	123.5	30.0	O	CH	2	2441	21.2		C	
999	E	111.5	24.0	O	CH	2	2436	19.3		C	
999	E	75.5	30.0	O	CH	2	2428	18.7		C	
999	E	135.5	24.0	O	CH	2	2443	13.5		C	
999	E	63.5	24.0	O	CH	2	2423	8.4		C	
999	E	63.5	30.0	O	CH	2	2425	7.7		C	
999	E	51.5	46.0	O	CH	2	2421	2.6		C	
999	E	26.1	24.7	TS	RG	1	7920	1.8		C	
999	E	39.5	36.0	O	CH	2	2415	1.3		C	

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

THE FOLLOWING DATA POINTS PASSED BACKGROUND, DCGLw, AND EMC SCREENING TESTS:

Survey Unit # 250E

Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm <sup>2</sup> )	Remarks	Exc	Res.
999	E	156.0	12.0	B	CH	2	2381	223.3			
999	E	204.0	12.0	B	CH	2	2396	223.3			
999	E	168.0	31.0	B	CH	2	2387	222.7			
999	E	175.1	24.7	B	RG	1	7940	216.4			
999	E	192.0	31.0	B	CH	2	2395	214.9			
999	E	208.2	8.2	B	RG	1	7945	211.9			
999	E	192.0	24.0	B	CH	2	2394	211.1			
999	E	216.0	24.0	B	CH	2	2401	209.8			
999	E	156.0	31.0	B	CH	2	2384	209.1			
999	E	147.5	32.0	B	CH	2	2448	207.9			
999	E	191.6	24.7	B	RG	1	7942	202.7			
999	E	158.5	8.2	B	RG	1	7939	201.8			
999	E	152.0	31.0	B	CH	2	2379	201.4			
999	E	144.0	12.0	B	CH	2	2377	201.4			
999	E	216.0	31.0	B	CH	2	2402	201.4			
999	E	144.0	24.0	B	CH	2	2378	198.2			
999	E	224.0	24.0	B	CH	2	2405	187.9			
999	E	204.0	31.0	B	CH	2	2398	186.0			
999	E	216.0	12.0	B	CH	2	2399	186.0			
999	E	168.0	24.0	B	CH	2	2386	183.4			
999	E	180.0	31.0	B	CH	2	2392	181.5			
999	E	147.5	24.0	B	CH	2	2446	180.2			
999	E	158.5	24.7	B	RG	1	7938	179.0			
999	E	168.0	12.0	B	CH	2	2385	177.6			
999	E	224.7	8.2	B	RG	1	7947	174.4			
999	E	208.2	26.9	B	RG	1	7944	173.5	Pipe Rack		
999	E	192.0	12.0	B	CH	2	2393	172.5			
999	E	204.0	24.0	B	CH	2	2397	171.2			
999	E	180.0	24.0	B	CH	2	2390	170.5			
999	E	147.5	12.0	B	CH	2	2445	165.4			
999	E	224.0	31.0	B	CH	2	2406	165.4			
999	E	191.6	8.2	B	RG	1	7943	162.6			
999	E	224.7	24.7	B	RG	1	7946	160.7			
999	E	175.1	8.2	B	RG	1	7941	154.3			
999	E	9.5	8.2	B	RG	1	7929	138.8			
999	E	152.0	10.0	M	CH	2	2380	53.2			
999	E	26.1	8.2	C	RG	1	7930	39.2			
999	E	27.5	12.0	C	CH	2	2412	39.2			
999	E	141.9	8.2	B	RG	1	7937	31.1			
999	E	27.5	24.0	C	CH	2	2411	25.6			
999	E	147.5	22.0	M	CH	2	2447	25.0			
999	E	105.5	21.0	M	CH	2	2438	11.9			
999	E	180.0	12.0	B	CH	2	2389	7.1			
999	E	108.8	8.2	M	RG	1	7935	3.8			
999	E	125.4	8.2	W	RG	1	7936	1.8			
999	E	59.2	24.7	TS	RG	1	7923	0.0			
999	E	108.8	24.7	TS	RG	1	7926	-0.9			
999	E	135.5	12.0	O	CH	2	2442	-12.9			
999	E	141.9	24.7	TS	RG	1	7928	-15.5			

