FINAL STATUS SURVEY REPORT
BUILDING 250 INTERIOR

MALLINCKRODT, INC.
COLUMBIUM- TANTULUM PROJECT- PHASE 1

MARCH 2004

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C-T PROJECT – PHASE I

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Building 250 Interior

Survey Units 2502, 2503, & 2504

Revision 0

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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 interior surfaces of Building 250 on the Mallinckrodt St. Louis site (designated as Survey Units (SU) 2502, 2503, and 2504). This report is being provided in accordance with the Mallinckrodt C-T Project, Phase I Decommissioning Plan (D Plan). This FSS was performed in accordance with Field Instruction (FI) CT-FI-003[1] and CT-FI-004[2] 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 these survey units 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 Mallinckrodt in 1961 by the Atomic Energy Commission (AEC), later the Nuclear

[1] CT-FI-003, *Final Status Survey Guide for Survey Units 2502 and 2503.*
[2] CT-FI-004, *Final Status Survey Guide for Survey Unit 2504.*

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 affected interior walls and floors on the 2nd floor of Building 250 excluding the stairwells have been designated as 2 survey units, SU-2502 and SU-2503. The affected interior walls and floors on the 1st floor of Building 250 including the stairwells, have been designated as a single survey unit, SU-2504. Each survey unit has been classified 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[3]
Survey Area Descriptions

Area	Survey Unit	Location / Surface
273	2504	1st Floor - Rm 101 Closet: Area remodeled for entrance to lobby area. Walls are studded and drywalled on north side. South side masonry painted with epoxy coating.
274	2504	1st Floor - Rm 103/A/B Doors: Removed and area remodeled for new conference room. Walls are studded and drywalled.
275	2504	1st Floor - Rm 110 Desk Drawer: Removed and disposed of.
276	2504	1st Floor - Rm 115 Doorways: Removed and disposed of. New walls installed. Area is studded and drywalled for labs and office cubicles on north side. New drop ceilings.
280	2504	1st Floor - East Stairwell-original
281	2504	1st Floor - West Stairwell-original
282	2504	1st Floor - CT Lead Well
283	2504	1st Floor CT Lab Office - Interior Walls-mostly drywall covered post CT operations, block walls original and covered with one coat of epoxy paint since CT.
284	2504	1st Floor CT Lab Office - Floor: removed and replaced with linoleum post CT operations.
285	2504	1st Floor CT Lab Office - Ceiling: all new ceiling tiles post CT, drop ceiling structural components accessible.

[3] Appendix A of D Plan.

Area	Survey Unit	Location / Surface
286	2504	1st Floor CT Lab Hall - Interior Walls: drywall post CT except areas of exposed block. Exposed block painted with one coat epoxy paint.
287	2504	1st Floor CT Lab Hall - Floor: replaced with new tile post CT operations.
288	2504	1st Floor CT Lab Hall - Ceiling: all new ceiling tiles post CT, drop ceiling structural components accessible.
289	2504	1st Floor CT Lab Count - Interior Walls: all drywall covered post CT operations.
290	2504	1st Floor CT Lab Count - Floor tile replaced post CT operations.
292	2504	1st Floor CT Lab Count - Ceiling Drain Pipes-original
293	2503	2nd Floor Rm 201 - Countertops/Sinks: original
294	2503	2nd Floor Rm 201 - East Hood: original
297	2503	2nd Floor Rm 201 - North Wall: Painted with epoxy coating.
298	2503	2nd Floor Rm 202 - Floors: New inlaid linoleum installed.
299	2503	2nd Floor Rm 202 - Interior Walls: Repainted with epoxy coating.
303	2502	2nd Floor Rm 205 - East Wall: Repainted with epoxy coating.
305	2502	2nd Floor Rm 207 - Staging Area: floor under sink remediated post CT operations
308	2502	2nd Floor Rm 209 - Countertops: original
309	2502	2nd Floor Rm 209 - Drains: original
310	2502	2nd Floor Rm 209 - Floors: original
311	2502	2nd Floor Rm 210 - Floors: original
312	2502	2nd Floor Rm 210 - North and West Walls: original
313	2502	2nd Floor Rm 210 - Mechanical Room Equipment: Vacuum hold tank, air compressor, air handler, and chiller unit - original.
314	2502	2nd Floor Rm 211 - West Hood: original
315	2502	2nd Floor Rm 211 - Countertops: original
316	2502	2nd Floor Rm 211 - Drain: original
317	2502	2nd Floor Rm 211 - Cabinets: original

2.1.3. A summary report for the survey units listing all the surfaces and fixed apparatus assigned to SU-2502, SU-2503, and SU-2504 is presented in Appendix 1. Drawings of the first and second floor of Building 250 showing the location of the rooms that were surveyed are presented in Appendix 2, Figures 2.1 and 2.2. The blue numbers in the drawings represent rooms that were surveyed as part of the FSS.[4] Where possible, the original room number was used. When necessary, new

[4] Rooms 102, 103, and 120-123 were surveyed and reported separately under survey unit 2501.

numbers were created to identify each space that was surveyed. Walls shown with dashed lines are walls which have been removed since 1985 and which could not be surveyed. Walls shown in red have been constructed since the C-T era and need not be surveyed since they are unaffected. Some rooms have been outlined in blue to clarify the old boundaries of the rooms that were surveyed in the current building configuration.

2.1.4. Details of the laboratory rooms on the second floor are illustrated in Appendix 2, Figures 2.3 through 2.9 showing the location of all items of installed apparatus not part of the ceiling.

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.[5]

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. For matrices where no background data were available, a value of zero was used.

2.3.2. Where additional background measurements were required for the FSS, they were taken on unaffected surfaces nearby or offsite. 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. Background levels for the contaminants of interest are presented in Table 2.2.

[5] Mallinckrodt C-T Project D Plan Appendix D.

Table 2.2
Background Reference Data

Matrix	Code	Mean ($dpm_p/100cm^2$)[6]	Standard Deviation ($dpm_p/100cm^2$)
Asbestos Tile	AT	0	0
Asphalt	A	78	52
Brick	B	192	16
Carpet	CPT	0	0
Celotex Ceiling Tile	CTX	153	15
Ceramic Tile	CT	214	40
Concrete	C	35	20
Concrete Block	CB	96	22
Counter Top – Lab (Bldg 250)	CTP	144	29
Giberglass	FG	0	0
Glass	G	0	0
Gypsum Board	GB	0	0
Metal	M	24	16
Other Non Metal	O	0	0
Plastic	P	0	0
Red Clay Tile	R	0	0
Rubber Base	RB	0	0
Tar/roofing	TR	78	52
Transite Wall Panels	TS	0	0
Vinyl Tile	VT	15	24
Wood	W	13	24

2.3.3. Gamma background. The average of the gamma background levels recorded in the rooms where gamma measurements were taken is presented in Table 2.3

Table 2.3
Gamma Background Reference Data*

Room	Ambient BK (cpm)
101C	7,000
103AB	6,500
110	7,000
115	6,770**
127	6,500
139	6,500
140	6,500

* 3" x 3" shielded NaI detector
** Average of 4 readings.

2.3.4. The average value for the building was 6,700 cpm and standard deviation (σ) was 250 cpm. For all net gamma scan measurements, the average gamma background

[6] $Dpm_p/100\ cm^2$ refers to the disintegrations per minute per 100 cm^2 for the combined nuclide series.

of **6,700 cpm** was used. For direct measurements the local background value from Table 2.3 was used.

2.4. RELEASE CRITERIA

2.4.1. Table 2.4 displays the Derived Concentration Guideline (DCGLw) for measurements on building surfaces and fixed equipment. This value is the primary release criterion from the D Plan and is applied net of background to building surfaces. 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)[7] was developed and was used during the FSS as if it were the DCGLw with certain exceptions.[8]

Table 2.4
Building Surface and Installed Apparatus Release Criteria

Criterion	(dpm_p /100 cm^2)
DCGLw	13,000
ARG	2,600

2.4.3. Elevated Measurements Criterion (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 to this FSS.

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.

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[7] NEXTEP Tech Memo 0211, *Recommendation for an Administrative Release Guideline for the Mallinckrodt C-T Project,* A.H. Thatcher, CHP.

[8] Final Status Survey Design Guide (Phase I), Section 3.2, covers the rules governing use of the ARG.

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.

2.5.4. All calibration and source check records were completed, reviewed, signed-off and retained in accordance with the Mallinckrodt Quality Assurance Program. 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^2 for the purpose of alpha attenuation[9]. 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[10]. The difference in the two readings is attributable to beta emissions above 80 KeV in energy.[11] The sensitivity of the AB-100 was derived from experiments by Lucas and Colyott which were reported in Attachment 3 to the D Plan.[12] The actual instruments used were calibrated and normalized to the reference instrument tested by Lucas and Colyott as prescribed in CT-QA-6.1[13] .

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 on 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 βpm/100 cm^2. Removable contamination measurements were not compared with

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[9] As specified in Appendix D of the D Plan. Measurements taken with only the mylar covering the probe were "open window" measurements.

[10] The "closed window" reading was taken with a 1/8" soft Aluminum plate covering the face of the detector. It is sufficient to exclude β rays from the U and Th series.

[11] Internal Conversion Electrons (ICE) will also be included in this number but are a second order effect and may be ignored.

[12] *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.

[13] CT-QA-6.1 - *Calibration and Control of Measuring and Survey Equipment.*

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) was performed.

2.6. Lower Limit 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.[14]

2.6.2. The LLD requirements for the FSS have been developed in accordance with MARSSIM[15] Chapter 4 guidelines. They are contained in the Design Guide and are listed in Table 2.4.

Table 2.4
MDC Requirements

Measurement Type	MDC Requirement
Direct	50% of ARG
Class 2 Scans	ARG

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 for the AB-100 are presented in NEXTEP Tech Memo 0230.[16]

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[14] CT-QA-6.1, Ibid.
[15] NUREG 1575, *Multi Agency Radiation Survey and Site Investigation Manual.*
[16] 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[17]

Measurement	Matrix	Calculated MDC ($dpm_p/100\ cm^2$)	Required MDC ($dpm_p/100\ cm^2$)
BETA DIRECT	Brick	100	1,300
BETA SCAN	Brick	760	2,600
GAMMA DIRECT	Vinyl Tile	1,170	1,300
	Carpet	1,090	
GAMMA SCAN	Vinyl Tile	1,130	2,600
	Carpet	1,030	

2.6.4. MDCs for the 3"x3" shielded NaI Gamma Detector were calculated using Equation 1[18]. The conversion factors, F_g, for direct gamma readings taken through carpet and vinyl tile over concrete were calculated in NEXTEP Tech Memo 0317[19] and are presented in Table 2.6.

Equation 1

$$\text{Calculated Gamma Direct MDC} = \frac{2.71 + 3.29 * \sigma_b * \sqrt{\left(1 + \frac{t_{s+b}}{t_b}\right)}}{F_g * t_{s+b}} \left(dpm_p / 100cm^2\right)$$

Where:

σ_b = *Shielded gamma background sample standard deviation*[20] *(250 cpm)*
F_g = *gamma conversion factor (Table 2.6)*
t_b = *Background count time (5 minutes)*
t_{s+b} = *Sample count time (1 minute)*

[17] All Values given are net of background.
[18] NEXTEP Tech Memo 0230, Equation 6.
[19] NEXTEP Tech Memo 0317, *Use of the 3" x 3" NaI Detector for Measurement of Contamination on Concrete through Vinyl Tile and Carpet*, Ning Zhang
[20] Section 2.3

Table 2.6
Gamma Conversion Factors[21]

Measurement Type and Floor Covering		Conversion Factor (cpm/dpm/100cm^2)
Direct	Vinyl Tile	0.77
	Carpet	0.83
Scan	Vinyl Tile	0.60
	Carpet	0.66

2.6.5. Scan MDCs for the 3"x3" shielded NaI Gamma Detector were calculated using Equation 2 which is the combination of Equations 8 and 9 from NEXTEP Tech Memo 0230[22]. The background value from Section 2.3 and conversion factors from Table 2.6 were used in the calculations.

Equation 2

$$Scan\ MDC = \frac{d'}{F_g}\sqrt{\frac{60 * BK}{p * i}} = 8.3\frac{\sqrt{BK}}{F_g}$$

Where:

d' = *1.38 when decision error, $\alpha = 0.60$, and correct decision fraction, $1-\beta = 0.95$*[23]
i = *observation interval*[24] *(sec) = (detector area)$^{1/2}$/scan speed = 3.33sec*
BK = *background (cpm)= 6,700 cpm*
60 = *conversion, 60 (sec/min)*
p = *surveyor efficiency, assumed*[25] *to be 0.5*
Fg = *gamma conversion factor for scans from Table 2.6*

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 and the results are presented in Table 2.7.

2.7.2. The action threshold for beta scans is derived in NEXTEP Tech Memo 0230[26] and is based upon the ARG.

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[21] NEXTEP Tech Memo 0317, Ibid.
[22] NEXTEP Tech Memo 0230, Ibid.
[23] Abelquist, E.W., Table 6.1 p 6.23.
[24] The observation interval is based upon a scan speed of 30 cm/s and an effective detector area of 10,000 cm² (see TM 0229).
[25] Abelquist, E.W., et.al., §6.7.1.
[26] NEXTEP Tech Memo 0230, ibid.

2.7.3. The action thresholds for both direct and scan gamma measurements were calculated using equations presented in NEXTEP Tech Memo 0230[27] and gamma conversion factors, F_g, from Table 2.6. Since gamma readings were occasionally at or above the ARG, these thresholds were based upon the less conservative DCGLw.

2.7.4. The calculation for the direct gamma action threshold is given by Equation 3.

Equation 3

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

Where:

T_{inv} = The investigation threshold. (cpm)
F_g = The direct gamma conversion factor (Listed in Table 2.6)

2.7.5. The calculation for the gamma scan action threshold is given by Equation 4.

Equation 4

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

Where:

F_g = The gamma conversion factor for scans. (Listed in Table 2.6)
p = surveyor efficiency (assumed to be = 0.50)

Table 2.7
Action Thresholds[28]

Measurement	Floor Covering	T_{inv} (cpm)
BETA SCAN	NA	2,000
GAMMA DIRECT	Vinyl Tile	10,000
	Carpet	10,800
GAMMA SCAN	Vinyl Tile	7,080
	Carpet	7,630

2.8. INSTRUMENT SENSITIVITY, BACKSCATTER AND PAINT ATTENUATION

2.8.1. Beta direct measurements taken in the field were converted to $dpm_p/100\ cm^2$ of the parent nuclide series in accordance with Section 9 of the Design Guide using the following equation:

[27] NEXTEP Tech Memo 0230, ibid.

[28] The Class 3 action threshold is always equal to the greater of the T_{BK} or the MDC of the instrument used. T_{BK} is defined for each matrix as mean background plus two standard deviations (2σ) as described in Section 3.5.4.

Equation 5

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

Where:

AD	=	*Areal Density in $dpm_p/100\ cm^2$ 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.*[29]
S_i	=	*Normalized Instrument sensitivity without backscatter.*
$S_b(m)$	=	*Backscatter factor (a function of matrix)*
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.[30] Reference backscatter coefficients for several matrices were generated using an MCNP model and are described in NEXTEP Tech Memo 0213.[31] 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.

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[29] When the majority of the data used were FSSE data taken in the 1990's, zero coats of paint were assumed to cover those measurements and PAF was set to 1.0 for the entire surface.

[30] NEXTEP Tech Memo 0215, *Separation of Backscatter & Derivation of Instrument Sensitivity*, A.H. Thatcher CHP, (Included with FSSR 2501).

[31] NEXTEP Tech Memo 0213, *Beta Backscatter Factors for Several Materials at the Mallinckrodt Site,* N. Zhang and D. Wilson, (Included with FSSR 2501).

Table 3.1

Survey Procedures and Documents
CT Decommissioning Plan (Phase I)
CT Decommissioning Project, Final Status Survey Design Guide (Phase I)
CT-FI-003, Final Status Survey Guide for Survey Units 2502 and 2503
CT-FI-004, Final Status Survey Guide for Survey Unit 2504
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 was 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[32] developed for quality verification of FSS data was used as a guide to data verification.

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. SPECIFIC SURVEY METHODS

3.2.1. Rooms 110 and 115

3.2.1.1. Only portions of the original rooms 110 and 115 remain in place. Each room consists of the floor, 1 wall, and small items of equipment attached to the ceiling. The floor has been at least partially recovered with vinyl tile since CT operations ceased and approximately 4 coats of paint exist on the concrete block walls. Therefore, characterization surveys were the primary source of data in the rooms. Rooms 110 and 115 contain 9 and 26 FSS measurements on wall and floor surfaces respectively. Of these, only 2 regular grid (RG) points in each room were taken during the FSS surveys in 2003. Therefore, the surfaces in these two rooms were coded for zero paint (PAF=1.0) to reflect the condition of the surfaces when characterization data were collected.

[32] NEXTEP Tech Memo 0206, *QA Data Verification for MI CT Final Status Survey Data*, B. Anderson, (Included with FSSR 2501).

3.2.1.2. Four coats of paint (PAF=0.10) would have the effect of inflating the four RG readings by a factor of 10. Since all four RG measurements were less than 45 $dpm_p/100cm^2$ the affect of the additional paint would raise the values to something less than 450 $dpm_p/100cm^2$ and would not affect the outcome of the analysis performed.

3.2.1.3. β scans were taken on the exposed concrete block to cover at least 10% of the total wall area and 100% of the floor area was scanned with a shielded NaI gamma detector.

3.2.2. Room 103AB

3.2.2.1. Only portions of the original rooms 103A and 103B remain in place. The middle partition between them has been removed, and the rooms have been consolidated into one room, 103AB. The affected areas consist of the floor, 2 walls, and small items of equipment attached to the ceiling. The floor has been recovered with carpet since C-T operations ceased and the walls have been studded and drywalled.

3.2.2.2. Existing FSSE measurements were used for the FSS. Bias β measurements were also collected on the equipment attached to the ceiling and on any exposed portion of the original walls above the suspended ceiling.

3.2.2.3. β scans were taken on exposed concrete block to cover at least 10% of the total wall area and 100% of the floor was scanned with a shielded NaI detector.

3.2.3. Room 101C

3.2.3.1. Room 101C consists of the floor, 4 walls, and a sink. The walls have been painted with two coats of paint and the north wall has been studded and drywalled. The floor covering was assumed to be new.

3.2.3.2. Direct β measurements were taken on the grid locations where possible. Bias direct β measurements were collected in the sink basin, and on the light and vent.

3.2.3.3. β scans were taken on at least 10% of the exposed concrete block on the walls, and 100% of the floor was scanned with a shielded NaI detector.

3.2.4. Rooms 139 and 140

3.2.4.1. Rooms 139 and 140 each consist of the floor, 4 walls, and small items of equipment attached to the ceiling. The floor of room 139 has been recovered with vinyl floor covering and the floor of room 140 with tile. Most wall surfaces have been studded and drywalled. Remaining exposed concrete block on non-drywalled walls has been painted with 1 coat of paint since C-T operations.

3.2.4.2. Room 139 has 54 FSS measurements on the walls and floor. Of these only 2 RG data points were taken in 2003. Therefore the surfaces of this room were coded for zero paint (PAF=1.0) to reflect the condition of the surfaces when characterization data were collected. One coat of paint (PAF=0.357) would have the effect of inflating these readings by a factor of about 3. Since both RG measurements were less than 55 $dpm_p/100cm^2$, the effect of the additional paint would raise the values to something less than 165 $dpm_p/100cm^2$ and would not affect the outcome of the analysis performed.

3.2.4.3. All but 2 of the direct beta measurements recorded on the building surfaces in room 140 were FSSE measurements from the characterization program. Therefore the walls were also coded for zero paint. The 2 bias measurements taken in 2003 were below 88 $dpm_p/100cm^2$. The affect of paint on these points would raise the values to something less than 265 $dpm_p/100cm^2$ and would not affect the outcome of the analysis performed.

3.2.4.4. Direct β measurements were also taken on small pieces of equipment attached to the ceiling including the fire sprinkler system and the electrical track in room 139.

3.2.4.5. β scans were taken on at least 10% of the exposed concrete block on the walls and 100% of the floor was scanned with a shielded NaI detector.

3.2.5. Room 127

3.2.5.1. Room 127 consists of the floor, 4 walls, and small items of equipment attached to the ceiling. The floor has been recovered with floor tile since CT operations ceased and the walls have been studded, drywalled, and mostly covered by wall lockers.

3.2.5.2. Portions of a drain line running through the ceiling of Building 250 above room 127 were removed during decommissioning remediation activity in the period between February and March 2003. The connecting pipes that were cut to allow removal of the main line were surveyed with direct beta measurements and capped off.

3.2.5.3. A full compliment of FSSE measurements were taken on the original surfaces, and those measurements were used for the FSS. For this reason, the coats of paint on the wall surfaces of room 127 (which were applied post C-T operations) were set to zero as shown in Appendix 1. Bias measurements were also taken on installed apparatus.

3.2.5.4. β scans were taken on at least 10% of the exposed concrete block on the walls and 100% of the floor was scanned with a shielded NaI detector.

3.3. SURVEY MEASUREMENTS

3.3.1. Beta Measurements:

3.3.1.1. *Direct* – A systematic grid of direct beta measurements was obtained on the wall and floor surfaces as described in the FI. Direct beta measurements were collected on the surfaces of the survey units. Bias measurements were taken on building surfaces and on fixed apparatus at locations determined by the surveyor in an effort to fully characterize the fixed apparatus.

3.3.1.2. *Scans* - Beta scans were performed using the same instruments used for the direct beta measurements. Beta Scans were performed on the wall surfaces and on the floor surfaces except in rooms 101C, 103AB, 110, 127, 139, and 140. 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.

3.3.2. Gamma Measurements:

3.3.2.1. *Direct* – Direct gamma measurements were taken on the floor of room 115 which was covered with new vinyl tile. A 3"x3" Sodium Iodide (NaI) gamma detector was placed on each location on the surface and the count was taken for one minute.

3.3.2.2. *Scans* - Gamma Scans were performed in straight lines 5 cm above the surface of the floor in rooms 101C, 103AB, 110, 115, 127, 139, and 140 with each scan line separated from the next by 1 meter. The scan rate did not exceed 1 ft/s.

3.3.3. Removable Contamination Measurements:

3.3.3.1. *Swipes* - Removable contamination samples were collected at all regular grid locations on the surfaces of each survey unit. 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 DCGLw, that the removable fraction measures less than 20% of the DCGLw[33].

3.4. MEASUREMENT LOCATIONS

3.4.1. Statistical Grid Data Points

3.4.1.1. The *Visual Sample Plan*© (VSP)[34] software was used to develop a MARSSIM grid for all three survey units. The minimum number of

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[33] Section 3.3 of the C-T Design Guide.

[34] NEXTEP Tech Memo 0008, *Verification and Validation of Applicable Portions of VSP Software*, A. H. Thatcher, CHP.

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.

3.4.1.2. VSP uses the Data Quality Objective (DQO) input values to calculate the 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 Interior

DQO	Value
Type I error rate	5%
Type II error rate	5%
Width of Gray Region	200 $dpm_p/100cm^2$
Level (ARG)	2,600 $dpm_p/100cm^2$
Estimated Std Deviation	200 $dpm_p/100cm^2$

3.4.1.3. The minimum required number of grid measurements for all survey units was 24. The number 29 was used for survey planning to account for approximately 20% inaccessible or unusable locations.

3.4.1.4. A rectangular grid pattern was used for all three survey units. Grid spacing varied from room to room wherever FSSE data taken during previous surveys was used for the FSS. For all cases the spacing of old data points was less than that called for by VSP. The number of grid points actually recorded for each survey unit is presented in Table 3.3.

Table 3.3
Grid Points Recorded by Survey Unit

Survey Unit	Class	N (actual)
SU-2502	2	31
SU-2503	2	28
SU-2504	2	68

3.4.2. Bias Measurement Locations

3.4.2.1. Bias direct measurements were taken at the discretion of the HP technician performing the survey.

3.4.2.2. Bias surveys were also taken at hot spot locations identified by scans as directed in the Hot Spot Protocol[35].

[35] CT-FI-004, ibid.

3.5. REFERENCE COORDINATE SYSTEM

3.5.1. 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.

3.5.2. 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.

Table 3.4
Coordinate System Locators

Location	Identifier	X	Y
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		

3.5.3. 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".

3.5.4. 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".

3.5.5. 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.

3.6. DATA EVALUATION

3.6.1. 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 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[36].

3.6.2. 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.

3.6.3. 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[37]. An abbreviated summary of these tests is presented in Table 3.5.

3.6.4. *Background Screen.*

3.6.4.1. 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

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

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

3.6.4.3. 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.

3.6.5. *Min/Max Test.*

3.6.5.1. Find the maximum direct survey result, in $dpm_p/100cm^2$, for the survey data set.

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

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

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[36] NEXTEP Tech Memo 0231, *Validation and Verification of the C-T Database Analysis Report,* B. Anderson, (included with FSSR 2501).

[37] A more detailed explanation is provided in the Design Guide.

3.6.6. *DCGLw Screen.*

3.6.6.1. 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

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

3.6.6.2. 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.

3.6.7. *EMC Screen.*

3.6.7.1. 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

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

3.6.7.2. 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.

3.6.8. *DCGL Average Test.*

3.6.8.1. For each matrix material in the survey unit, calculate the mean 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

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

3.6.9. *Statistical Tests.*

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

3.6.9.2. The Wilcoxon Rank Sum Test[38] is applicable for survey units with measurements on a single matrix type or on matrices with similar

[38] Described in Appendix I of MARSSIM.

background characteristics. Where more than one matrix was present, the Sign Test for Paired Data[39] was used.

Table 3.5
Threshold Screening Tests

Test	Test Criteria for PASS
Min/Max	Difference between minimum background measurement and maximum survey value less than DCGLw
Background	All samples must be less than the background threshold[a]
$DCGL_w$	All samples must be no more than $DCGL_w$ + the background threshold
$DCGL_{avg}$	The average of all net survey values must be less than $DCGL_w$
EMC	All samples must be less than $DCGL_{EMC}$ + the background threshold
Sign Test for Paired Data	The Sign Test for Paired Data is described in detail in NUREG 1505[40]
Wilcoxon Rank Sum Test	This statistical test is described in detail in MARSSIM, Appendix I.

[a] The background threshold is equal to the mean background value plus twice σ_{BK}.

3.6.10. The output of the Threshold Comparison Test Report (TCTR) was used for analysis of the data for the interior of Building 250 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.

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

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

3.6.10.3. 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". If remediated data points are included in the run, it will be noted in this section. Normally they will be excluded.

[39] Described in NEXTEP Tech Memo 0231, Ibid.
[40] NUREG 1505, *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys.*

3.6.10.4. Values for DCGLw (ARG) and $DCGL_{EMC}$ are also specified at the start of the run and are listed in this section. Normally, the values for DCGLw and $DCGL_{EMC}$ are initialized to 2,600 and 13,000 $dpm_p/100cm^2$ respectively. If, however, measurements within the survey unit exceeded the ARG value of 2,600 $dpm_p/100cm^2$, the DCGLw initialization value was increased as necessary up to 13,000 $dpm_p/100cm^2$, the actual limit stipulated in the D Plan.

3.6.10.5. Survey Unit Test Status: Lists Pass/Fail status of all tests and gives a high level summary of key activity levels in the survey unit.

3.6.10.6. Points that failed tests: Lists all points that failed each specified threshold test (EMC, DCGL, and Background).

3.6.10.7. 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.

3.6.10.8. 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.

3.6.10.9. 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.

3.6.11. Provided all additional considerations such as scan data, swipes, sampling of removable contamination or sludge from traps, etc. indicate that the survey unit meet 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*[41]**

Test	Class 1	Class 2	Class 3
Min/Max	not required[a]	not required[a]	PASS
Background	not required	not required	PASS
$DCGL_w$	not required	PASS	PASS
$DCGL_{avg}$	PASS	PASS	PASS
EMC	PASS	PASS	PASS
Sign Test for Paired Data	PASS	PASS	PASS

[a] Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

[41] See MARSSIM, Chapter 8, Table 8.2

4. FSS Results and Discussion

4.1. Characterization Data

4.1.1. Characterization data taken in these survey units from 1992 to 1996 with an HP-210 instrument cannot be normalized to the AB-100 calibration standards and therefore are not included in the data set.

4.1.2. Data were taken in 9 rooms from 1995-1999 with an AB-100, and those data are included in the data set. In rooms where the original surface has since been covered with new vinyl tile, drywall, or carpet, survey measurements were taken from these data. All measurements included from characterization that were not counted as grid measurements were treated as bias measurements.

4.2. Survey Unit 2502

4.2.1. Direct Beta Measurements on Building Surfaces

4.2.1.1. SU-2502 was surveyed in January 1995, April and July 2003. Sixty-nine direct beta measurements were taken on the floor and wall surfaces. 31 of these were included in the systematic grid. Diagrams of the room layouts of the walls and floor with the beta measurements taken are presented in Appendix 2, Figures 4.1 – 4.2.

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 526 $dpm_p/100cm^2$. The average value for the survey unit was 150 $dpm_p/100cm^2$.

Table 4.1
SU-2502 Direct Measurements Summary
(Building Surfaces)

Matrix	Points	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Brick	6	177.4	353.7
Concrete	17	8.0	278.2
Concrete Block	33	224.7	526.2
Fiberglass	1	260.4	260.4
Metal	1	-15.3	-15.3
Other Non Metal	6	224.3	311.6
Plastic	1	-175.4	-175.4
Vinyl Tile	4	76.7	92.2

[a] Dpm_p refers to disintegrations per minute of the parent nuclide series.

4.2.2. Direct Beta Measurements on Installed Apparatus

4.2.2.1. All items of installed apparatus assigned to SU-2502 (listed in Appendix 1) were surveyed by direct beta measurements. A summary of

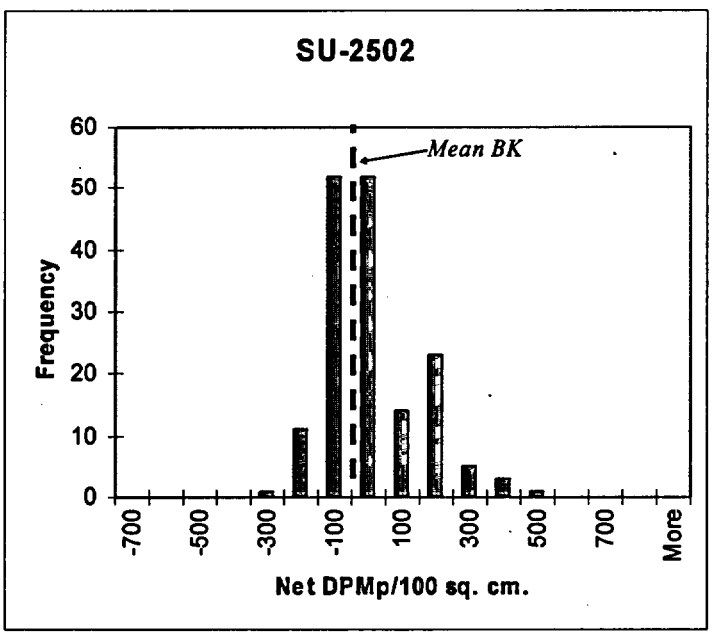
the measurements taken is provided in Table 4.2 sorted by matrix. The net values observed ranged from -175 to 139 $dpm_p/100cm^2$. All values were less than 6% of the ARG.

Table 4.2
SU-2502 Direct Measurements Summary
(Installed Apparatus)

Matrix	Points	Avg Net Activity ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Asbestos Tile	4	95.3	139.1
Celotex Ceiling Tile	2	12.1	127.7
Counter Top – Lab	20	-75.2	62.6
Fiberglass	1	31.0	31.0
Glass	7	22.5	58.0
Metal	55	3.3	117.6
Other Non Metal	2	68.7	104.7
Plastic	2	39.7	62.3

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-2502 is provided in Figure 4.1. The distribution appears to have two modes, one at background and the other centered about 250 $dpm_p/100cm^2$. This is consistent with a normal distribution of background radioactivity with some residual radioactivity. All measurements were well below the ARG.



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-2502. The TCTR report contains a complete listing of all the beta direct measurements taken in the Final Status Survey within SU-2502 sorted by room, surface, and activity. The summary pages indicate that all tests described in the D Plan passed except for the background test. All tests required for release of a Class 2 survey unit were passed. A comparison of test results and requirements for release of the survey unit is presented in Table 4.3.

Table 4.3
Requirements for SU Release[a]

Test	Class 2	SU-2502
Min/Max	PASS	PASS
Background	PASS	FAIL
$DCGL_W$	PASS	PASS
$DCGL_{avg}$	PASS	PASS
EMC	PASS	PASS
Sign Test for Paired Data	PASS	PASS

[a] Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

4.2.4. Measurements of removable contamination

4.2.4.1. Swipes were taken at each location where a direct grid measurement was performed and on some fixed equipment. The results of the measurements are presented in Table 4.4.

Table 4.4
SU-2502 Removable Contamination Summary

Surface	Points	Avg Net Beta ($\beta pm/100cm^2$)	Max Net Beta ($\beta pm/100cm^2$)	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
N	5	9.2	29.0	1.9	6.0
E	6	5.0	21.0	1.0	4.4
S	9	-1.2	18.0	-0.3	3.8
W	5	12.8	20.0	2.7	4.2
F	8	-4.1	12.0	-0.9	2.5
Q2	2	15.5	17.0	3.2	3.5
Q3	2	4.5	6.0	0.9	1.3
Q9	2	-6.0	-6.0	-1.3	-1.3
Q10	2	-1.0	6.0	-0.2	1.3
Q12	18	7.6	36.0	1.6	7.5

[a] Activity was converted to $dpm_p/100\ cm^2$ from $\beta pm/100\ cm^2$ using an approximate figure of 4.8 betas per disintegration.

4.2.4.2. The results show that removable contamination averages near zero $dpm_p/100cm^2$ and varies between –3.5 and +7.5 $dpm_p/100cm^2$. The data confirm that virtually no removable contamination is present within SU-2502.

4.2.5. Beta Scan Measurements

4.2.5.1. Beta scans were performed on about 15% of the surfaces of the walls and floor. Diagrams of the areas surveyed are presented in Appendix 2, Figures 4.9 through 4.13.

4.2.5.2. The scan threshold used for these surveys was 2,000 cpm (net of background) which corresponds to the ARG of 2,600 $dpm_p/100cm^2$. The calculation of threshold count rate and MDC for scans is presented in NEXTEP Tech Memo 0230[42].

4.2.5.3. All scans performed on the wall and floor surfaces were taken on concrete, concrete block, and vinyl tile. The average background value used for analysis of the concrete and concrete block raw data was obtained from the open window, direct beta readings (in cpm) taken in the survey unit. This value was 244 cpm for concrete and 301 cpm for concrete block. The average background value used for analysis of the vinyl tile raw data was obtained from the open window, direct beta readings (in cpm) taken in the background data set. This value was 161 cpm. The average of all open window survey readings taken on concrete and concrete block in the background data set were 331 cpm and 412 cpm respectively. The average of all open window, direct survey readings taken on vinyl tile in the survey unit was 262 cpm.

4.2.5.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. The beta scan data are summarized for SU-2502 and presented in Table 4.5.

Table 4.5
SU-2502 Scan Measurements Summary

Matrix	Areas	Maximum (cpm)	Average (cpm)	Max Net (cpm)	Avg Net (cpm)
Concrete	9	350	239	19	-92
Concrete Block	6	400	300	-12	-112
Vinyl Tile	5	300	170	139	9

4.2.5.5. The maximum net scan value of 139 cpm is well below the scan threshold of 2000 cpm. No beta scan data were observed in SU-2502 above the scan threshold.

[42] NEXTEP Tech Memo 0230, Ibid.

4.3. SURVEY UNIT 2503

4.3.1. Direct Beta Measurements on Building Surfaces

4.3.1.1. SU-2503 was surveyed in February 1996, December 1999 and July 2003. One hundred and thirty-nine direct beta measurements were taken on the floor and wall surfaces. 28 of these were included in the systematic grid. Diagrams of the room layouts (walls and floor) with the beta measurements taken are presented in Appendix 2, Figure 4.3.

4.3.1.2. A summary of the direct measurement results is presented in Table 4.6 and shows that the maximum activity measured, net of background, was 1054 $dpm_p/100cm^2$. The average value for the survey unit was 299 $dpm_p/100cm^2$. [43]

Table 4.6
SU-2503 Direct Measurements Summary

Matrix	Points	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Asbestos Tile	1	201.8	201.8
Ceramic Tile	1	-43.4	-43.4
Concrete	24	81.3	992.7
Concrete Block	86	447.2	1053.9
Counter Top – Lab	1	185.2	185.2
Metal	10	-29.9	77.8
Plastic	3	118.7	209.8
Vinyl Tile	13	51.6	102.8

[a] Dpm_p refers to disintegrations per minute of the parent nuclide series.

4.3.2. Direct Beta Measurements on Installed Apparatus

4.3.2.1. All items of installed apparatus assigned to SU-2503 (listed in Appendix 1) were surveyed by direct beta measurements. A summary of the measurements taken is provided in Table 4.7 sorted by matrix. All net values observed ranged from -221 to 3,473 $dpm_p/100cm^2$ and, except for one, were less than the ARG.

4.3.2.2. One elevated value was measured on the laboratory countertops in Room 201. The activity measured, 3,473 $dpm_p/100cm^2$, exceeded the ARG but is still less than a third of the DCGLw.

