N60087.AR.002638
NAS BRUNSWICK
5090.3a

FINAL TASK SPECIFIC PLAN FOR SCOPING SURVEY BUILDING 200 NAS BRUNSWICK ME

5/1/2012

TETRA TECH

Final

Task Specific Plan
Building 200 Scoping Survey

Naval Air Station Brunswick
Brunswick, Maine

May 2012

Prepared for:
Department of the Navy
Base Realignment and Closure
Program Management Office Northeast
Philadelphia, Pennsylvania

Prepared by:
Tetra Tech, Inc.
661 Anderson Drive, Suite 5
Pittsburgh, Pennsylvania

Prepared under:
Naval Facilities Engineering Command
Contract Number: N62470-08-D-1001
Task Order: WE03

Contract Number: N62470-08-D-1001
Task Order: WE03

FINAL

TASK SPECIFIC PLAN
Building 200 SCOPING SURVEY

NAVAL AIR STATION BRUNSWICK
BRUNSWICK, MAINE

May 2012

Contract Task Order WE03

Prepared for:
Department of the Navy
Base Realignment and Closure
Program Management Office Northeast
Philadelphia, Pennsylvania

REVIEW AND APPROVAL

Lawson Bailey
Project Manager

Paul Burgio
BRAC Environmental Coordinator

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

α	Alpha
β	Beta
ε_i	Instrument efficiency
ε_s	Contaminated surface efficiency
B	Background count rate
b_i	Number of background counts in scan time interval
d'	Index of sensitivity
E	Detector efficiency
G	Source activity
i	Scan or observation interval
ρ or P	Probability
p	Surveyor efficiency factor
R_B	Background count rate
t	Time interval of detector over source
T_B	Background counting time
T_{S+B}	Sample counting time
W_A	Area of the detector window
$Z_{1-\alpha}$	Type I decision error level
$Z_{1-\beta}$	Type II decision error level
cm	Centimeter
cm^2	Square centimeter
cm/sec	Centimeter per second
cpm	Count per minute
Co-60	Cobalt 60
Cs-137	Cesium 137
dpm	Disintegration per minute
DFW	Definable features of work
ft^2	Square feet
GCA	Ground Control Approach
HASP	Health and Safety Plan
HRA	Historical radiological assessment
inch/sec	Inch per second
LBGR	Lower bound of the gray region

MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum detectable concentration
MDCR	Minimum detectable count rate
min	Minute
N	Number of data points
NAS	Naval Air Station
NRC	Nuclear Regulatory Commission
PSPC	Position sensitive proportional counter
Ra-226	Radium 226
RASO	Radiological Affairs Support Office
SCM	Surface contamination monitor
sec	Second
SIMS	Survey Information Management System
SSO	Site Safety Officer
SOP	Standard operating procedure
TSP	Task specific plan

1.0 INTRODUCTION

This task specific plan (TSP) provides task-specific details for the scoping survey at Building 200 at the Naval Air Station Brunswick (NASB) in Brunswick, Maine. The survey will be conducted in accordance with the general approach and methodologies that are given in the Basewide Radiological Management Plan at Naval Air Station Brunswick (TetraTech 2012a) and standard operating procedures (SOP). The surveys will conform to the requirements of the Health and Safety Plan (HASP) (TetraTech 2012b) prepared for the survey program. No exceptions to the management plan, SOPs or HASP are noted.

1.1 SITE DESCRIPTION AND HISTORICAL SUMMARY

Building 200 was built in 1952 to house Air Operations and replace the original Old Control Tower. Building 200 was completely renovated in 1985. The control tower and adjacent operations building combined total 22,409 square feet. A new tower and facility were built in 2005 and Air Operations and the station's air traffic control were moved from Facility 200 to the new facility. In addition to the function of control tower and the use of radar equipment, this facility was used to house the Ground Support Electronics Maintenance Shop.