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

### Summary of Background Data and Thresholds Used in this Analysis

Measurement Type: BK      DCGL: 2,600      EMC: 13,000

<i>Matrix</i>	<i>Number of Data Points</i>	<i>Average Background</i>	<i>Sigma</i>	<i>Background Threshold (T<sub>bk</sub>)</i>	<i>DCGLw Threshold (T<sub>d</sub>)</i>	<i>EMC Threshold (T<sub>c</sub>)</i>
	(dpm <sub>p</sub> /100cm <sup>2</sup> )	(dpm <sub>p</sub> /100cm <sup>2</sup> )	(dpm <sub>p</sub> /100cm <sup>2</sup> )			
B	30	192.4	16.0	224.4	2,824	13,224
C	90	35.4	20.1	75.5	2,675	13,075
M	10	24.0	15.7	55.3	2,655	13,055
O	0	0.0	0.0	0.0	2,600	13,000
TS	0	0.0	0.0	0.0	2,600	13,000
W	10	13.4	24.0	61.3	2,661	13,061

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## *Threshold Comparison Test Report - Buildings*

### STATISTICAL TEST RESULTS

Run Date: 3/4/2004 5:40:08 PM  
Survey Unit Number 250E Class: 2  
Selected Test: SIGN TEST FOR PAIRED DATA  
Test Status Pass  
Thresholds:

EMC 13,000 DCGL 2,600

### DATA SUMMARY TABLE

25 Survey points processed and 5 matrices processed

S+ = 25 Wc = 17

\*\*\*\*\* The survey unit has passed the SIGN TEST FOR PAIRED DATA \*\*\*\*\*

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

Run Date: Thursday, March 04, 2004

Survey Unit Number: 250S      Class: 3      Data Points: Beta      Grid Type: R

### SURVEY UNIT TABLE

<u>Bldg</u>	<u>Rm</u>	<u>Surface</u>	<u>Surface Area</u>		<u>Remarks</u>
			<u>Fixed Equipment</u>	<u>Included (sq. ft)</u>	
B250	999	S	Q1-Q18	4350	Does not include appendages on the west side.
				Total Area	4350

### INITIALIZATION DATA

Measurement Types Selected:    RG, PG, BI, CH

Date Range:                      All

Thresholds:

EMC:    13,000      DCGLw:    2,600

### SURVEY UNIT TEST STATUS

<u>Test Performed</u>	<u>Status</u>	<u>dpm<sub>p</sub>/100 cm<sup>2</sup></u>		
Min/Max	Pass	Maximum Survey Value	B	298.0
Background	Fail	<u>Minimum Background</u>	M	1.0
DCGLw	Pass	Difference		297.0
DCGLavg	Pass	Average Activity	59.8	
EMC	Pass	Average Below DCGL	59.8	
Wilcoxon Rank Sum Test	N/A	Average Background	150.3	
Sign Test for Paired Data	Pass			

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

THE FOLLOWING DATA POINTS FAILED THE EMC TEST:

NONE

THE FOLLOWING DATA POINTS FAILED THE DCGLw TEST:

NONE

THE FOLLOWING DATA POINTS FAILED THE BACKGROUND TEST:

Survey Unit # 250S

Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas.		Gross Activity		Remarks	Exc	Res.
					Type	Min	SID	(dpm/100cm <sup>2</sup> )			
999	Q1	1.0	0.0	M	BI	1	7654	98.0		C	
999	Q1	4.0	0.0	M	BI	1	7657	77.4		C	
999	Q1	3.0	0.0	M	BI	1	7656	75.5		C	
999	Q2	12.0	0.0	M	BI	1	7669	208.7		C	
999	Q2	9.0	0.0	M	BI	1	7666	177.4		C	
999	Q2	8.0	0.0	M	BI	1	7665	121.5		C	
999	Q2	11.0	0.0	M	BI	1	7668	115.6		C	
999	Q2	13.0	0.0	M	BI	1	7670	58.8		C	
999	Q3	1.0	0.0	M	BI	1	7673	106.8		C	
999	Q3	2.0	0.0	M	BI	1	7674	103.9		C	
999	Q4	1.0	0.0	FG	BI	1	7675	29.5		C	
999	Q7	1.0	0.0	M	BI	1	7688	158.8		C	
999	Q7	3.0	0.0	M	BI	1	7690	72.5		C	
999	Q7	2.0	0.0	M	BI	1	7689	60.8		C	
999	Q8	4.0	0.0	M	BI	1	7695	57.8		C	
999	Q8	1.0	0.0	M	BI	1	7692	55.9		C	
999	Q9	1.0	0.0	M	BI	1	7698	179.3		C	
999	S	91.3	2.3	B	RG	1	7877	297.9		C	
999	S	41.7	2.3	B	RG	1	7873	270.0		C	
999	S	54.1	14.8	B	RG	1	7866	253.7		C	
999	S	4.4	14.8	B	RG	1	7862	243.9		C	
999	S	4.4	2.3	B	RG	1	7870	242.2		C	
999	S	16.8	14.8	B	RG	1	7863	240.6		C	
999	S	41.7	14.8	B	RG	1	7865	240.6		C	
999	S	91.3	27.2	B	RG	1	7861	227.5		C	
999	S	54.1	2.3	M	RG	1	7874	181.3		C	
999	S	29.3	39.6	TS	RG	1	7849	76.9		C	
999	S	41.7	27.2	TS	RG	1	7857	75.3		C	
999	S	78.9	27.2	TS	RG	1	7860	58.9		C	
999	S	54.1	27.2	TS	RG	1	7858	57.3		C	
999	S	66.5	39.6	TS	RG	1	7852	50.7		C	
999	S	54.1	39.6	TS	RG	1	7851	26.2		C	
999	S	16.8	27.2	TS	RG	1	7855	16.4		C	
999	S	29.3	27.2	TS	RG	1	7856	16.4		C	
999	S	78.9	39.6	TS	RG	1	7853	8.2		C	
999	S	16.8	39.6	TS	RG	1	7848	8.2		C	

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

THE FOLLOWING DATA POINTS PASSED BACKGROUND, DCGLw, AND EMC SCREENING TESTS:

Survey Unit # 250S

Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm <sup>2</sup> )	Remarks	Exc	Res.
999	Q1	2.0	0.0	M	BI	1	7655	-3.9			
999	Q10	3.0	0.0	M	BI	1	7701	37.2			
999	Q10	9.0	0.0	M	BI	1	7707	24.5			
999	Q10	5.0	0.0	M	BI	1	7703	21.6			
999	Q10	1.0	0.0	M	BI	1	7699	17.6			
999	Q10	6.0	0.0	M	BI	1	7704	16.7			
999	Q10	4.0	0.0	M	BI	1	7702	14.7			
999	Q10	8.0	0.0	M	BI	1	7706	11.8			
999	Q10	7.0	0.0	M	BI	1	7705	11.8			
999	Q10	2.0	0.0	M	BI	1	7700	5.9			
999	Q11	3.0	0.0	M	BI	1	7710	31.4			
999	Q11	4.0	0.0	M	BI	1	7711	24.5			
999	Q11	1.0	0.0	M	BI	1	7708	22.5			
999	Q11	5.0	0.0	M	BI	1	7712	19.6			
999	Q11	2.0	0.0	M	BI	1	7709	2.0			
999	Q12	1.0	0.0	M	BI	1	7713	35.3			
999	Q12	3.0	0.0	M	BI	1	7715	32.3			
999	Q12	2.0	0.0	M	BI	1	7714	17.6			
999	Q13	1.0	0.0	M	BI	1	7716	37.2			
999	Q14	5.0	0.0	M	BI	1	7721	24.5			
999	Q14	4.0	0.0	M	BI	1	7720	24.5			
999	Q14	1.0	0.0	M	BI	1	7717	21.6			
999	Q14	3.0	0.0	M	BI	1	7719	13.7			
999	Q14	2.0	0.0	M	BI	1	7718	7.8			
999	Q15	2.0	0.0	M	BI	1	7723	28.4			
999	Q15	1.0	0.0	M	BI	1	7722	25.5			
999	Q16	1.0	0.0	M	BI	1	7724	21.6			
999	Q17	1.0	0.0	M	BI	1	7725	21.6			
999	Q18	1.0	0.0	M	BI	1	7726	19.6			
999	Q18	2.0	0.0	M	BI	1	7727	6.9			
999	Q18	3.0	0.0	M	BI	1	7728	2.9			
999	Q2	2.0	0.0	M	BI	1	7659	41.2			
999	Q2	10.0	0.0	M	BI	1	7667	41.2			
999	Q2	14.0	0.0	M	BI	1	7671	37.2			
999	Q2	3.0	0.0	M	BI	1	7660	32.3			
999	Q2	15.0	0.0	M	BI	1	7672	32.3			
999	Q2	1.0	0.0	M	BI	1	7658	23.5			
999	Q2	5.0	0.0	M	BI	1	7662	21.6			
999	Q2	4.0	0.0	M	BI	1	7661	18.6			
999	Q2	7.0	0.0	M	BI	1	7664	15.7			
999	Q2	6.0	0.0	M	BI	1	7663	-2.0			
999	Q5	1.0	0.0	M	BI	1	7676	34.3			
999	Q5	4.0	0.0	M	BI	1	7679	24.5	Bad Geo.		
999	Q5	7.0	0.0	M	BI	1	7682	20.6			
999	Q5	5.0	0.0	M	BI	1	7680	14.7			
999	Q5	10.0	0.0	M	BI	1	7685	13.7			
999	Q5	9.0	0.0	M	BI	1	7684	10.8			
999	Q5	6.0	0.0	M	BI	1	7681	10.8			
999	Q5	8.0	0.0	M	BI	1	7683	3.9			
999	Q5	2.0	0.0	M	BI	1	7677	-9.8			
999	Q5	3.0	0.0	M	BI	1	7678	-10.8	Roof Drain		
999	Q6	1.0	0.0	M	BI	1	7686	29.4			
999	Q7	2.0	0.0	M	BI	1	7687	21.6			
999	Q7	4.0	0.0	M	BI	1	7691	44.1			
999	Q8	6.0	0.0	M	BI	1	7697	21.6			