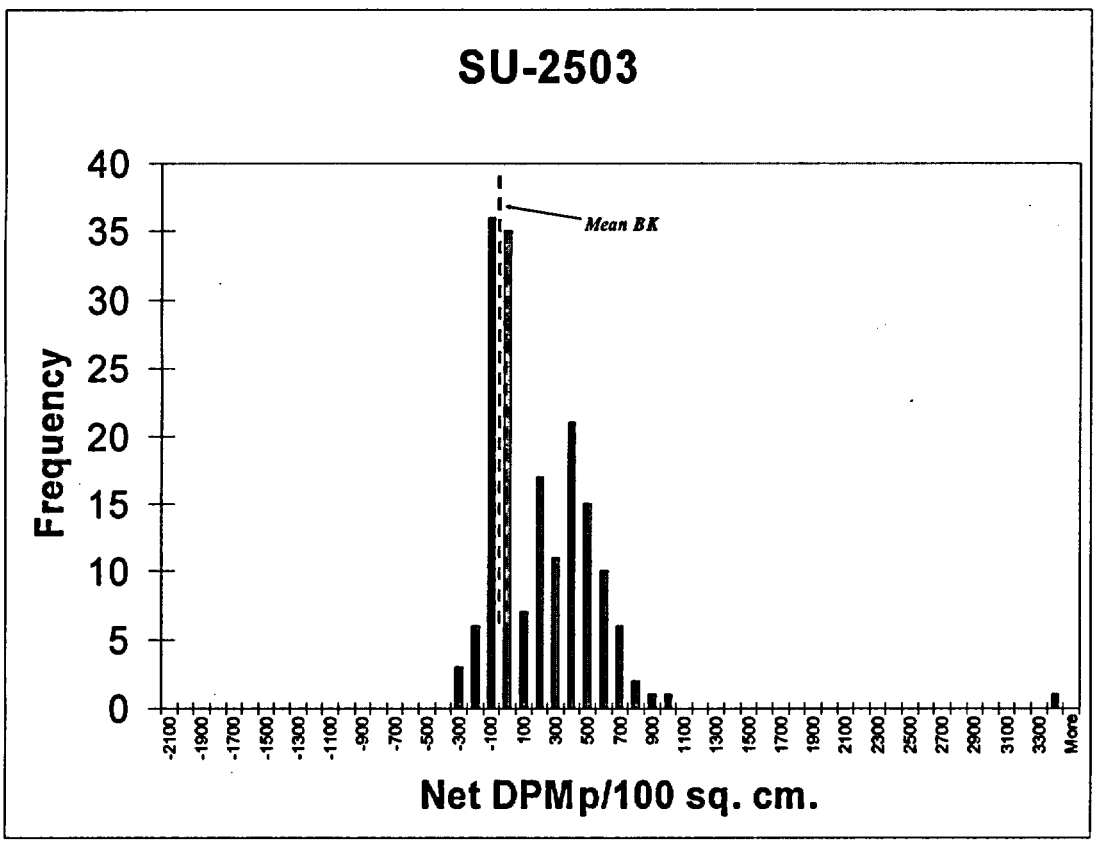
[43] Since all of the walls are coded for 3 coats of paint, the characterization data points have been biased high because they were taken before some (or all) of the paint layers were applied and have been amplified by the paint attenuation factor (PAF) in equation 2.

Table 4.7
SU-2503 Fixed Equipment Direct Measurements Summary

Matrix	Points	Avg Net Activity ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Asbestos Tile	2	70.4	126.0
Celotex	2	0.4	56.8
Counter Top	15	148.6	3472.9
Glass	4	-1.3	38.7
Metal	9	-19.1	-3.4

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-2503 is provided in Figure 4.2. The distribution appears to have two modes with the majority of the data centered at approximately 0 $dpm_p/100cm^2$ and 450 $dpm_p/100cm^2$. This is consistent with a normal distribution of background radioactivity and low levels of residual radioactivity. The single elevated measurement on the countertop in Room 201 appears far to the right of the rest of the data. All measurements were below the DCGLw.



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-2503. Since a measurement in this survey unit exceed the ARG, the TCTR limits for SU-2503 were initialized at 5,000 and 13,000 $dpm_p/100cm^2$ instead of the normal values as described in paragraph 3.6.10.4. The TCTR report contains a complete listing of all the beta direct measurements taken in the Final Status Survey within SU-2503 sorted by room, surface, and activity. The summary pages indicate that all tests described in the D Plan passed except for the background test. All tests required for release of a Class 2 survey unit were passed. A comparison of test results and requirements for release of the survey unit is presented in Table 4.8.

Table 4.8
Requirements for SU Release[a]

Test	Class 2	SU-2503
Min/Max	Not required	PASS
Background	Not required	FAIL
$DCGL_w$	PASS	PASS
$DCGL_{avg}$	PASS	PASS
EMC	PASS	PASS
Sign Test for Paired Data	PASS	PASS

[a] Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

4.3.4. Measurements of removable contamination

4.3.4.1. Swipes were taken at each location where a direct grid measurement was performed and on some fixed equipment. The results of the measurements are presented in Table 4.9.

Table 4.9
SU-2503 Removable Contamination Summary

Surface	Points	Avg Net Beta ($\beta pm/100cm^2$)	Max Net Beta ($\beta pm/100cm^2$)	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
N	3	9.3	17.0	1.9	3.5
E	7	-9.3	19.0	-1.9	4.0
S	3	11.3	20.0	2.4	4.2
W	8	-12.9	3.0	-2.7	0.6
F	9	7.8	28.0	1.6	5.8
Q2	3	-4.7	0.0	-1.0	0.0
Q7	4	5.5	25.0	1.1	5.2
Q9	5	0.0	25.0	0.0	5.2

[a] Activity was converted to $dpm_p/100\ cm^2$ from $\beta pm/100\ cm^2$ using an approximate figure of 4.8 betas per disintegration.

4.3.4.2. The results show that removable contamination averages near zero $dpm_p/100cm^2$ and varied between –7.5 and +5.8 $dpm_p/100cm^2$. The data confirm that virtually no removable contamination is present within SU-2503.

4.3.5. Beta Scan Measurements

4.3.5.1. Beta scans were performed on about 15% of the surfaces of the walls and floor. Scans were also performed on the casework in the survey unit. Diagrams of the areas surveyed are presented in Appendix 2, Figures 4.14 and 4.15.

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 $dpm_p/100cm^2$.[44]

4.3.5.3. All scans performed on the wall and floor surfaces were taken on concrete, concrete block, and vinyl tile. The scans performed on the casework were performed on counter top and metal. Background values for beta scans were calculated from the open window measurements in either the survey unit or the background data set for each matrix. The averages of these open window measurements are presented in Table 4.10. The lower of the two averages was used in each case when calculating net scan values.

Table 4.10
Beta Scan Background Data
(Open Window Averages)

Matrix	Survey Unit Data Set (cpm)	Background Data Set (cpm)
C	378	331*
CB	373*	412
VT	286	161*
CT	379*	706
M	238	167*

*Background count rate used for calculation of net scan readings.

4.3.5.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. Net scan values were obtained by subtracting the background count rate obtained from Table 4.10 for each matrix. The beta scan data are summarized for SU-2503 and presented in Table 4.11.

[44] NEXTEP Tech Memo 0230, Ibid.

Table 4.11
SU-2503 Scan Measurements Summary

Matrix	Areas	Maximum (cpm)	Average (cpm)	Max Net (cpm)	Avg Net (cpm)
Concrete	1	850	700.0	518.8	368.8
Concrete Block	1	175	150.0	-236.8	-261.8
Counter Top – Lab (Bldg 250)	1	2000	1000.0	1293.7	293.7
Metal	2	125	100.0	-42.2	-67.2
Vinyl Tile	2	250	150.0	89.4	-10.6

4.3.5.5. The maximum net scan value of 1,294 cpm is below the scan threshold of 2,000 cpm. No beta scan data were observed in SU-2503 above the scan threshold.

4.4. SURVEY UNIT 2504

4.4.1. The original floor of rooms 101C, 103AB, 110, 115, 127, 139, and 140 have been covered with carpet or vinyl tile since CT operations ceased. Therefore, beta detection methods are not adequate to characterize these portions of the survey unit and gamma methods were employed instead for scan measurements and to focus on elevated areas. The characterization data adequately covered the grid requirements, so the only direct measurements taken on the floor of these rooms, were bias measurements.

4.4.2. Direct Beta Measurements on Building Surfaces

4.4.2.1. SU-2504 was surveyed in February and March 1995, July 1996, August 2003, and November 2003. Two hundred and seventy direct beta measurements were taken on the floor and wall surfaces. 68 of these were included in the systematic grid. Five bias measurements were taken in response to the elevated gamma scan reading described in paragraph 4.4.3. Diagrams of the room layouts (walls and floor) with the beta measurements taken are presented in Appendix 2, Figures 4.4 through 4.8.

4.4.2.2. A summary of the direct beta measurement results is presented in Table 4.12 and shows that the maximum activity measured, net of background, was 811 $dpm_p/100cm^2$. The average value for the survey unit was 12 $dpm_p/100cm^2$.

Table 4.12
SU-2504 Direct Measurements Summary
Building Surfaces

Matrix	Points	Avg Net Activity ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Concrete	5	-0.3	31.1
Concrete Block	115	27.8	810.8
Gypsum Board	32	18.7	66.6
Metal	23	-24.7	67.9
Other Non Metal	2	-8.2	27.8
Rubber Base	19	10.9	43.1
Vinyl Tile	74	-4.2	27.6

4.4.3. Direct Gamma Measurements on Building Surfaces

4.4.3.1. Gamma direct measurements were taken to augment the data set of beta points and to confirm the scan results. The NaI readings were converted to $dpm_p/100cm^2$ using conversion factors calculated for carpet and vinyl tile overlaying the contamination as described in Table 2.6.

4.4.3.2. Eight direct gamma measurements were collected from the floor of Room 115. Five of these were to confirm an elevated gamma scan reading which was obtained over the carpeted portion of the floor. Figure 4.5 of Appendix 2 shows the layout of both gamma and beta confirmation samples, The insert in the figure shows a close- up of the offsets along with the values for both sets of readings. Although the maximum gamma count rate translated to a maximum value of 8,001 $dpm_p/100cm^2$, confirmation by beta measurement after removal of the carpet revealed that the elevated spot measured approximately 67 $dpm_p/100cm^2$ and was less than about one foot in diameter. The beta result is considered to be the most accurate and applicable reading for purposes of the FSS. However, both readings were substantially less than the $DCGL_W$.

4.4.3.3. A summary of the gamma direct measurement results for SU-2504 is presented in Table 4.13 and shows that the maximum activity measured, net of background, was 8,001 $dpm_p/100cm^2$. The average for the survey unit was 1,672 $dpm_p/100cm^2$. All the direct gamma measurements in the survey unit were less than the DCGLw.

Table 4.13
SU-2504 Direct Gamma Measurements Summary
Building Surfaces

Matrix	Points	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Carpet	5	1787	8001
Vinyl Tile	3	1480	1923

[a] Dpm_p refers to disintegrations per minute of the parent nuclide series.

4.4.4. Direct Beta Measurements on Installed Apparatus

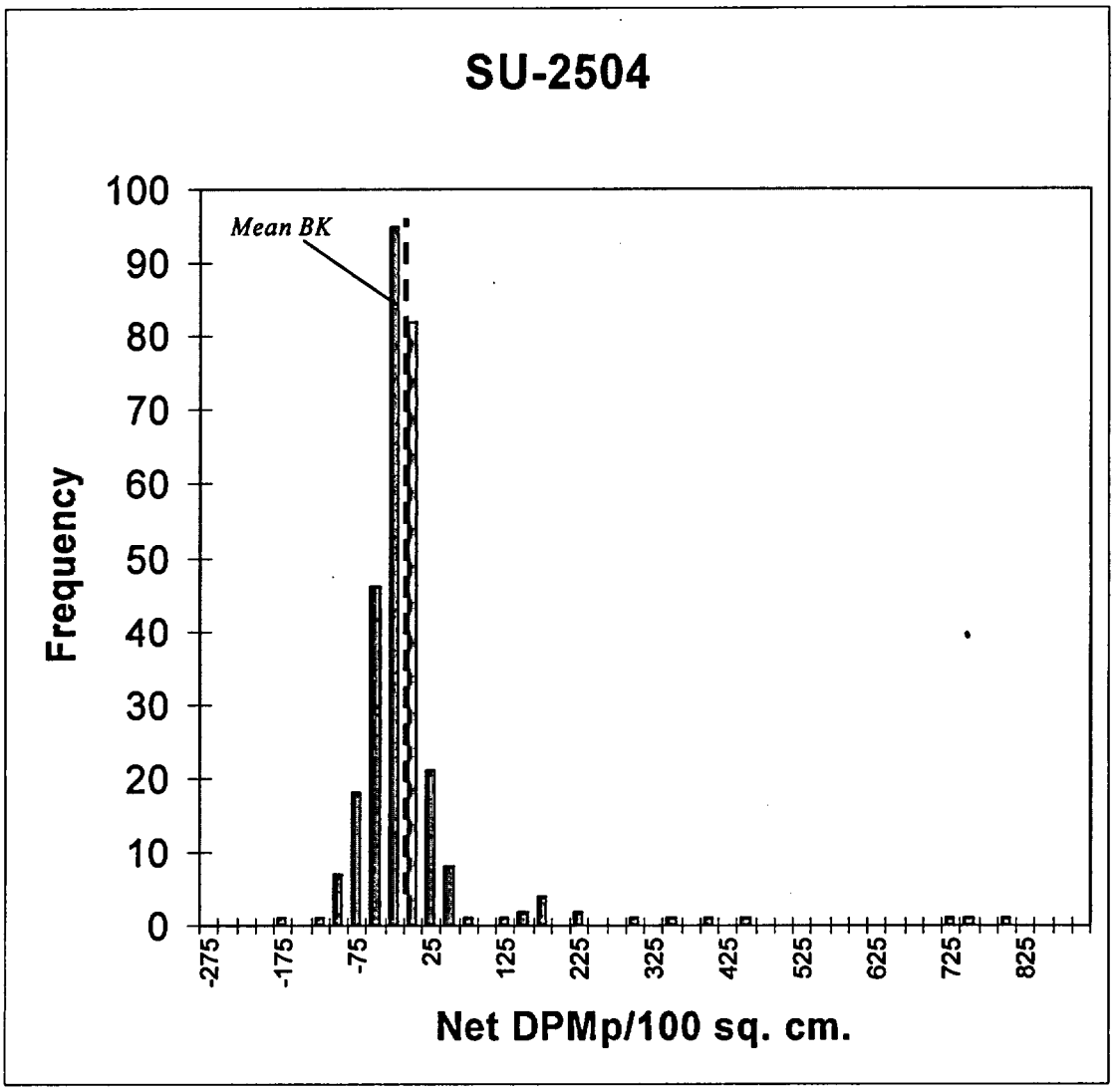
4.4.4.1. All 17 items of installed apparatus assigned to SU-2504 (listed in Appendix 1) were surveyed by direct beta measurements. The CT lead well in Room 127 had been previously removed and disposed of and was therefore not surveyed. A summary of the measurements taken on the installed apparatus is provided in Table 4.14 sorted by matrix. The net values observed ranged from -45 to 89 $dpm_p/100cm^2$. All values were less than 4% of the ARG.

Table 4.14
SU-2504 Direct Measurements Summary
Installed Apparatus

Matrix	Points	Avg Net Activity ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
Metal	25	-1.9	88.7

4.4.5. Direct Beta Measurement Distribution and Threshold Tests

4.4.5.1. A histogram of all the beta direct net activity values found in SU-2504 is provided in Figure 4.3. The distribution appears to have a single mode, with small amounts of residual activity out to a maximum of 811 $dpm_p/100\ cm^2$. This is consistent with a normal distribution of background radioactivity with some residual activity above background. All measurements were below the ARG.



Histogram of Net Direct Beta Measurements
Figure 4.3

4.4.5.2. All the direct beta measurements in the survey unit were analyzed using the Threshold Comparison Test Report (TCTR) and the results are presented in Appendix 4 for SU-2504. The TCTR report contains a complete listing of all the beta direct measurements taken in the Final Status Survey within SU-2504 sorted by room, surface, and activity. The summary pages indicate that all tests described in the D Plan passed except for the background test. All tests required for release of a Class 2 survey unit were passed. A comparison of test results and requirements for release of the survey unit is presented in Table 4.15.

Table 4.15
Requirements for SU Release[a]

Test	Class 2	SU-2504
Min/Max	Not required	PASS
Background	Not required	FAIL
$DCGL_w$	PASS	PASS
$DCGL_{avg}$	PASS	PASS
EMC	PASS	PASS
Sign Test for Paired Data	PASS	PASS

[a] Class 1 or 2 survey units which pass Min/Max may be released without further consideration.

4.4.6. Measurements of Removable Contamination

4.4.6.1. Swipes were taken at all of the locations where a direct grid measurement was performed on the walls. Swipes were also taken at locations determined by the surveyor on the floor. The results of these measurements are presented in Table 4.16. The results show that removable contamination in SU-2504 averages near zero and ranges between –5 and +12 $dpm_p/100cm^2$. No significant removable contamination is present in SU-2504.

Table 4.16
SU-2504 Removable Contamination Summary

Surface	Points	Avg Net Beta ($\beta pm/100cm^2$)	Max Net Beta ($\beta pm/100cm^2$)	Avg Net Activity[a] ($dpm_p/100cm^2$)	Max Net Activity ($dpm_p/100cm^2$)
N	8	4.9	33.0	1.0	6.9
E	7	14.6	31.0	3.0	6.5
S	8	6.8	25.0	1.4	5.2
W	6	12.0	19.0	2.5	4.0
F	12	21.4	59.0	4.5	12.3

[a]Activity was converted to $dpm_p/100\ cm^2$ from $\beta pm/100\ cm^2$ using an approximate figure of 4.8 betas per disintegration.

4.4.7. Beta Scan Measurements

4.4.7.1. Beta scans were performed on about 15% of the accessible surfaces in all rooms except 103AB and 115. Some beta scans were also performed under the carpet of room 115. Diagrams of the areas surveyed are presented in Appendix 2, Figures 4.16 through 4.26.

4.4.7.2. The scan threshold used for these surveys was 2,000 cpm (net of background) which corresponds to the ARG of 2,600 $dpm_p/100cm^2$. The calculation of threshold count rate and MDC for scans is presented in NEXTEP Tech Memo 0230[45].

[45] NEXTEP Tech Memo 0230, Ibid.

4.4.7.3. All scans performed on the wall and floor surfaces were taken on brick, concrete, concrete block, and vinyl tile. Background values for beta scans were calculated from the open window measurements in either the survey unit or the background data set for each matrix. The averages of these open window measurements are presented in Table 4.17. The lower of the two averages was used in each case when calculating net scan values.

Table 4.17
Beta Scan Background Data
(Open Window Averages)

Matrix	Survey Unit Data Set (cpm)	Background Data Set (cpm)
B	314*	552
C	244*	331
CB	301*	412
VT	262	161*

* used for beta scan background

4.4.7.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. The beta scan data are summarized for SU-2504 and presented in Table 4.18.

Table 4.18
SU-2504 Beta Scan Measurements Summary

Matrix	Areas	Maximum (cpm)	Average (cpm)	Max Net (cpm)	Avg Net (cpm)
Brick	1	300	250	-252	-302
Concrete	8	270	172	-61	-159
Concrete Block	11	275	180	-137	-232
Vinyl Tile	2	230	165	69	4

4.4.7.5. The maximum net scan value of 69 cpm is well below the scan threshold of 2000 cpm. No beta scan data were observed in SU-2504 above the scan threshold.

4.4.8. Gamma Scan Measurements

4.4.8.1. Gamma scans were performed on portions of rooms 101C, 103AB, 110, 115, 127, 139, and 140. Diagrams of the areas surveyed are presented in Appendix 2, Figures 4.16 – 4.26.

4.4.8.2. The scan thresholds used for these surveys are presented in Table 2.7. They correspond to the DCGLw of 13,000 $dpm_p/100cm^2$ using conversion factors derived in NEXTEP Tech Memo 0317 and the threshold equation from NEXTEP Tech Memo 0230.[46]

4.4.8.3. The average background value used for analysis of the raw data was the average ambient background described in section 2.3.

4.4.8.4. During the surveys the maximum and average gross count rates were recorded for each area scanned. The gamma scan data for SU-2504 are summarized and presented in Table 4.19.

Table 4.19
SU-2504 Gamma Scan Measurements Summary

Matrix	Points	Maximum* (cpm)	Average* (cpm)	Max Net (cpm)	Avg Net (cpm)
Carpet	2	14,000	7,000	7,300	300
Concrete	2	8,000	7,000	1,300	300
Vinyl Tile	4	8,000	6,500	1,300	-200

* Gross readings

4.4.8.5. One scan measurement was elevated considerably above the others and came close to the gamma scan threshold. This elevated measurement was examined and resolved by beta and gamma direct measurements as described in paragraph 4.4.3.2.

4.4.8.6. No net gamma scans were above the gamma scan threshold equivalent to the DCGLw.

5. CONCLUSIONS

5.1. SU-2502

5.1.1. SU-2502 passed all the tests described in the D Plan except background. (Par. 4.2.3.2)

5.1.2. No residual radioactivity was measured above 6% of the ARG on the items of installed apparatus in SU-2502. (Par. 4.2.2.1)

[46] ibid.

5.1.3. Virtually no removable contamination is present within SU-2502. (Par. 4.2.4.2)

5.1.4. No beta scan data were observed in SU-2502 above the scan threshold of 2,000 cpm. (Par. 4.2.5.5)

5.1.5. SU-2502 meets all the requirements of the D Plan for unconditional release.

5.2. SU-2503

5.2.1. SU-2503 passed all the tests described in the D Plan except background. (Par. 4.3.3.2)

5.2.2. All direct beta measurements in SU-2503 were below the ARG except one. The one elevated location on a lab countertop was less than one third of the $DCGL_W$. (Par. 4.3.2.1 and 4.3.2.2)

5.2.3. Virtually no removable contamination is present within SU-2503. (Par. 4.3.4.2)

5.2.4. No beta scan data were observed in SU-2503 above the scan threshold of 2,000 cpm. (Par. 4.3.5.5)

5.2.5. SU-2503 meets all the requirements of the D Plan for unconditional release.

5.3. SU-2504

5.3.1. SU-2504 passed all the tests described in the D Plan except background. (Par. 4.4.3.4)

5.3.2. No residual radioactivity was measured above 1% of the $DCGL_W$. (Par. 4.4.4.1)

5.3.3. No significant removable contamination is present within SU-2504. (Par. 4.4.5.1)

5.3.4. No beta scan data were observed in SU-2504 above the scan threshold of 2,000 cpm. (Par. 4.4.7.5)

5.3.5. No gamma scans were above the DCGLw threshold. (Par. 4.4.8.5)

5.3.6. SU-2504 meets all the requirements of the D Plan for unconditional release.

6. RECOMMENDATIONS

6.1. Survey Units 2502, 2503, and 2504 should be released from the license.

Appendix 1
Building Survey Unit Listing for
Building 250 Interior

Building Survey Unit Listing

SurfaceCode	*Xmax*	*Ymax*	*Area (sq.ft.)*	*Paint (Coats)*	*Description*
SurveyUnitID: 2502					***Class:*** 2
Room 205					
F	15.8	8.7	138	0.0	
N	15.8	10	158	2.0	
S	15.8	10	158	2.0	
E	8.7	10	87	2.0	
W	8.7	10	87	2.0	
Q1				0.0	Ceiling light fixture, piping and ducting above drop ceiling
Q2				0.0	sink and glass drain line
Q3				0.0	sink counter
Q4				0.0	Supply lines near floor
Q5				0.0	Dishwasher
Q6				0.0	Ventilaton filter
Summary for Room 205 (11 detail records)				*628* **Sq. Feet**	
Room 207					
F	6.83	18.1	124	0.0	
N	6.83	14	96	2.0	
S	6.83	14	96	2.0	
E	18.1	14	253	2.0	
W	18.1	14	253	2.0	
Q1				0.0	Ceiling light fixture, ducting, piping, horizontal support surfaces
Q2				0.0	All cabinetry in room
Q3				0.0	Light switch and piping, pipe along south wall
Q4				0.0	Towel holder on North wall
Summary for Room 207 (9 detail records)				*822* **Sq. Feet**	

Building Survey Unit Listing

	SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 209						
	F	18.4	28	515	0.0	
	N	18.4	10	184	2.0	
	S	18.4	14	258	2.0	
	E	28	10	280	2.0	
	W	28	10	280	2.0	
	Q1				0.0	Drop ceiling, sprinkler system
	Q2				0.0	E. Hood and ducting
	Q3				0.0	East sink and glass drain
	Q4				0.0	East counters
	Q5				0.0	SS cabinets on E and W wall, 1" conduit on S wall
	Q6				0.0	Island counters
	Q7				0.0	West counters
	Q8				0.0	West sink and glass drain lines
	Q9				0.0	W. Hood and ducting
	Q10				0.0	East and West glass lines
	Q11				0.0	Chalk board on Northern wall
	Q12				0.0	Vacuum Line Fixtures (11)
Summary for Room 209 (17 detail records)					*1,517* **Sq. Feet**	

Building Survey Unit Listing

	SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 210						
	F	40.35	26.33	1,062	0.0	
	N	40.35	14	565	1.0	
	S	40.35	14	565	1.0	
	E	26.33	14	369	1.0	
	W	26.33	14	369	1.0	
	Q1				0.0	Ceiling lights and associated supports
	Q2				0.0	Vent chase (2) and electrical panel in NW corner of room
	Q3				0.0	Motor Housing North central location in room
	Q4				0.0	Tank North central location in room
	Q5				0.0	Compressor and electrical motor, North eastern portion of room
	Q6				0.0	Exhaust fan on ceiling
	Q7				0.0	Pressure tank North eastern portion of room
	Q8				0.0	Misc piping, North eastern portion of room
	Q9				0.0	Cooling filter, louvered vent, North eastern portion of room
	Q10				0.0	Misc. piping - extends from east wall south of blowout panel to several feet onto south wall
	Q11				0.0	Electrical panels (6) in South west corner of room
	Q12				0.0	MCC unit, Western side of room near wall
	Q13				0.0	Old chase to roof attached to new ductwork
Summary for Room 210 (18 detail records)					*2,930* **Sq. Feet**	

Building Survey Unit Listing

	SurfaceCode	*Xmax*	*Ymax*	*Area (sq.ft.)*	*Paint (Coats)*	*Description*
Room 211						
	F	20.33	28	569	0.0	
	N	20.33	10	203	2.0	
	S	20.33	14	285	2.0	
	E	28	10	280	2.0	
	W	28	10	280	2.0	
	Q1				0.0	Drop ceiling, lights, sprinklers, vent. Ducting
	Q2				0.0	Cylinder rack on Northern wall
	Q3				0.0	E. Hood and ducting
	Q4				0.0	Eastern sink and glass drain line
	Q5				0.0	Eastern counters
	Q6				0.0	Glass line on Eastern wall, vent pipe on southern wall
	Q7				0.0	Island counter
	Q8				0.0	Western counters
	Q9				0.0	Western sink and glass drain line
	Q10				0.0	W. Hood and ducting
	Q11				0.0	Chalk board on northern wall
	Q12				0.0	Vacuum Line Fixtures (10)
Summary for Room 211 (17 detail records)					*1,617* **Sq. Feet**	
TOTAL for Survey Unit 2502					***7,514*** **Sq. Feet**	

Building Survey Unit Listing

SurfaceCode	*Xmax*	*Ymax*	*Area (sq.ft.)*	*Paint (Coats)*	*Description*
SurveyUnitID: 2503					***Class:*** 2
Room 201					
F	20	29	544	0.0	
N	20	10	200	3.0	
S	20	14	280	3.0	
E	29	10	290	3.0	
W	29	14	406	3.0	
Q1				0.0	ceiling light fixtures, sprinkler system
Q2				0.0	north fume hood duct work
Q3				0.0	glass drain/vents, N, S, & W walls (3)
Q4				0.0	Island casework & countertop
Q5				0.0	West sink
Q6				0.0	West casework
Q7				0.0	South sink
Q8				0.0	South casework
Q9				0.0	Vacuum line fixtures (11)
Summary for Room 201 (14 detail records)			*1,720* **Sq. Feet**		

Building Survey Unit Listing

	SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 202						
	F	20	26.5	560	0.0	
	N	20	14	280	3.0	
	S	20	10	200	3.0	
	E	26.5	10	280	3.0	
	W	26.5	14	392	3.0	
	Q1				0.0	Ceiling light fixture, sprinkler system, ventilation ducting (top)
	Q2				0.0	E. Sink
	Q3				0.0	E. Casework
	Q4				0.0	Center Casework
	Q5				0.0	W. Sink
	Q6				0.0	W. Casework
	Q7				0.0	Vacuum Line Fixtures (9)
Summary for Room 202 (12 detail records)					*1,712* Sq. Feet	
TOTAL for Survey Unit 2503					***3,432*** **Sq. Feet**	

Building Survey Unit Listing

SurfaceCode	*Xmax*	*Ymax*	*Area (sq.ft.)*	*Paint (Coats)*	*Description*
SurveyUnitID: 2504					***Class:*** 2
Room *101C*					
F	3.3	6.1	20	0.0	
N	3.3	14	46	2.0	
S	3.3	14	46	2.0	
E	6.1	14	85	2.0	
W	6.1	10	61	2.0	
Q1				0.0	Light and vent
Q2				0.0	sink
Summary for Room 101C (7 detail records)				*259*	**Sq. Feet**
Room *103AB*					
F	21	13	273	0.0	
S	21	12	252	0.0	
W	13	12	156	0.0	
Q1				0.0	Small equipment attached to ceiling
Summary for Room 103AB (4 detail records)				*681*	**Sq. Feet**
Room *110*					
F	10	11	108	0.0	
N	10	10	100	0.0	
Q1				0.0	Small equipment attached to ceiling
Q2				0.0	Fire sprinkler system
Summary for Room 110 (4 detail records)				*208*	**Sq. Feet**

Building Survey Unit Listing

SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 115					
F	39	17	663	0.0	
S	34	12	408	0.0	
Q1				0.0	Small equipment attached to ceiling
Q2				0.0	Fire sprinkler system
Summary for Room 115 (4 detail records)				*1,071*	**Sq. Feet**
Room 118					
F	10.8	5.88	64	0.0	
N	7.5	14	105	2.0	
S	10.8	14	151	2.0	
E	5.88	14	82	2.0	
W	5.88	14	82	2.0	
Q1				0.0	Heater
Summary for Room 118 (6 detail records)				*484*	**Sq. Feet**
Room 119					
F	3.92	4.5	18	0.0	
N	3.92	14	55	2.0	
S	3.92	14	55	2.0	
E	4.5	14	63	2.0	
Summary for Room 119 (4 detail records)				*190*	**Sq. Feet**
Room 127					
F	15.5	10	155	0.0	
N	15.5	14	217	0.0	
S	15.5	14	217	0.0	
E	10	14	140	0.0	
W	10	14	140	0.0	
Q1				0.0	Small equipment attached to ceiling
Summary for Room 127 (6 detail records)				*869*	**Sq. Feet**

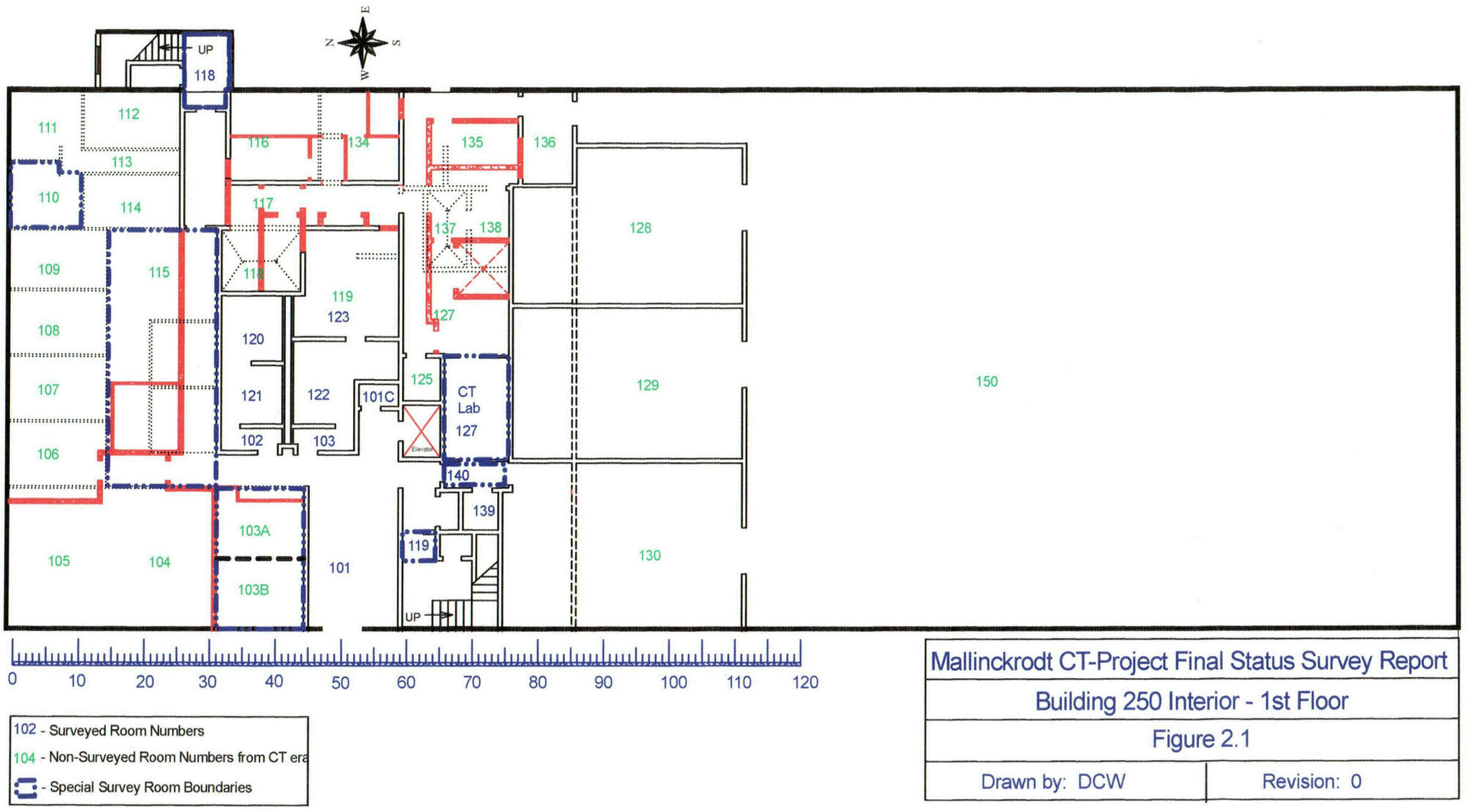
Building Survey Unit Listing

SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 139					
F	5.9	5.6	33	0.0	
N	5.9	14	83	0.0	
S	5.9	14	83	0.0	
E	5.6	14	78	0.0	
W	5.6	14	78	0.0	
Q1				0.0	Small equipment attached to ceiling
Q2				0.0	Fire sprinkler system
Q3				0.0	Electrical trac - south and west walls
Summary for Room 139 (8 detail records)				*355*	**Sq. Feet**
Room 140					
F	4.3	10	43	0.0	
N	4.3	14	60	0.0	
S	4.3	14	60	0.0	
E	10	14	140	0.0	
W	10	14	140	0.0	
Q1				0.0	Fire sprinkler system
Q2				0.0	Small equipment attached to ceiling
Summary for Room 140 (7 detail records)				*443*	**Sq. Feet**
Room 218					
F	10.83	19.92	170	0.0	
N	10.83	28	220	2.0	
S	10.83	28	162	2.0	
E	19.92	28	375	2.0	
W	19.92	28	315	2.0	
Summary for Room 218 (5 detail records)				*1,242*	**Sq. Feet**

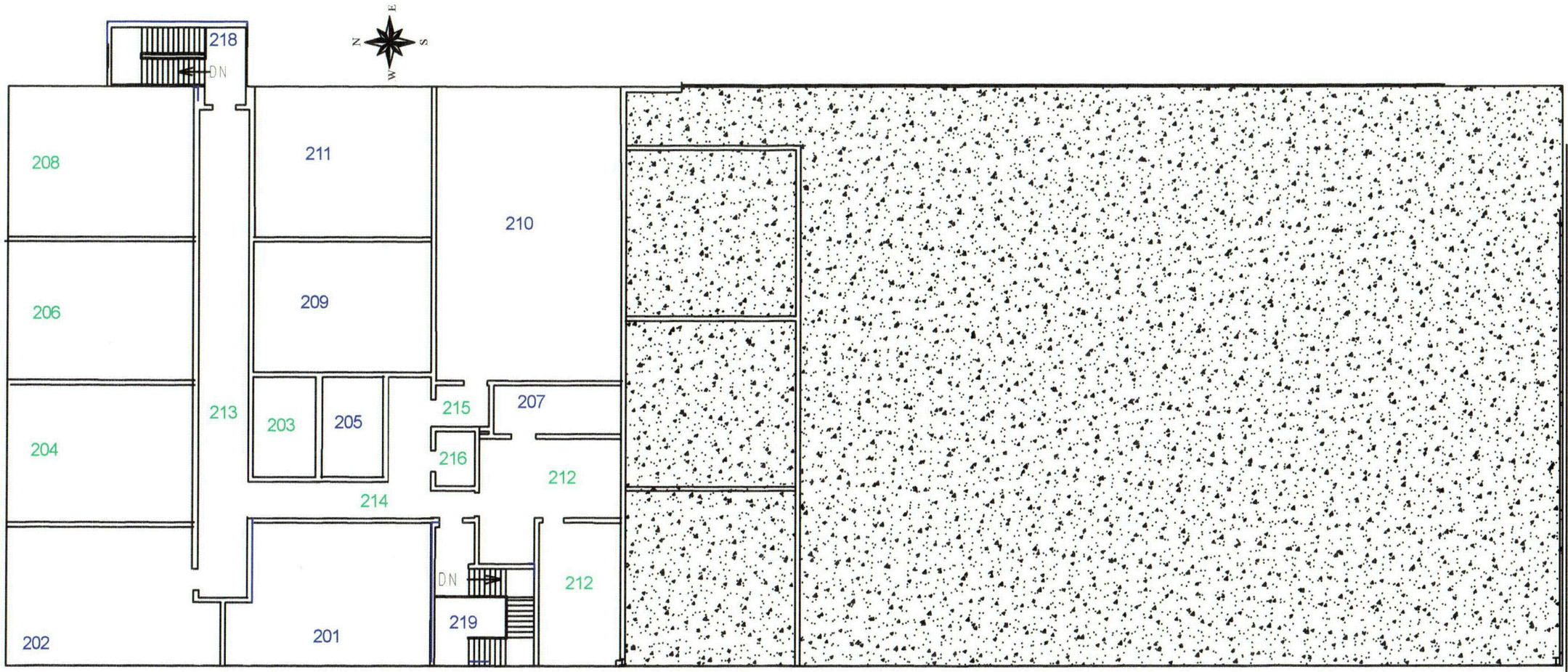
Building Survey Unit Listing

	SurfaceCode	Xmax	Ymax	Area (sq.ft.)	Paint (Coats)	Description
Room 219						
	F	20.4	14	223	0.0	
	N	20.4	28	416	2.0	Entire north wall, both levels, minus Rm 119 contribution
	S	20.4	28	415	2.0	
	E	14	28	299	2.0	
	W	14	28	372	2.0	
	Q1				0.0	Heater
	Q2				0.0	Ladder - upper stairwell
	Q3				0.0	Lights (2)
Summary for Room 219 (8 detail records)					*1,725*	**Sq. Feet**
TOTAL for Survey Unit 2504				**7,527**		**Sq. Feet**

APPENDIX 2
Figures



Mallinckrodt CT-Project Final Status Survey Report	
Building 250 Interior - 1st Floor	
Figure 2.1	
Drawn by: DCW	Revision: 0



Mallinckrodt CT-Project Final Status Survey Report	
Building 250 Interior - 2nd Floor	
Figure 2.2	
Drawn by: DCW	Revision: 0