In the 1970s, the Navy identified specific Ground Control Approach (GCA) radar units that contained radium painted knobs and toggle switches. Facilities were advised that the radium bearing components represented no immediate hazard to personnel, however, recommendations were made that all components be identified, labeled, smeared for leakage, and replaced with non-radium bearing components at NAVELEX repair and maintenance facilities. Surveys were conducted by the Radiological Affairs Support Office (RASO) in August 1977, at which time it was determined that the level of radium contamination found on or in the vicinity of GCA radar units and compass roses exceeded acceptable levels. The radioluminescent items were removed from GCA radar units and shipped from the Brunswick site.

Examples of known radioactive material uses in this site are electronic devices containing electron tubes and self-illuminated knobs, toggle switches, gauges and dials. As identified in the Historical Radiological Assessment (HRA) (TetraTech 2012c) the isotopes of concern in Building 200 are cobalt 60 (Co-60), cesium 137 (Cs-137) and radium 226 (Ra-226).

Navy, MRRA and regulatory personnel attended a facility walk-down in April 2012 and were briefed on the methodology for radiologically impacting areas. A more detailed site reconnaissance and review of site drawings and operational history was also performed by the Navy to identify impacted areas requiring surveys. Based on these activities rooms 209A, 209B, 210, 211, 219 and 221 were determined to be impacted.

2.0 SURVEY DESCRIPTION

This survey is being performed to assess if residual activity is above the established release criteria, as defined in Table 6-1 of the management plan (TetraTech 2012a). Surveys of the facility will be performed to determine the existence of isotopes associated with the maintenance of aircraft and weapons instrumentation. Surveys will be performed for the presence of Co-60, Cs-137 and Ra-226. Positive indications for beta surveys will be based on surface contamination monitor (SCM) data indicating measurements outside the normal distribution expected in clean areas and as represented by reference area survey data. The large number of measurements made by the SCM, 400 per square meter, allows identification of small areas not within the normal distribution parameters. The activity levels that are not part of the normal distribution are considered positive indications and will be investigated if investigation levels (defined in Section 2.4) are exceeded. Due to the extremely low number of counts in the SCM survey interval associated with the release criteria, positive indications for alpha surveys will be based on exceeding a threshold value in both a primary and recount detector in a 100 cm^2 area. Areas that exceed the investigation criteria based on the activity level determined by the SCM will be investigated.

2.1 SURVEY PREPARATION AND REMEDIATION ACTIVITIES

Floor coverings exist in several areas within the impacted areas of Building 200. The air traffic control center floor is covered by carpeting while the flooring behind the panels is linoleum sheets over tile flooring. In all impacted areas, the flooring will be removed to expose the concrete surface or the originally installed tile prior to conducting the required scan and fixed measurement surveys. Materials containing asbestos will be removed by a certified asbestos abatement contractor. Materials (tile, carpet, cabinets, shelving) will be surveyed for release in accordance with SOP-012, *Release of Materials and Equipment* (see Appendix B of the management plan [TetraTech 2012a]). Materials with radioactivity above the limits specified in Table 6-1 of the work plan will be packaged for storage and subsequent disposal. Materials that cannot be surveyed due to physical size or porosity will be considered potentially radioactive and will be packaged for storage and subsequent evaluation. Survey area preparation activities will be performed under radiological controls established in the SOPs. A listing of applicable SOPs for both preparation and survey activities is provided in Table 1. Surveys conducted in support of area preparation activities can provide input into final reports, but will not be used to demonstrate compliance with the release criteria or determination for additional survey requirements.

2.2 RELEASE CRITERIA

The building surface release criteria for Co-60 and Cs-137 is 5,000 disintegrations per minute (dpm) per 100 square centimeters (cm^2) total activity and for Ra-226 it is 100 dpm/100 cm^2 (TetraTech 2012a). The removable contamination release criteria is one-fifth of the total activity limits (TetraTech 2012a). The limits for the specific radionuclides to be addressed in Building 200 are provided in Table 2. Surveys will be performed to meet the more restrictive criteria if more than one beta-emitting or alpha emitting nuclide exists in a survey area.