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm <sup>2</sup> )	Remarks	Exc	Res.
999	Q8	5.0	0.0	M	BI	1	7696	17.6			
999	Q8	3.0	0.0	M	BI	1	7694	11.8			
999	Q8	2.0	0.0	M	BI	1	7693	9.8			
999	S	66.5	14.8	B	RG	1	7867	217.7			
999	S	29.3	2.3	B	RG	1	7872	199.7			
999	S	91.3	14.8	B	RG	1	7869	170.2			
999	S	29.3	14.8	B	RG	1	7864	157.1			
999	S	78.9	14.8	B	RG	1	7868	148.9			
999	S	66.5	2.3	M	RG	1	7875	17.6			
999	S	78.9	2.3	M	RG	1	7876	14.7			
999	S	66.5	27.2	TS	RG	1	7859	-3.3			
999	S	4.4	27.2	TS	RG	1	7854	-13.1			
999	S	4.4	39.6	TS	RG	1	7847	-14.7			
999	S	41.7	39.6	TS	RG	1	7850	-16.4			
999	S	16.8	2.3	M	RG	1	7871	-21.6			

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## Threshold Comparison Test Report - Buildings

### Summary of Background Data and Thresholds Used in this Analysis

Measurement Type: BK      DCGL: 2,600      EMC: 13,000

<i>Matrix</i>	<i>Number of Data Points</i>	<i>Average Background</i>	<i>Sigma</i>	<i>Background Threshold (T<sub>bk</sub>)</i>	<i>DCGLw Threshold (T<sub>d</sub>)</i>	<i>EMC Threshold (T<sub>c</sub>)</i>
	(dpm <sub>p</sub> /100cm <sup>2</sup> )	(dpm <sub>p</sub> /100cm <sup>2</sup> )	(dpm <sub>p</sub> /100cm <sup>2</sup> )			
B	30	192.4	16.0	224.4	2,824	13,224
FG	0	0.0	0.0	0.0	2,600	13,000
M	10	24.0	15.7	55.3	2,655	13,055
TS	0	0.0	0.0	0.0	2,600	13,000

# MALLINCKRODT C-T DECOMMISSIONING PROJECT

## *Threshold Comparison Test Report - Buildings*

### STATISTICAL TEST RESULTS

Run Date: 3/4/2004 5:41:53 PM  
Survey Unit Number 250S Class: 3  
Selected Test: SIGN TEST FOR PAIRED DATA  
Test Status Pass  
Thresholds:  
EMC 13,000 DCGL 2,600