C02

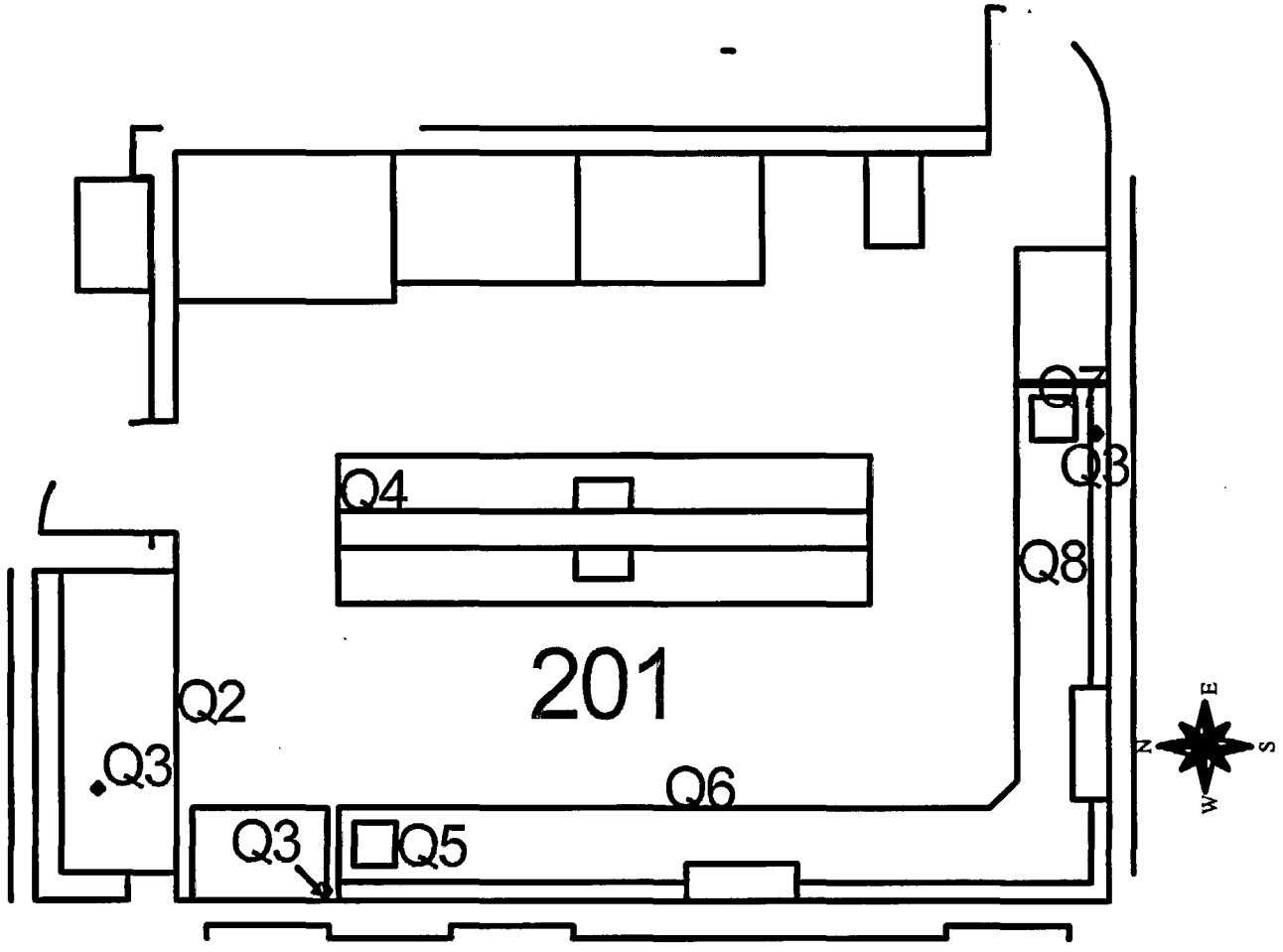


Figure 2.3

Room 201

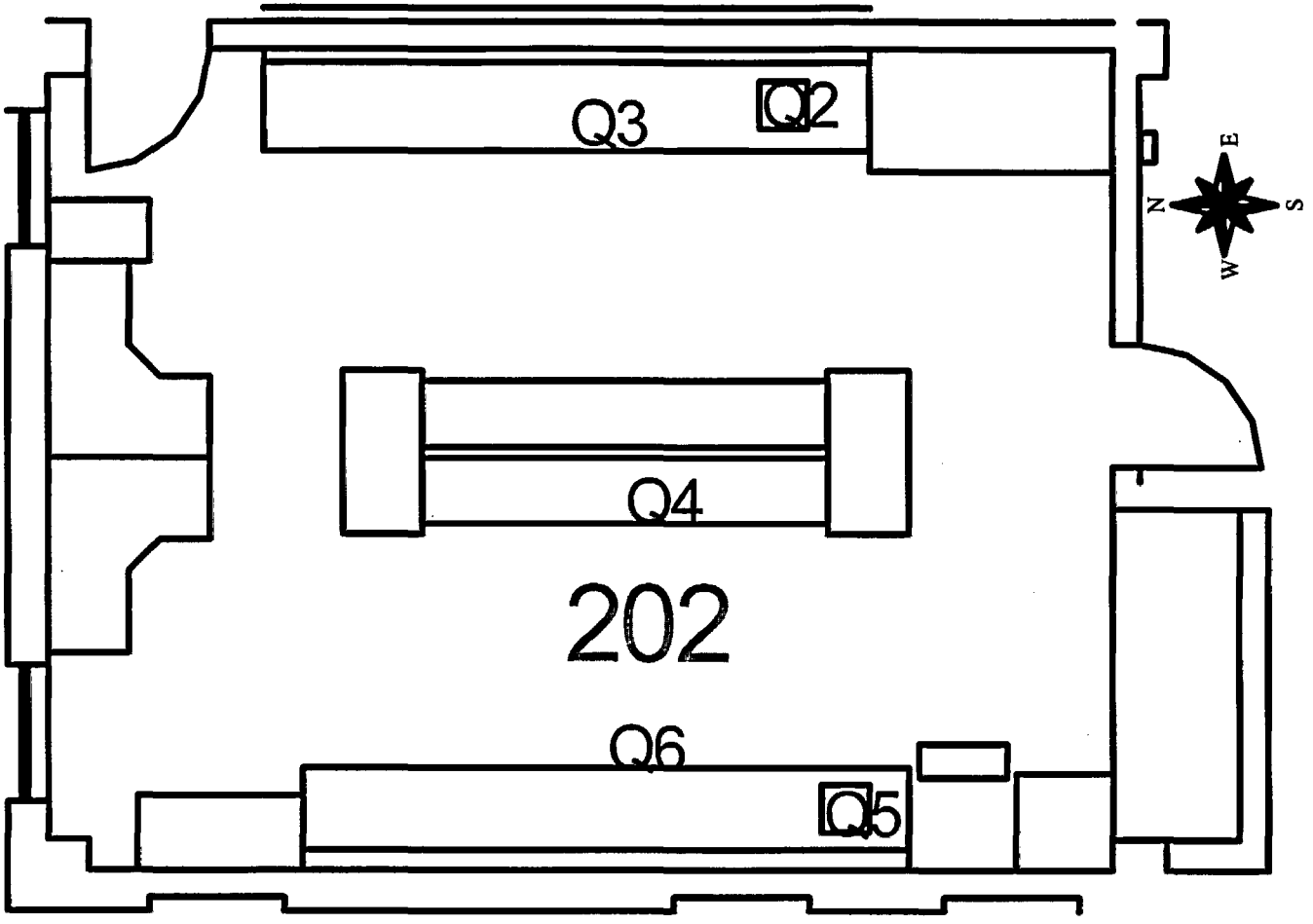


Figure 2.4

Room 202

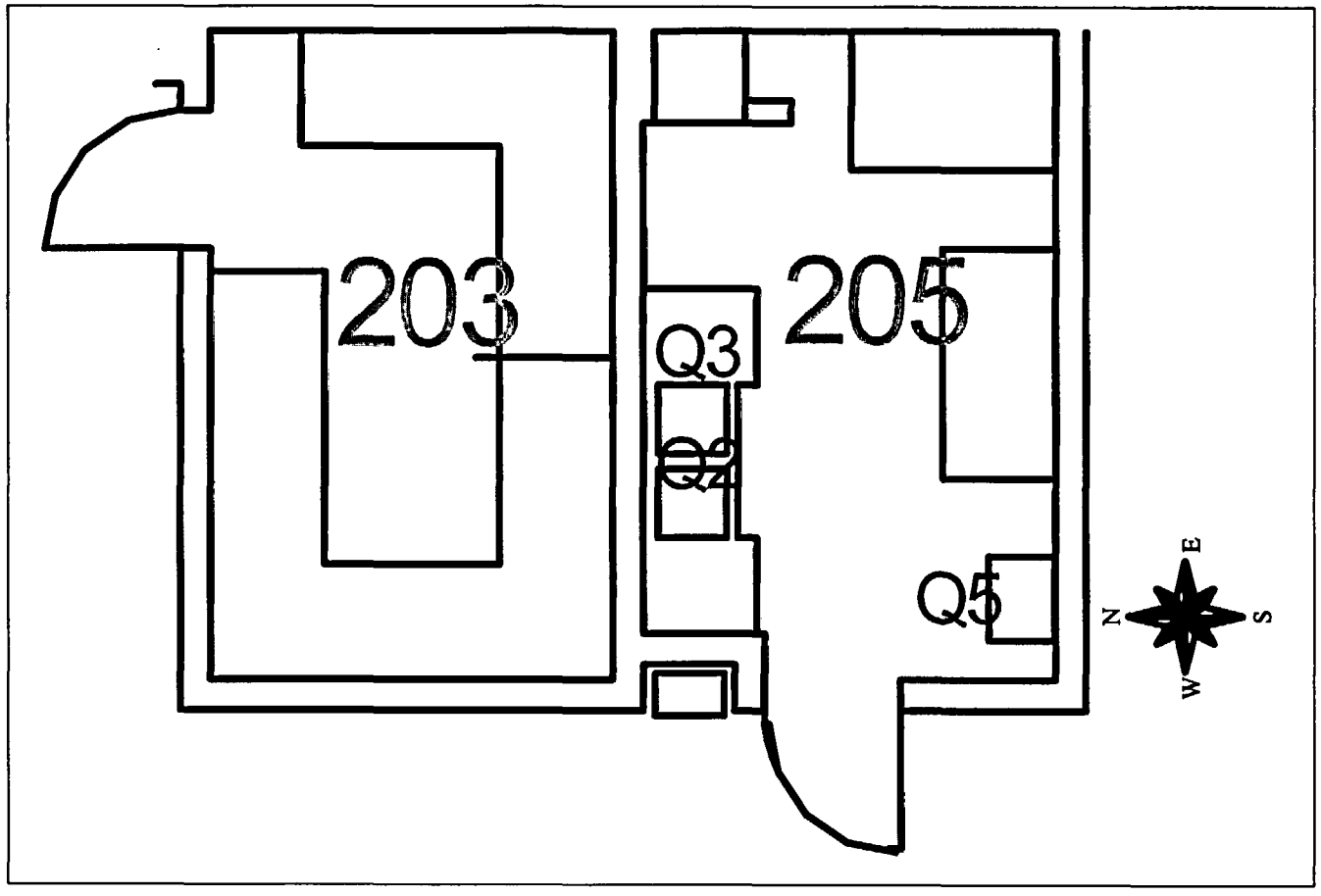


Figure 2.5

Room 205

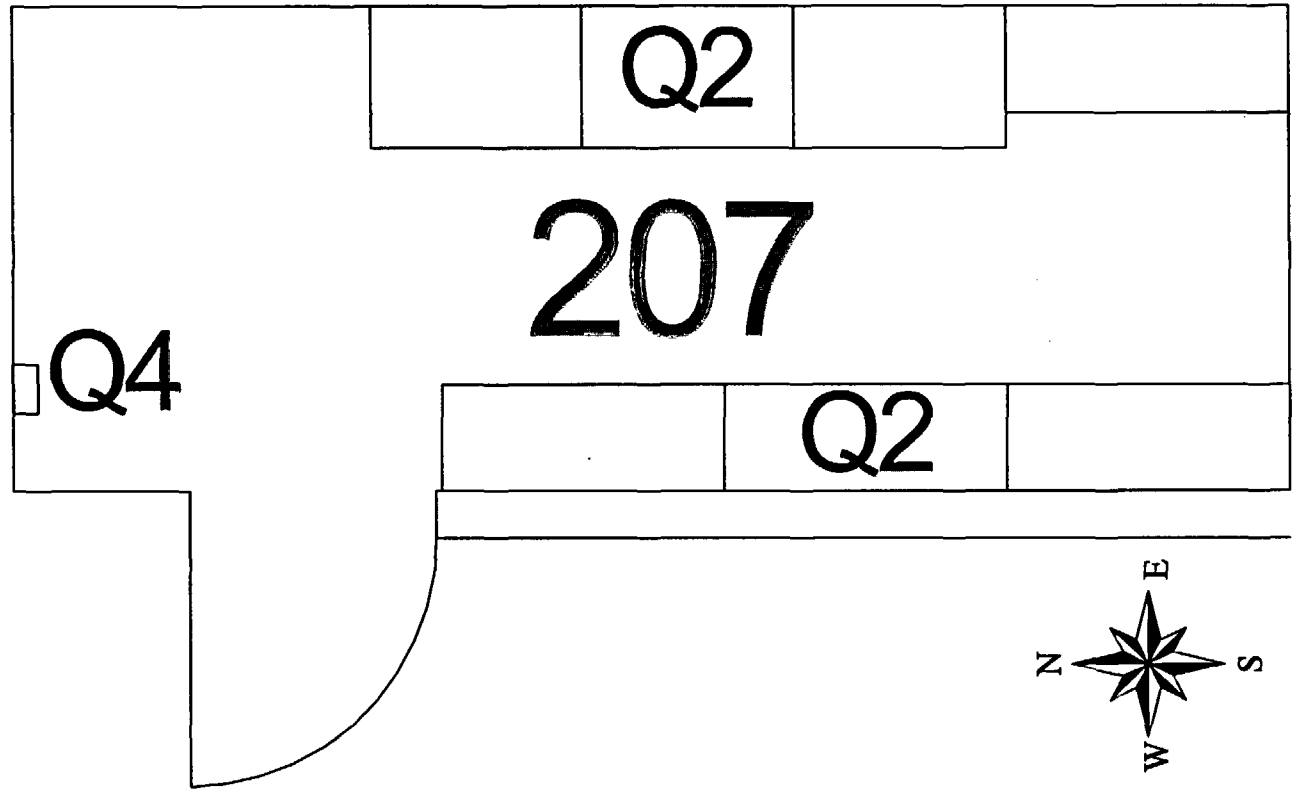


Figure 2.6

Room 207

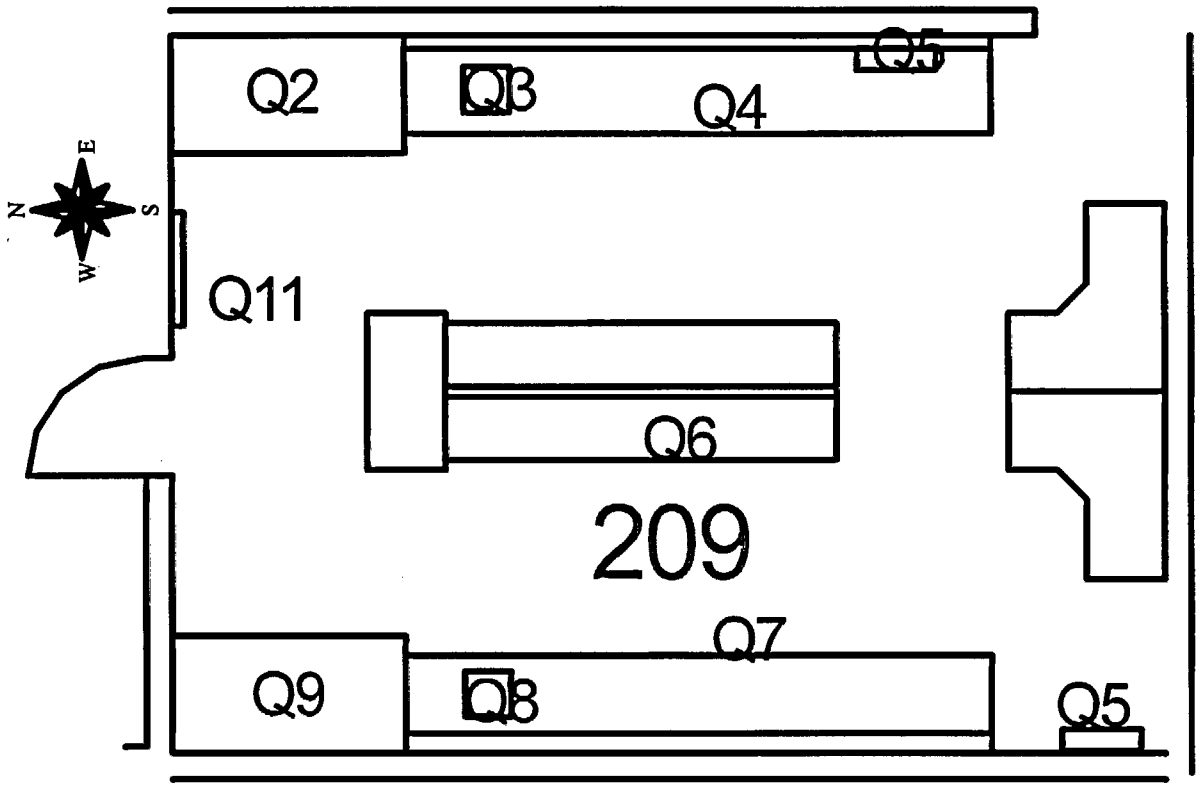


Figure 2.7

Room 209

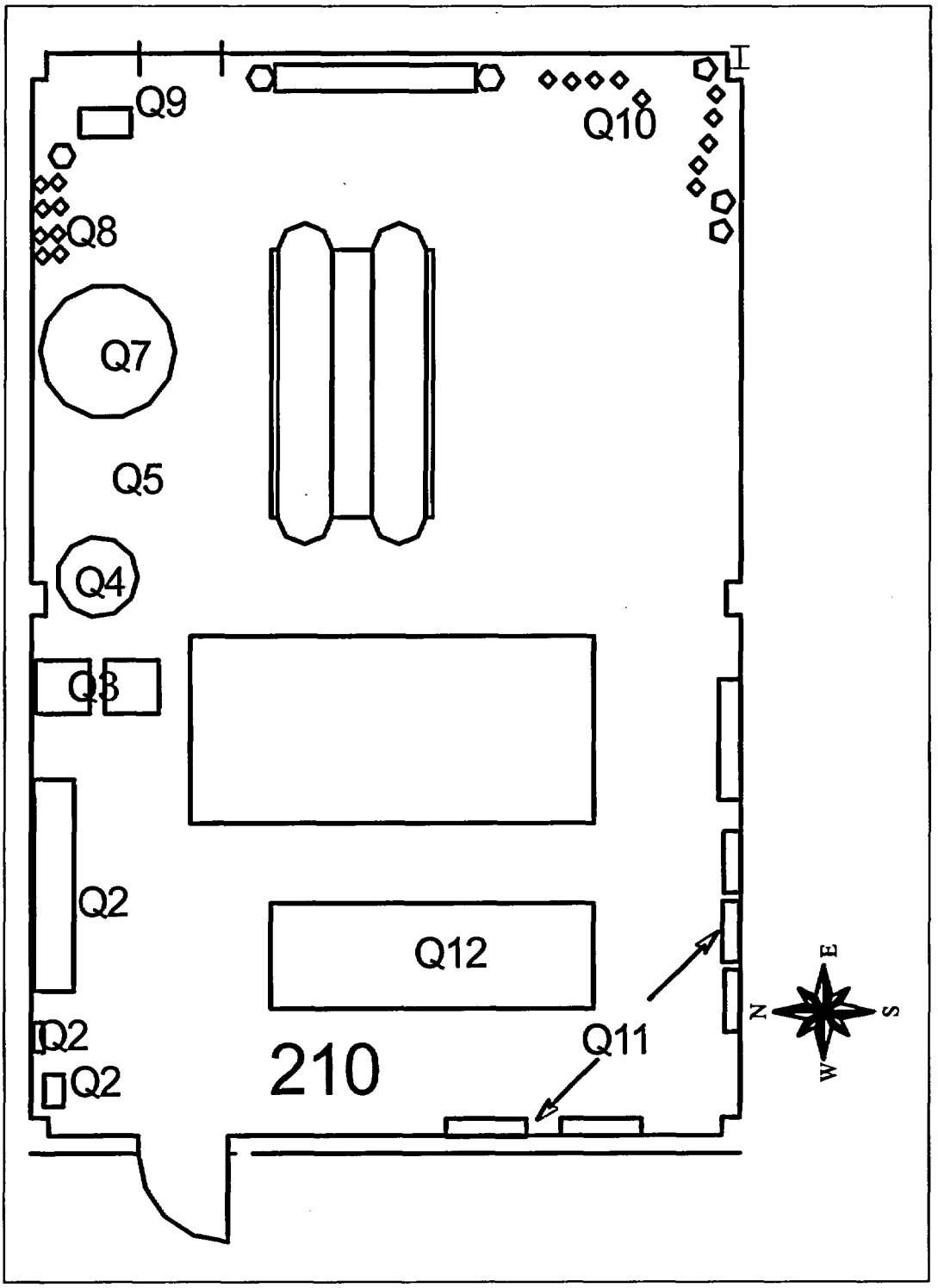


Figure 2.8

Room 210

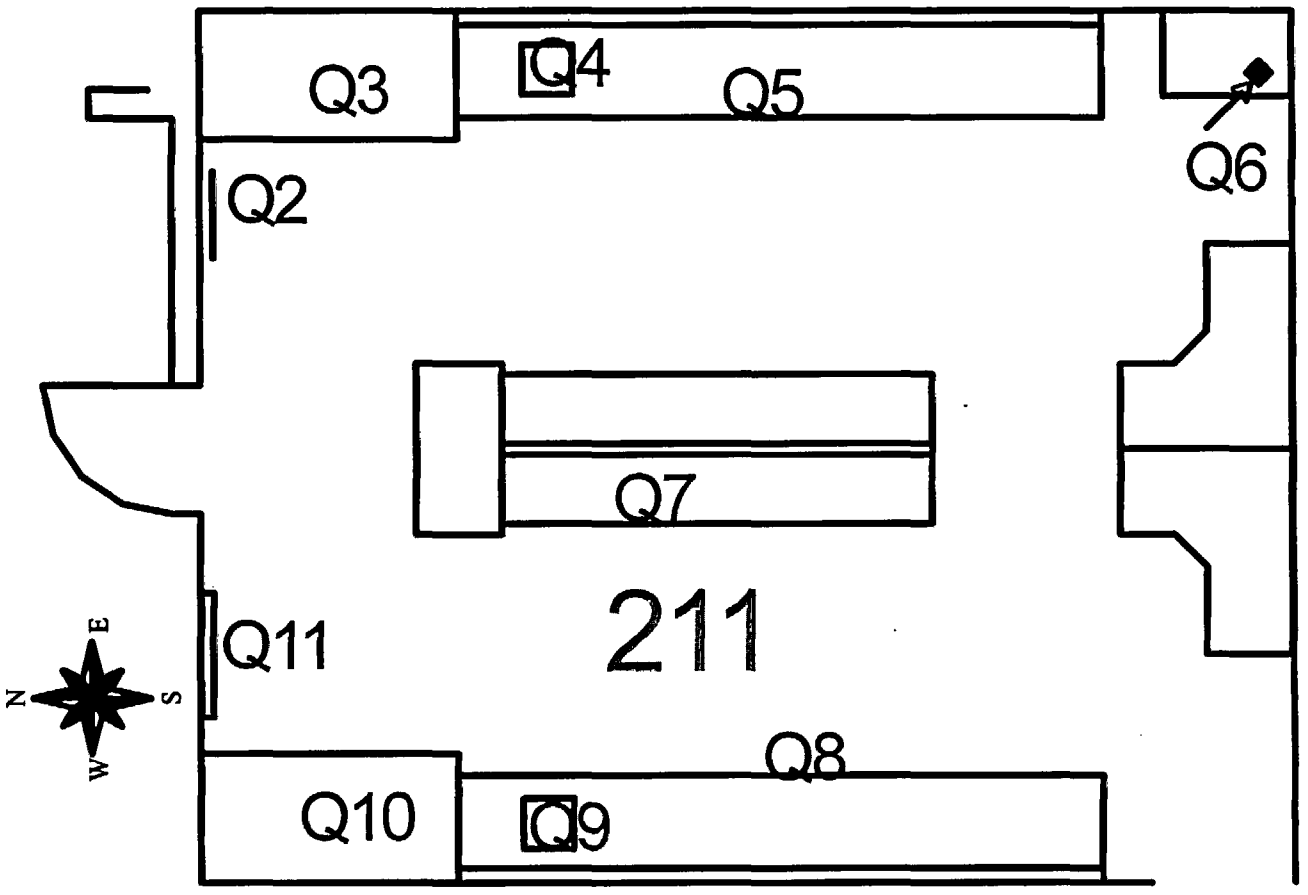
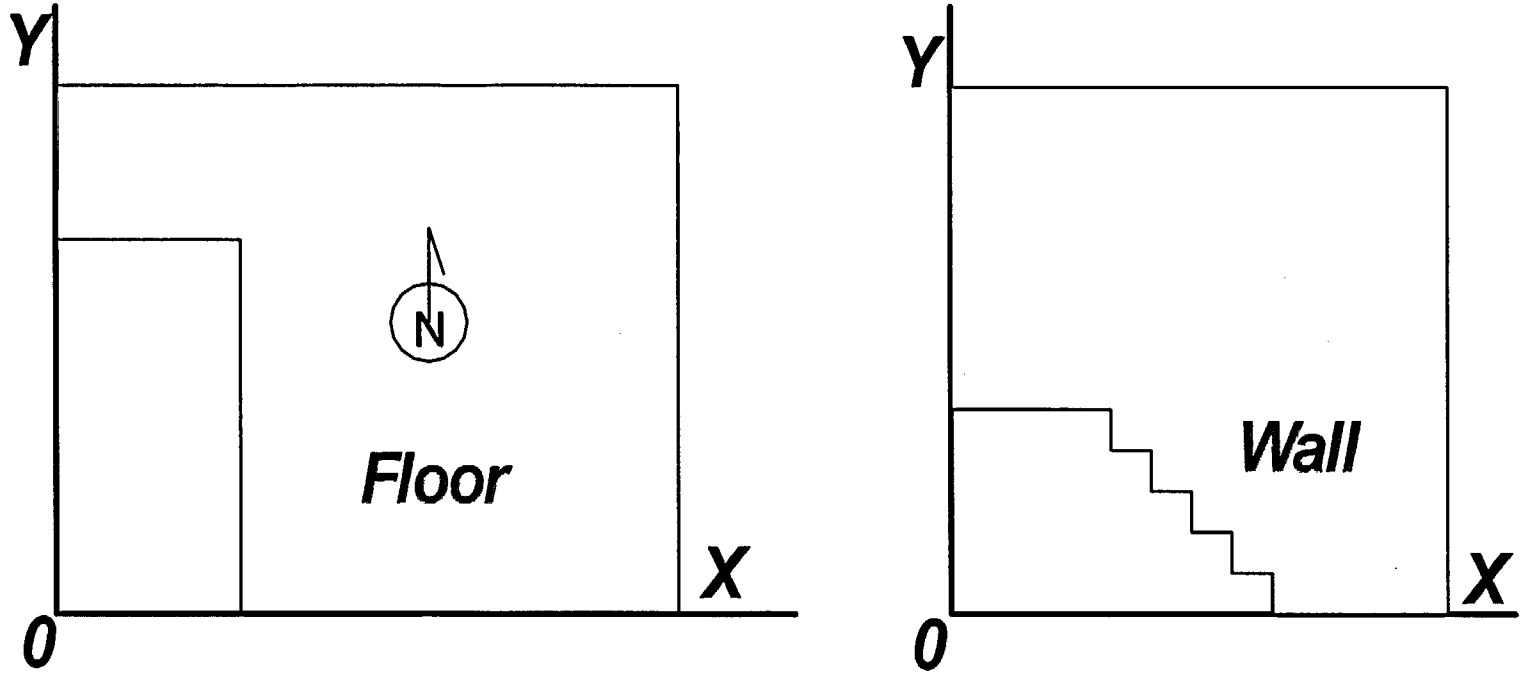


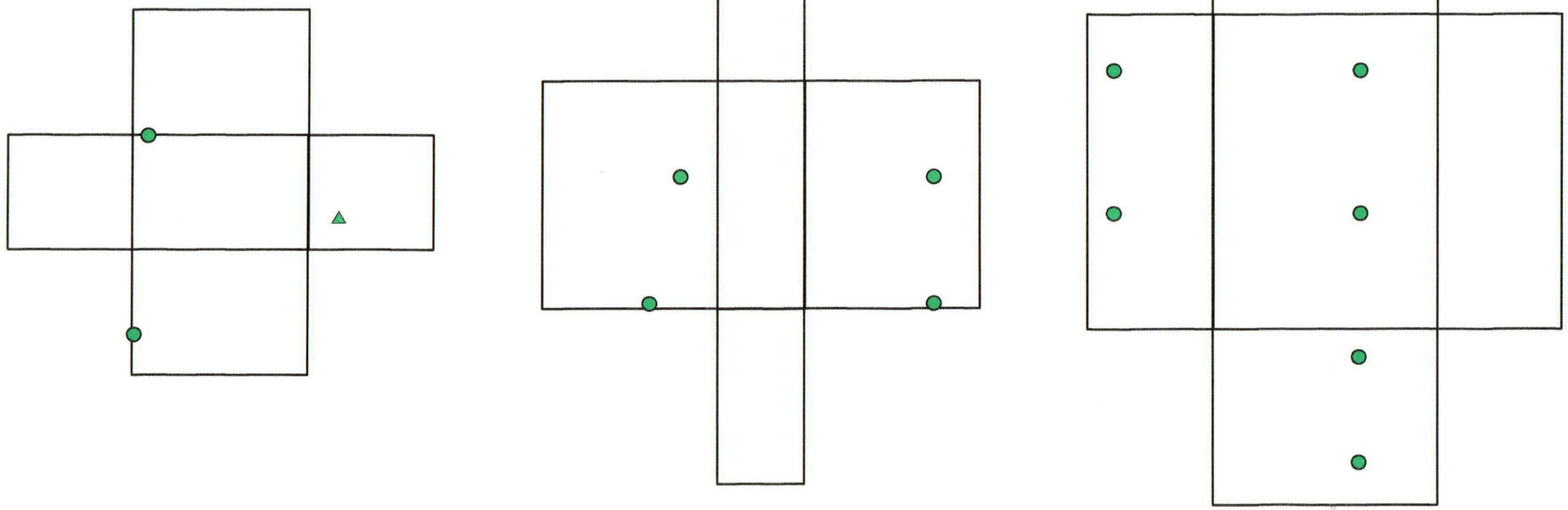
Figure 2.9

Room 211



Coordinate System

Figure 3.1



MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq. cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

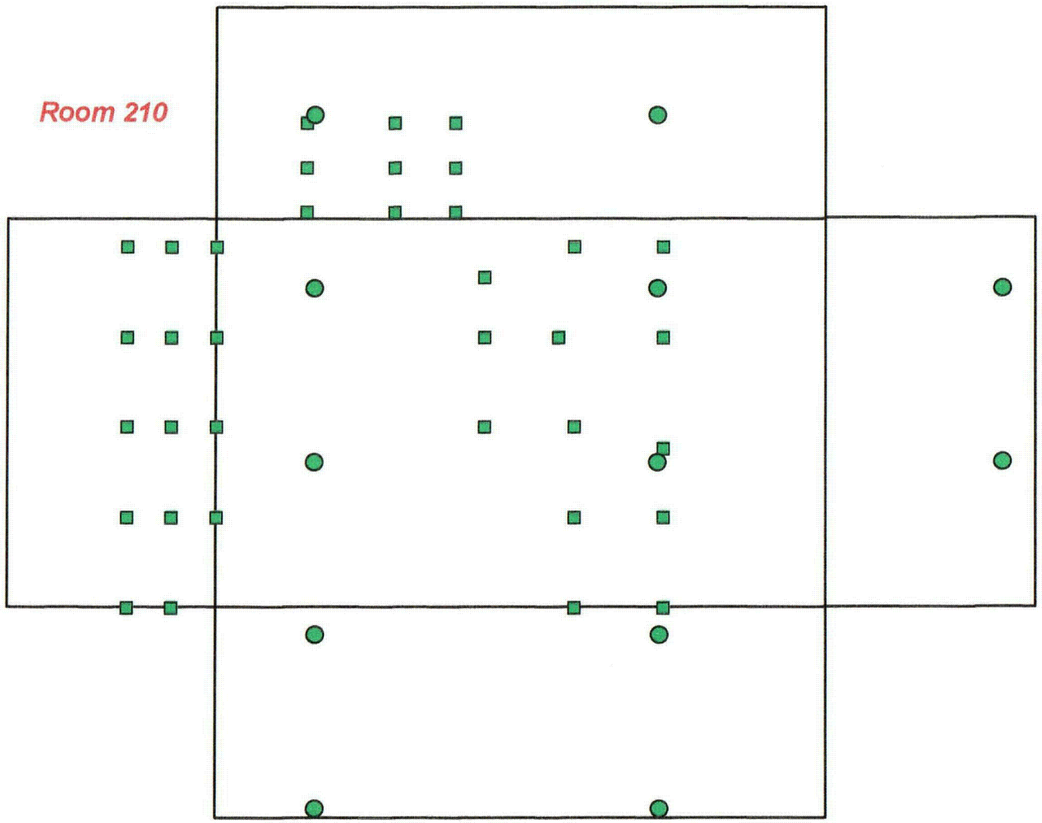
N W E S

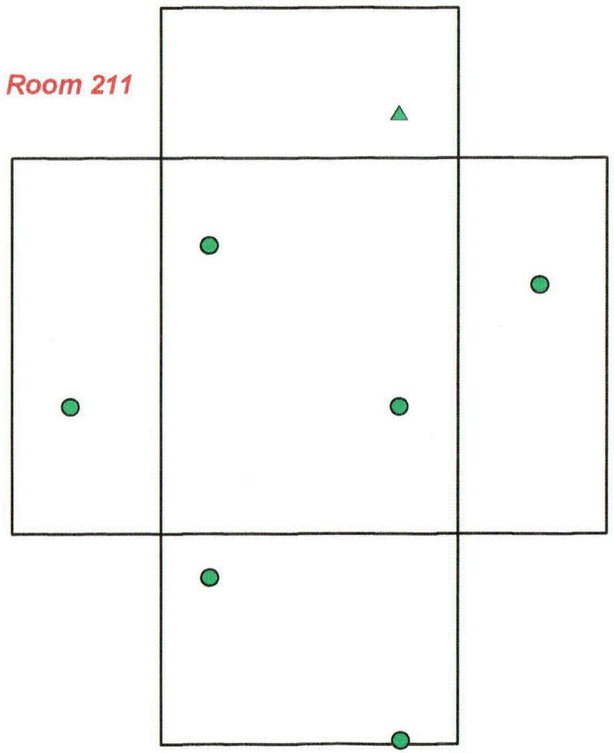
5 0 5 10 Feet

Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.1
SU-2502
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0





MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq. cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
■	●	▲	2,600 - 13,000
■	●	▲	13,000 or More

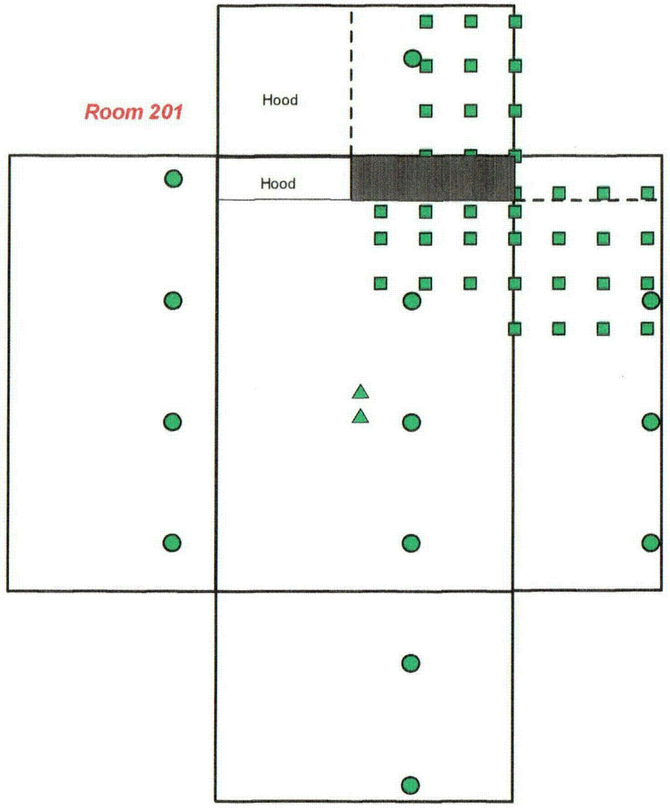
N W E S

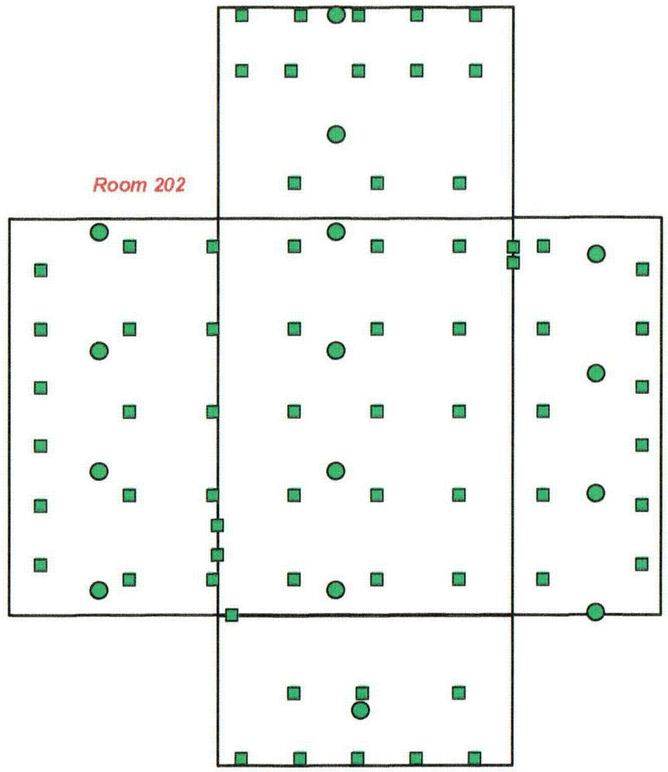
5 0 5 10 Feet

Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.2
SU-2502
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0





MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements ($dpm_p/100\ cm^2$)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