2.3 REFERENCE AREA

The reference area will be selected with the concurrence of RASO. The reference areas for the Building 200 survey will consist of concrete floors, tile floors and sheetrock walls. The reference materials will be identified in on-site buildings that have no history of containing radioactive material. The reference area survey data will be obtained prior to final recording of surveys within Building 200 and will be included in the Building 200 survey report.

2.4 INVESTIGATION LEVELS

Investigation levels for the alpha and beta surveys will be equal to 75 percent of the release criteria for the more restrictive isotope of concern in each area to be surveyed.

2.5 SURVEY UNITS AND CLASSIFICATION

Building 200 will be surveyed as Class 1, Class 2 and Class 3 areas. Class 1 areas will require 100 percent survey of floors and walls up to 6 feet. Class 2 areas will require 50 percent of floors and walls up to 6 feet, or of the walls above 6 feet and ceilings in areas above Class 1 areas. Class 3 areas will require 25 percent survey of floor and walls up to 6 feet. A drawing indicating classification and survey units is provided as Figure 1. Using a random start point, systematic data collection locations (N) will be laid out in a triangular grid pattern for the survey units using the computer process provided by Visual Sample Plan (Gilbert et al. 2001). In some cases, the number of data collection locations may exceed N. Locations for data collection locations are provided in Figures 2 through 7. Additional biased surveys will be performed and samples will be collected at accessible points of ventilation systems and drain entrances within the building, if applicable.

2.6 ESTABLISHING THE NUMBER OF MEASUREMENTS

To determine the number of measurements, N, to be taken per survey unit when the contaminant is not present in background, Equation 5-3 of the management plan (TetraTech 2012a) is used:

Equation 5-3 from the Management Plan (TetraTech 2012a)

$$N = \left(\frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(Sign\ \rho - 0.5)^2} \right)(1.2)$$

Where:

N = Number of data points

$Z_{1-\alpha}$ = Type I decision error level, 1.645

$Z_{1-\beta}$ = Type II decision error level, 1.645

$Sign\ \rho$ = random measurement probability, 0.945201

1.2 = 20 percent increase in number of samples over the minimum

The values used in the calculation are from Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (Nuclear Regulatory Commission [NRC] 2000) and are based on a recommended value for the relative shift (Δ/σ) of 1.6 as discussed in Section 5.5.2.2 of MARSSIM (NRC 2000). Type I and Type II decision errors are based on 0.05 false negative and 0.05 false positive rates. The associated Z values are obtained from MARSSIM Table 5.2 (NRC 2000). The random measurement probability, Sign ρ, is from MARSSIM Table 5.4 (NRC 2000).

Using the defined values, the equation becomes:

$$N = \left(\frac{(1.645 + 1.645)^2}{4(0.945201 - 0.5)^2} \right)(1.2)$$

The calculation results in a value of N = 16.38328. Therefore, a minimum of 17 measurements will be obtained in each survey unit.

2.7 ALPHA AND BETA SCAN MEASUREMENTS

Scan measurements are performed to identify elevated areas of radioactivity within the survey unit. Alpha scans will be effective for identifying elevated concentrations of Ra-226. Beta scans will be effective in identifying elevated concentrations of Co-60. Twenty five percent of floor and wall surfaces the Class 3 survey units will be scanned with the SCM or the Ludlum 43-68 gas flow proportional detectors coupled to a Ludlum 2221 or 2241. Based on the identified ROCs, all impacted areas within Building 200 will be surveyed by both an alpha and beta scan. All scan surveys will be performed using the (SCM).

The SCM utilizes a gas flow position sensitive proportional counter (PSPC). The PSPC functions as any gas flow proportional counter, using P-10 as the counting gas. As in any proportional counter, voltage plateaus are established for the detection of alpha or alpha plus beta particles. High voltage appropriate for the type of particles to be detected is applied to the single anode wire which runs the length of the detector. The SCM computer compares the pulse heights of pulses sensed at each end of the anode wire and establishes the location on the anode wire where the pulsed was sensed. Although the available resolution is greater than 2,000 locations on the anode wire, the SCM computer will “bin” the data in 5 centimeters (cm) wide increments along the length of the wire.