### DATA SUMMARY TABLE

31 Survey points processed and 3 matrices processed

S+ = 31 Wc = 20

\*\*\*\*\* The survey unit has passed the SIGN TEST FOR PAIRED DATA \*\*\*\*\*

**APPENDIX 5**  
**Gamma Readings on Building 101 Roof**

Room	Type	Xcoord (ft)	Ycoord (ft)	Survey_Gamma (counts)	Ambient (counts)	t (min.)	Net_Gamma (cpm)	Net_Gamma (dpm/100 cm <sup>2</sup> )	SampleID	SurveyDate
9991	RG	65.00	18.42	3,867.00	3,254.00	1	613.00	817	7484	30-Sep-03
9991	RG	41.42	53.75	2,333.00	3,254.00	1	-921.00	(1,228)	7461	30-Sep-03
9991	RG	29.67	53.75	2,941.00	3,254.00	1	-313.00	(417)	7460	30-Sep-03
9991	RG	17.83	53.75	3,318.00	3,254.00	1	64.00	85	7459	30-Sep-03
9991	RG	6.08	53.75	4,252.00	3,254.00	1	998.00	1,331	7458	30-Sep-03
9991	RG	53.17	6.58	4,985.00	3,254.00	1	1,731.00	2,308	7488	30-Sep-03
9991	RG	41.42	6.58	4,867.00	3,254.00	1	1,613.00	2,151	7487	30-Sep-03
9991	RG	76.75	18.42	4,199.00	3,254.00	1	945.00	1,260	7485	30-Sep-03
9991	RG	53.17	18.42	3,411.00	3,254.00	1	157.00	209	7483	30-Sep-03
9991	RG	41.42	18.42	2,975.00	3,254.00	1	-279.00	(372)	7482	30-Sep-03
9991	RG	29.67	18.42	2,957.00	3,254.00	1	-297.00	(396)	7481	30-Sep-03
9991	RG	17.83	18.42	3,717.00	3,254.00	1	463.00	617	7480	30-Sep-03
9991	RG	6.08	18.42	4,712.00	3,254.00	1	1,458.00	1,944	7479	30-Sep-03
9991	RG	76.75	30.17	4,566.00	3,254.00	1	1,312.00	1,749	7478	30-Sep-03
9991	RG	65.00	30.17	3,220.00	3,254.00	1	-34.00	(45)	7477	30-Sep-03
9991	RG	29.67	42.00	3,073.00	3,254.00	1	-181.00	(241)	7467	30-Sep-03
9991	RG	29.67	6.58	5,900.00	3,254.00	1	2,646.00	3,528	7486	30-Sep-03
9991	RG	53.17	30.17	2,902.00	3,254.00	1	-352.00	(469)	7476	30-Sep-03
9991	RG	65.00	53.75	2,841.00	3,254.00	1	-413.00	(551)	7463	30-Sep-03
9991	RG	76.75	53.75	3,582.00	3,254.00	1	328.00	437	7464	30-Sep-03
9991	RG	17.83	42.00	3,506.00	3,254.00	1	252.00	336	7466	30-Sep-03
9991	RG	41.42	42.00	2,516.00	3,254.00	1	-738.00	(984)	7468	30-Sep-03
9991	RG	53.17	53.75	2,904.00	3,254.00	1	-350.00	(467)	7462	30-Sep-03
9991	RG	17.00	30.17	3,044.00	3,254.00	1	-210.00	(280)	7473	30-Sep-03
9991	RG	41.42	30.17	2,161.00	3,254.00	1	-1,093.00	(1,457)	7475	30-Sep-03
9991	RG	6.08	42.00	4,484.00	3,254.00	1	1,230.00	1,640	7465	30-Sep-03
9991	RG	29.67	30.17	2,938.00	3,254.00	1	-316.00	(421)	7474	30-Sep-03
9991	RG	53.17	42.00	2,985.00	3,254.00	1	-269.00	(359)	7469	30-Sep-03
9991	RG	6.08	30.17	4,623.00	3,254.00	1	1,369.00	1,825	7472	30-Sep-03
9991	RG	76.75	42.00	3,217.00	3,254.00	1	-37.00	(49)	7471	30-Sep-03
9991	RG	65.00	42.00	3,222.00	3,254.00	1	-32.00	(43)	7470	30-Sep-03