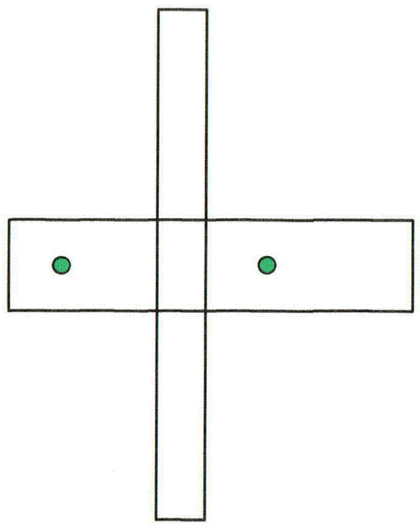
N W E S

5 0 5 10 Feet

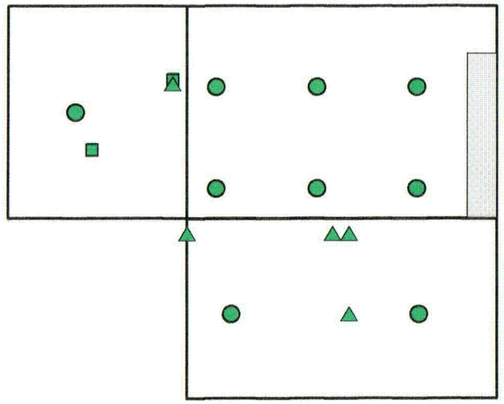
Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.3
SU-2503
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0



Room 101C



Room 103AB

Room 110

MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq. cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

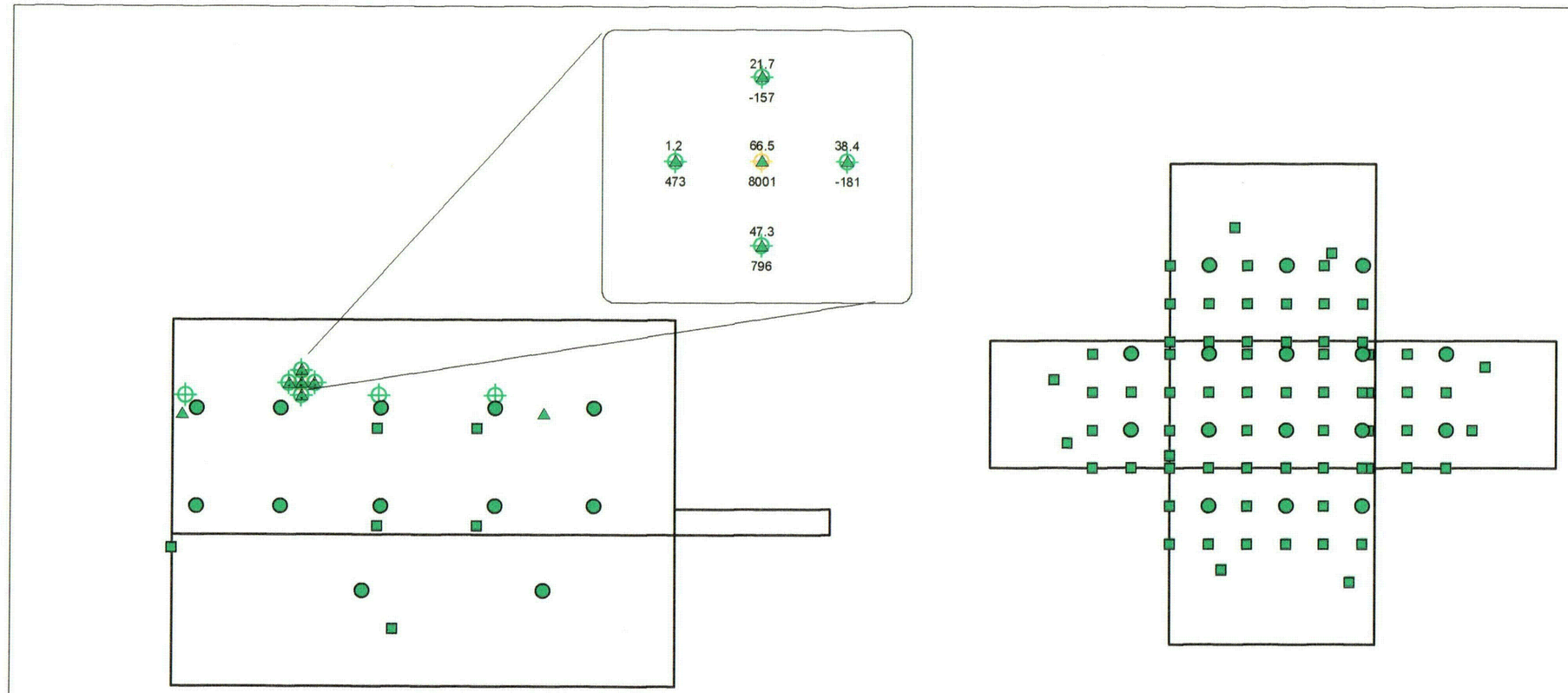
N W E S

5 0 5 10 Feet

Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.4
SU-2504
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0



MALLINCKRODT

NEXTEP ENVIRONMENTAL

Direct Gamma Measurements (cpm)

- > 13,000
- 2600 - 13000
- < 2600

Direct Beta Measurements (dpm_p /100 cm^2)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

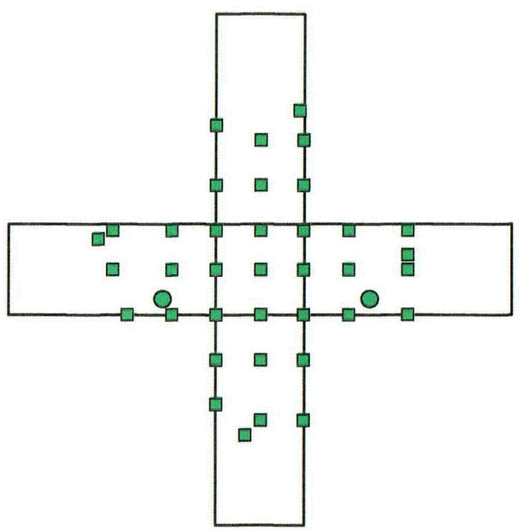
N W E S

5 0 5 10 Feet

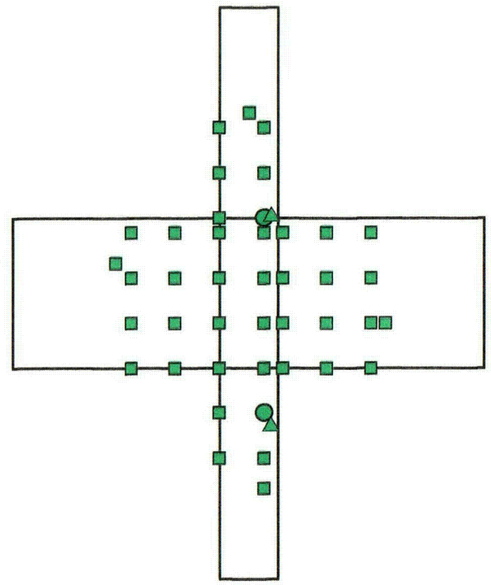
Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.5
SU-2504
Direct Beta & Gamma Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0



Room 139



Room 140

MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq.cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
■	●	▲	2,600 - 13,000
■	●	▲	13,000 or More

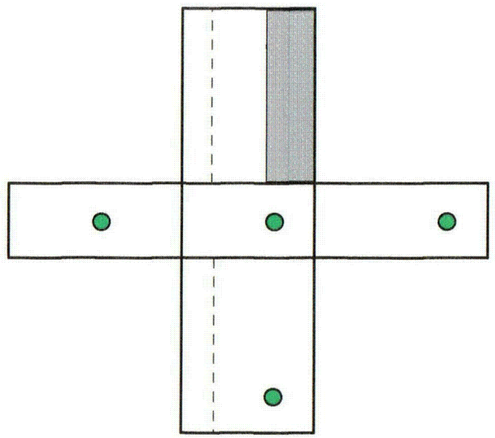
N W E S

5 0 5 10 Feet

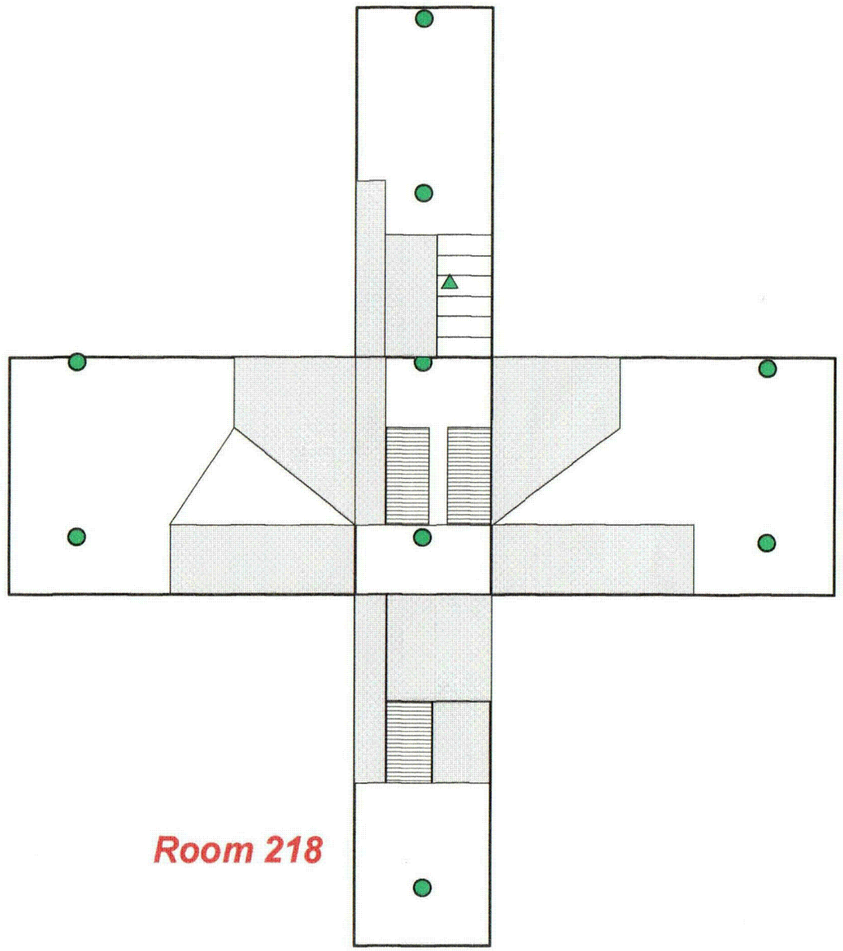
Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.6
SU-2504
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0



Room 118



Room 218

MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq. cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

N

W E

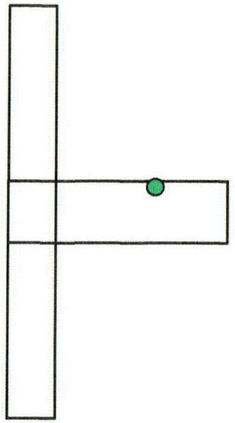
S

5 0 5 10 Feet

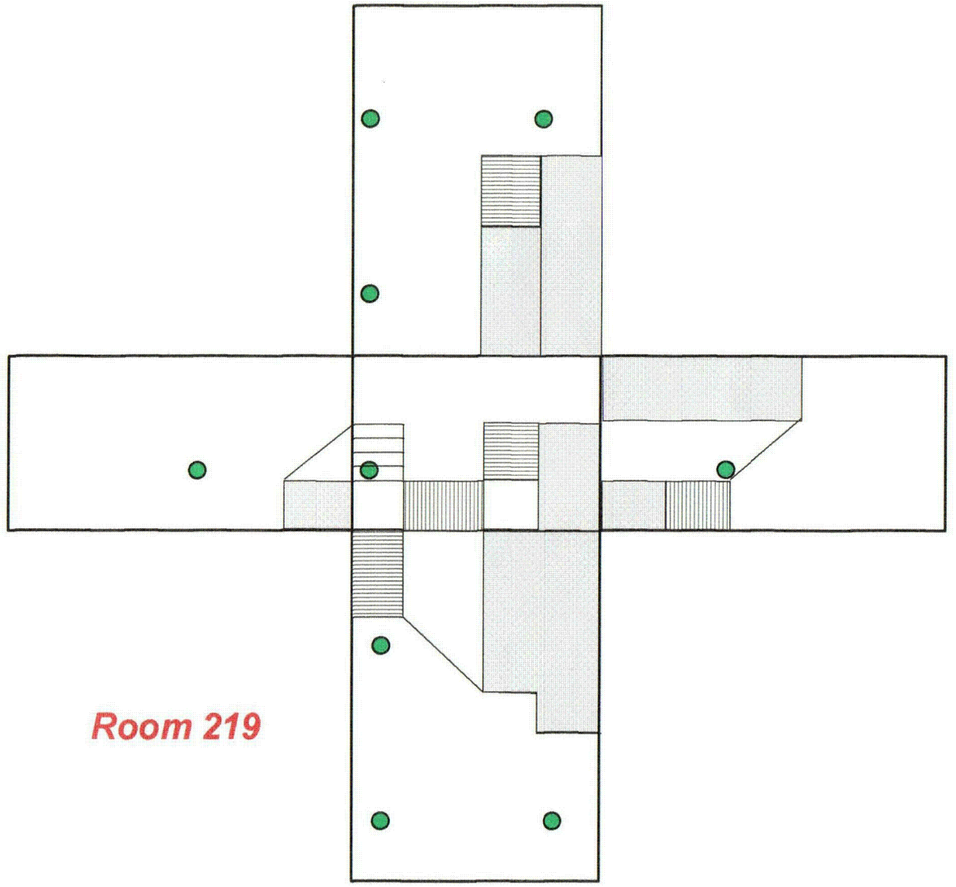
Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.7
SU-2504 - Western Stairwell
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0



Room 119



Room 219

MALLINCKRODT

NEXTEP ENVIRONMENTAL

Legend

Direct Beta Measurements (dpmp/100sq. cm.)