The SCM can be operated in both a dynamic or “rolling” mode or a static or “corner” mode. In the dynamic mode, the system uses a direct current powered drive motor affixed to a cart which contains all electronics and computer hardware, and a detector (or two) is mounted to the front of the cart. The SCM’s design focuses on the elimination of human issues associated with performing surveys of large areas. The system is designed such that surveys are performed at constant speed, the detector held at a set distance from the surface being surveyed, and survey data recorded automatically. In the dynamic mode, a precision wheel encoder is mounted to the cart axle to determine distance traveled by the cart. The encoder can measure to a small fraction of a centimeter and is used to trigger the computer to capture data for every 5 cm of travel of the SCM cart. The result is count data (counts) for every 5 cm "bin" for every 5 cm of travel, or a matrix of 25 cm^2 "pixels" of data. In the static mode, a preset time is applied to the collection of data from a stationary detector. Data is binned in a manner similar to the dynamic mode.

Data is transferred from the SCM to a processing station containing the Survey Information Management Systems (SIMS) software via removable media. SIMS software is used to "stitch" the individual strips of data to create a single survey of an entire area. The data collected in 25 cm^2 "pixels" is summed with adjacent "pixels" in a manner that will result in the evaluation of every possible 100 cm^2 area. When determining activity, each 25 cm^2 "pixel" is 25 percent of four overlapping 100 cm^2 areas. This process ensures that small areas of activity above limits are not missed through grid registration errors.

2.7.1 Alpha Scan Measurements

The SCM will be the primary instrument used to perform alpha surveys. Alpha scans will be performed in all survey units within Building 200. The limiting alpha emitting ROC in Building 200 is Ra-226. To achieve the sensitivity to detect at the release criteria for Ra-226, the SCM will be used in the recount mode, using two detectors hard mounted to each other at a set distance. The system will be operated at a target speed of 0.5 inch per second (inch/sec) with detection probability of greater than 95 percent at the release criteria value for Ra-226 of 100 dpm/100 cm^2 (TetraTech 2012a). The probability of detecting two counts due to a source is given by Equation 7-4 from the Management Plan (TetraTech 2012a) below.

Equation 7-4 from the Management Plan (TetraTech 2012a)

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE + B)t}{60}\right)e^{\frac{-(GE+B)t}{60}}$$

Where:

$P(n \geq 2)$ = probability of getting two or more counts during the time interval t

t = time interval of detector over source (second [sec])

G = source activity (dpm)

E = detector efficiency (4π)

B = background count rate (count per minute [cpm])

60 = conversion factor, seconds to minutes

Since the detectors associated with the SCM are manufactured to the same specifications, the efficiency of each detector is similar. Therefore, the probability of obtaining two or more counts on each detector as they traverse the same 100 dpm source is the square of the probability for a single detector.

Typical background values observed with the SCM are less than 1 cpm/100 cm^2. Efficiency (4π) of the SCM for alpha emitters has been measured at 25 percent or greater. The efficiency for a point source would be 50 percent. The detector width is 12 cm. Survey speed for alpha emitters is 1.25 centimeter per second (cm/sec) (0.5 inch/sec). Using these parameters, equation 7-5 from the Management Plan (TetraTech 2012a) becomes:

$$P(n \geq 2) = 1 - \left(1 + \frac{(100 * 0.5 + 1)9.6}{60}\right) e^{\frac{-(100*0.5+1)9.6}{60}}$$

Where:

$P(n \geq 2)$ = probability of getting two or more counts during the time interval t

t = 9.6 sec

G = 100 dpm

E = 0.5

B = 1 cpm

Therefore:

$$P(n \geq 2) = 0.9974 \text{ or } 99.74\%$$

The probability of both detectors responding with two or more counts from a point source of 100 dpm at a speed of 1.25 cm/sec (0.5 inch/sec) would be the square of a single detector, or:

$$P(n \geq 2)_{2\ det} = 99.48\%$$

Therefore, the scan speed for the SCM for alpha emitting nuclides in the electronics repair shop, the air traffic control center and the ground support electronic maintenance shop will be 1.25 cm/sec (0.5 inch/sec).