Room	Type	Xcoord (ft)	Ycoord (ft)	Survey_Gamma (counts)	Ambient (counts)	t (min.)	Net_Gamma (cpm)	Net_Gamma (dpm/100 cm <sup>2</sup> )	SampleID	SurveyDate
9992	RG	50.17	69.42	3,646.00	3,489.00	1	157.00	327	7529	24-Sep-03
9992	RG	2.25	85.42	4,695.00	3,489.00	1	1,206.00	2,513	7520	24-Sep-03
9992	RG	50.17	53.50	3,671.00	3,489.00	1	182.00	379	7535	24-Sep-03
9992	RG	18.25	53.50	3,411.00	3,489.00	1	-78.00	(163)	7533	24-Sep-03
9992	RG	2.25	53.50	4,100.00	3,489.00	1	611.00	1,273	7532	24-Sep-03
9992	RG	82.08	69.42	4,184.00	3,489.00	1	695.00	1,448	7531	24-Sep-03
9992	RG	66.17	69.42	4,277.00	3,489.00	1	788.00	1,642	7530	24-Sep-03
9992	RG	34.25	53.50	3,287.00	3,489.00	1	-202.00	(421)	7534	24-Sep-03
9992	RG	34.25	69.42	3,390.00	3,489.00	1	-99.00	(206)	7528	24-Sep-03
9992	RG	18.25	69.42	3,190.00	3,489.00	1	-299.00	(623)	7527	24-Sep-03
9992	RG	2.25	69.42	3,167.00	3,489.00	1	-322.00	(671)	7526	24-Sep-03
9992	RG	82.08	85.42	4,855.00	3,489.00	1	1,366.00	2,846	7525	24-Sep-03
9992	RG	66.17	85.42	4,321.00	3,489.00	1	832.00	1,733	7524	24-Sep-03
9992	RG	50.17	85.42	3,391.00	3,489.00	1	-98.00	(204)	7523	24-Sep-03
9992	RG	18.25	85.42	4,201.00	3,489.00	1	712.00	1,483	7521	24-Sep-03
9992	RG	82.08	53.50	4,764.00	3,489.00	1	1,275.00	2,656	7537	24-Sep-03
9992	RG	2.25	37.50	4,589.00	3,489.00	1	1,100.00	2,292	7538	24-Sep-03
9992	RG	34.25	85.42	4,414.00	3,489.00	1	925.00	1,927	7522	24-Sep-03
9992	RG	50.17	5.58	2,319.00	3,489.00	1	-1,170.00	(2,438)	7553	24-Sep-03
9992	RG	66.17	53.50	3,475.00	3,489.00	1	-14.00	(29)	7536	24-Sep-03
9992	RG	66.17	5.58	2,318.00	3,489.00	1	-1,171.00	(2,440)	7554	24-Sep-03
9992	RG	34.25	5.58	2,237.00	3,489.00	1	-1,252.00	(2,608)	7552	24-Sep-03
9992	RG	18.25	5.58	3,780.00	3,489.00	1	291.00	606	7551	24-Sep-03
9992	RG	2.25	5.58	4,750.00	3,489.00	1	1,261.00	2,627	7550	24-Sep-03
9992	RG	82.08	21.58	3,922.00	3,489.00	1	433.00	902	7549	24-Sep-03
9992	RG	66.17	21.58	2,582.00	3,489.00	1	-907.00	(1,890)	7548	24-Sep-03
9992	RG	50.17	21.58	2,336.00	3,489.00	1	-1,153.00	(2,402)	7547	24-Sep-03
9992	RG	34.25	37.50	2,707.00	3,489.00	1	-782.00	(1,629)	7540	24-Sep-03
9992	RG	18.25	21.58	3,379.00	3,489.00	1	-110.00	(229)	7545	24-Sep-03
9992	RG	2.25	21.58	4,631.00	3,489.00	1	1,142.00	2,379	7544	24-Sep-03
9992	RG	82.08	37.50	4,608.00	3,489.00	1	1,119.00	2,331	7543	24-Sep-03
9992	RG	66.17	37.50	3,262.00	3,489.00	1	-227.00	(473)	7542	24-Sep-03
9992	RG	50.17	37.50	3,209.00	3,489.00	1	-280.00	(583)	7541	24-Sep-03
9992	RG	82.08	5.58	2,899.00	3,489.00	1	-590.00	(1,229)	7555	24-Sep-03
9992	RG	18.25	37.50	3,372.00	3,489.00	1	-117.00	(244)	7539	24-Sep-03
9992	RG	34.25	21.58	2,168.00	3,489.00	1	-1,321.00	(2,752)	7546	24-Sep-03