CH	Grid	Bias	
■	●	▲	Under 2,600
□	○	△	2,600 - 13,000
■	●	▲	13,000 or More

N
W E
S

5 0 5 10 Feet

Mallinckrodt C-T Project Final Status Survey
Building 250 Interior

Figure 4.8
SU-2504 - Eastern Stairwell
Direct Beta Measurements

Drawn by: BPA	Date: 12/20/2003
Building: 250	Revision: 0

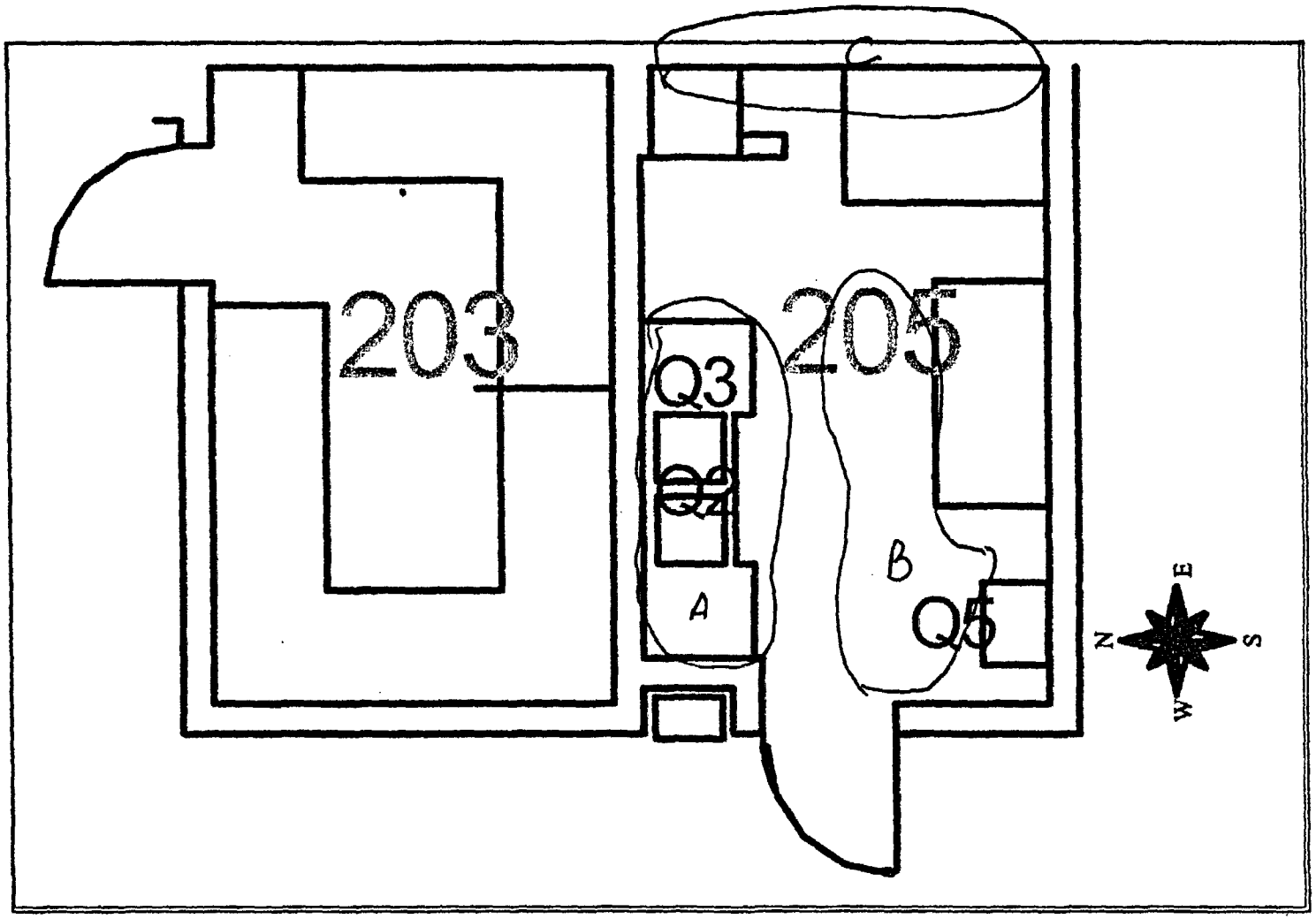


Figure 4.9
Beta Scans Room 205

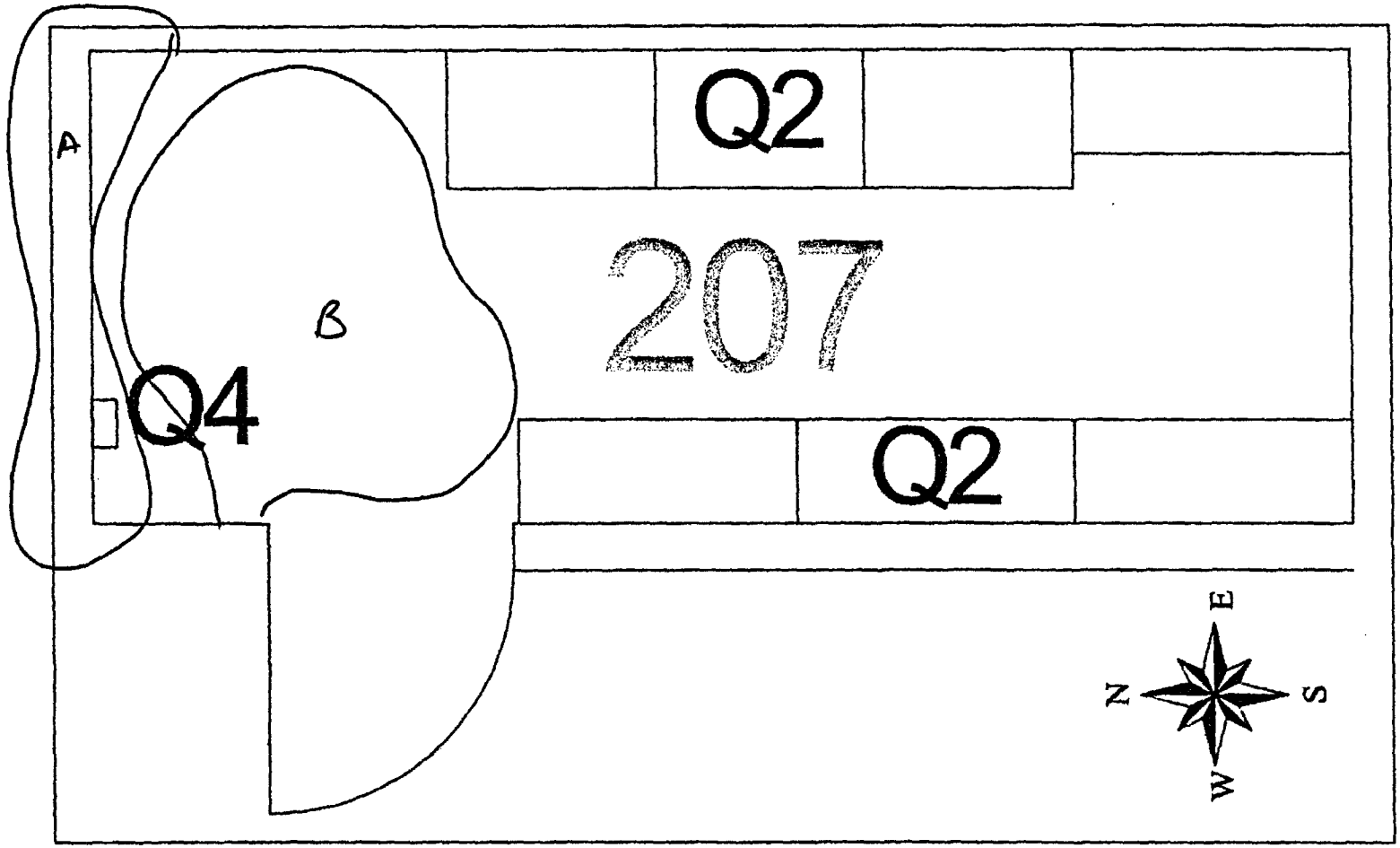


Figure 4.10
Beta Scans Room 207

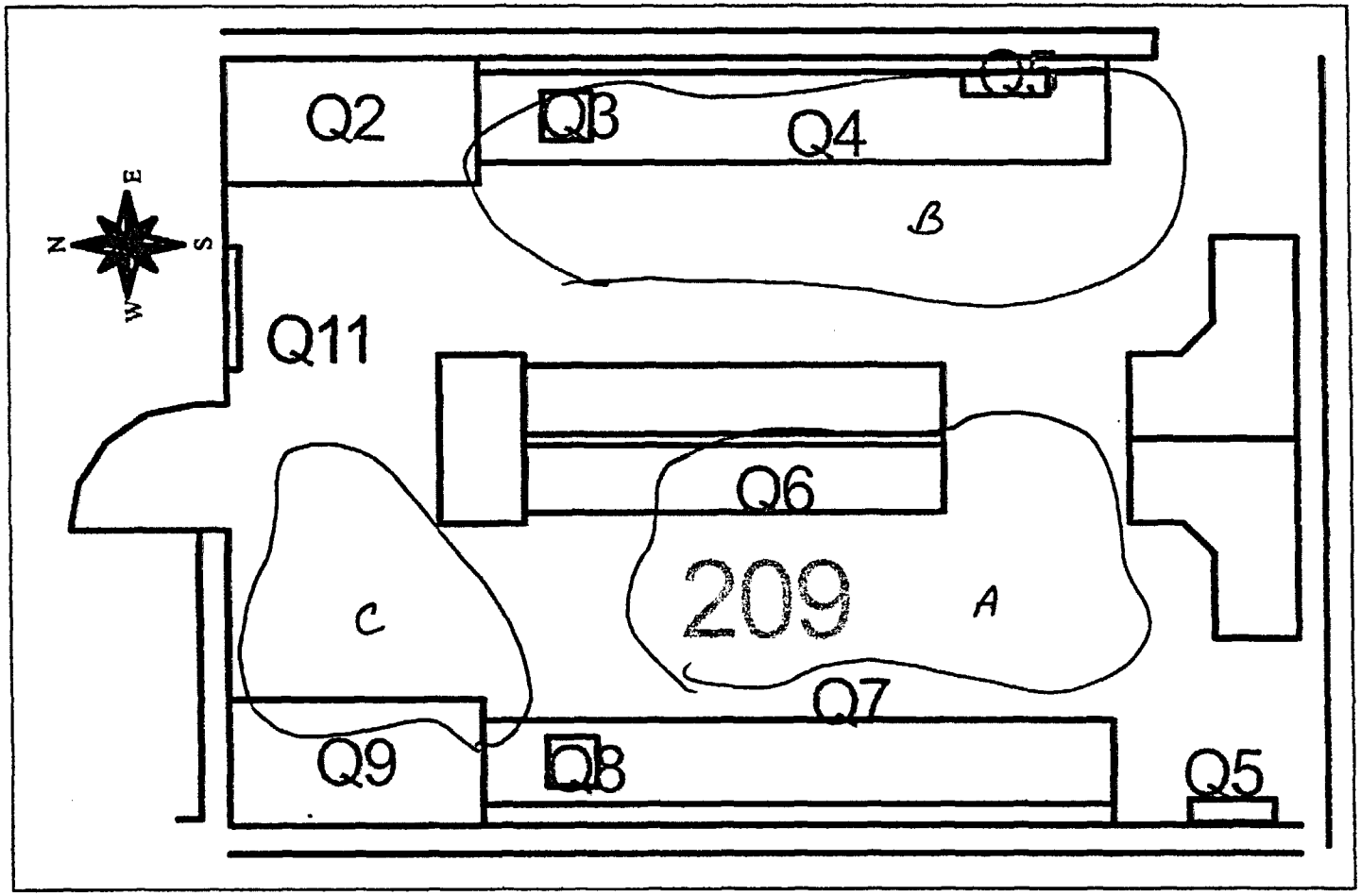


Figure 4.11
Beta Scans Room 209

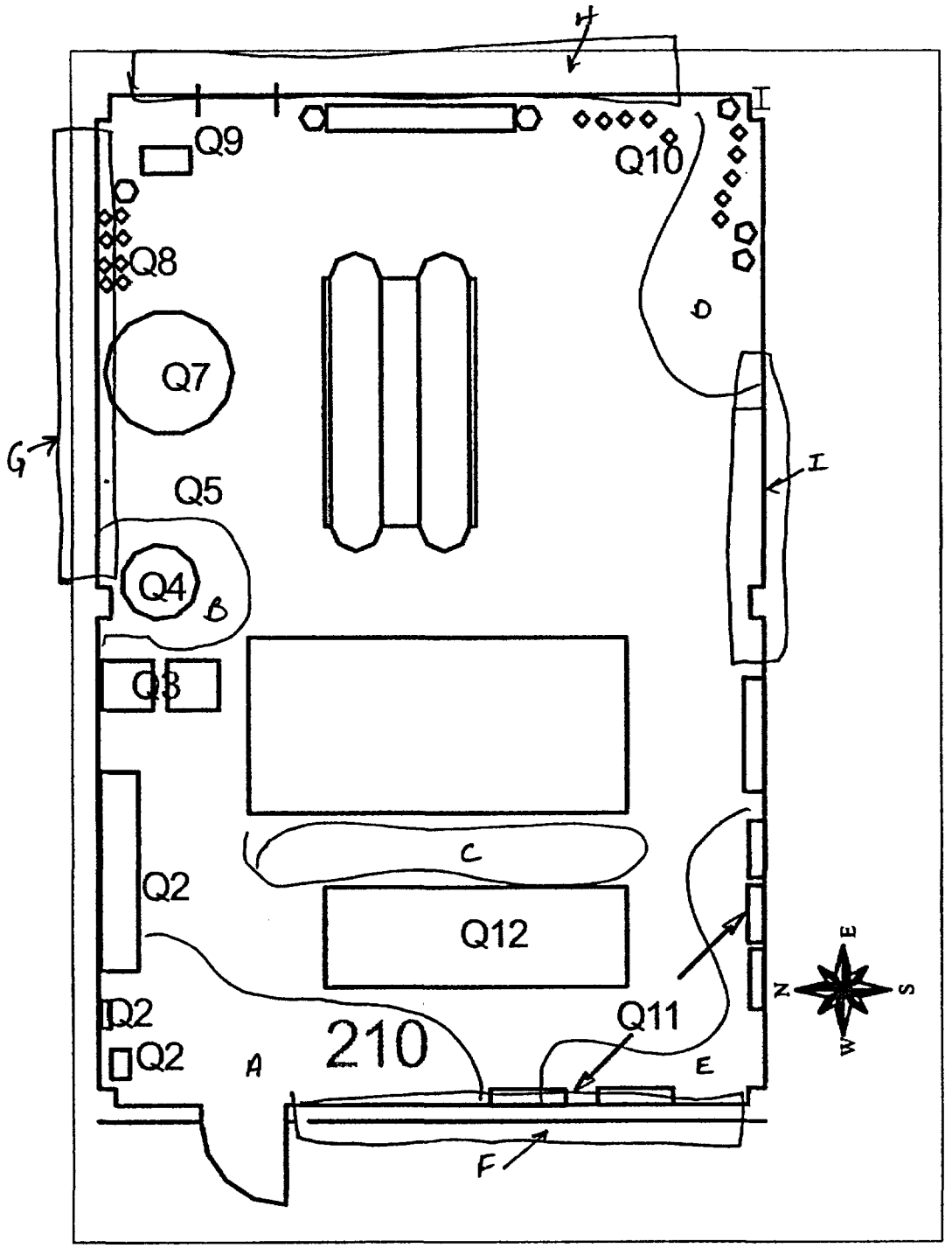


Figure 4.12
Beta Scans Room 210

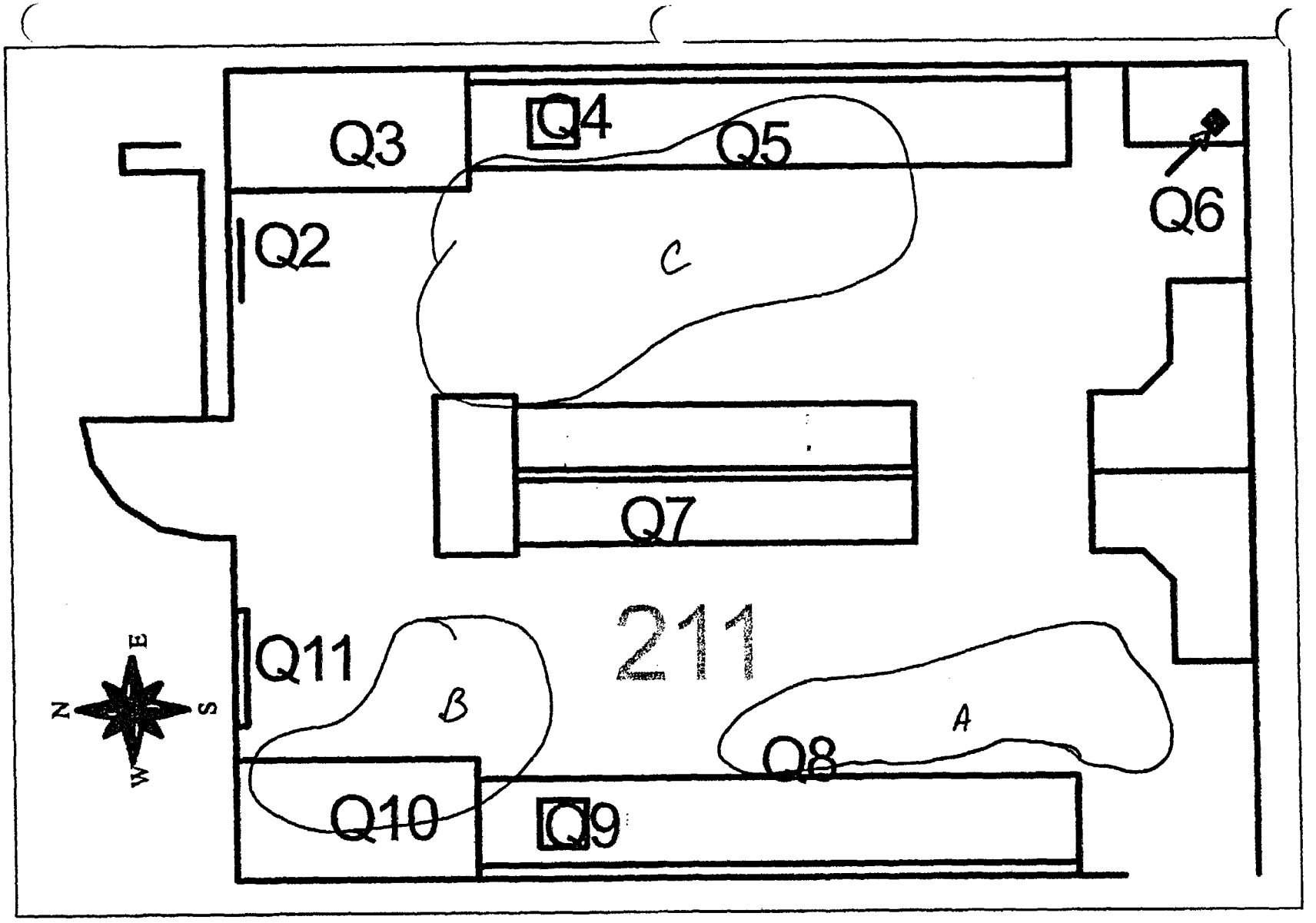


Figure 4.13
Beta Scans Room 211

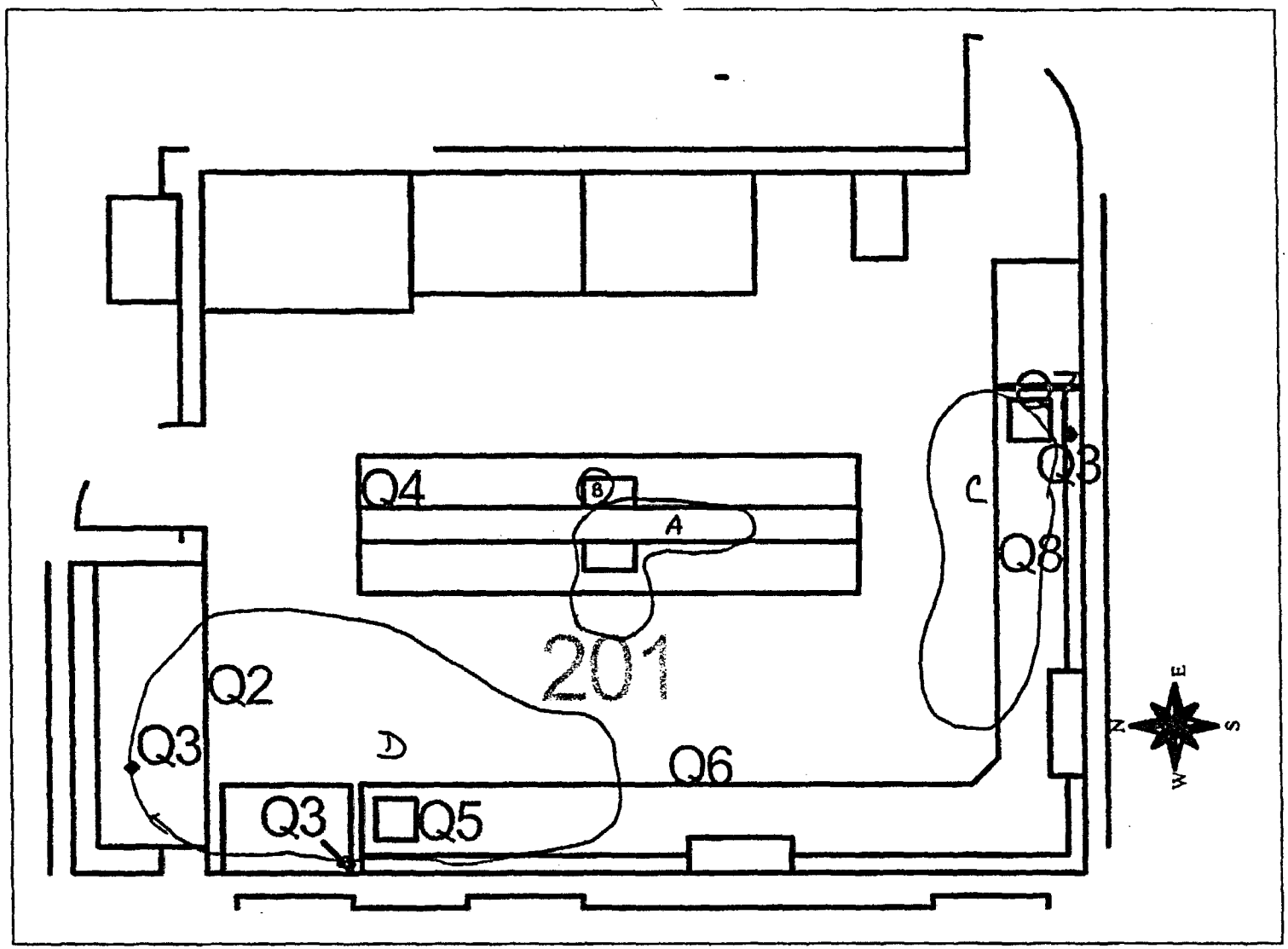


Figure 4.14
Beta Scans Room 201

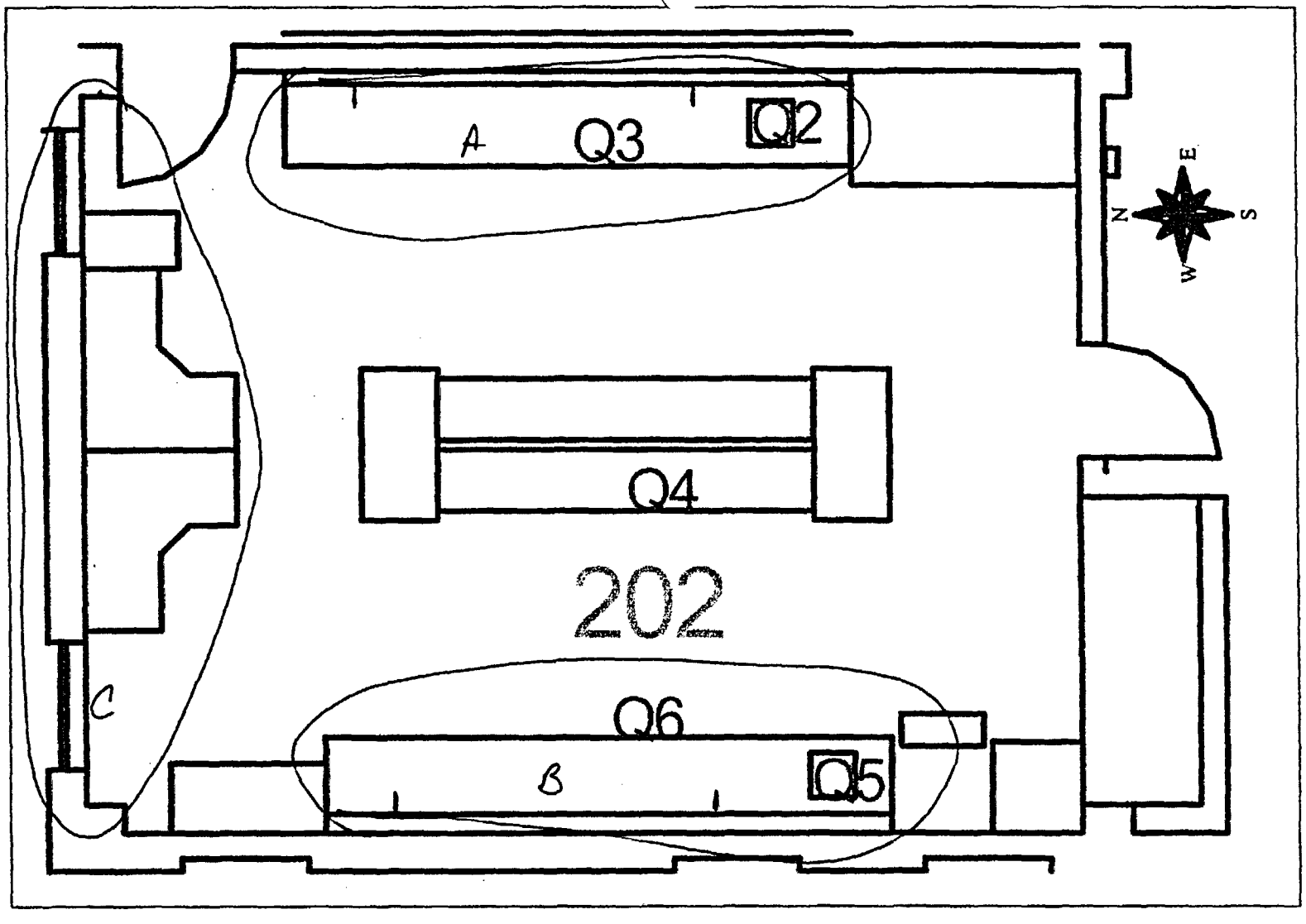


Figure 4.15
Beta Scans Room 202

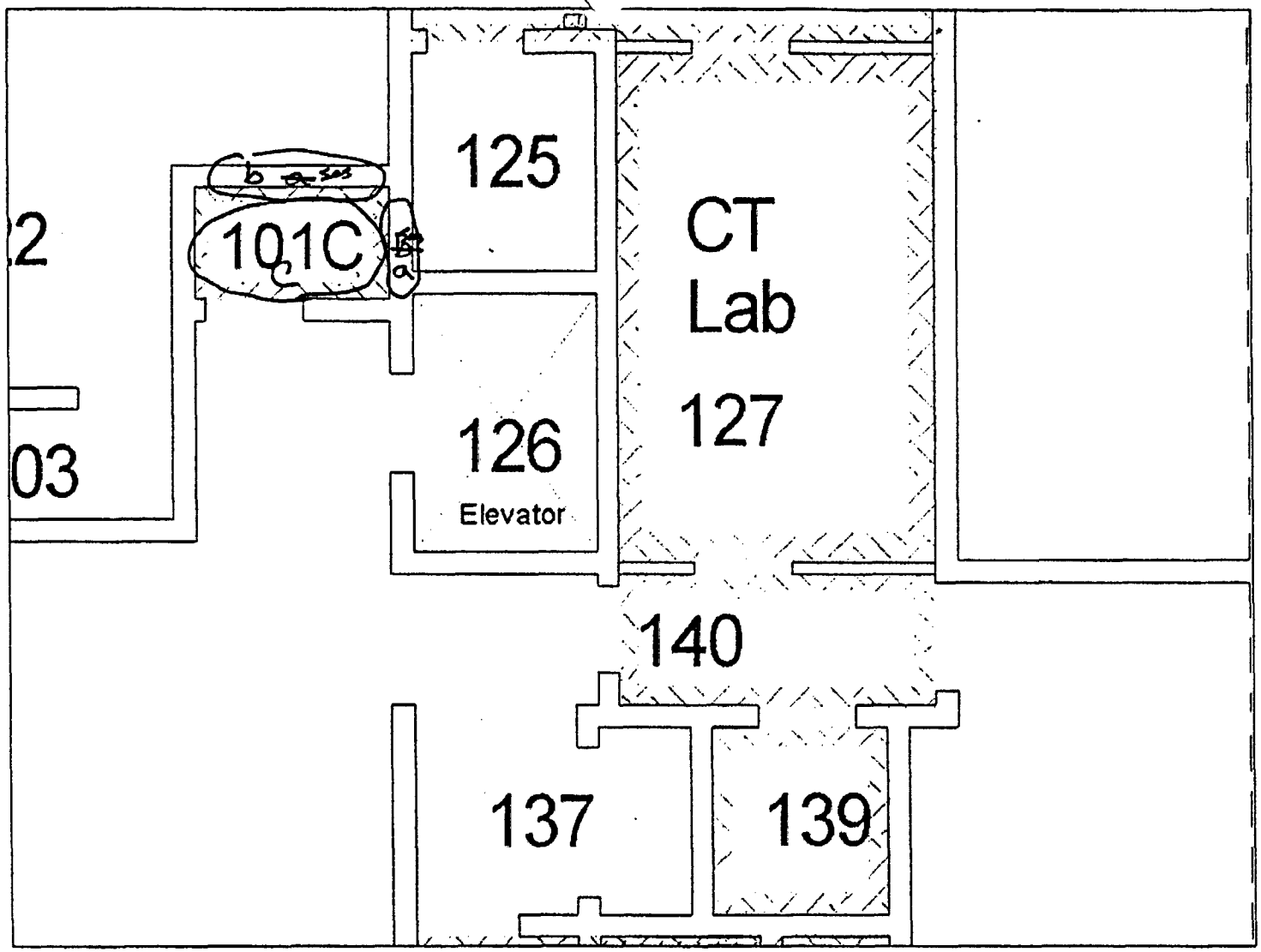


Figure 4.16
Beta and Gamma Scans Room 101C
a,b: beta
c: gamma

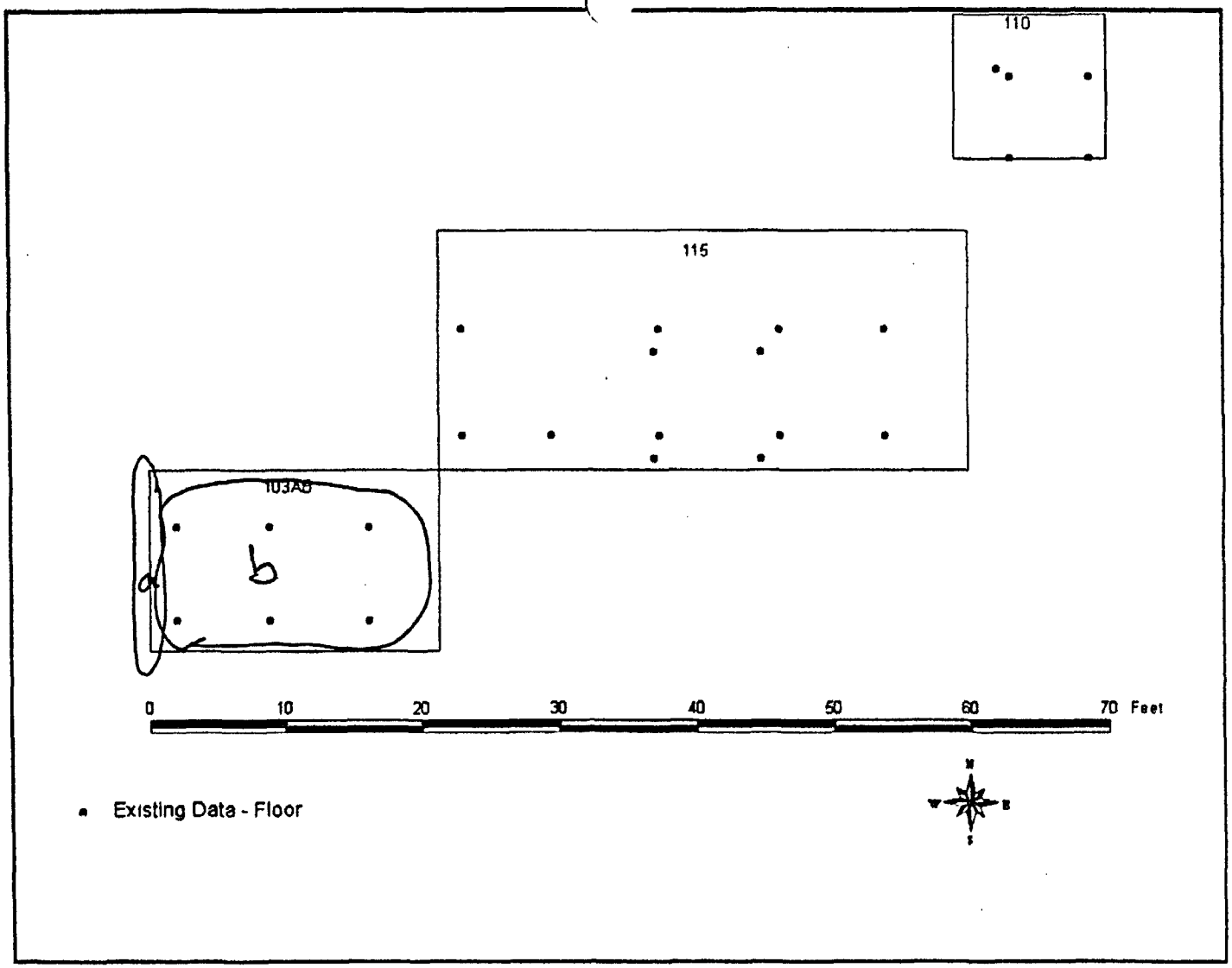


Figure 4.17
Gamma Scans Room 103AB

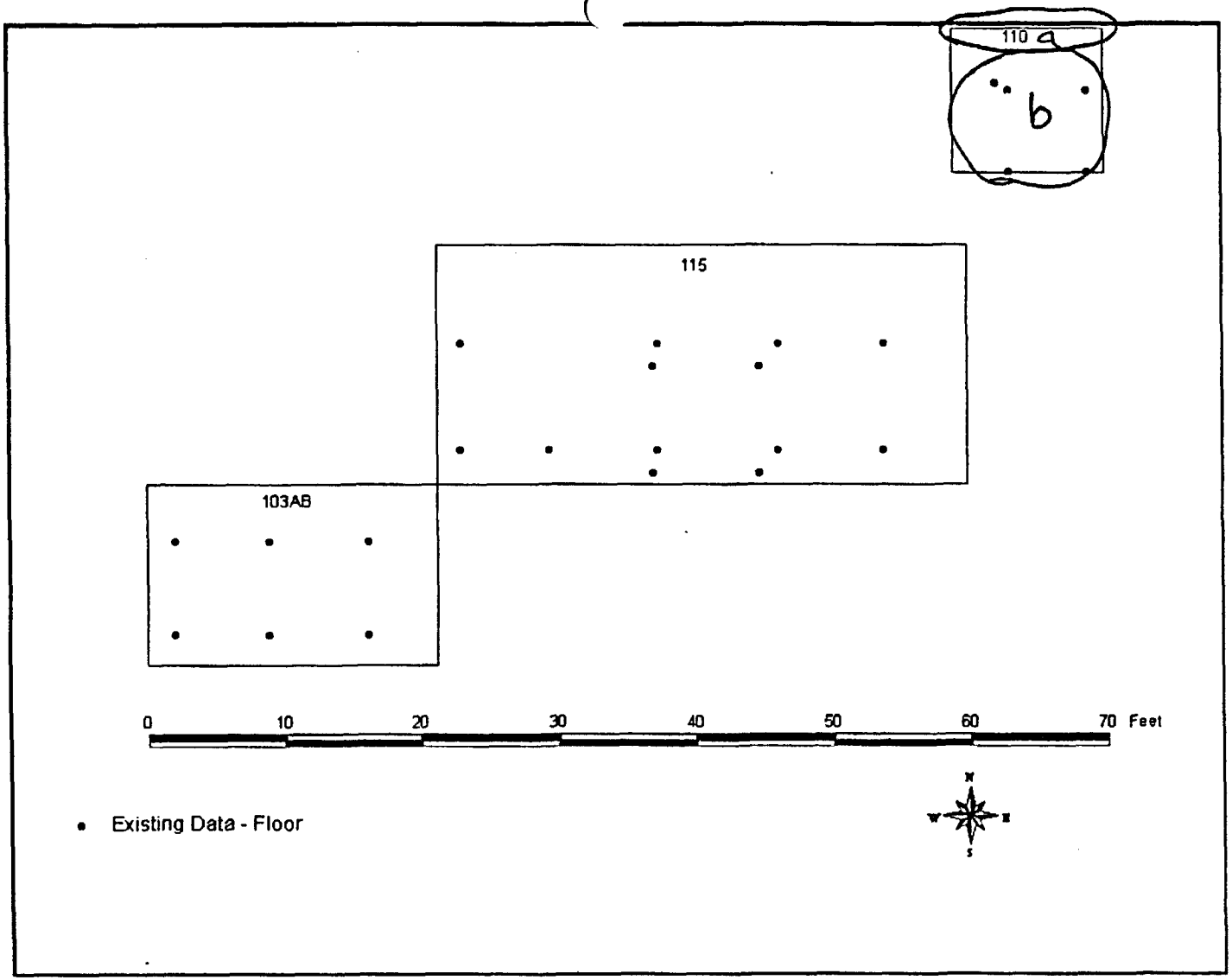


Figure 4.18
Beta and Gamma Scans Room 110
a: beta
b: gamma

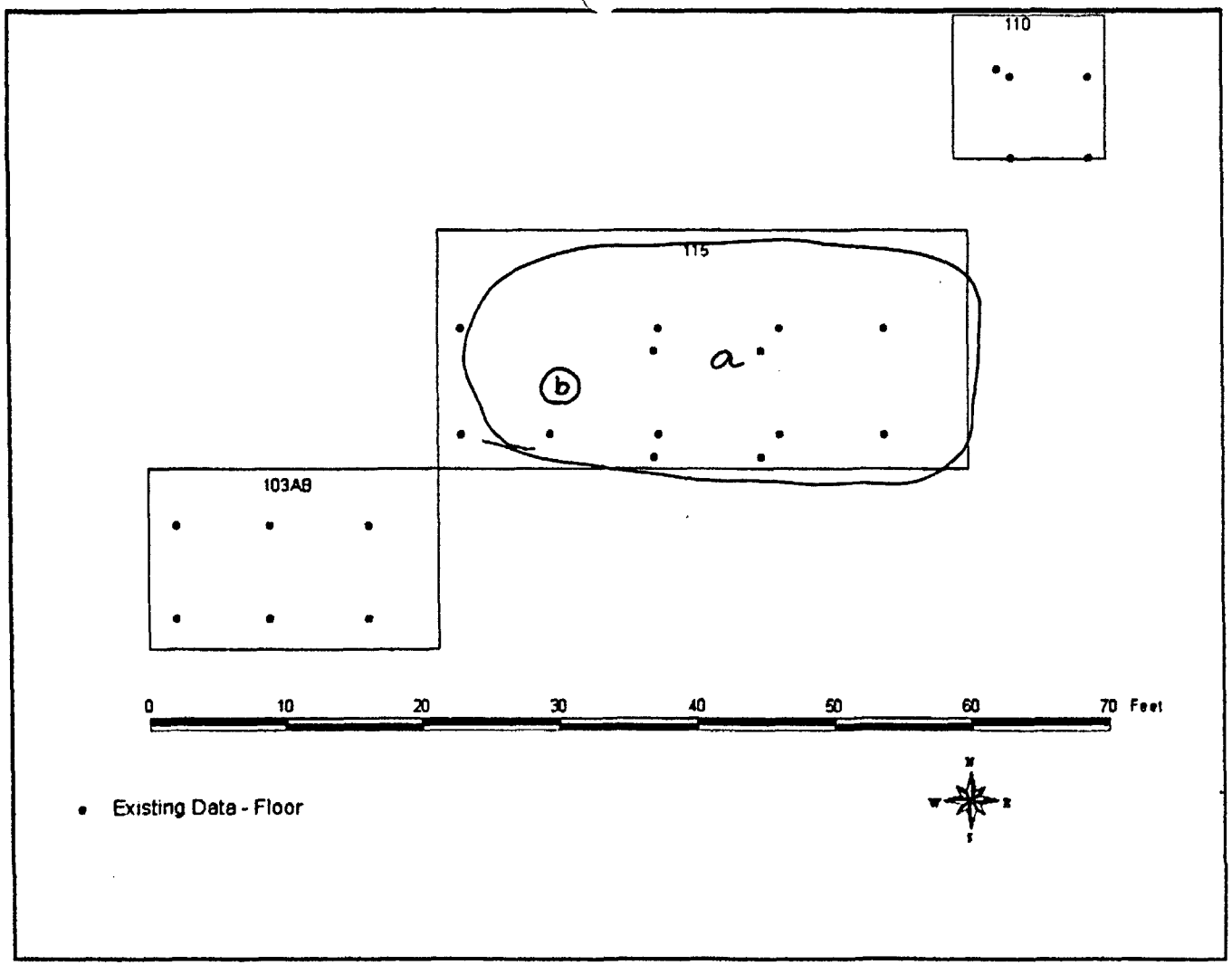


Figure 4.19
Gamma Scans Room 115

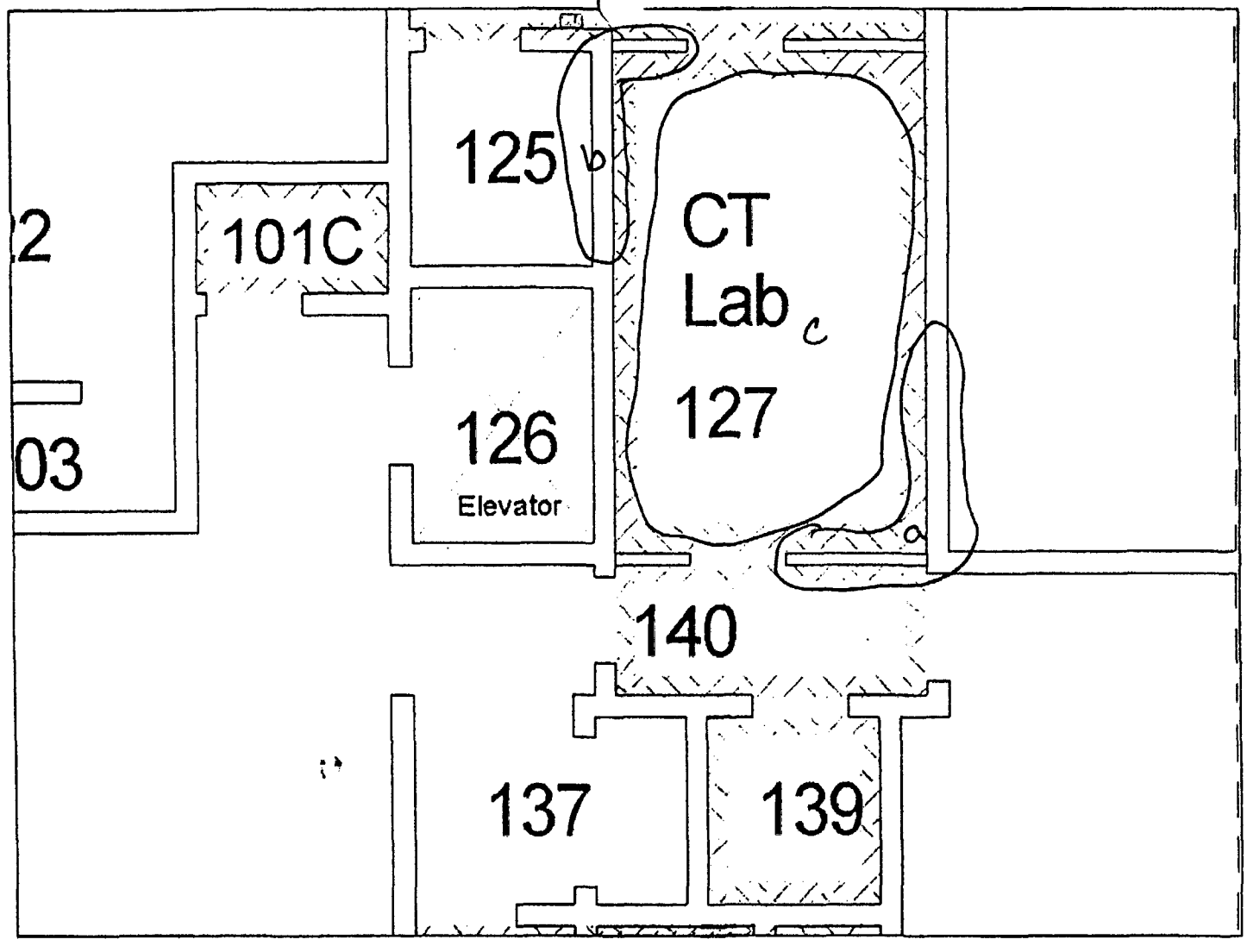


Figure 4.20
Beta and Gamma Scans Room 127
a,b: beta
c: gamma

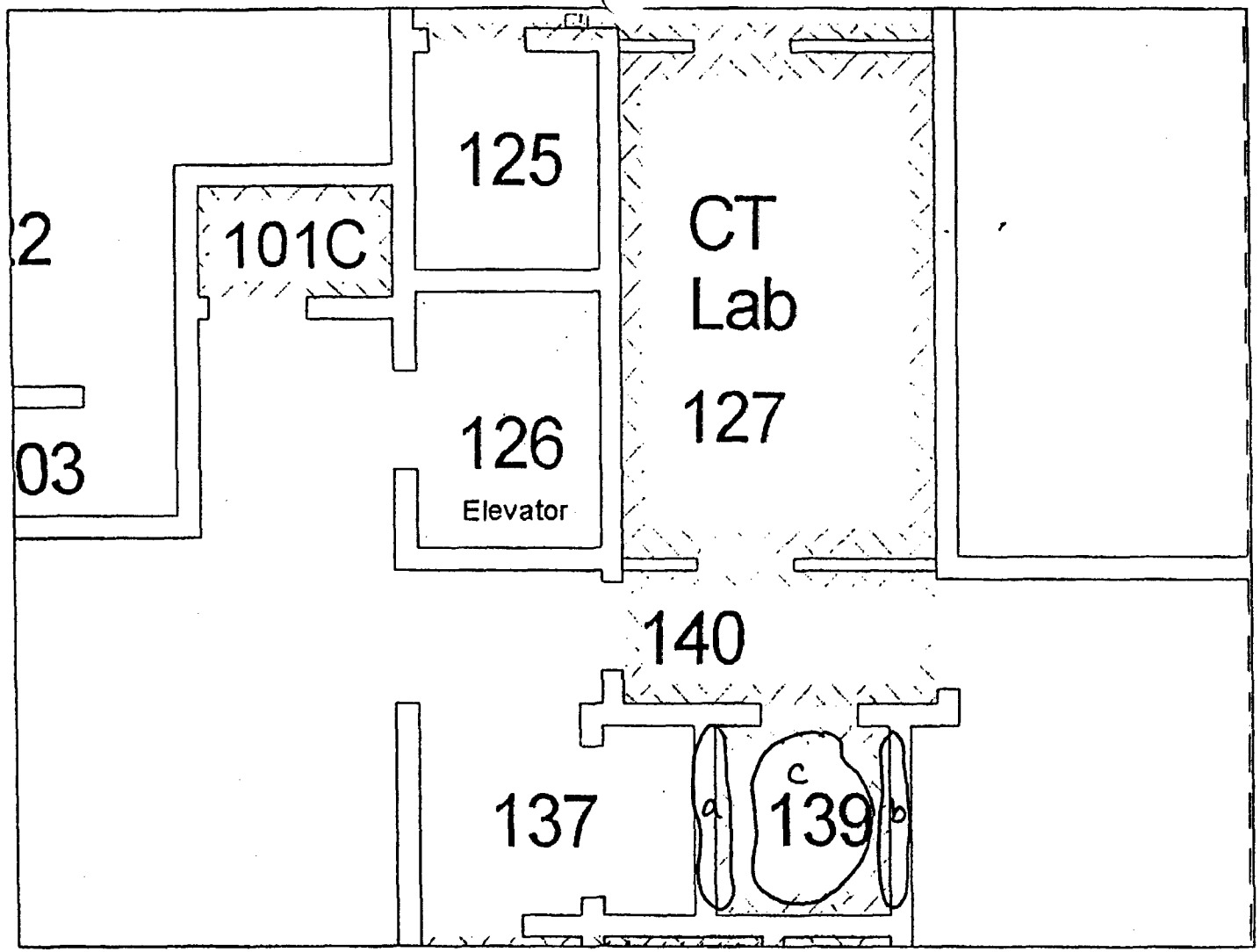


Figure 1-3

Figure 4.21
Beta and Gamma Scans Room 139
a,b: beta
c: gamma

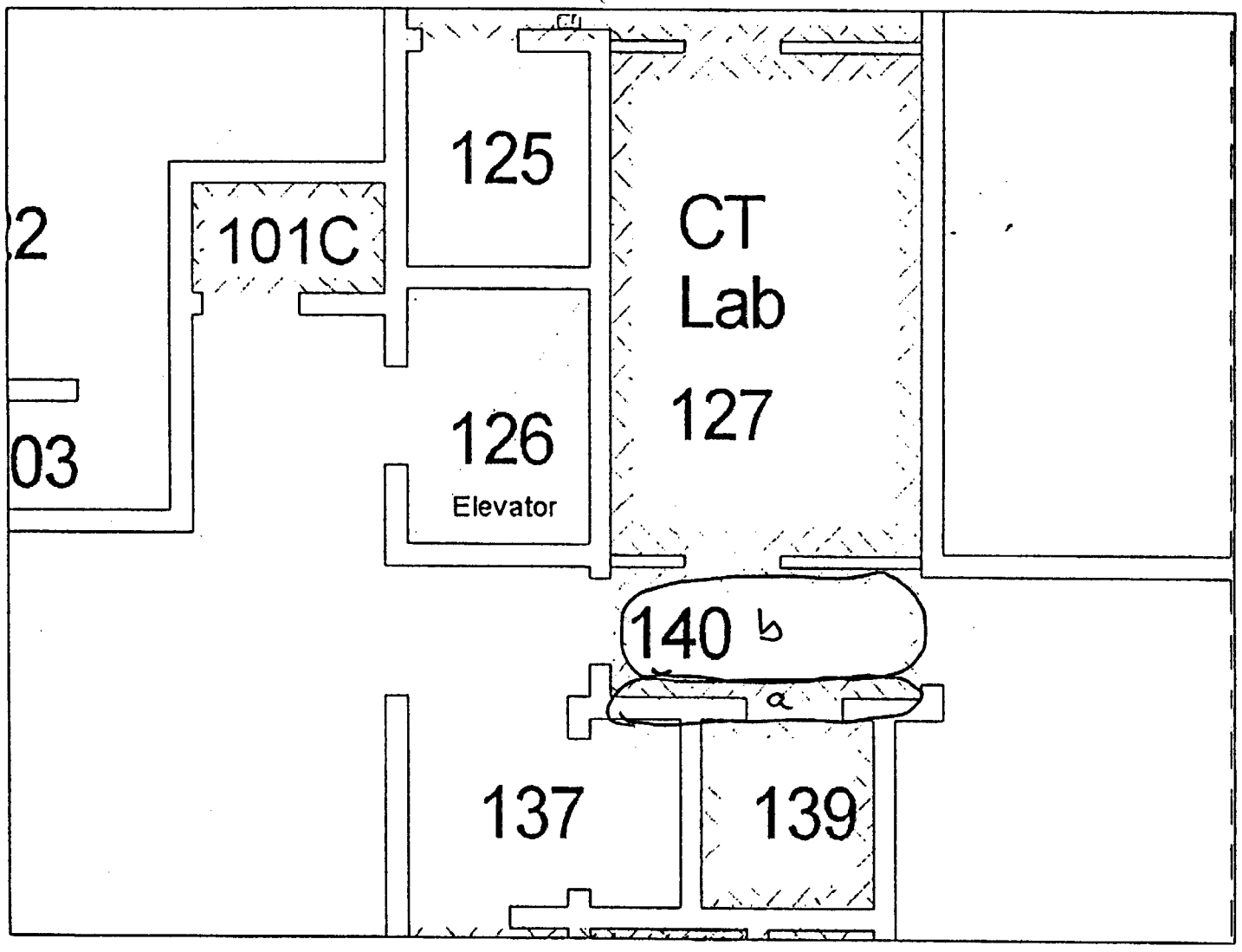


Figure 4.22
Beta and Gamma Scans Room 140
a: beta
b: gamma

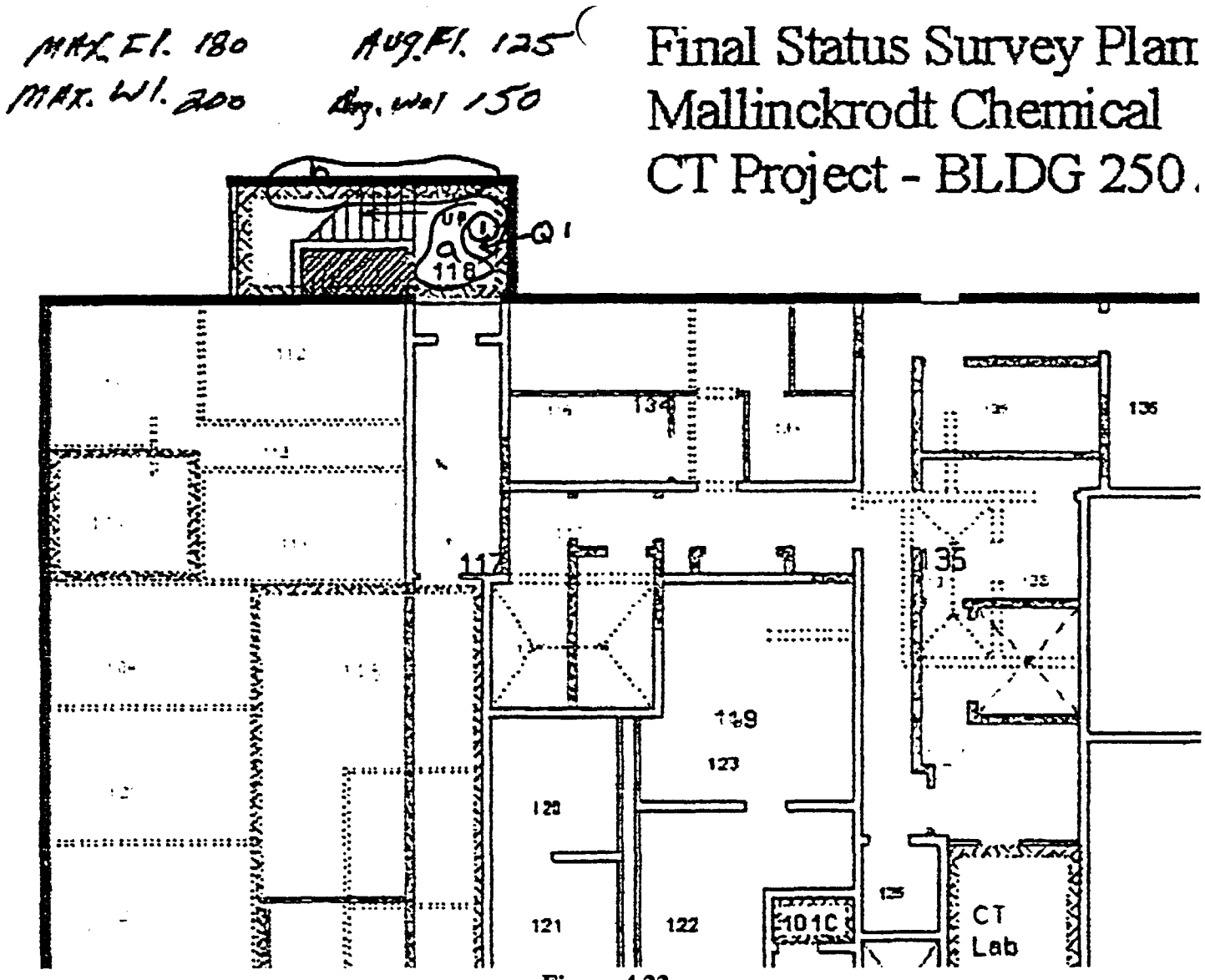


Figure 4.23
Beta Scans Room 118

MAX FL. 180 AVG FL. 125
MAX. WL. 200 Avg. WAL 150

Final Status Survey Plan
Mallinckrodt Chemical
CT Project - BLDG 250

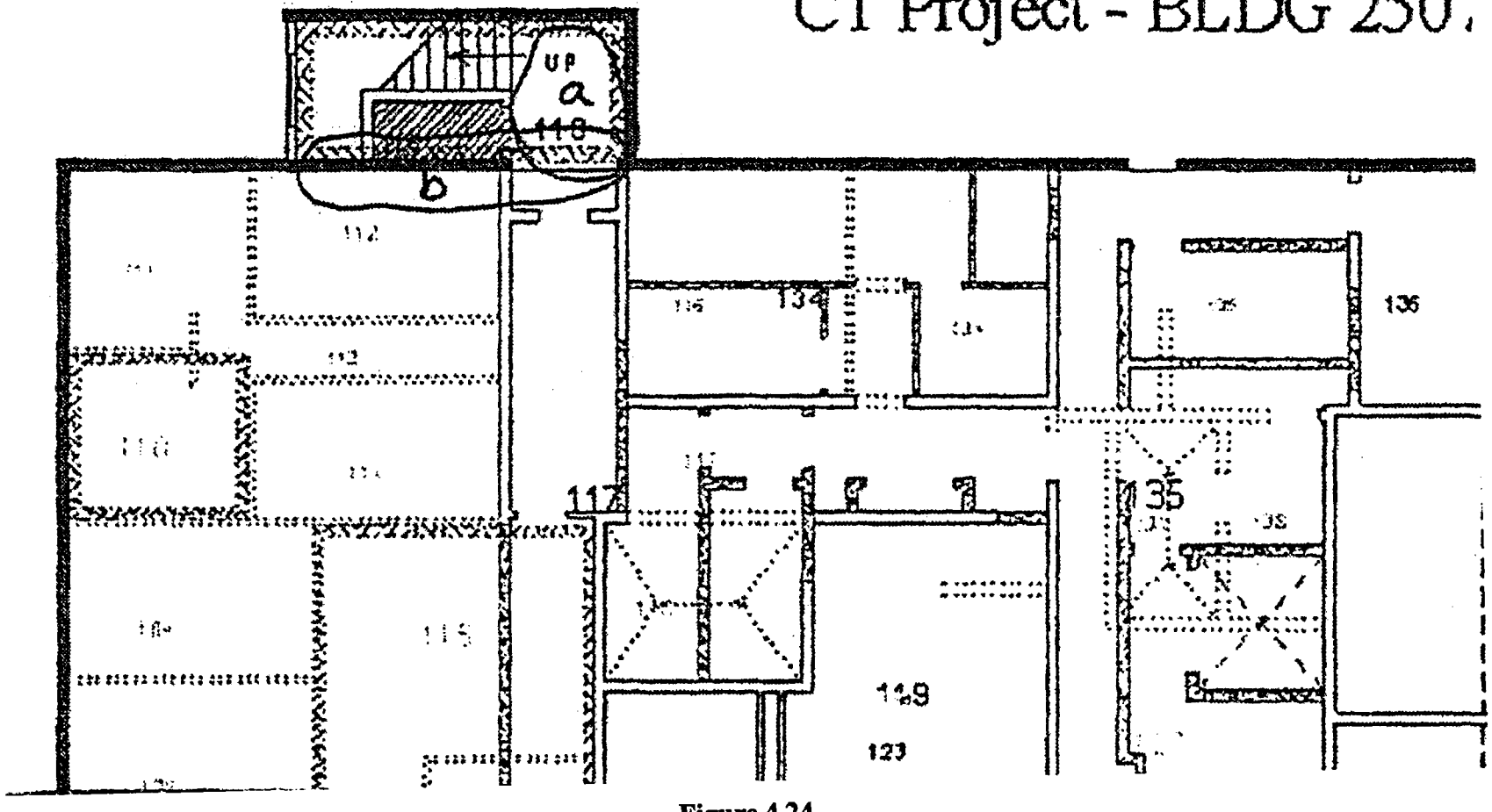


Figure 4.24
Beta Scans Room 218

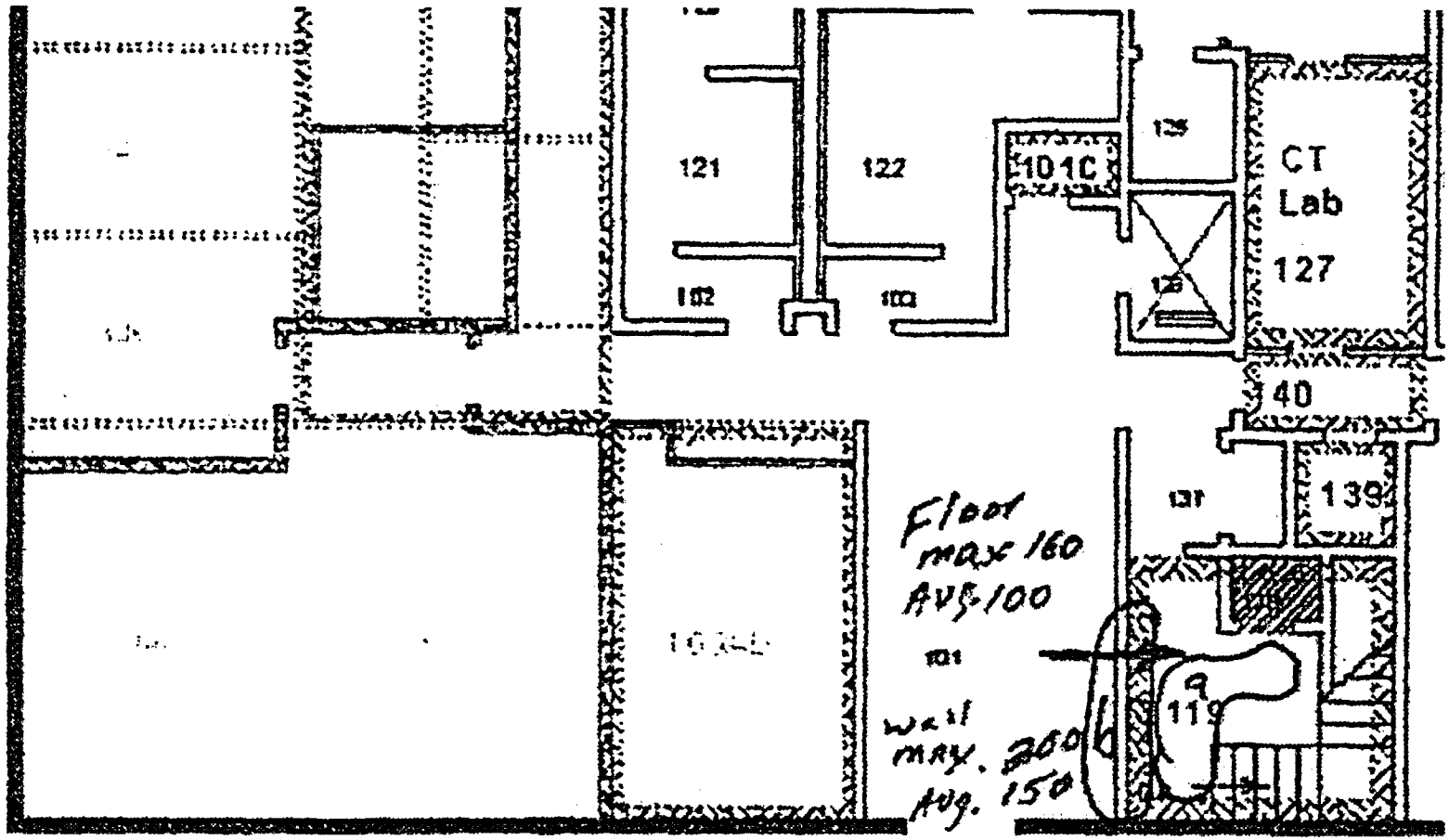


Figure 4.25
Beta Scans Room 119

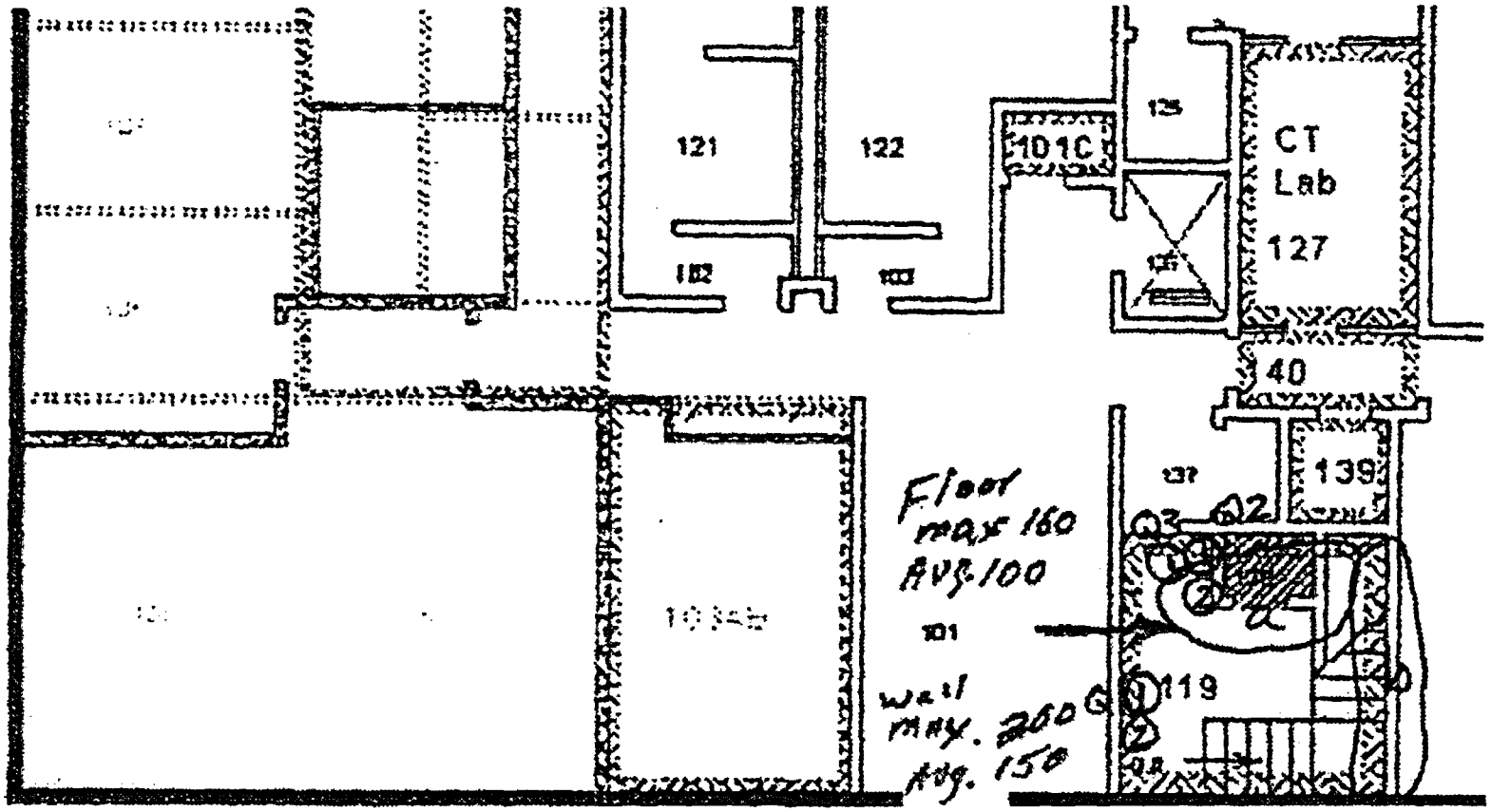


Figure 4.26
Beta Scans Room 219

APPENDIX 3
Calibration Sheets

Type	S/N	Cal Date	Sensitivity
Beta	106729/A0281	1/5/1995	0.777
	131415/188704	6/17/2003	0.611
	163666/B426W	1/16/2003	0.774
	131410/188707	4/16/2003	0.450
	115126/B861N	1/18/1996	1.078
	126509/B859N	1/18/1996	1.031
	131415/B426W	5/15/2002	1.073
	106729/B859N	1/6/1995	0.879
	117332/A0446	1/17/1995	0.735
	117332/A0447	1/17/1995	0.644
	117332/A0448	1/17/1995	0.697
	117362/B860N	1/18/1996 3/5/1996 10/20/1999	1.039 0.979 1.089
Gamma	138368/201774	11/4/2003	
	157020/020429-6	4/26/2003	
Swipe	179562	11/8/2002 7/22/2003	
	179577	2/26/2003	

Thermo Analytical

TMA/Eberline
601 Scarboro Rd.
Oak Ridge, TN 37830
(615) 481-0683 Fax (615) 483-4621

Site: —
Job #: —

ABP-100
~~AC-3-7~~
CALIBRATION DATA SHEET

ABP-100
~~AC-3-7~~ SN: A0281 Property of: EBERLINE INST.