For areas that are not surveyed with the SCM due to physical constraints, areas will be scanned with the Ludlum 43-68 gas flow detector and a Ludlum 2221or 2241 count rate meter. The surveyor will move the detector at a scan speed of 1.25 cm/sec (0.5 inch/sec) at a height of ¼ to ½ inch above the surface while maintaining audio observation of the instrument. A single count will cause the surveyor to pause and observe the area for an additional eight seconds. The probability of getting a second count from a 100 dpm source if given by MARSSIM equation J-5 (NRC 2000):

MARSSIM Equation J-5 (NRC 2000)

$$P(n \geq 1) = 1 - e^{\frac{-(GE+B)t}{60}}$$

Where:

$P(n \geq 1)$ = probability of getting one or more counts during the time interval t

t = time interval of detector over source (sec)

G = source activity (dpm)

E = detector efficiency (4π)

B = background count rate (cpm)

60 = conversion factor seconds to minutes

Or:

$$P(n \geq 1) = 1 - e^{\frac{-(100*0.25+1)8}{60}}$$

Where:

$P(n \geq 1)$ = probability of getting one or more counts during the time interval t

t = 15.2 sec (based on the initial scan interval of 7.2 seconds plus the 8 second recount)

G = 100 dpm

E = 0.25 (4π)

B = 1 cpm

Therefore:

$$P(n \geq 1) = 0.999 = 99.9\%$$

If the surveyor does not observe a second count in the eight second window, the surveyor can continue the scan survey. If a second count is observed during the eight second window, the surveyor will obtain a 60 second count at that location and record the data with the direct measurement surveys for the survey unit.

2.7.2 Beta Scan Measurements

Beta scan surveys will be performed in the electronics repair shop, the air traffic control center and the ground support electronic maintenance shop. For these beta surveys, the SCM will be the primary instrument. The limiting isotope of concern in the Class 3 area is Co-60. In Class 3 areas, the SCM will be operated at a target speed of 2 inch/sec (5 cm/sec).

For SCM scans for Co-60 in Class 3 areas, the MDCR from Equation 7-5 of the Management Plan (TetraTech 2012a) is:

$$MDCR = 3.28\sqrt{6.67}\left(\frac{60}{2}\right) = 254 \text{ cpm}$$

Where:

$d' = 3.28$

$b_i = 6.67$ counts (based on a 200 cpm background)

$i = 2$ sec (based on a scan speed of 5 cm/sec and detector width of 10 centimeters)

And the scan MDC from Equation 7-6 of the Management Plan (TetraTech 2012a) is:

$$Scan\ MDC = \frac{254}{\sqrt{1} * 0.404 * 0.25 * \frac{100}{100\ cm^2}} = 2{,}515 \text{ dpm}$$

Where:

$p = 1$

$\varepsilon_i = 0.404$

$\varepsilon_s = 0.25$

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

If necessary, for areas that are not surveyed for Co-60 with the SCM due to physical constraints, areas will be scanned with the Ludlum 43-68 gas flow detector and a Ludlum 2221 or 2241count rate meter. The detector will be operated on the alpha plus beta plateau. The surveyor will move the detector at a scan speed of 0.5 inch/sec (1.25 cm/sec) at a height of ¼ to ½ inch above the surface while maintaining audio observation of the instrument. The response of the Ludlum 43-68 detector to the beta emissions from Co-60 is approximately ½ that of the SCM. Background values are similar. The surveyor efficiency factor is 0.5, detector width is approximately 9 centimeters and the active area of the detector is 126 cm^2.