Room	Type	Xcoord (ft)	Ycoord (ft)	Survey_Gamma (counts)	Ambient (counts)	t (min.)	Net_Gamma (cpm)	Net_Gamma (dpm <sub>p</sub> /100 cm <sup>2</sup> )	SampleID	SurveyDate
9993	RG	21.92	18.92	4,428.00	3,254.00	1	1,174.00	2,446	7614	24-Sep-03
9993	RG	5.33	18.92	5,848.00	3,254.00	1	2,594.00	5,404	7613	24-Sep-03
9993	RG	71.75	35.50	4,849.00	3,254.00	1	1,595.00	3,323	7612	24-Sep-03
9993	RG	38.58	35.50	4,275.00	3,254.00	1	1,021.00	2,127	7610	24-Sep-03
9993	RG	21.92	2.33	4,797.00	3,254.00	1	1,543.00	3,215	7619	24-Sep-03
9993	RG	21.92	35.50	4,182.00	3,254.00	1	928.00	1,933	7609	24-Sep-03
9993	RG	55.17	35.50	4,399.00	3,254.00	1	1,145.00	2,385	7611	24-Sep-03
9993	RG	38.58	18.92	4,816.00	3,254.00	1	1,562.00	3,254	7615	24-Sep-03
9993	RG	55.17	18.92	3,404.00	3,254.00	1	150.00	313	7616	24-Sep-03
9993	RG	5.33	2.33	5,135.00	3,254.00	1	1,881.00	3,919	7618	24-Sep-03
9993	RG	38.58	2.33	5,399.00	3,254.00	1	2,145.00	4,469	7620	24-Sep-03
9993	RG	55.17	2.33	4,224.00	3,254.00	1	970.00	2,021	7621	24-Sep-03
9993	RG	5.33	35.50	4,554.00	3,254.00	1	1,300.00	2,708	7608	24-Sep-03
9993	RG	5.33	68.75	4,213.00	3,489.00	1	724.00	1,508	7597	24-Sep-03
9993	RG	71.75	18.92	3,964.00	3,254.00	1	710.00	1,479	7617	24-Sep-03
9993	RG	55.17	68.75	4,380.00	3,489.00	1	891.00	1,856	7600	24-Sep-03
9993	RG	5.33	85.33	5,213.00	3,489.00	1	1,724.00	3,592	7592	24-Sep-03
9993	RG	21.92	85.33	4,689.00	3,489.00	1	1,200.00	2,500	7593	24-Sep-03
9993	RG	38.58	85.33	4,500.00	3,489.00	1	1,011.00	2,106	7594	24-Sep-03
9993	RG	55.17	85.33	5,003.00	3,489.00	1	1,514.00	3,154	7595	24-Sep-03
9993	RG	71.75	85.33	5,522.00	3,489.00	1	2,033.00	4,235	7596	24-Sep-03
9993	RG	38.58	68.75	4,340.00	3,489.00	1	851.00	1,773	7599	24-Sep-03
9993	RG	21.92	68.75	4,040.00	3,489.00	1	551.00	1,148	7598	24-Sep-03
9993	RG	71.75	52.17	2,613.00	3,254.00	1	-641.00	(1,335)	7607	24-Sep-03
9993	RG	71.75	68.75	4,643.00	3,489.00	1	1,154.00	2,404	7601	24-Sep-03
9993	RG	88.42	68.75	4,686.00	3,489.00	1	1,197.00	2,494	7602	24-Sep-03
9993	RG	5.33	52.17	4,375.00	3,489.00	1	886.00	1,846	7603	24-Sep-03
9993	RG	21.92	52.17	3,756.00	3,489.00	1	267.00	556	7604	24-Sep-03
9993	RG	38.58	52.17	3,821.00	3,489.00	1	332.00	692	7605	24-Sep-03
9993	RG	55.17	52.17	3,907.00	3,254.00	1	653.00	1,360	7606	24-Sep-03
9993	RG	71.75	2.33	4,391.00	3,254.00	1	1,137.00	2,369	7622	24-Sep-03