Readout Inst.: L00 2200 SN: 106729 Cal. Exp. Date: 4-4-95
BETA
~~Alpha~~ Source: Sr90-Y90 SN: 1239/92 Activity: 22800 DPM

Date of Cal.: 10-3-94

PLATEAU: * CALIBRATED @ 35mV I.S.

High Voltage	Source (CPM) ~~ALPHA~~	BETA	BKGD	High Voltage	Source (CPM)		Background Check	CPM
~~650~~				1050	203	6979 187	High Voltage	
650 SEE NOTE		—		1100	225	7123 219	Op. Voltage -5%	NA
700		—		1150	286	7183 264	Op. Voltage	
750		—		1200	355	7382 339	Op. Voltage +5%	
800	—	1164	12	1250	—	8116 483		
850	—	2172	23	1300	—	9863 902		
900	—	4111	78	1350		—		
950	—	5439	125	1400		—		
1000	—	6426	147					

NOTE: MYLAR SHEET ADDED TO ATTENUATE ALPHA RESPONCE TO "0" CPM CONTRIBUTION. ALPHA SOURCE @ 7500 DPM NOM.

High Voltage set at: 1100 volts

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

Pos "A": 34732 Pos "B": 32230
Average (A + B)/2: 33481.0 Gross CPM: 6696.2
Background: CPM: 296.2 Net CPM: 6400.0
1481

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

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

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

Reviewed by: R.W. Doane Date: 1/5/95

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-2

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

Ludlum
43-89
~~AG-3-T~~

CALIBRATION DATA SHEET

43-89
~~43-3-T~~ SN: 188704 Property of: BALT

Readout Inst.: 2241-2 SN: 131415 Cal.Exp.Date: 6-12-04

~~Alpha~~ Beta Source: ~~TA-~~ Sr-90 SN: 2158/96 Activity: 16700 DPM
RHS

Date of Cal.: 10-24-00

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	N/A	~~1050~~ 850	1598
650		~~1100~~ 875	2165
700		~~1150~~ 900	2631
750		~~1200~~ 925	3251
800	1552	~~1250~~ 950	3698
850	2771	~~1300~~ 975	4235
900	3737	1350	—
950	4542	1400	—
1000	5755		

High Voltage set at: ~~900~~ 925 RHS volts

Background Check

High Voltage	CPM
Op. Voltage ~~-50~~ -25	131
Op. Voltage	169
Op. Voltage ~~+50~~ +25	239

Efficiency:
5 Minute Gross Counts:

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

1 min Gr. 3213
1 min Bkg 183
3030 / 16700 = 18.1 %

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

Date of Calibration: 6-17-03 Expiration Date: 12-17-03

Calibrated by: Randall N. Sells (Print Name) (Signature)

Reviewed by: Dan Quigley Date: 6/18/03

EA4.10
Rev: 2
Date: 25 Feb 99

Page 4 of 4

L224-2/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 SrY-90 ON 47 mm DISK: 18.1 % CAL DATE: 6-17-03

	BACKGROUND		BR	SOURCE		SR		SA	Efficiency
SURFACE MATERIAL	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM	Source #	Source Activity	SR-BR SA
Concrete	396	308	88	5005	181	4824	L-A	25900	18.2
				4945	179	4766			18.1
				4951	210	4741			18.0
				5113	184	4929			18.7
259 x 100 = 25900								Average =	18.5
								Std Dev =	0.3
Wood	0	0	0	4007	226	3781	M-2	17400	21.7
	0	0	0	3876	216	3660			21.0
	0	0	0	3971	211	3760			21.6
	0	0	0	3887	240	3647			21.0
174 x 100 = 17400								Average =	21.3
								Std Dev =	0.4
Masonite	0	0	0	3964	249	3715	M-2	17400	21.4
	0	0	0	3809	191	3698			21.3
	0	0	0	3853	234	3619			20.8
	0	0	0	3996	198	3748			21.5
								Average =	21.2
								Std Dev =	0.3
Aluminum	0	0	0	4362	224	4138	M-2	17400	23.8
	0	0	0	4399	211	4186			24.1
	0	0	0	4358	257	4101			23.6
	0	0	0	4390	230	4160			23.9
								Average =	23.9
								Std Dev =	0.2

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

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

REVIEWED BY: Alan Ziegler DATE: 6/18/03

@ Contact Geometry

L224-2/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 #	2178-86 ok
Probe Serial #	188704	Source dpm (4x):	56039
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 Observed	Expected	Background Counts
1	10358	10449	121
2	10405	10449	130
3	10502	10449	122
4	10336	10449	148
5	10281	10449	156
6	10196	10449	
7	10620	10449	
8	10466	10449	
9	10454	10449	
10	10328	10449	
11	10625	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		
		MDA(cpm) =	57
df = n-1 =	19	MDA(dpm) =	305
chitest = p(x<χ^2) =	6.727E-02		
chisquare (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 =	9984		
Daily Source Check Mean Net Counts	10313		
95% Conf. Interval Test max =	10683		
99% Conf. Interval Test max =	10773		

Test performed by: Steve Struck

Checked by: Date:

L224-2/L43-89
S/N: 131415/188704
6/17/03

Thermo NUtech
A ThermoRetec Company
601 Scarboro Road
Oak Ridge, TN 37830

LUDLUM 2221
CALIBRATION DATA SHEET

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Ludlum2221S/N: 163666 Property O

Battery Check OK @ 5.6 Rds
Replace @6.4

High Voltage Check

HV Meter: Fluke 29 S/N: 65410232 Cal Exp. Date 1-30-03

Meter Reading	Pre Cal	Post Cal	Tolerance
600 Volts	660	605	10 %
1000 Volts	1100	1005	10 %
1400 Volts	1540	1410	10 %

Input Sensitivity:

(Threshold @ 10 mv) Pre Cal: 35 mV , Post Cal: 35 m

MP-2 S/N: 1684 Calibration Exp. Date: 1-29-03

Rate/ Meter	MP-2	2221	Digital Display	Analog Display	Tol
400 CPM		x1	400	400	10%
4K CPM		x10	3998	4000	10%
40K CPM		x100	39999	40000	10%
400K CPM		x1000	400080	400000	10%
Scaler: 100K CPM		0.5 sec	50010	100000	10%
100K CPM		1.0 min	100020		10%
100K CPM		2.0 min	200039		10%
100K CPM		5.0 min	500097		10%

Log 400 400 4K 4K 40K 40K 400k 400k

Functional Check:

Ext Count ✓ Reset ✓ Speaker ✓ Headphones ✓ Light ✓

Date Of Calibration: 1-16-03 Expiration Date: 1-16-03

Calibrated By: Randall H. Sells (Print) (Signature)

Reviewed By: [signature] Date: 1/30/03

L2221/AB-100
S/N: 163666/B426W
1/16/03

CALN100A

Thermo NUtech

For Mallinckrodt Chemical, Inc

NATIONAL NUCLEAR ABP-100
MATERIAL SPECIFIC CALIBRATION DATA SHEET

RHS

ABP-100 SN: B426W HIGH VOLTAGE: 875 V PROPERTY OF: TYCO E.S.

READOUT INST: Ludl 2221 SN: 163666 CAL EXPIRE DATE: 7-16-03

ABP-100 EFFICIENCY TO SrY-90 ON 47 mm DISK: 42.0 % CAL DATE: 1-22-03

	BACKGROUND		BR	SOURCE		SR		SA	Efficiency
SURFACE MATERIAL	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM	Source #	Source Activity	SR-BR SA
Concrete	561	416	73	6857	292	6625	6-A	33250	19.9
				6853	246	6607			19.9
				6846	242	6604			19.9
				6784	236	6548			19.7
								Average =	19.9
266X125 = 33250 dpm								Std Dev =	0.1
Wood	0	0	0	5222	238	4984	M-2	22250	22.4
	0	0	0	5281	240	5041			22.6
	0	0	0	5181	224	4957			22.3
	0	0	0	5296	232	5064			22.8
								Average =	22.5
178 dpm X 125 = 22250								Std Dev =	0.2
Masonite	0	0	0	5296	232	5064	M-2	22250	22.8
	0	0	0	5302	234	5068			22.8
	0	0	0	5311	248	5063			22.8
	0	0	0	5366	236	5130			23.1
								Average =	22.9
178 dpm X 125 = 22250								Std Dev =	0.2
Aluminum	0	0	0	6037	223	5814	M-2	22250	26.1
	0	0	0	5706	236	5470			24.6
	0	0	0	6013	248	5765			25.9
	0	0	0	5892	227	5665			25.5
								Average =	25.5
178 dpm X 125 = 22250								Std Dev =	0.7

DATE OF CALIBRATION: 1-29-03 EXPIRATION DATE: 7-29-03

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

REVIEWED BY: [signature] DATE: 1/30/03

L2221/AB-100
S/N: 163666/B426W
1/16/03

CT-RP-66
Chi Squared Test

Instrument Model #	2221	Date:	02/04/2003
Instrument Serial#	163666	Source Nuclide:	SrY90
Probe Model #	AB 100	Source Serial #	2178-96
Probe Serial #	B426W	Source dpm (4π):	66489
Window Setting:	3720	Efficiency (cpm/dpm):	0.28
Threshold Setting:	352	Background cpm:	183.4
High Voltage:	875	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Counts Observed	Expected	Background Counts
1	15380	15546	185
2	15381	15546	193
3	15477	15546	179
4	15662	15546	179
5	15520	15546	181
6	15587	15546	
7	15476	15546	
8	15392	15546	
9	15639	15546	
10	15609	15546	
11	15401	15546	
12	15433	15546	
13	15601	15546	
14	15743	15546	
15	15606	15546	
16	15828	15546	
17	15577	15546	
18	15518	15546	
19	15510	15546	
20	15599	15546	

sample mean (xbar) =	15546	Multiplier to convert	
sample variance (s^2) =	15181	to dpm:	3.6
background variance (b^2) =	34.8		
sample sigma (s) =	123		
(95% Confidence) 2.752 s =	339		
(99% Confidence) 3.615 s =	446		
		MDA (cpm) =	66
		MDA (dpm) =	240
df = n-1 =	19		
chitest = p(x<χ^2) =	4.858E-01		
chisquare (χ^2) =	18.654		
Acceptable χ^2 min =	8.907		
Acceptable χ^2 max =	32.852		
χ^2 test passes (yes/no)?	YES		
99% Conf. Interval Test min =	14917		
95% Conf. Interval Test min =	15023		
Daily Source Check Mean Net Counts	15383		
95% Conf. Interval Test max =	15702		
99% Conf. Interval Test max =	15809		

Test performed by: Steve Struck 2/4/03

Checked by: Date: 2-4-03

L2221/AB-100
S/N: 163666/B426W
1/16/03

Lud
43-89
~~AG-5-7~~

CALIBRATION DATA SHEET

4309
~~AG-5-7~~ SN: 188707 Property of: MALT

Readout Inst.: Lud 2241-2 SN: 131910 Cal.Exp.Date: 10-16-03

Beta
~~Alpha~~ Source: Sr-Y-90 SN: 2158/96 Activity: 17100 DPM

Date of Cal.: 10-24-00

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	—	~~1850~~ 750	2657
650	—	~~1100~~ 760	2899
700	1320	~~1450~~ 770	3161
750	2640	~~1200~~ 780	3519
800	4040	1250	N/A
850	N/A	1300	
900		1350	
950		1400	
1000			

High Voltage set at: 770 volts

Background Check

High Voltage	CPM
Op. Voltage -10 ~~-50~~	107
Op. Voltage	111
Op. Voltage +10 ~~+50~~	134

* 47mm Source @ Contact Geome... Center of Probe

Efficiency:

5 Minute Gross Counts:

Pos "A": Pos "B":

Average (A + B)/2: Gross CPM:

Background: CPM: Net CPM:

1min Ct 3196

1min BKG 127

3019 / 17100 dpm

17.7%

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

Date of Calibration: 4-16-03 Expiration Date: 10-16-03

Calibrated by: Randall H. Sells (Print Name) (Signature)

Reviewed by: Allen J. Hegler Date: 4/22/03

A4.10
Rev: 2
Date: 25 Feb 99

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L2241-2/L43-89
S/N: 131410/188707
4/16/03

CALN100A

Thermo NUtech

For Mallinckrodt Chemical, Inc

NATIONAL NUCLEAR ABP-100
MATERIAL SPECIFIC CALIBRATION DATA SHEET

Lud 43-89

ABP-100 SN: 180707 HIGH VOLTAGE: 770 V PROPERTY OF: MALT

READOUT INST: Lud 2241-2 SN: 131410 CAL EXPIRE DATE: 10-16-03

ABP-100 EFFICIENCY TO SrY-90 ON 47 mm DISK: 17.7 % CAL DATE: 4-16-03

	BACKGROUND		BR	SOURCE		SR		SA	Efficiency
SURFACE MATERIAL	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM	Source #	Source Activity	SR/SA
Concrete	264	230	17	4753	277	4476	L-A	25900	[illegible]
				4877	301	4576			17.6
				4811	297	4514			17.4
				4705	315	4390			16.9
259 x 100 = 25900								Average =	17.3
								Std Dev =	0.3
Wood	0	0	0	3725	256	3469	M-2	17400	19.9
	0	0	0	3606	243	3365			19.3
	0	0	0	3581	223	3358			19.3
	0	0	0	3544	245	3309 (3299)			19.0
174 x 100 = 17400								Average =	19.4
								Std Dev =	0.4
Masonite	0	0	0	3646	318	3328	M-2	17400	19.1
	0	0	0	3713	324	3389			19.5
	0	0	0	3735	319	3416			19.6
	0	0	0	3600	327	3273			18.8
								Average =	19.3
								Std Dev =	[illegible]
Aluminum	0	0	0	4203	193	4010	M-2	17400	23.1
	0	0	0	4185	207	3978			22.9
	0	0	0	4119	193	3936			22.6
	0	0	0	4025	195	3828			22.0
								Average =	22.7
								Std Dev =	0.5

DATE OF CALIBRATION: 4-17-03 EXPIRATION DATE: 10-17-03

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

REVIEWED BY: [signature] DATE: 4/22/03

L2241-2/L43-89
S/N: 131410/188707
4/16/03

CT-RP-66

Chi Squared Test

Instrument Model #	2241	Date:	04/28/2003
Instrument Serial#	131410	Source Nuclide:	SrY90
Probe Model #	43-89	Source Serial #	2178-96
Probe Serial #	188707	Source dpm (4π):	55258
Window Setting:		Efficiency (cpm/dpm):	0.14
Threshold Setting:	35 mV	Background cpm:	79.8
High Voltage:	770	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Counts Observed	Expected	Background Counts
1	7865	7848	82
2	7914	7848	80
3	7726	7848	80
4	8036	7848	82
5	7901	7848	76
6	7851	7848	
7	7823	7848	
8	7889	7848	
9	7693	7848	
10	7890	7848	
11	7874	7848	
12	7831	7848	
13	7929	7848	
14	7861	7848	
15	7700	7848	
16	7852	7848	
17	7828	7848	
18	7861	7848	
19	7724	7848	
20	7805	7848	

sample mean (xbar) =	7848	Multiplier to convert to dpm:	7.2
sample variance (s^2) =	7273		
background variance (b^2) =	8.2		
sample sigma (s) =	85	FSS Normalization	
(95% Confidence) 2.752 s =	235	S_i =	0.287
(99% Confidence) 3.615 s =	308		
		MDA(cpm) =	45
df = n-1 =	19	MDA(dpm) =	320
chitest = p(x<χ^2) =	6.487E-01		
chisquare (χ^2) =	17.609		
Acceptable χ^2 min =	8.907		
Acceptable χ^2 max =	32.852		
χ^2 test passes (yes/no)?	YES		
99% Conf. Interval Test min =	7459		
95% Conf. Interval Test min =	7533		
Daily Source Check Mean Net Counts	7768		
95% Conf. Interval Test max =	8003		
99% Conf. Interval Test max =	8076		

Test performed by: Steve Struck 4-28-03

Checked by: Jim C. Woolford Date: 4-28-03

L2241-2/L43-89
S/N: 131410/188707
4/16/03

Site: _____
Job #: _____

AB-100
~~AC-3-7~~
CALIBRATION DATA SHEET

AB100
~~AC-3-7~~ SN: B 861 N Property of: EAC

Readout Inst.: Ludlum 2221 SN: 115126 Cal. Exp. Date: 7-8-96

~~Alpha~~ Beta Source: Sr-Y90 SN: 1239/92 Activity: 20300 DPM

Date of Cal.: 10-1-95

PLATEAU: * CALIB @ 35mV

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	_____	1050	8754
650	_____	1100	_____
700	_____	1150	_____
750	_____	1200	_____
800	2180	1250	_____
850	4226	1300	_____
900 / 925	6334 / 7041	1350	_____
950 / 975	7577 / 8010	1400	_____
1000 / 1025	8047 / 8387		

Background Check	
High Voltage	CPM
Op. Voltage -50	240
Op. Voltage	315
Op. Voltage +50	355

High Voltage set at: 1000 volts

A: Front Cntr Pos.
B. Rear Cntr Pos.
Cntr "C"

Efficiency:

5 Minute Gross Counts:

Pos "A": 40734 41487 Pos "B": 41508

)/3 Average ~~(A + B)/2~~: 41243 Gross CPM: 8248.6

Background: CPM: 322.6 (1613) Net CPM: 7926

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 39.0\ \%$$

Date of Calibration: 1-18-96 Expiration Date: 7-18-96

Calibrated by: SARA SMITH (Print Name) Sara Smith (Signature)

Reviewed by: Randall A. Dell Date: 1-23-96

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-66

L2221/AB-100
S/N: 115126/B861N
1/18/96

Site: _____
Job #: _____

AB-100
~~AC-3-7~~
CALIBRATION DATA SHEET

AB-100
~~AC-3-7~~ SN: B859N Property of: EAC

Readout Inst.: Ludlum 2221 SN: 126509 Cal. Exp. Date: 7-8-96

~~Alpha~~ Beta Source: Sr Y 90 SN: 1239/92 Activity: 20300 DPM

Date of Cal.: 10-1-95

PLATEAU: * CALIB @ 35 mv

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	_____	1050	8650
650	_____	1100	_____
700	_____	1150	_____
750	_____	1200	_____
800	2705	1250	_____
850	4990	1300	_____
900	6847	1350	_____
925	7605		
950	7884	1400	_____
975	7977		
1000	8206		

Background Check	
High Voltage	CPM
Op. Voltage -50	223
Op. Voltage	250
Op. Voltage +50	317

High Voltage set at: 950 volts

Efficiency:

A= Front Cntr. Pos.
B. Rear Cntr Pos.

5 Minute Gross Counts:

	Pos "A"	Cntr "C"	Pos "B"
	38633	39234	39447
B+C)/3 Average ~~(A + B)/2~~:	39104.67		Gross CPM: 7820.93
Background: CPM:	258.6		Net CPM: 7562.33
	1293		

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 37.3\ \%$$

Date of Calibration: 1-18-96 Expiration Date: 7-18-96

Calibrated by: SARA SMITH (Print Name) Sara Smith (Signature)

Reviewed by: Randall H. Sudd Date: 1-23-96

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-66

L2221/AB-100
S/N: 126509/B859N
1/18/96

AC-3-7
CALIBRATION DATA SHEET

AB-100
~~AC-3-7~~ SN: B426W Property of: E.S.

Readout Inst.: 2241-2 SN: 131415 Cal.Exp.Date: 5-15-03

Beta
~~Alpha~~ Source: Sr-Y-90 SN: 2158/96 Activity: 17500 DPM

Date of Cal.: 10-24-00

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)	Background Check	
				High Voltage	CPM
600	———	1050			
650	998	~~1100~~ 775	5992	Op. Voltage ~~-50~~ -25	244
700	3053	~~1150~~ 800	6612	Op. Voltage	272
750	5422	~~1200~~ 825	6999	Op. Voltage ~~+50~~ +25	353
800	6698	~~1250~~ 850	7358		
850	7550	~~1300~~ 875	8880		
900	23305	1350			
950	———	1400			
1000	———	High Voltage set at : 825 volts			

*Contact Geometry @ Probe Center

Efficiency:

~~5 Minute Gross Counts~~:

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

1min Ct 7054
1min Bkg 256
6798/17500 dpm = 38.8 ~~39.0%~~ eff

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

Date of Calibration: 5-15-02 Expiration Date: 5-15-03

Calibrated by: Randall H. Sells (Print Name) (Signature)

Reviewed by: Allen Shapley Date: 5/15/02

4.10
Rev: 2
Date: 25 Feb 99

* Replaced Inner & Outer Mylar

Page 4 of 4

L2241-2/AB-100
S/N: 13145/B426W
5/15/02

CALN100A

Thermo NUtech

For Mallinckrodt Chemical, Inc

NATIONAL NUCLEAR ABP-100
MATERIAL SPECIFIC CALIBRATION DATA SHEET

ABP-100 SN: B426W HIGH VOLTAGE: 825 V PROPERTY OF: E.S.

READOUT INST: 2241-2 SN: 131415 CAL EXPIRE DATE: 5-15-02 RHS 03

ABP-100 EFFICIENCY TO SrY-90 ON 47 mm DISK: 39.0 % CAL DATE: 5-15-02

	BACKGROUND		BR	SOURCE		SR		SA	Efficiency
SURFACE MATERIAL	OPEN Cts/2 min	SHIELD Cts/2 min	NET CPM	OPEN Cts/1 min	SHIELD Cts/1 min	NET CPM	Source #	Source Activity	SR-BR/ SA
Concrete	648	550	98	8744	294	8450	L-A	33250	25.4
	↓	↓	↓	8696	299	8397	↓	↓	25.3
	↓	↓	↓	8522	292	8230	↓	↓	24.8
	↓	↓	↓	8697	294	8403	↓	↓	25.3
125 x ~~36600~~ 266 dpm = 33250								Average =	25.2
								Std Dev =	0.3
Wood	0	0	0	6691	251	6440	M-2	22250	28.9
	↓	↓	↓	6772	282	6490	↓	↓	29.1
	↓	↓	↓	6793	290	6503	↓	↓	29.2
	↓	↓	↓	6588	283	6305	↓	↓	28.3
125 x 178 = 22250								Average =	28.9
								Std Dev =	0.4
Masonite	0	0	0	6682	304	6378	M-2	22250	28.7
	↓	↓	↓	6635	268	6367	↓	↓	28.6
	↓	↓	↓	6857	279	6558	↓	↓	29.5
	↓	↓	↓	6626	304	6322	↓	↓	28.4
125 x 178 dpm = 22250								Average =	28.8
								Std Dev =	0.5
Aluminum	0	0	0	7468	312	7156	M-2	22250	32.2
	↓	↓	↓	7578	300	7278	↓	↓	32.7
	↓	↓	↓	7411	305	7106	↓	↓	31.9
	↓	↓	↓	7564	296	7268	↓	↓	32.7
125 x 178 dpm = 22250								Average =	32.4
								Std Dev =	0.4

DATE OF CALIBRATION: 5-15-02 EXPIRATION DATE: 5-15-03

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

REVIEWED BY: [signature] DATE: 5/15/02

L2241-2/AB-100
S/N: 13145/B426W
5/15/02

TMA
Thermo Analytical

TMA/Eberline
601 Scarboro Rd.
Oak Ridge, TN 37830
(615) 481-0683 Fax (615) 483-4621

Site: —
Job #: —

AB-100
~~AB-3-7~~
CALIBRATION DATA SHEET

AB-100
~~AB-3-7~~ SN: B859 N Property of: EAC

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

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

Date of Cal.: 10-3-94

PLATEAU: * CALIB. @ 35 mv I.S.

High Voltage	Source (CPM) ALPHA	BETA	BKGD	High Voltage	Source (CPM)
600	SEE NOTE:	390		1050	NA
650	82	1594	74	1100	
700	192	4129	163	1150	
750	229	6996	214	1200	
800	266	8088	265	1250	
850	338	8591	301	1300	
900	453	8693	440	1350	
950	922	10148	815	1400	
1000		17209			

Background Check:

High Voltage	CPM
Op. Voltage -50	—
Op. Voltage	—
Op. Voltage +50	—

NOTE: MYLAR SHEET ADDED TO ATTENUATE ALPHA CONTRIBUTION TO "0" CPM CONTRIBUTION.
ALPHA SOURCE @ 7500 DPM Nom.

High Voltage set at: 850 volts

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

Pos "A": 38561 Pos "B": 37185
Average (A + B)/2: 37873.0 Gross CPM: 7574.6
Background: CPM: 319.8 Net CPM: 7254.8
1574

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 31.8\ \%$$

Date of Calibration: 1-6-95 Expiration Date: 7-6-95

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

Reviewed by: Randall H. Dull Date: 1-6-95

EA4.10
Rev: 1

L2200/AB-100
S/N: 106729/B859N
1/6/95

TMA
Thermo Analytical

TMA/Eberline
601 Scarboro Rd.
Oak Ridge, TN 37830
(615) 481-0683 Fax (615) 483-4621

Site: MALT-5
Job #: —

ABP-100
~~AC-3-7~~
CALIBRATION DATA SHEET

ABP-100
~~AC-3-2~~ SN: A0446 Property of: EAC

Readout Inst.: LUDLUM 2221 SN: 117332 Cal. Exp. Date: 7-17-95

~~Alpha~~ GFPC Source: 1239/92 SRS-90 SN: 1239/92 Activity: 22800 DPM

Date of Cal.: 10-3-94

PLATEAU: * CALIB @ 35 mv

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	—	1050	2562
650	—	1100	3686
700	—	1150	4985
750	—	1200	5894
800	—	1250	6194 · 194
		1275	6852 · 198
850	—	1300	6708 · 209
		1325	6670 · 253
900	—	1350	6662 · 257
		1375	6923 · 263
950	773	1400	7093 · 293
1000	1606		

Background Check

High Voltage		CPM
Op. Voltage	-100	177
	-50	198
Op. Voltage		253
	+50	263
Op. Voltage	+100	—

High Voltage set at: 1325 volts

A = FORWARD CNTR POS.
B = REAR CNTR POS.

Efficiency:

5 Minute Gross Counts:

CNTR

Pos "A": 29953 32817 Pos. "B": 31796

Average ~~(A + B)/2~~: 31522.0 Gross CPM: 6304.4

Background: CPM: 245.6 1228 Net CPM: 6058.8

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 26.6\ \%$$

Date of Calibration: 1-17-95 Expiration Date: 7-17-95

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

Reviewed by: Marianne McNamee Date: 1-17-95

EA4.10
Rev: 1
Date: 03 Jan 88

EA4.10-1a

L2221/ABP-100
S/N: 117332/A0446
1/17/95

TMA
Thermo Analytical

TMA/Eberline
601 Scarboro Rd.
Oak Ridge, TN 37830
(615) 481-0683 Fax (615) 483-4621

Site: MALT-5
Job #: —

ABP-100
~~AC-3-7~~
CALIBRATION DATA SHEET

ABP-100
~~AC-3-7~~ SN: A 0447 Property of: SAC

Readout Inst.: LUDLUM 2221 SN: 117332 Cal. Exp. Date: 7-17-95

~~Alpha~~ BETA Source: SR4-90 SN: 1239/92 Activity: 22800 DPM

Date of Cal.: 10-3-94

PLATEAU: * CALIB. @ 35 mV

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	—	1050	3100
650	—	1100	4382
700	—	1150 / 1175	5184·185 / 5527·233
750	—	1200 / 1225	5767·290 / 5934·306
800	—	1250	6475·401
850	—	1300	7364
900	618	1350	—
950	1269	1400	—
1000	2118		

Background Check

High Voltage		CPM
Op. Voltage	-100 / -50	96 / 185
Op. Voltage		290 / 407
Op. Voltage	+50 / +100	527

High Voltage set at: 1200 volts

Efficiency:

A = FORWARD CNTR POS
B = REAR CNTR POS

5 Minute Gross Counts:

	A	B (CNTR)	
Pos "A":	25943	29159	Pos. "B": 28277
Average (A + B)/2:	27793.0		Gross CPM: 5558.6
Background: CPM:	252.4 / 1262		Net CPM: 5306.2

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 23.3\ \%$$

Date of Calibration: 1-17-95 Expiration Date: 7-17-95

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

Reviewed by: Marianne McNamee Date: 1-17-95

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-22

L2221/ABP-100
S/N: 117332/A0447
1/17/95

TMA
Thermo Analytical

TMA/Eberline
601 Scarboro Rd.
Oak Ridge, TN 37830
(615) 481-0683 Fax (615) 483-4621

Site: MALT-5
Job #: —

ABP-100
~~AC-3-7~~
CALIBRATION DATA SHEET

ABP-100
~~AC-3-7~~ SN: A 0448 Property of: SAC

Readout Inst.: LUDUM 2221 SN: 117332 Cal. Exp. Date: 7-17-95
BETA
~~Alpha~~ Source: SR-90 SN: 1239/92 Activity: 22800 DPM

Date of Cal.: 10-3-94

PLATEAU: * CALIB @ 35mV

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	—	1050	2941
650	—	1100	4000
700	—	1150	5255
750	—	1200 / 1225	6066·179 / 6145·194
800	—	1250 / 1275	6443·236 / 6594·312
850	—	1300	6709·383
900	246	1350	7393·483
950	887	1400	29K
1000	1732		

Background Check

High Voltage		CPM
Op. Voltage	-100 / -50	63 / 179
Op. Voltage	+50	236 / 383
Op. Voltage	+100	483

High Voltage set at: 1250 volts

Efficiency:

A: FRONT CNTR Pos.
B: REAR CNTR Pos.

5 Minute Gross Counts:

Pos "A": 30192 31848 Pos, "B": 27835
Average (A + B)/2: 29958.33 Gross CPM: 5991.66
Background: CPM: 248.0 1240 Net CPM: 5743.67

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 25.2\ \%$$

Date of Calibration: 1-17-95 Expiration Date: 7-17-95

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

Reviewed by: Marianne McNamee Date: 1-17-95

EA4.10
Rev: 1
Date: 25 Jan 88 EA4.10-10

L2221/ABP-100
S/N: 117332/A0448
1/17/95

Site: _____
Job #: _____

AB-100
~~AC-3-7~~
CALIBRATION DATA SHEET

AB-100
~~AC-3-7~~ SN: B860N Property of: EAC

Readout Inst.: Ludlum 2221 SN: 117362 Cal. Exp. Date: 7-8-96

SrY-90
~~Alpha~~ Source: 1239/92 SN: 1239/92 Activity: 20300 DPM

Date of Cal.: 10-1-95

PLATEAU: * CALIB @ 35 mv

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600		1050	
650		1100	
700		1150	
750		1200	
800	4460	1250	
850	6636	1300	
875	7338		
900	7759	1350	
925	8008		
950	8115	1400	
975	8280		
1000	8656		

Background Check

High Voltage	CPM
Op. Voltage -50	284
Op. Voltage	440
Op. Voltage +50	574

High Voltage set at: 950 volts

Efficiency:

A: Front Cntr Pos.
B: Rear Cntr Pos.
C: Cntr "C"

5 Minute Gross Counts:

Pos "A": 38683 40964 Pos "B": 40956

(A+B+C)/3 Average ~~(A + B)/2~~: 40181 Gross CPM: 8036.2

Background: 1982 CPM: 396.4 Net CPM: 7639.8

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 37.6\ \%$$

Date of Calibration: 1-18-96 Expiration Date: 7-18-96

Calibrated by: SARA SMITH (Print Name) Sara Smith (Signature)

Reviewed by: Randall A. Dulls Date: 1-23-96

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-66

L2221/AB-100
S/N: 117362/B860N
1/18/96

Site: _____
Job #: _____

AB-100

~~AC-7-7~~
CALIBRATION DATA SHEET

AB-100
~~AC-7-7~~ SN: B860N Property of: EAC
Readout Inst.: 2221 SN: 117362 Cal. Exp. Date: 7-8-96
~~Alpha~~ Beta Source: Sr-90 SN: 1239/92 Activity: 20300 DPM
Date of Cal.: 10-25-95

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	0	1050	8796
650	2	1100	15162
700	106	1150	N/A
750	699	1200	
800	2042	1250	
850	4403	1300	
900	6287	1350	
950	7569	1400	
1000	7950		

Background Check

High Voltage	CPM
Op. Voltage -50	
Op. Voltage	
Op. Voltage +50	

High Voltage set at: 950 volts

Efficiency:
5 Minute Gross Counts:

Pos "A": 37171
Average (A + B)/2: N/A
Background: CPM: 247.8
1239

Pos "B": N/A
Gross CPM: 7434.2
Net CPM: 7186.4

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 35.4\ \%$$

Date of Calibration: 3-5-96 Expiration Date: 9-5-96
Calibrated by: Randall H. Sells (Print Name) Randall H. Sells (Signature)

Reviewed by: _____ Date: _____

EA4.10
Rev: 1
Date: 25 Jan 88

EA4.10-66

L2221/AB-100
S/N: 117362/B860N
3/5/96

Thermo NUtech
A ThermoRetec Company
601 Scarboro Road
Oak Ridge, TN 37830

ThermoRetec
Smart Solutions. Positive Outcomes.