For the Ludlum 43-68 detector scans for Co-60 in Class 3 areas the MDCR and Scan MDC are:

$$MDCR = 3.28\sqrt{24}\left(\frac{60}{7.2}\right) = 134 \text{ cpm}$$

Where:

$d' = 3.28$

$b_i = 24$ counts (based on a 200 cpm background)

i = 7.2 sec (based on a scan speed of 1.25 cm/sec and a detector width of 9 centimeters)

And:

$$Scan\,MDC = \frac{134}{\sqrt{0.5} * 0.202 * 0.25 * \frac{100}{100\,cm^2}} = 3{,}753 \text{ dpm}$$

Where:

$p = 0.5$

$\varepsilon_i = 0.202$

$\varepsilon_s = 0.25$

$W_A = 126$ cm^2 (areas greater than 100 cm^2 default to 100 cm^2)

2.8 ALPHA AND BETA STATIC MEASUREMENTS

Alpha and Beta static measurements will be obtained with both the SCM and the Ludlum 43-68 detector coupled to the Ludlum 2221or 2241 rate meter. The SCM static measurements will supplement the surveys performed in the dynamic or rolling mode when the rolling mode cannot get into areas such as on floors against the wall, or on walls where interferences make rolling surveys impractical. The Ludlum 43-68 detector will be used to obtain fixed measurements at the number of locations identified in Section 2.5.

2.8.1 Alpha Static Measurement MDC

In Building 200, the limiting alpha emitting ROC is Ra-226. Static counts for alpha emitting Ra-226 obtained with the SCM will utilize the detection probability approach similar to that for the SCM in the dynamic or scan method described in Section 2.7. The SCM will use a single detector; however, 2 data acquisitions of 8 seconds each will be obtained at each location. The surveyor will place the detector against the surface to be surveyed and hold it steady for two 8 second counts. Data will be processed by creating 2 separate surveys of an area, the first 8 second count of each static measurement comprising the first data set and the second 8 second count, the second data set. The second data set will be over-laid on the first, and both sets evaluated for each 100 cm^2 area. Those areas in which both sets show a positive value above a prescribed threshold, will be indicative of an area in excess of the release criteria. The process assures that areas greater than the release criteria are detected with greater than 95 percent probability while suppressing false positives due to background. The approach is consistent with that of the SCM in the dynamic mode.

The probability of detecting two counts due to a source is given by Equation 7-4 from the management plan (TetraTech 2012a) below.

Equation 7-4 from the Management Plan (TetraTech 2012a)

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE+B)t}{60}\right)e^{\frac{-(GE+B)t}{60}}$$

Where:

$P(n \geq 2)$ = probability of getting two or more counts during the time interval t

t = time interval of detector over source (sec)

G = source activity (dpm)

E = detector efficiency (4π)

B = background count rate (cpm)

60 = conversion factor, seconds to minutes

Since the same detector will be used to acquire data at each location, all factors are equal for the 2 data sets. Typical background values observed with the SCM are less than 1 cpm/100 cm^2. Efficiency (4π) of the SCM for alpha emitters has been measured at 25 percent or greater. The efficiency for a point source would be 50 percent. The time interval will be 8 seconds. Using these parameters, equation 7-5 from the management plan (TetraTech 2012a) becomes:

$$P(n \geq 2) = 1 - \left(1 + \frac{(100 * 0.5 + 1)8}{60}\right)e^{\frac{-(100*0.5+1)8}{60}}$$

Where:

$P(n \geq 2)$ = probability of getting two or more counts during the time interval t

t = 8 sec

G = 100 dpm

E = 0.5

B = 1 cpm

Therefore:

$$P(n \geq 2) = 0.9913 \text{ or } 99.13\%$$

The probability of both detectors responding with two or more counts from a point source of 100 dpm with a count time of 8 seconds would be the square of a single detector, or:

$$P(n \geq 2)_{2\ det} = 98.27\%$$

Therefore, the count time for the SCM in the static mode will be 8 seconds.