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

Bicron
AB-100
~~AG-3-7~~

CALIBRATION DATA SHEET

AB-100
~~AG-3-7~~ SN: B860N Property of: TR

Readout Inst.: 2221 SN: 117362 Cal.Exp.Date: 7/21/2000

Beta
~~Alpha~~ Source: Sr-90 SN: 123892 Activity: ~~15400~~ RHS DPM 15200 dpm

Date of Cal.: 4/20/99

* @35mV
@Contact Geometry

PLATEAU:

High Voltage	Source (CPM)	High Voltage	Source (CPM)
600	—	1050	6942
650	—	1100	9136
700	—	1150	—
750	—	~~1200~~ 925	5077
800	1062	~~1250~~ 950	5652
850	2726	~~1300~~ 975	6046
900	4438	~~1350~~ 1000	6324
950	5594	~~1400~~ 1025	6493
1000	6470		

Background Check

High Voltage	CPM
Op. Voltage -~~50~~ 25	245
Op. Voltage	261
Op. Voltage +~~50~~ 25	261

1050 − 6913

High Voltage set at: 1000 volts

Efficiency:
5 Minute Gross Counts:

Pos "A": 30485 Pos "B": 31943
Average (A + B)/2: 31214 Gross CPM: 6242.8
Background: CPM: 257.3 Net CPM: 5985.6
1286

$$\text{Efficiency} = \frac{\text{Net CPM}}{\text{DPM}} \times 100 = 39.4\ \%$$

Date of Calibration: 10/20/99 Expiration Date: 10/20/2000

Calibrated by: Randall H. Sells (Print Name) (Signature)

Reviewed by: Alan Hagley Date: 10/20/99

EA4.10
Rev: 2
Date: 25 Feb 99

L2221/AB-100
S/N: 117362/B860N
10/20/99

Certificate of Calibration

Voltage Plateau Form

ERG
Environmental Restoration Group Inc.
12809 Arroyo De Vista NE
Albuquerque NM 87111
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-20 Serial No.: PR201774

Counter Mfg.: Ludlum Model: 2221 Serial No.: 138368

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: [illegible] Other:

Count Time: 0.5 minute(s)

High Voltage	Gross Source Counts	Background Counts
600	59843	
700	88692	
800	97759	
900	105063	
1000	106569	15542
1100	107134	
1150	110266	
1200	132170	

Recommended Operating Voltage: 1000 volts

Calibrated By: [signature] Calibration Date: 04NOV03

Calibration Due: 04NOV04

Reviewed By: [signature] Date: 11/4/03

L2221/3x3
S/N: 138368/201774
11/4/03

Certificate of Calibration

Ratemeter / Scaler Certificate of Calibration

ERG
Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Manufacturer: Ludlum Model: 2221 Serial No.: 138368

All Ranges Calibrated Electronically; Ludlum Pulser Generator S.N. 97743

Reset ✓ Audio ✓ Mechanical ✓ Battery ✓ Window Operation ✓

High Voltage 500v ✓ 1000v ✓ 1500v ✓

Instrument found within tolerance (+/- 10%) (Yes) No

Reference Setting	Ratemeter	Instrument "As found reading"
400 Kcpm	400K	400K
100 Kcpm	100K	100K
40 Kcpm	40K	40K
10 Kcpm	10K	10K
4 Kcpm	4K	4K
1 Kcpm	1K	1K
400 cpm	400	400
100 cpm	100	100

Reference Setting	Integrated Counts (1-minute count)	Log Scale Count Rate	Instrument "As found reading"
400 Kcpm	400071	400K	400K
40 Kcpm	39986	40K	40K
4 Kcpm	4008	4K	4K
400 cpm	401	400	400

Calibrated By: Kenneth R Baker Calibration Date: 10-21-03

Calibration Due: 10-21-04

Reviewed By: Patricia C Baker Date: 10/23/03

L2221/3x3
S/N: 138368/201774
11/4/03

CT-RP-66
Chi Squared Test

Instrument Model #	2221	Date:	11/11/2003
Instrument Serial#	138368	Source Nuclide:	cs-137
Probe Model #	3x3	Source Serial #	2538-99
Probe Serial #	201774	Source dpm (4π):	228660
Window Setting:		Efficiency (cpm/dpm):	0.13
Threshold Setting:		Background cpm:	3510.4
High Voltage:	1000	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Counts Observed	Expected	Background Counts
1	29749	29733	3559
2	29919	29733	3525
3	29500	29733	3508
4	29688	29733	3475
5	29999	29733	3485
6	29908	29733	
7	29779	29733	
8	29505	29733	
9	29771	29733	
10	29534	29733	
11	29892	29733	
12	29462	29733	
13	29937	29733	
14	29599	29733	
15	29341	29733	
16	29726	29733	
17	29743	29733	
18	29865	29733	
19	29886	29733	
20	29853	29733	

sample mean (xbar) =	29733	Multiplier to convert	
sample variance (s^2) =	34474	to dpm:	7.7
background variance (b^2) =	1119.8		
sample sigma (s) =	189		
(95% Confidence) 2.752 s =	519		
(99% Confidence) 3.615 s =	682		
		MDA (cpm) =	279
df = n-1 =	19	MDA (dpm) =	2142
chitest = p(x<χ^2) =	2.628E-01		
chisquare (χ^2) =	22.030		
Acceptable χ^2 min =	8.907		
Acceptable χ^2 max =	32.852		
χ^2 test passes (yes/no)?	YES		
99% Conf. Interval Test min =	25540		
95% Conf. Interval Test min =	25703		
ily Source Check Mean Net Counts	26223		
95% Conf. Interval Test max =	26742		
99% Conf. Interval Test max =	26905		

Test performed by: Dirk Hartman
Checked by: Drew Thatcher Date: 11/11/2003

L2221/3x3
S/N: 138368/201774
11/4/03

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. 325-236-4672
SWEETWATER, TEXAS 79556, U.S.A.

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

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 202-150

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 77 °F RH 31 % Alt 566 ft

☐ New Instrument Instrument Received ☑ Within Toler. +-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 ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 6.0 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 Counts V Input Sens. Counts mV Det. Oper. Counts V at Counts/ 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
High Voltage:	434 v	650 v
Threshold dial:	642	100 (10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	~ 10 %	n/a

Model 2221 currently set for Gross Counts
High voltage set with detector connected.

Firmware: 2.6 10 10

Gamma Calibration. GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

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 ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400 K cpm	398 (0)	398 (0)
	40 K cpm	398 (0)	398 (0)
	4 K cpm	398 (0)	398 (0)
	400 cpm	400	400
	40 cpm	4 (0)	4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500 K cpm	450K	450K
	50 K cpm	50K	50K
	5 K cpm	4.5K	4.5K
	500 cpm	500	500
	50 cpm	55	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 technique. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M865 ☐ 5105 ☐ T1008 ☐ T879 ☐ E5512 ☐ E551 ☐ Neutron Am-241 Be S.N. 1604

☐ Alpha S/N ☐ Beta S/N ☐ Other

Ohm 500 S/N 81084 ☐ Oscilloscope S/N ☑ Multimeter S/N 80040300

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

Reviewed By: Rhonda Harris Date 30 Apr 03

This 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

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 3X3 Serial No. 020429-6

Customer TYCO/MALLINCKRODT ST LOUIS Order #. 296103/271822

Counter 2221 Serial No. 157020 Counter Input Sensitivity 10 mV

Count Time 6 sec Distance Source to Detector Surface

Other

High Voltage	Background	Isotope Am-241 Size ≈0.77uCi	Isotope _____ Size _____	Isotope _____ Size _____	Isotope _____ Size _____
450	1443	5324			
500	1654	18326			
550	1572	22461			
600	1614	22466			
→ 650	1687	22705			
700	1729	22867			
750	2057	23047			
800	2521	25948			
850	3899	29371			
900	6780	40237			
950	16139	53980			
1000	19708	78799			

Signature Michael J Thomas Date 26-Apr-03

FORM C-AN 04/09/2003

• *Serving The Nuclear Industry Since 1962* •

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 #	NaI 3x3	Source Serial #	2658
Probe Serial #	020429-6	Source dpm (4π):	21634000
Window Setting:	3700 3480	Efficiency (cpm/dpm):	0.01
Threshold Setting:	100mV 104	Background cpm:	3676.2
High Voltage:	650V	BKGD N-1	4
		BKGD Count Time (min):	1

Count # (n)	Gross Counts Observed	Expected	Background Counts
1	226601	227689	3624
2	227278	227689	3830
3	228251	227689	3610
4	227614	227689	3701
5	228344	227689	3616
6	228647	227689	
7	227269	227689	
8	227708	227689	
9	227138	227689	
10	227004	227689	
11	227520	227689	
12	227819	227689	
13	228608	227689	
14	228689	227689	
15	227778	227689	
16	227078	227689	
17	227572	227689	
18	227573	227689	
19	227841	227689	
20	227443	227689	

sample mean (xbar) =	227689	Multiplier to convert	
sample variance (s^2) =	334344	to dpm:	94.6
background variance (b^2) =	8750.2		
sample sigma (s) =	586		
(95% Confidence) 2.752 s =	1612		
(99% Confidence) 3.615 s =	2117		
		MDA (cpm) =	285
df = n-1 =	19	MDA (dpm) =	26948
chitest = p(x<χ^2) =	8.637E-02		
chisquare (χ^2) =	27.900		
Acceptable χ^2 min =	8.907		
Acceptable χ^2 max =	32.852		
χ^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):	2286600
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 Counts 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	28667	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	28506	28492	
20	28592	28492	

sample mean (xbar) =	28492	Multiplier to convert to dpm:	80.3
sample variance (s^2) =	44336		
background variance (b^2) =	3699.2		
sample sigma (s) =	210		
(95% Confidence) 2.762 s =	603		
(99% Confidence) 3.615 s =	792		
		MDA (cpm) =	297
df = n-1 =	19	MDA (dpm) =	23801
chitest = p(x<χ^2) =	5.769E-02		
chisquare (χ^2) =	29.566		
Acceptable χ^2 min =	8.907		
Acceptable χ^2 max =	32.852		
χ^2 test passes (yes/no)?	YES		
99% Conf. Interval Test min =	23714		
95% Conf. Interval Test min =	23903		
Daily Source Check Mean Net Counts	24506		
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

of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER TYCO/HEALTHCARE/MALLINCKRODT ORDER NO. 288367 / 268024

Mfg. Ludlum Measurements Inc. Model 3030 Serial No. 179562

Cal. Date 6-Nov-02 Cal Due Date 6-May-03 Cal. Interval 6 Months

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 32 % Alt 699.8 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 60 mV

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

Instrument Volt Set 627 V High Voltage set with detector connected.

☑ HV Readout (2 points) Ref./Inst. 499 / 500 V Ref./Inst. 1501 / 1600 V

Instrument in DPM mode.
QC mode turned OFF.
Firmware version: 2001/10
Overload set at 1/4 turn past OFF.
Battery voltage measured at 12.40 Vdc.
C-14 Efficiency = 9 %(4 pi) Net

(EEPROM Settings)
(PC) Count Time: 10
Alpha Alarm: 50000 cpm
Beta Alarm: 50000 cpm
Alpha/Beta Alarm: 50000 cpm
Calibration Due Date: 6-May-03
LOC (Loss of Count) time = 30 minutes (default)

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Alpha Channel Digital Readout	400K cpm	399264	399264
	40K cpm	39927	39927
	4K cpm	3993	3993
	400 cpm	400	400
	40 cpm	40	40
Beta/Gamma Channel Digital Readout	400K cpm	399449	399449
	40K cpm	39950	39950
	4K cpm	3995	3995
	400 cpm	400	400
	40 cpm	40	40

*Uncertainty within ± 10% C.F. within ± 20% (@) Indicates 0.1 minute count

COMMENTS:
Eff. for Th-230 s/n 2748-00, 3070cpm, read 665 in 1 minute = 8% 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. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration Licensee No. LO-1903

Reference Instruments and/or Sources:

☑ Alpha S/N Th-230 2748-00, Ra-226 002-4 ☑ Beta S/N Tc-99 M1-47 ☐ Other

☑ m 500 S/N 134709 ☐ Oscilloscope S/N ☐ Multimeter S/N

Calibrated By: Leonard Tolbert Date 6-Nov-02

Reviewed By: Rhonda Harris Date 11Nov02

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FORM C26-2 05/03/2002

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

L3030
S/N: 179562
11/8/02

Ludlum Measurements, Inc.
Model 3030 Plateau Data

11/11/02
11:25:35 AM

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

Calibration Due Date: 5/8/03

Model 3030 Date: 11/8/02
Model 3030 Time: 10:16:33 AM

User PC Time: 1.0

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

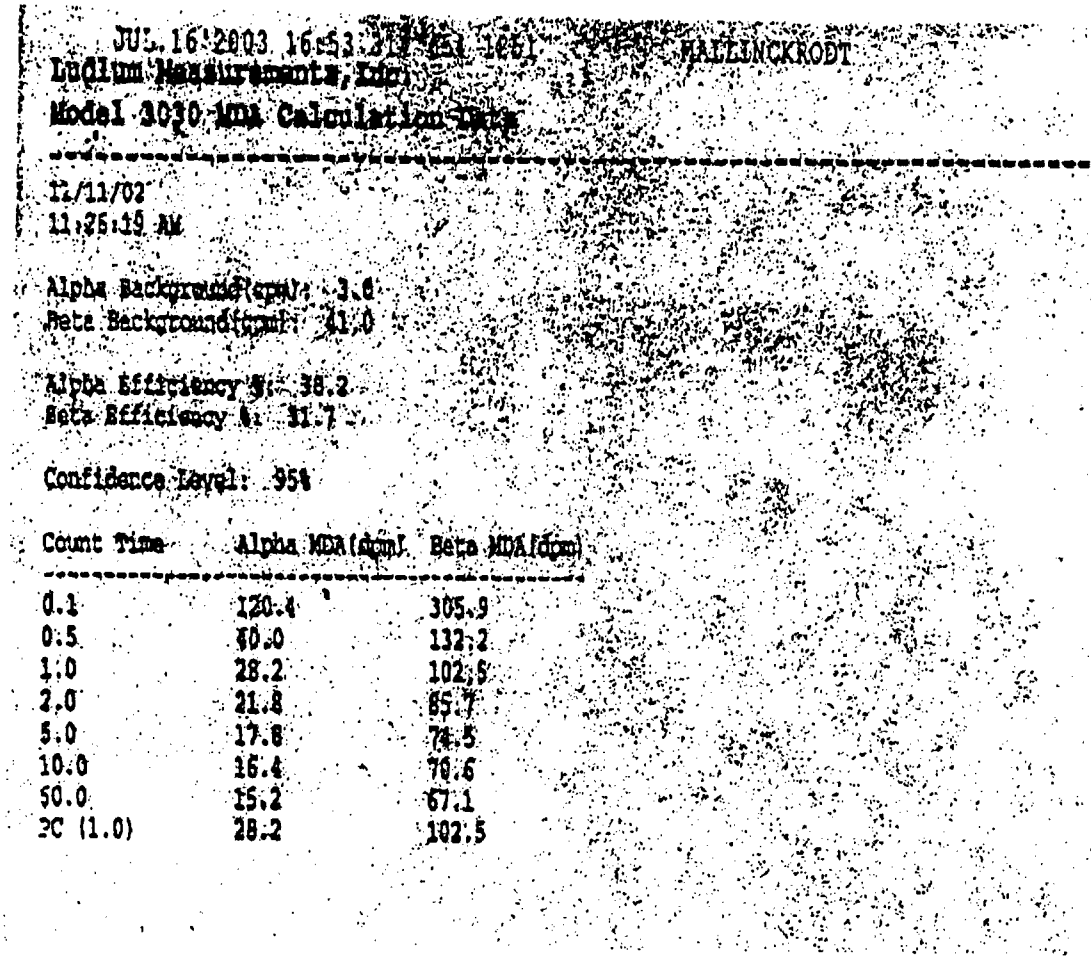
Beta Isotope: Tc-99
Beta Source Size (dpm): 22600
Beta Source Size (µCi): 0.01018018

Starting High Voltage: 625
Starting High Voltage: 750
High Voltage Increment: 25

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

	ALPHA				BETA			
HV	Source (Beta)	Background	Eff	CrossTalk	Source (Alpha)	Background	Eff	Crosstalk
625	9306 (348)	1	36.9%	3.5%	5347 (0)	25	23.5%	0.0%
650	9467 (311)	2	37.6%	2.9%	6243 (4)	40	27.6%	0.0%
675	9632 (328)	3	38.2%	3.0%	7209 (3)	41	31.7%	0.0%
700	9755 (360)	5	38.7%	3.6%	8087 (1)	43	35.6%	0.0%
725	9627 (267)	2	38.2%	2.1%	8928 (3)	68	39.2%	0.0%
750	9773 (316)	3	38.8%	3.4%	9646 (3)	183	41.9%	0.0%

L3030
S/N: 179562
11/8/02



JUL.16'2003 16:53 [illegible] MALLINCKRODT #2114 P.010

Ludlum Measurements, Inc.

Model 3030 MDA Calculation Data

12/11/02
11:26:19 AM

Alpha Background(cpm): 3.6
Beta Background(cpm): 41.0

Alpha Efficiency %: 38.2
Beta Efficiency %: 31.7

Confidence Level: 95%

Count Time	Alpha MDA(dpm)	Beta MDA(dpm)
0.1	120.4	305.9
0.5	50.0	132.2
1.0	28.2	102.5
2.0	21.8	85.7
5.0	17.8	74.5
10.0	16.4	70.6
50.0	15.2	67.1
2C (1.0)	28.2	102.5

L3030
S/N: 179562
11/8/02

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. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER TYCO/ MALLINCKRODT ORDER NO. 200546 / 274002

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 12/06/89.

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: 10

GC mode turned OFF. Alpha Alarm: 999999 cpm

Firmware version: 39013NHO Beta Alarm: 999999 cpm

Overload set at 1/4 turn past OFF. Alpha/Beta Alarm: 999999 cpm

Battery voltage measured at 12.5 Vdc. Calibration Due Date: 01/22/2004

C-S Efficiency = 21 %(4 pi) Net LOC (Loss of Count) time = 30 minutes (default)

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Alpha Channel Digital Readout	400K cpm	399903	399903
	40K cpm	39992	39992
	4K cpm	3995	3995
	400 cpm	400	400
	40 cpm	40	40
Beta/Gamma Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm	399907	399907
	40K cpm	39992	39992
	4K cpm	3997	3997
	400 cpm	400	400
	40 cpm	40	40

Tolerance my within ± 10% C.F. within ± 20% (*) Indicates 0.1 minute count

COMMENTS:
Eff. for Th-230 s/n 2748-00, 3070cpm read 2377 in 1 minute = 77% 2pi

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Reference Instruments and/or Sources:

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 134709 ☐ Oscilloscope S/N ☑ Multimeter S/N 67390613

Calibrated By: Conrad Holmes Date 22 Jul 03

Reviewed By: W J Ludlum Date 22 July 03

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FORM C25-3 04/09/2003

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

L3030
S/N: 179562
7/22/03

Ludlum Measurements,Inc.
Model 3030 Plateau Data

7/22/03
9:48:42 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 (µCi): 0.011351351

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

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

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

	ALPHA					BETA				
	Source (Beta)		Background	Eff	CrossTalk	Source (Alpha)		Background	Eff	Crosstalk
600	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%
650	9483	(363)	0	37.6%	3.5%	6502	(3)	33	28.6%	0.0%
675	9586	(357)	1	38.0%	3.3%	7454	(3)	36	32.8%	0.0%
00	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
9:49:53 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
[illegible]	0.1	66.8
[illegible] (1.0)	7.2	102.9

L3030
S/N: 179562
7/22/03

JUL 16 2003 16:52 314 654 1251 MALLINCKRODT #2114 P.006

Ludlum Measurements, Inc. — Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER TYCO / MALLINCKRODT ORDER NO. 292439 / 270031

Mfg. Ludlum Measurements, Inc. Model 3030 Serial No. 179577

Cal. Date 26-Feb-03 Cal Due Date 26-Aug-03 Cal. Interval 6 Months

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 20 % Alt 701.8 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 725 V High Voltage set with detector connected.

☑ HV Readout (2 points) Ref./Inst. 498 / 500 V Ref./Inst. 1486 / 1500 V

(EEPROM Settings)

CC mode turned OFF.	(PC) Count Time: 1.0
Firmware version: 39013N12	Alpha Alarm: 999999 cpm
Overload set at 1/4 turn past OFF.	Beta Alarm: 999999 cpm
Battery voltage measured at 13.27 Vdc.	Alpha/Beta Alarm: 999999 cpm
C-14 Efficiency = 11 %(4 pi) Net	Calibration Due Date: 08/26/2003
	LOC (Loss of Count) time = 30 minutes (default)

Alpha Channel Digital Readout

REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400K cpm	399414	399414
40K cpm	39944	39944
4K cpm	3995	3995
400 cpm	400	400
40 cpm	40	40

Beta/Gamma Channel Digital Readout

REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400K cpm	399439	399439
40K cpm	39945	39945
4K cpm	3995	3995
400 cpm	400	400
40 cpm	40	40

*Uncertainty within ± 10% C.F. within ± 20% (0) indicates 0.1 minute count

COMMENTS:
Eff. for Sr-90 & 2π 4016, 4452 cpm, read 2878 in one minute : 64% 2π
Eff. for Th-230 2π 2748.00, 3020 cpm, read 2444 in one minute : 80% 2π

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 technique. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

☑ Alpha S/N Pu-239 3744 ☑ Beta S/N Tc-99 Ni-60 ☐ Other

☑ m 500 S/N 134709 ☐ Oscilloscope S/N ☐ Multimeter S/N

Calibrated By: Conrad Galindo Date 26 Feb 03

Reviewed By: [signature] Date 4 Mar 03

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

L3030
S/N: 179577
2/26/03

Ludlum Measurements, Inc.

Model 3030 Plateau Data

2/26/03
1:38:50 PM

Header 1: John Q Public
Header 2: Serial#179577
Header 3: Site:Building 1
Header 4: Room 7 EastWall
Header 5: More Comments?
Header 6: More Comments?

Calibration Due Date: 2/26/04

Model 3030 Date: 2/26/03
Model 3030 Time: 11:42:00 AM

User PC Time: 1.0

Alpha Isotope: Pu-239
Alpha Source Size (dpm): 365000
Alpha Source Size (µCi): 0.164414414

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

Starting High Voltage: 675
Starting High Voltage: 800
High Voltage Increment: 25

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

HV	ALPHA Source (Beta)	ALPHA Background	ALPHA Eff	ALPHA CrossTalk	BETA Source (Alpha)	BETA Background	BETA Eff	BETA Crosstalk
675	137685 (3889)	0	37.7%	2.8%	6010 (1)	36	26.4%	0.0%
700	137877 (3657)	0	37.8%	2.6%	6966 (1)	45	30.6%	0.0%
725	138583 (2500)	2	38.0%	1.8%	7969 (1)	49	35.0%	0.0%
750	137851 (1483)	0	37.8%	1.0%	8551 (3)	50	37.6%	0.0%
775	137047 (1071)	1	37.5%	0.7%	9470 (1)	70	41.6%	0.0%
0	137105 (783)	1	37.6%	0.4%	10082 (2)	203	43.7%	0.0%

L3030
S/N: 179577
2/26/03

Model 3030 MDA Calculation Data

2/26/03
1:42:00 PM

Alpha Background(cpm): 2.0
Beta Background(cpm): 49.0

Alpha Efficiency %: 38.0
Beta Efficiency %: 35.0

Confidence Level: 95%

Count Time	Alpha MDA(dpm)	Beta MDA(dpm)
0.1	111.9	295.7
0.5	35.5	129.5
1.0	24.4	100.8
2.0	18.6	84.5
5.0	14.8	73.6
10.0	13.6	69.8
50.0	12.5	66.5
RC (1.0)	24.4	100.8

L3030
S/N: 179577
2/26/03

APPENDIX 4
Threshold Comparison Test Reports (TCTR)

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Run Date: Wednesday, December 24, 2003

Survey Unit Number: 2502 Class: 2 Data Points: Beta Grid Type: R

SURVEY UNIT TABLE

Bldg	Rm	Surface	Fixed Equipment	Surface Area Included (sq. ft)	Remarks
B250	205	FNSEW	Q1-6	628	Dishwashing Room
B250	207	FNSEW	Q1-4	822	Storage Room. Had contaminated sink that was
B250	209	FNSEW	Q1-12	1517	Lab
B250	210	FNSEW	Q1-13	2930	Mechanical Room
B250	211	FNSEW	Q1-12	1617	Lab
			Total Area	7514	

INITIALIZATION DATA

Measurement Types Selected: RG, BI, CH

Date Range: All

Thresholds:

EMC: 13,000 DCGLw: 2,600

SURVEY UNIT TEST STATUS

Test Performed	Status			$dpm_p/100\ cm^2$
Min/Max	Pass	Maximum Survey Value	CB	622.0
Background	Fail	Minimum Background	VT	-26.0
DCGLw	Pass	Difference		648.0
DCGLavg	Pass	Average Activity	119.4	
EMC	Pass	Average Below DCGL	119.4	
Wilcoxon Rank Sum Test	N/A	Average Background	87.7	
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 # 2502 Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
205	E	6.5	2.5	CB	BI	1	6460	330.4		C	
205	N	1.2	0.0	CB	RG	1	6458	622.3		C	
205	Q2	2.0	0.0	G	BI	1	6465	7.1		C	
205	Q4	2.0	0.0	P	BI	1	6469	62.3		C	
205	Q4	1.0	0.0	P	BI	1	6468	17.0		C	
205	S	14.0	6.8	CB	RG	1	6459	236.8		C	
207	W	10.4	3.0	CB	RG	1	6476	490.1		C	
207	W	0.3	5.5	CB	RG	1	6478	192.7		C	
209	F	11.8	20.5	VT	RG	1	6542	91.7		C	
209	F	11.8	9.2	VT	RG	1	6543	75.3		C	
209	N	11.8	3.9	CB	RG	1	6539	230.2		C	
209	Q10	2.0	0.0	G	BI	1	6571	58.0		C	
209	Q10	1.0	0.0	G	BI	1	6570	38.7		C	
209	Q11	1.0	0.0	O	BI	1	6572	32.7		C	
209	Q2	3.0	0.0	AT	BI	1	6551	68.7		C	
209	Q2	2.0	0.0	AT	BI	1	6550	55.6		C	
209	Q8	2.0	0.0	G	BI	1	6564	55.4		C	
209	Q9	2.0	0.0	AT	BI	1	6566	139.1		C	
209	Q9	1.0	0.0	AT	BI	1	6565	117.8		C	
209	S	6.7	2.3	CB	RG	1	6544	167.4		C	

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
209	S	6.7	10.6	CB	RG	1	6545	153.5		C	
209	W	20.5	8.0	CB	RG	1	6540	355.8		C	
209	W	9.2	8.0	CB	RG	1	6541	313.9		C	
210	E	5.1	12.3	B	RG	1	6494	455.7		C	
210	E	16.6	12.3	C	RG	1	6497	313.6		C	
210	N	6.0	6.0	CB	CH	2	2103	509.8		C	
210	N	6.0	0.0	CB	CH	2	2101	506.1		C	
210	N	29.6	6.5	B	RG	1	6491	491.8		C	
210	N	6.0	3.0	CB	CH	2	2102	394.5		C	
210	N	12.0	6.0	O	CH	2	2123	311.6		C	
210	N	6.5	6.5	FG	RG	1	6490	260.4		C	
210	N	12.0	0.0	O	CH	2	2121	257.6		C	
210	N	12.0	3.0	O	CH	2	2122	246.8		C	
210	N	16.0	0.0	O	CH	2	2124	221.6		C	
210	N	16.0	6.0	O	CH	2	2126	169.3		C	
210	N	16.0	3.0	O	CH	2	2125	138.7		C	
210	Q1	1.0	0.0	M	BI	1	6502	141.6		C	
210	Q1	2.0	0.0	M	BI	1	6503	128.4		C	
210	Q1	3.0	0.0	M	BI	1	6504	118.4		C	
210	Q6	1.0	0.0	M	BI	1	6512	93.6		C	
210	Q6	2.0	0.0	M	BI	1	6513	71.9		C	
210	S	10.8	1.8	B	RG	1	6499	546.1		C	
210	S	33.9	13.4	B	RG	1	6500	405.0		C	
210	S	10.8	13.4	B	RG	1	6501	343.6		C	
210	W	24.0	3.0	CB	CH	2	2141	435.9		C	
210	W	6.0	0.0	CB	CH	2	2131	426.9		C	
210	W	24.0	6.0	CB	CH	2	2142	374.7		C	
210	W	12.0	3.0	CB	CH	2	2135	367.5		C	
210	W	6.0	3.0	CB	CH	2	2132	340.4		C	
210	W	18.0	0.0	CB	CH	2	2137	336.8		C	
210	W	18.0	3.0	CB	CH	2	2138	333.2		C	
210	W	12.0	6.0	CB	CH	2	2136	329.6		C	
210	W	0.0	3.0	CB	CH	2	2129	302.6		C	
210	W	6.0	6.0	CB	CH	2	2133	300.8		C	
210	W	0.0	6.0	CB	CH	2	2130	300.8		C	
210	W	12.0	0.0	CB	CH	2	2134	270.2		C	
210	W	24.0	0.0	CB	CH	2	2140	237.8		C	
211	E	8.8	5.1	CB	RG	1	6727	319.4		C	
211	F	16.0	8.4	VT	RG	1	6724	107.2		C	
211	F	3.2	19.2	VT	RG	1	6726	93.0		C	
211	N	16.0	2.6	CB	BI	1	6722	391.0		C	
211	Q1	2.0	0.0	CT	BI	1	6730	280.4		C	
211	Q1	1.0	0.0	M	BI	1	6729	78.1		C	
211	Q10	2.0	0.0	M	BI	1	6751	62.7		C	
211	Q11	1.0	0.0	O	BI	1	6755	104.7		C	
211	Q4	2.0	0.0	G	BI	1	6739	19.3		C	
211	Q6	2.0	0.0	FG	BI	1	6743	31.0		C	
211	Q8	2.0	0.0	CT	BI	1	6747	206.7		C	
211	S	17.2	3.0	CB	RG	1	6728	517.6		C	
211	W	8.4	6.2	CB	RG	1	6723	280.8		C	

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

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

Survey Unit # 2502 Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
205	Q1	2.0	0.0	M	BI	1	6462	34.0			
205	Q1	1.0	0.0	M	BI	1	6461	24.0			
205	Q1	3.0	0.0	M	BI	1	6463	16.2			
205	Q2	1.0	0.0	CT	BI	1	6464	45.2			
205	Q3	2.0	0.0	CT	BI	1	6467	71.1			
205	Q3	1.0	0.0	CT	BI	1	6466	58.1			
205	Q5	1.0	0.0	M	BI	1	6470	28.6			
205	Q5	2.0	0.0	M	BI	1	6471	16.2			
205	Q6	1.0	0.0	M	BI	1	6472	15.5			
207	E	7.7	10.5	CB	RG	1	6477	82.6			
207	E	17.8	10.5	CB	RG	1	6479	11.0			
207	Q1	2.0	0.0	M	BI	1	6481	40.2			
207	Q1	1.0	0.0	M	BI	1	6480	22.4			
207	Q1	3.0	0.0	M	BI	1	6482	20.9			
207	Q3	2.0	0.0	M	BI	1	6484	38.7			
207	Q3	1.0	0.0	M	BI	1	6483	13.2			
207	Q4	1.0	0.0	M	BI	1	6485	49.5			
209	Q1	1.0	0.0	CT	BI	1	6546	49.1			
209	Q1	3.0	0.0	M	BI	1	6548	26.5			
209	Q1	2.0	0.0	M	BI	1	6547	4.9			
209	Q2	4.0	0.0	M	BI	1	6552	19.6	Blower Motor		
209	Q2	1.0	0.0	M	BI	1	6549	-2.0			
209	Q3	1.0	0.0	CT	BI	1	6554	-1.6			
209	Q3	2.0	0.0	G	BI	1	6555	-14.2			
209	Q4	2.0	0.0	CT	BI	1	6557	135.8			
209	Q4	1.0	0.0	CT	BI	1	6556	132.6			
209	Q5	1.0	0.0	M	BI	1	6558	32.3			
209	Q6	1.0	0.0	CT	BI	1	6559	19.6			
209	Q6	2.0	0.0	CT	BI	1	6560	1.6			
209	Q7	1.0	0.0	CT	BI	1	6561	173.5			
209	Q7	2.0	0.0	CT	BI	1	6562	163.7			
209	Q8	1.0	0.0	CT	BI	1	6563	-29.5			
209	Q9	4.0	0.0	M	BI	1	6568	49.0	Blower Motor		
209	Q9	3.0	0.0	M	BI	1	6567	-5.9			
210	F	24.0	0.0	C	CH	2	2108	75.4			
210	F	30.0	0.0	C	CH	2	2113	74.9			
210	F	29.6	9.7	C	RG	1	6496	73.7			
210	F	30.0	10.6	C	CH	2	2115	50.3			
210	F	30.0	24.0	C	CH	2	2117	49.3			
210	F	24.0	12.0	C	CH	2	2110	39.2			
210	F	18.0	22.0	C	CH	2	2106	25.6			
210	F	6.5	9.7	C	RG	1	6495	24.2			
210	F	30.0	18.0	C	CH	2	2116	13.1			
210	F	18.0	12.0	C	CH	2	2104	11.1			
210	F	18.0	18.0	C	CH	2	2105	5.0			
210	F	24.0	24.0	C	CH	2	2112	2.5			
210	F	23.0	18.0	C	CH	2	2111	1.0			
210	F	29.6	21.3	C	RG	1	6493	-2.0			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
210	F	24.0	6.0	C	CH	2	2109	-9.0			
210	F	30.0	6.0	C	CH	2	2114	-11.1			
210	F	6.5	21.3	B	RG	1	6492	-23.3			
210	Q10	2.0	0.0	M	BI	1	6521	27.1			
210	Q10	1.0	0.0	M	BI	1	6520	26.3			
210	Q10	3.0	0.0	M	BI	1	6522	16.2			
210	Q11	1.0	0.0	M	BI	1	6523	26.3			
210	Q11	3.0	0.0	M	BI	1	6525	-6.2			
210	Q11	2.0	0.0	M	BI	1	6524	-10.1			
210	Q12	1.0	0.0	M	BI	1	6526	16.2			
210	Q2	2.0	0.0	M	BI	1	6506	13.9			
210	Q2	1.0	0.0	M	BI	1	6505	-4.6			
210	Q2	3.0	0.0	M	BI	1	6507	-9.3			
210	Q3	2.0	0.0	M	BI	1	6509	35.6			
210	Q3	1.0	0.0	M	BI	1	6508	-7.0			
210	Q4	1.0	0.0	M	BI	1	6510	-8.5			
210	Q5	1.0	0.0	M	BI	1	6511	16.2			
210	Q7	1.0	0.0	M	BI	1	6514	48.0			
210	Q8	2.0	0.0	M	BI	1	6516	44.1			
210	Q8	3.0	0.0	M	BI	1	6517	37.1			
210	Q8	1.0	0.0	M	BI	1	6515	28.6			
210	Q9	1.0	0.0	M	BI	1	6518	-0.8			
210	Q9	2.0	0.0	M	BI	1	6519	-38.7			
210	S	33.9	1.8	M	RG	1	6498	8.7			
210	W	18.0	6.0	P	CH	2	2139	-175.4			
211	Q1	3.0	0.0	M	BI	1	6731	19.3			
211	Q10	4.0	0.0	M	BI	1	6753	28.6	Blower Motor		
211	Q10	1.0	0.0	M	BI	1	6750	9.3			
211	Q10	3.0	0.0	M	BI	1	6752	-6.2			
211	Q2	1.0	0.0	M	BI	1	6732	25.5			
211	Q3	3.0	0.0	M	BI	1	6735	20.9			
211	Q3	4.0	0.0	M	BI	1	6736	16.2	Blower Motor		
211	Q3	2.0	0.0	M	BI	1	6734	11.6			
211	Q3	1.0	0.0	M	BI	1	6733	-10.8			
211	Q4	1.0	0.0	CT	BI	1	6738	18.1			
211	Q5	2.0	0.0	CT	BI	1	6741	156.3			
211	Q5	1.0	0.0	CT	BI	1	6740	84.0			
211	Q6	1.0	0.0	G	BI	1	6742	-7.1			
211	Q7	1.0	0.0	CT	BI	1	6744	42.6			
211	Q7	2.0	0.0	CT	BI	1	6745	28.4			
211	Q8	1.0	0.0	CT	BI	1	6746	122.7			
211	Q9	2.0	0.0	CT	BI	1	6749	-20.7			
211	Q9	1.0	0.0	CT	BI	1	6748	-31.0			
211	S	4.3	13.8	CB	RG	1	6725	121.2			

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

Matrix	*Number of Data Points*	*Average Background*	*Sigma*	*Background Threshold (Tbk)*	*DCGLw Threshold (Td)*	*EMC Threshold (Tc)*
	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)
AT	0	0.0	0.0	0.0	2,600	13,000
B	30	192.4	16.0	224.4	2,824	13,224
C	90	35.4	20.1	75.5	2,675	13,075
CB	51	96.1	21.7	139.4	2,739	13,139
CTP	10	144.1	29.2	202.4	2,802	13,202
CTX	30	152.6	15.1	182.9	2,783	13,183
FG	0	0.0	0.0	0.0	2,600	13,000
G	0	0.0	0.0	0.0	2,600	13,000
M	10	24.0	15.7	55.3	2,655	13,055
O	0	0.0	0.0	0.0	2,600	13,000
P	0	0.0	0.0	0.0	2,600	13,000
VT	10	15.1	24.0	63.0	2,663	13,063

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

STATISTICAL TEST RESULTS

Run Date: 12/24/2003 10:34:08

Survey Unit Number 2502 Class: 2

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 6 matrices processed

S+ = 31 **Wc =** 20

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

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Run Date: Wednesday, December 24, 2003

Survey Unit 2503 Class: 2 Data Points: Beta Grid Type: R

SURVEY UNIT TABLE

Bldg	Rm	Surface	Fixed Equipment	Surface Area Included (sq. ft)	Remarks
B250	201	FNSEW	Q1-9	1720	CT Lab. Highest contamination of upstairs labs
B250	202	FNSEW	Q1-7	1712	Test production Lab. FSS data already taken.
			Total Area	3432	

INITIALIZATION DATA

Measurement Types Selected: RG, BI, CH

Date Range: All

Thresholds:

EMC: 13,000 DCGLw: 5,000

SURVEY UNIT TEST STATUS

Test Performed	Status			$dpm_\beta/100\ cm^2$
Min/Max	Pass	Maximum Survey Value	CTP	3,617.0
Background	Fail	Minimum Background	VT	-26.0
DCGLw	Pass	Difference		3,643.0
DCGLavg	Pass	Average Activity	329.0	
EMC	Pass	Average Below DCGL	329.0	
Wilcoxon Rank Sum Test	N/A	Average Background	111.3	
Sign Test for Paired Data	Pass			

MALLINCKRODT C-T
DECOMMISSIONING PROJECT

Threshold Comparison Test Report -

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 # 2503 Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
201	E	8.5	0.0	CB	CH	2	2487	747.4		C	
201	E	2.5	0.0	CB	CH	2	2481	730.5		C	
201	E	2.5	3.0	CB	CH	2	2482	713.7		C	
201	E	5.5	3.0	CB	CH	2	2485	674.3		C	
201	E	11.5	3.0	CB	CH	2	2491	564.7		C	
201	E	8.5	6.0	CB	CH	2	2489	508.5		C	
201	E	2.5	6.0	CB	CH	2	2483	458.0		C	
201	E	11.5	6.0	CB	CH	2	2492	452.4		C	
201	E	2.5	9.0	CB	CH	2	2493	415.8		C	
201	E	25.8	9.3	CB	RG	1	6608	393.0		C	
201	E	17.8	9.3	CB	RG	1	6605	393.0		C	
201	E	5.5	6.0	CB	CH	2	2486	354.0		C	
201	E	8.5	3.0	CB	CH	2	2488	348.4		C	
201	E	8.5	9.0	CB	CH	2	2495	281.0		C	
201	E	11.5	9.0	CB	CH	2	2496	264.1		C	
201	E	11.5	0.0	CB	CH	2	2490	255.7		C	
201	E	5.5	0.0	CB	CH	2	2484	179.8		C	
201	F	9.7	11.7	C	BI	1	6612	1,028.0		C	
201	F	9.7	13.3	C	BI	1	6611	714.8		C	
201	F	13.1	19.3	VT	RG	1	6601	117.8		C	
201	F	13.1	3.2	VT	RG	1	6607	96.6		C	
201	F	13.1	11.3	VT	RG	1	6604	94.9		C	
201	F	14.0	23.5	VT	CH	2	2476	90.0		C	
201	F	17.0	25.3	VT	CH	2	2472	88.3		C	
201	F	11.0	23.5	VT	CH	2	2479	82.3		C	
201	F	14.0	25.3	VT	CH	2	2475	81.0		C	
201	F	14.0	20.5	VT	CH	2	2477	78.4		C	
201	F	11.0	25.3	VT	CH	2	2478	77.5		C	
201	N	13.1	6.5	CB	RG	1	6596	775.4		C	
201	N	20.0	3.0	CB	CH	2	2498	590.0		C	
201	N	17.0	0.0	CB	CH	2	2501	581.6		C	
201	N	17.0	6.0	CB	CH	2	2503	564.7		C	
201	N	17.0	3.0	CB	CH	2	2502	542.3		C	
201	N	20.0	0.0	CB	CH	2	2497	519.8		C	
201	N	14.0	3.0	CB	CH	2	2506	407.4		C	

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
201	N	14.0	9.0	CB	CH	2	2508	373.7		C	
201	N	14.0	6.0	CB	CH	2	2507	373.7		C	
201	N	20.0	6.0	CB	CH	2	2499	351.2		C	
201	N	14.0	0.0	CB	CH	2	2505	199.5		C	
201	N	17.0	9.0	CB	CH	2	2504	179.8		C	
201	Q1	1.0	0.0	CT	BI	1	6613	209.5		C	
201	Q2	3.0	0.0	AT	BI	1	6618	126.0		C	
201	Q2	2.0	0.0	AT	BI	1	6617	14.7		C	
201	Q3	2.0	0.0	G	BI	1	6620	38.7		C	
201	Q3	3.0	0.0	G	BI	1	6621	6.4		C	
201	Q4	3.0	0.0	CT	BI	1	6625	3,617.0		C	
201	S	6.9	12.9	CB	RG	1	6610	648.0	No Paint	C	
201	S	6.9	4.8	CT	RG	1	6609	329.3		C	
201	W	27.4	3.0	AT	RG	1	6597	201.8		C	
201	W	3.2	3.0	M	RG	1	6606	101.8		C	
201	W	19.3	3.0	M	RG	1	6600	76.3		C	
202	E	2.0	0.0	CB	CH	3	2659	956.9		C	
202	E	12.9	2.0	CB	CH	3	2662	820.5		C	
202	E	18.5	2.0	CB	CH	3	2661	772.2		C	
202	E	24.1	2.0	CB	CH	3	2660	738.6		C	
202	E	19.2	8.7	CB	CH	3	2690	679.9		C	
202	E	7.4	2.0	CB	CH	3	2663	631.6		C	
202	E	23.1	8.7	CB	CH	3	2689	610.6		C	
202	E	3.5	8.7	CB	CH	3	2694	587.5		C	
202	E	18.4	5.6	CB	RG	1	6683	573.6		C	
202	E	1.9	2.0	CB	CH	3	2664	518.3		C	
202	E	15.2	8.7	CB	CH	3	2691	459.5		C	
202	E	2.5	5.6	CB	RG	1	6677	456.8		C	
202	E	11.3	8.7	CB	CH	3	2692	455.3		C	
202	E	10.4	5.6	CB	RG	1	6680	446.1		C	
202	E	7.4	8.7	CB	CH	3	2693	402.9		C	
202	E	3.0	0.0	CB	CH	3	2688	381.9		C	
202	E	26.3	5.6	M	RG	1	6686	95.4		C	
202	F	1.0	0.0	C	CH	2	2644	97.0		C	
202	N	8.0	13.5	CB	RG	1	6673	679.8		C	
202	N	1.6	9.8	CB	CH	3	6819	666.3		C	
202	N	9.5	9.8	CB	CH	3	6821	644.2		C	
202	N	10.8	2.3	CB	CH	3	2711	642.1		C	
202	N	8.0	5.5	CB	RG	1	6674	552.4		C	
202	N	13.5	9.8	CB	CH	3	6822	545.9		C	
202	N	5.0	9.8	CB	CH	3	6820	519.8		C	
202	N	16.4	2.3	P	CH	1	2712	209.8	Window	C	
202	N	5.2	2.3	P	CH	1	2710	82.8	Window	C	
202	N	9.5	13.5	M	CH	1	6826	75.7		C	
202	N	17.4	13.5	M	CH	1	6828	75.7		C	
202	N	17.4	9.8	P	CH	1	6823	63.4		C	
202	S	10.2	5.2	CB	CH	3	2666	646.3		C	
202	S	14.8	5.2	CB	CH	3	2665	591.7		C	
202	S	10.5	9.5	CB	CH	3	2697	572.0		C	
202	S	2.6	9.5	CB	CH	3	2699	545.9		C	
202	S	14.4	9.5	CB	CH	3	2696	521.8		C	
202	S	3.6	5.2	CB	CH	3	2667	518.3		C	
202	S	18.4	9.5	CB	CH	3	2695	447.5		C	
202	S	10.3	6.3	CB	RG	1	6687	308.0		C	
202	S	6.5	9.5	CB	CH	3	2698	301.0		C	
202	W	19.1	11.9	CB	CH	3	2705	1,149.9		C	
202	W	24.6	0.3	CB	CH	3	2674	927.5		C	
202	W	11.3	11.9	CB	CH	3	2703	842.9		C	
202	W	13.6	0.3	CB	CH	3	2671	816.3		C	
202	W	15.2	11.9	CB	CH	3	2704	814.8		C	

202	W	24.6	5.9	CB	CH	3	2708	814.2	C
202	W	8.0	0.3	CB	CH	3	2670	797.4	C
202	W	19.1	0.3	CB	CH	3	2672	778.5	C
202	W	7.3	11.9	CB	CH	3	2702	752.6	C
202	W	4.0	0.0	CB	CH	3	2668	751.2	C
202	W	3.4	11.9	CB	CH	3	2701	686.4	C
202	W	25.5	7.9	CB	RG	1	6675	648.0	C
202	W	23.0	11.9	CB	CH	3	2706	616.1	C
202	W	19.1	5.9	CB	CH	3	2678	614.8	C
202	W	1.7	7.9	CB	RG	1	6684	573.6	C
202	W	13.6	5.9	CB	CH	3	2677	558.2	C
202	W	24.6	0.3	CB	CH	3	2707	503.6	C
202	W	8.0	5.9	CB	CH	3	2676	430.2	C
202	W	2.4	0.3	CB	CH	3	2669	379.8	C
202	W	2.4	5.9	CB	CH	3	2675	375.6	C
202	W	17.6	7.9	CB	RG	1	6678	329.3	C
202	W	6.0	0.0	C	CH	2	2700	326.9	C
202	W	9.6	7.9	CB	RG	1	6681	318.7	C

THE FOLLOWING DATA POINTS PASSED BACKGROUND, DCGLw, AND EMC

Screen Tests:

Survey Unit # 2503 Building: B250

					Meas.		Gross Activity				
Room	SFC	X (ft)	Y (ft)	Mtx	Type	Min	SID	(dpm $_\beta$/100cm^2)	Remarks	Exc	Res.
201	E	5.5	9.0	CB	CH	2	2494	104.0			
201	E	9.7	9.3	M	RG	1	6602	-216.3			
201	F	20.0	20.5	C	CH	2	2471	73.7			
201	F	17.0	20.5	C	CH	2	2474	66.3			
201	F	11.0	20.5	VT	CH	2	2480	54.5			
201	F	17.0	23.5	C	CH	2	2473	48.0			
201	F	20.0	23.5	C	CH	2	2470	37.2			
201	F	20.0	25.3	C	CH	2	2469	27.1			
201	N	20.0	9.0	CB	CH	2	2500	104.0			
201	Q1	2.0	0.0	M	BI	1	6614	3.9			
201	Q1	3.0	0.0	M	BI	1	6615	2.0			
201	Q2	1.0	0.0	M	BI	1	6616	7.8			
201	Q3	4.0	0.0	G	BI	1	6622	-23.2			
201	Q3	1.0	0.0	G	BI	1	6619	-27.1			
201	Q4	1.0	0.0	CT	BI	1	6623	72.0			
201	Q4	2.0	0.0	CT	BI	1	6624	-22.9			
201	Q5	1.0	0.0	CT	BI	1	6626	111.3			
201	Q5	2.0	0.0	M	BI	1	6627	7.8			
201	Q6	1.0	0.0	CT	BI	1	6628	198.0			
201	Q6	2.0	0.0	CT	BI	1	6629	198.0			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
201	Q7	1.0	0.0	CT	BI	1	6630	26.2			
201	Q7	2.0	0.0	M	BI	1	6631	4.9			
201	Q8	1.0	0.0	CT	BI	1	6632	112.9			
201	Q8	2.0	0.0	CT	BI	1	6633	108.0			
201	W	11.3	3.0	M	RG	1	6603	-209.9			
202	F	8.0	1.7	CT	RG	1	6685	170.2			
202	F	5.2	2.4	C	CH	2	2645	64.0			
202	F	16.4	2.4	C	CH	2	2653	57.6			
202	F	10.8	8.0	C	CH	2	2650	47.0			
202	F	10.8	24.6	C	CH	2	2658	28.8			
202	F	5.2	8.0	C	CH	2	2646	27.7			
202	F	10.8	19.1	C	CH	2	2652	26.5			
202	F	10.8	13.6	C	CH	2	2651	25.8			
202	F	8.0	25.5	VT	RG	1	6676	22.9			
202	F	16.4	24.6	C	CH	2	2709	19.7			
202	F	16.4	13.6	C	CH	2	2655	15.5			
202	F	5.2	19.1	C	CH	2	2648	15.2			
202	F	5.2	24.6	C	CH	2	2657	14.8			
202	F	10.8	2.4	C	CH	2	2649	13.3			
202	F	16.4	8.0	C	CH	2	2654	12.1			
202	F	16.4	19.1	C	CH	2	2656	7.6			
202	F	5.2	13.6	C	CH	2	2647	6.8			
202	F	8.0	17.6	VT	RG	1	6679	6.5			
202	F	8.0	9.6	VT	RG	1	6682	-24.5			
202	N	5.6	13.5	M	CH	1	6825	-10.8			
202	N	13.5	13.5	M	CH	1	6827	-14.4			
202	N	1.6	13.5	M	CH	1	6824	-32.4			
202	Q1	2.0	0.0	CT	BI	1	6689	96.6	Ceiling Tile		
202	Q1	3.0	0.0	M	BI	1	6690	19.6	Piping		
202	Q1	1.0	0.0	M	BI	1	6688	-13.7	Light		
202	Q2	1.0	0.0	CT	BI	1	6691	44.2			
202	Q2	2.0	0.0	M	BI	1	6692	20.6			
202	Q3	1.0	0.0	CT	BI	1	6693	-1.6			
202	Q3	2.0	0.0	CT	BI	1	6694	-76.9			
202	Q5	1.0	0.0	CT	BI	1	6695	11.5			
202	Q5	2.0	0.0	M	BI	1	6696	-8.8			
202	Q6	1.0	0.0	CT	BI	1	6697	13.1			
202	Q6	2.0	0.0	CT	BI	1	6698	-21.3			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Summary of Background Data and Thresholds Used in this Analysis

Measurement Type: BK ***DCGL:*** 5,000 ***EMC:*** 13,000

Matrix	*Number of Data Points*	*Average Background*	*Sigma*	*Background Threshold (Tbk)*	*DCGLw Threshold (Td)*	*EMC Threshold (Tc)*
	($dpm_\gamma/100cm^2$)	($dpm_\gamma/100cm^2$)	($dpm_\gamma/100cm^2$)	($dpm_\gamma/100cm^2$)	($dpm_\gamma/100cm^2$)	($dpm_\gamma/100cm^2$)
AT	0	0.0	0.0	0.0	5,000	13,000
C	90	35.4	20.1	75.5	5,075	13,075
CB	51	96.1	21.7	139.4	5,139	13,139
CT	77	213.6	39.5	292.7	5,293	13,293
CTP	10	144.1	29.2	202.4	5,202	13,202
CTX	30	152.6	15.1	182.9	5,183	13,183
G	0	0.0	0.0	0.0	5,000	13,000
M	10	24.0	15.7	55.3	5,055	13,055
P	0	0.0	0.0	0.0	5,000	13,000
VT	10	15.1	24.0	63.0	5,063	13,063

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

STATISTICAL TEST RESULTS

Run Date: 12/24/2003 10:59:02

Survey Unit Number 2503 Class: 2

Selected Test: SIGN TEST FOR PAIRED DATA

Test Status Pass

Thresholds:

EMC 13,000 DCGL 5,000

DATA SUMMARY TABLE

28 Survey points processed and 6 matrices processed

S+ = 28 **Wc =** 18

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

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Run Date: Monday, January 12, 2004

Survey Unit Number: 2504 Class: 2 Data Points: Beta Grid Type: R

SURVEY UNIT TABLE

Bldg	Rm	Surface	Fixed Equipment	Surface Area Included (sq. ft)	Remarks
B250	101C	FNSEW	Q1Q2	259	Janitor's closet
B250	103A	FSW	Q1	681	
B250	110	FN	Q1Q2	208	
B250	115	FS	Q1Q2	1071	
B250	118	FNSEW	Q1	484	Floor of eastern stairwell to first tread
B250	119	FNSE		190	Upper stairwell hallway, only floor to stairs, no
B250	127	FNSEW	Q1	869	CT Laboratory
B250	139	FNSEW	Q2Q3Q1	355	CT lab office
B250	140	FNSEW	Q1Q2	443	CT hallway
B250	218	FNESW		1242	Upper stairwell East. Incl. All treads, risers, walls,
B250	219	FNSEW	Q1Q2Q3	1725	Upper stairwell West. Incl. All treads, risers, walls,
			Total Area	7527	

INITIALIZATION DATA

Measurement Types Selected: RG, BI, CH

Date Range: All

Thresholds:

EMC: 13,000 DCGLw: 2,600

SURVEY UNIT TEST STATUS

Test Performed	Status			$dpm_p/100\ cm^2$
Min/Max	Pass	Maximum Survey Value	CB	907.0
Background	Fail	Minimum Background	VT	-26.0
DCGLw	Pass	Difference		933.0
DCGLavg	Pass	Average Activity	54.3	
EMC	Pass	Average Below DCGL	54.3	
Wilcoxon Rank Sum Test	N/A	Average Background	52.3	
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 # 2504 Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
101C	E	3.1	4.2	CB	RG	1	6921	146.5		C	
103AB	Q1	2.0	0.0	M	BI	1	6919	56.8	Vent	C	
103AB	W	9.0	1.0	GB	BI	3	7955	25.5		C	
103AB	W	7.1	7.5	GB	RG	3	7950	20.7		C	
110	Q2	1.0	0.0	M	BI	1	6979	112.7	Fire Sprinkler	C	
115	S	24.3	4.4	O	RG	1	6984	27.8	Drywall	C	
115	S	39.0	1.0	GB	CH	3	2823	17.5		C	
115	S	21.9	7.4	GB	CH	3	2822	15.8		C	
118	E	3.1	10.7	CB	RG	1	6831	509.2		C	
118	S	3.3	11.2	CB	RG	1	6832	286.0		C	
118	W	2.8	6.5	M	RG	1	6829	91.9		C	
119	E	0.5	8.1	CB	RG	1	6850	327.9		C	
127	E	7.0	8.0	GB	CH	2	2004	50.2		C	
127	E	1.0	3.0	GB	CH	2	2002	33.5		C	
127	E	7.0	6.0	GB	RG	2	1997	24.5		C	
127	E	7.0	0.0	RB	CH	2	1995	24.5		C	
127	E	4.0	6.0	GB	CH	2	2000	19.3		C	
127	E	10.0	6.0	GB	CH	2	1994	14.8		C	
127	E	1.0	6.0	GB	RG	2	2003	12.2		C	
127	E	10.0	3.0	GB	CH	2	1993	10.3		C	
127	E	2.0	9.0	GB	CH	2	2005	9.0		C	
127	E	10.0	0.0	RB	CH	2	1992	7.1		C	
127	E	1.0	0.0	RB	CH	2	2001	5.1		C	
127	E	4.0	0.0	RB	CH	2	1998	0.6		C	
127	N	9.0	0.0	RB	CH	2	1981	27.0		C	
127	N	12.0	0.0	RB	CH	2	1984	24.5		C	
127	N	15.0	0.0	RB	CH	2	1987	23.2		C	
127	N	6.0	0.0	RB	CH	2	1977	18.0		C	
127	N	0.0	0.0	RB	CH	2	1971	10.9		C	
127	S	15.5	0.0	RB	CH	2	2006	43.1		C	
127	S	0.5	0.0	RB	CH	2	2022	9.7		C	
127	S	6.5	0.0	RB	CH	2	2016	5.8		C	
127	S	3.5	0.0	RB	CH	2	2019	5.1		C	
127	W	3.0	3.0	GB	RG	2	2031	43.8		C	
127	W	0.0	3.0	GB	CH	2	2028	39.3		C	
127	W	0.0	0.0	RB	CH	2	2027	19.3		C	
127	W	9.0	3.0	GB	RG	2	2037	10.9		C	
127	W	9.0	0.0	RB	CH	2	2036	8.4		C	
127	W	3.0	0.0	RB	CH	2	2030	7.7		C	
127	W	7.0	9.0	GB	CH	2	2040	3.9		C	

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
127	W	2.0	8.0	GB	CH	2	2039	1.9		C	
139	Q2	1.0	0.0	M	BI	1	6909	88.2	Fire Sprinkler	C	
140	E	1.0	3.0	GB	CH	2	2074	66.6		C	
140	E	7.0	6.0	GB	CH	2	2069	50.1		C	
140	E	7.0	3.0	GB	CH	2	2068	40.4		C	
140	E	7.0	7.0	GB	CH	2	2076	39.8		C	
140	E	10.0	3.0	GB	CH	2	2065	25.6		C	
140	E	10.0	0.0	GB	CH	2	2064	23.3		C	
140	E	10.0	6.0	GB	CH	2	2066	22.2		C	
140	E	7.0	0.0	GB	CH	2	2067	19.9		C	
140	E	1.0	6.0	GB	CH	2	2075	11.4		C	
140	E	1.0	0.0	GB	CH	2	2073	4.6		C	
140	W	3.0	6.0	CB	CH	2	2090	156.4		C	
140	W	0.0	6.0	CB	CH	2	2087	150.7		C	
218	E	14.9	22.6	CB	RG	1	6858	411.6		C	
218	E	0.9	22.6	CB	RG	1	6855	265.1		C	
218	N	5.3	27.1	CB	RG	1	6851	830.1		C	
218	N	5.3	13.1	CB	RG	1	6852	460.4		C	
218	S	5.4	23.4	CB	RG	1	6860	565.0		C	
218	W	18.6	22.7	CB	RG	1	6853	906.9		C	
218	W	4.6	22.7	CB	RG	1	6856	258.1		C	
219	N	1.3	4.8	CB	RG	1	6875	851.1		C	
219	N	15.3	18.8	CB	RG	1	6874	341.8		C	
219	N	1.3	18.8	CB	RG	1	6872	279.0		C	
219	S	17.9	9.2	CB	RG	1	6889	272.1		C	
219	S	3.9	23.2	CB	RG	1	6891	272.1		C	
219	S	17.9	23.2	CB	RG	1	6890	244.2		C	

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

Survey Unit # 2504 Building: B250

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
101C	Q1	1.0	0.0	M	BI	1	6922	40.2	Light		
101C	Q2	1.0	0.0	M	BI	1	6923	-3.9	Sink		
101C	W	3.0	6.5	M	RG	1	6920	-33.4			
103AB	F	2.0	8.8	VT	RG	4	4942	22.3			
103AB	F	8.8	2.0	VT	RG	4	4941	21.6			
103AB	F	15.6	2.0	VT	RG	4	2513	12.0			
103AB	F	8.8	8.8	VT	RG	4	4943	10.7			
103AB	F	2.0	2.0	VT	RG	4	4940	10.0			
103AB	F	15.6	8.8	VT	RG	4	2514	-17.9			
103AB	Q1	1.0	0.0	M	BI	1	6918	-10.8	Light		
103AB	S	10.0	6.4	CB	BI	3	2556	128.0			
103AB	S	5.3	6.4	CB	RG	3	2557	113.8			
103AB	S	18.0	6.4	CB	RG	3	2541	113.2			
103AB	S	21.0	1.0	CB	BI	3	2540	111.0			
103AB	S	10.0	1.0	CB	BI	3	2555	96.2			
103AB	S	11.1	1.0	CB	BI	3	2542	61.2			
103AB	W	4.6	6.4	CB	CH	3	2531	76.1			
103AB	W	9.3	1.0	CB	CH	3	2532	60.6			
110	F	1.7	6.5	VT	RG	1	6977	40.9			
110	F	62.9	41.0	VT	CH	3	2870	7.4			
110	F	62.0	41.5	VT	CH	2	2543	6.1			
110	F	62.9	35.2	VT	CH	3	2866	3.1			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report - Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
110	F	68.6	35.2	VT	CH	3	2867	1.0			
110	F	68.6	41.0	VT	CH	3	2871	-7.7			
110	N	59.9	1.0	CB	CH	3	2842	106.7			
110	N	59.9	4.7	CB	CH	3	2841	87.9			
110	N	1.7	9.5	CB	RG	1	6924	42.6			
110	Q1	1.0	0.0	M	BI	1	6978	2.0	Vent		
110	Q2	2.0	0.0	M	BI	1	6980	32.3	Fire Sprinkler		
115	F	10.0	12.0	C	BI	1	7909	66.5	gamma hot spot		
115	F	10.0	11.0	C	BI	1	7912	47.3	South 1'		
115	F	11.0	12.0	C	BI	1	7911	38.4	West 1'		
115	F	0.8	9.6	VT	BI	1	6981	34.4	New Flooring		
115	F	32.7	2.3	VT	RG	3	2804	26.6			
115	F	1.9	10.0	VT	RG	3	2801	23.2			
115	F	10.0	13.0	C	BI	1	7913	21.7	North 1'		
115	F	23.6	8.4	VT	CH	3	2815	21.0			
115	F	15.9	0.7	VT	CH	3	2812	18.7			
115	F	23.6	0.7	VT	CH	3	2813	15.8			
115	F	25.0	10.0	VT	RG	3	2805	11.8			
115	F	8.4	10.0	VT	RG	3	2808	10.9			
115	F	16.2	10.0	VT	RG	3	2810	10.9			
115	F	1.9	2.3	VT	RG	3	2800	8.7			
115	F	8.4	2.3	VT	RG	3	2807	7.4			
115	F	9.0	12.0	C	BI	1	7910	1.3	East 1'		
115	F	32.7	10.0	VT	RG	3	2806	0.9			
115	F	16.0	11.0	VT	BI	1	6989	0.0			
115	F	1.0	11.0	VT	BI	1	6991	0.0			
115	F	25.0	11.0	VT	BI	1	6990	0.0			
115	F	10.0	12.0	CP	BI	1	7846	0.0	Hotspot @ Center		
115	F	9.0	12.0	CP	BI	1	7845	0.0	West of Hotspot 1'		
115	F	10.0	11.0	CP	BI	1	7843	0.0	South of Hotspot 1'		
115	F	10.0	13.0	CP	BI	1	7842	0.0	North of Hotspot 1'		
115	F	1.0	11.0	CP	BI	1	7345	0.0	Local Scan	X	
115	F	11.0	12.0	CP	BI	1	7844	0.0	East of Hotspot 1'		
115	F	25.0	2.3	VT	RG	3	2803	-2.4			
115	F	28.8	9.6	VT	BI	1	6983	-4.9	New Flooring		
115	F	15.9	8.4	VT	CH	3	2814	-9.5			
115	F	16.2	2.3	VT	RG	3	2809	-18.9			
115	Q1	1.0	0.0	M	BI	1	6986	21.6	Light		
115	Q2	2.0	0.0	M	BI	1	6988	23.5	Fire Sprinkler		
115	Q2	1.0	0.0	M	BI	1	6987	21.6	Fire Sprinkler		
115	S	10.3	4.4	O	RG	1	6985	-44.2	Drywall		
118	F	7.5	2.8	VT	RG	1	6830	-6.5			
118	Q1	2.0	0.0	M	BI	1	6834	9.8			
118	Q1	1.0	0.0	M	BI	1	6833	0.0			
127	E	4.0	3.0	GB	CH	2	1999	-10.3			
127	E	7.0	3.0	GB	CH	2	1996	-10.9			
127	F	0.0	3.0	VT	CH	2	1947	40.5			
127	F	9.0	6.0	VT	CH	2	1960	38.0			
127	F	15.0	9.0	VT	RG	2	1970	34.7			
127	F	9.0	9.0	VT	RG	2	1961	32.2			
127	F	3.0	0.0	VT	CH	2	1950	30.2			
127	F	15.0	0.0	VT	CH	2	1966	27.7			
127	F	3.0	9.0	VT	RG	2	1953	27.0			
127	F	6.0	3.0	VT	CH	2	1955	26.4			
127	F	0.0	9.0	VT	CH	2	1949	25.1			
127	F	9.0	0.0	VT	CH	2	1958	18.0			
127	F	12.0	3.0	VT	CH	2	1963	17.4			
127	F	12.0	0.0	VT	CH	2	1962	17.2			
127	F	12.0	6.0	VT	CH	2	1964	15.8			
127	F	15.0	3.0	VT	RG	2	1968	14.8			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report – Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
127	F	3.0	3.0	VT	RG	2	1951	12.2			
127	F	6.0	0.0	VT	CH	2	1954	7.2			
127	F	3.0	6.0	VT	CH	2	1952	7.1			
127	F	6.0	6.0	VT	CH	2	1956	5.7			
127	F	0.0	1.0	VT	CH	2	1946	4.3			
127	F	12.0	9.0	VT	CH	2	1965	1.9			
127	F	9.0	3.0	VT	RG	2	1959	1.3			
127	F	6.0	9.0	VT	CH	2	1957	-7.1			
127	F	15.0	3.0	VT	CH	2	1967	-7.7			
127	F	0.0	6.0	VT	CH	2	1948	-12.2			
127	F	15.0	6.0	VT	CH	2	1969	-19.9			
127	N	9.0	6.0	CB	RG	2	1983	120.3			
127	N	3.0	3.0	CB	CH	2	1975	93.3			
127	N	6.0	3.0	CB	CH	2	1978	88.8			
127	N	15.0	3.0	CB	CH	2	1988	85.6			
127	N	12.0	3.0	CB	CH	2	1985	81.7			
127	N	0.0	6.0	CB	CH	2	1973	75.3			
127	N	6.0	6.0	CB	CH	2	1980	75.3			
127	N	12.6	7.0	CB	CH	2	1991	74.0			
127	N	5.0	9.0	CB	CH	2	1990	72.1			
127	N	3.0	6.0	CB	RG	2	1976	70.8			
127	N	9.0	3.0	CB	CH	2	1982	63.7			
127	N	15.0	6.0	CB	RG	2	1989	50.8			
127	N	12.0	6.0	CB	CH	2	1986	32.2			
127	N	0.0	3.0	CB	CH	2	1972	10.9			
127	N	3.0	0.0	RB	CH	2	1974	-13.5			
127	Q1	1.0	0.0	M	BI	1	6917	15.7	Light Fixture		
127	S	9.5	3.0	CB	CH	2	2014	122.9			
127	S	6.5	3.0	CB	RG	2	2017	88.8			
127	S	12.5	6.0	CB	CH	2	2011	84.9			
127	S	0.5	6.0	CB	CH	2	2024	80.4			
127	S	15.5	6.0	CB	CH	2	2008	77.2			
127	S	3.5	6.0	CB	CH	2	2021	70.8			
127	S	1.5	9.0	CB	CH	2	2026	70.8			
127	S	6.5	6.0	CB	CH	2	2018	65.6			
127	S	9.5	6.0	CB	CH	2	2015	64.4			
127	S	0.5	3.0	CB	RG	2	2023	63.7			
127	S	3.5	3.0	CB	CH	2	2020	55.3			
127	S	11.5	8.0	CB	CH	2	2025	54.1			
127	S	15.5	3.0	CB	CH	2	2007	37.3			
127	S	12.5	3.0	CB	RG	2	2010	8.4			
127	S	9.5	0.0	RB	CH	2	2013	-9.0			
127	S	12.5	0.0	RB	CH	2	2009	-10.3			
127	W	6.0	6.0	M	CH	2	2035	21.2			
127	W	6.0	0.0	M	CH	2	2033	-3.1			
127	W	3.0	6.0	GB	CH	2	2032	-6.4			
127	W	0.0	6.0	GB	CH	2	2029	-7.7			
127	W	6.0	3.0	M	CH	2	2034	-20.4			
127	W	9.0	6.0	GB	CH	2	2038	-24.5			
139	E	2.6	7.0	CB	CH	2	1918	116.9			
139	E	5.6	7.0	CB	CH	2	1917	111.9			
139	E	0.0	7.0	CB	CH	2	1919	68.9			
139	E	2.6	3.0	CB	CH	2	1915	58.8			
139	E	1.6	7.0	CB	CH	2	1941	53.4			
139	E	0.0	3.0	CB	CH	2	1916	45.9			
139	E	5.6	0.0	CB	CH	2	1911	38.7			
139	E	2.6	0.0	CB	CH	2	1912	28.7			
139	E	4.6	4.4	CB	RG	1	6907	26.2			
139	E	0.0	0.0	CB	CH	2	1913	25.1			
139	E	5.6	3.0	CB	CH	2	1914	7.9			

MALLINCKRODT C-T DECOMMISSIONING PROJECT

Threshold Comparison Test Report – Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity (dpm/100cm²)	Remarks	Exc	Res.
139	F	0.0	0.0	VT	CH	2	1892	42.7			
139	F	0.0	3.0	VT	CH	2	1895	30.8			
139	F	5.9	0.0	VT	CH	2	1894	29.5			
139	F	5.9	5.6	VT	CH	2	1900	28.0			
139	F	0.0	5.6	VT	CH	2	1898	14.8			
139	F	3.0	3.0	VT	CH	2	1896	2.2			
139	F	3.0	0.0	VT	CH	2	1893	-17.9			
139	F	5.9	3.0	VT	CH	2	1897	-21.5			
139	F	3.0	5.6	VT	CH	2	1899	-27.3			
139	N	5.9	0.0	CB	CH	2	1908	77.6			
139	N	0.0	3.0	CB	CH	2	1903	76.2			
139	N	0.0	7.0	CB	CH	2	1904	70.1			
139	N	3.0	0.0	CB	CH	2	1905	66.0			
139	N	5.9	6.0	CB	CH	2	1910	57.1			
139	N	3.0	6.0	CB	CH	2	1907	37.4			
139	N	5.9	3.0	CB	CH	2	1909	37.4			
139	N	3.0	3.0	CB	CH	2	1906	35.4			
139	N	0.0	0.0	CB	CH	2	1902	26.5			
139	N	5.6	8.0	CB	CH	2	1940	18.7			
139	Q1	1.0	0.0	M	BI	1	6908	-20.6	Cabinet		
139	Q2	2.0	0.0	M	BI	1	6910	28.4	Fire Sprinkler		
139	Q3	1.0	0.0	M	BI	1	6911	5.9	Electrical Track		
139	S	0.0	3.0	CB	CH	2	1927	118.4			
139	S	5.9	6.0	CB	CH	2	1922	102.0			
139	S	2.9	7.0	CB	CH	2	1925	96.6			
139	S	0.0	0.0	CB	CH	2	1926	93.9			
139	S	0.0	7.0	CB	CH	2	1928	87.8			
139	S	5.9	0.0	CB	CH	2	1920	85.7			
139	S	2.9	3.0	CB	CH	2	1924	74.1			
139	S	3.9	8.0	CB	CH	2	1942	65.0			
139	S	2.9	0.0	CB	CH	2	1923	38.1			
139	S	5.9	3.0	CB	CH	2	1921	24.5			
139	W	3.0	7.0	CB	CH	2	1935	107.5			
139	W	0.0	0.0	CB	CH	2	1929	72.1			
139	W	3.0	0.0	CB	CH	2	1933	66.0			
139	W	0.0	6.0	CB	CH	2	1932	61.9			
139	W	1.0	3.7	CB	RG	1	6906	54.0			
139	W	5.0	8.0	CB	CH	2	1939	48.9			
139	W	3.0	3.0	CB	CH	2	1934	46.9			
139	W	0.0	3.0	CB	CH	2	1931	40.8			
139	W	5.6	3.0	CB	CH	2	1937	36.1			
139	W	5.6	7.0	CB	CH	2	1938	15.0			
139	W	5.6	0.0	CB	CH	2	1936	-8.8			
140	E	4.0	6.0	M	CH	2	2072	19.1			
140	E	4.0	0.0	M	CH	2	2070	7.8			
140	E	4.0	3.0	M	CH	2	2071	-4.4			
140	F	3.0	6.0	VT	CH	2	2053	42.1			
140	F	0.0	9.0	VT	CH	2	2054	42.1			
140	F	3.0	9.0	VT	CH	2	2055	27.9			
140	F	0.0	6.0	VT	CH	2	2052	17.9			
140	F	3.0	0.0	VT	CH	2	2049	14.2			
140	F	0.0	3.0	VT	CH	2	2050	-18.2			
140	F	3.0	3.0	VT	CH	2	2051	-19.9			
140	F	0.0	0.0	VT	CH	2	2048	-20.2			
140	N	2.0	7.0	CB	CH	2	2063	84.3			
140	N	0.0	6.0	M	CH	2	2058	18.4			
140	N	3.5	0.3	CB	BI	1	6912	11.5			
140	N	0.0	3.0	M	CH	2	2057	10.2			
140	N	0.0	0.0	M	CH	2	2056	10.2			

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Threshold Comparison Test Report – Buildings

Room	SFC	X (ft)	Y (ft)	Mtx	Meas. Type	Min	SID	Gross Activity ($dpm_\beta/100cm^2$)	Remarks	Exc	Res.
140	N	3.0	0.0	M	RG	2	2059	3.1			
140	N	3.0	6.0	M	CH	2	2061	1.7			
140	N	3.0	3.0	M	CH	2	2060	-1.0			
140	Q1	2.0	0.0	M	BI	1	6916	17.6	Fire Sprinkler		
140	Q1	1.0	0.0	M	BI	1	6915	2.9	Fire Sprinkler		
140	Q2	1.0	0.0	M	BI	1	6914	18.6	Light		
140	S	1.3	8.0	CB	CH	2	2084	119.0			
140	S	1.3	3.0	CB	RG	2	2081	112.1			
140	S	1.3	6.0	CB	CH	2	2082	99.0			
140	S	0.8	3.8	CB	BI	1	6913	88.4			
140	S	1.3	0.0	CB	CH	2	2080	29.6			
140	S	4.3	6.0	M	CH	2	2079	20.4			
140	S	4.3	0.0	M	CH	2	2077	12.6			
140	S	4.3	3.0	M	CH	2	2078	2.7			
140	W	0.0	3.0	CB	CH	2	2086	129.7			
140	W	9.0	6.0	CB	CH	2	2096	124.6			
140	W	9.0	0.0	CB	CH	2	2094	114.9			
140	W	9.0	3.0	CB	CH	2	2095	113.2			
140	W	3.0	3.0	CB	CH	2	2089	111.5			
140	W	3.0	0.0	CB	CH	2	2088	100.1			
140	W	0.0	0.0	CB	CH	2	2085	67.1			
140	W	7.0	7.0	CB	CH	2	2097	61.8			
140	W	6.0	6.0	M	CH	2	2093	14.0			
140	W	6.0	0.0	M	CH	2	2091	3.7			
140	W	6.0	3.0	M	CH	2	2092	-10.9			
218	F	5.3	4.6	VT	RG	1	6857	13.1			
218	F	5.3	18.6	VT	RG	1	6854	6.5			
218	N	7.5	10.9	M	BI	1	6835	20.9			
219	E	9.2	10.1	M	RG	1	6888	-142.0			
219	F	1.3	4.8	VT	RG	1	6886	-1.6			
219	Q1	2.0	0.0	M	BI	1	6902	38.2	Heater		
219	Q1	1.0	0.0	M	BI	1	6901	12.7	Heater		
219	Q2	2.0	0.0	M	BI	1	6904	18.6	Ladder		
219	Q2	1.0	0.0	M	BI	1	6903	13.7	Ladder		
219	Q3	1.0	0.0	M	BI	1	6905	5.9	Light		
219	W	4.8	12.8	M	RG	1	6883	-58.5			

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

EMC	*Matrix Data Points*	*Number of Background*	*Average*	*Sigma Threshold (Tbk)*	*Background Threshold (Td)*	*DCGLw Threshold (Tc)*
	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)	($dpm_p/100cm^2$)
C	90	35.4	20.1	75.5	2,675	13,075
CB	51	96.1	21.7	139.4	2,739	13,139
CPT	0	0.0	0.0	0.0	2,600	13,000
GB	0	0.0	0.0	0.0	2,600	13,000
M	10	24.0	15.7	55.3	2,655	13,055
O	0	0.0	0.0	0.0	2,600	13,000
RB	1	0.0	0.0	0.0	2,600	13,000
VT	10	15.1	24.0	63.0	2,663	13,063

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Threshold Comparison Test Report - Buildings

STATISTICAL TEST RESULTS

Run Date: 1/12/2004 4:38:38 PM
Survey Unit Number 2504 Class: 2
Selected Test: SIGN TEST FOR PAIRED DATA
Test Status Pass
Thresholds:

EMC 13,000 DCGL 2,600

DATA SUMMARY TABLE

68 Survey points processed and 5 matrices processed

S+ = 68 Wc = 41

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