Static measurements for alpha emissions in Building 200 bay will require a 2 minute count time for the Ludlum 43-68 for Ra-226. The MDC calculation for the specified count time from Equation 7-8 of the management plan (TetraTech 2012a):

Equation 7-8 from Management Plan (TetraTech 2012a)

$$MDC = \frac{3 + 3.29\sqrt{1 * 2 * \left(1 + \frac{2}{10}\right)}}{0.25 * 0.25 * \frac{100}{100\,cm^2} * 2}$$

MDC = 64.8 dpm

Where:

R_B = 1 cpm

T_B = 600 sec or 10 min

T_{S+B} = 120 sec or 2 min

ε_i = 0.25

ε_s = 0.25

W_A = 126 cm^2 (areas greater than 100 cm^2 default to 100 cm^2)

2.8.2 Beta Static Measurement MDC

Static measurement count times for the beta from the limiting ROC, Co-60, will be 8 seconds for the SCM and 30 seconds for the Ludlum 43-68 with the 2221 or 2241 rate meter.

For the SCM surveying for Co-60, the MDC equation becomes:

$$MDC = \frac{3 + 3.29\sqrt{200 * 0.1333 * \left(1 + \frac{0.1333}{0.1333}\right)}}{0.404 * 0.25 * \frac{100}{100\,cm^2} * 0.1333} = 2{,}007 \text{ dpm}$$

Where:

R_B = 200 cpm

T_B = 8 sec or 0.1333 min

T_{S+B} = 8 sec or 0.1333 min

ε_i = 0.404

$\varepsilon_s = 0.25$

$W_A = 100\ cm^2$

For the Ludlum 43-68 surveying for Co-60, the equation becomes:

$$MDC = \frac{3 + 3.29\sqrt{200 * 0.5 * \left(1 + \frac{0.5}{0.5}\right)}}{0.202 * 0.25 * \frac{100}{100\,cm^2} * 0.5} = 1{,}961 \text{ dpm}$$

Where:

$R_B = 200$ cpm

$T_B = 30$ sec or 0.5 min

$T_{S+B} = 30$ sec or 0.5 min

$\varepsilon_i = 0.202$

$\varepsilon_s = 0.25$

$W_A = 126\ cm^2$ (areas greater than 100 cm^2 default to 100 cm^2)

2.9 GAMMA WALKOVER SURVEYS

Gamma walkover surveys will be conducted in each survey unit with a 2” by 2” sodium iodide detector and a Ludlum 2241 ratemeter. Gamma readings will be obtained in accordance with Section 8.2.2 of the Basewide Radiological Management Plan (TetraTech 2012a).

2.10 REMOVABLE CONTAMINATION SURVEYS

Removable contamination will be assessed by swiping a Masslin cloth on a suspect area and monitoring the swiped cloth with a Ludlum 43-68 detector coupled to a Ludlum 2221 or 2241 detector. Since both alpha and beta emitting nuclides are present, detectors will be operated on the both the alpha plateau then on the alpha plus beta plateau. Areas in which the first swipe of the Masslin cloth indicates any increase in activity will be re-wiped with the Masslin cloth to determine the specific area that contains removable contamination. Swipe surveys will be conducted at any area indicating activity above background. Swipe surveys will also be conducted in at least one location within each 1,000 ft^2 in a Class 3 survey unit, and at each floor and sink drain. Swipe surveys will also be performed at each of the systematic data collection locations. All swipe surveys will be counted using a Ludlum 2929 detector. Swipe surveys will be performed and documented in accordance with SOP-006, *Radiation and Contamination Surveys* (see Appendix B of the management plan [TetraTech 2012a]).

2.11 MEDIA SAMPLES

Samples will be collected if sediment is found in sumps, floor drains, and sink drains to support evaluation of compliance with release criteria and to determine specific nuclides as necessary. Sampling may also be performed as an integral part of investigations to determine the cause of elevated measurements. Samples will be collected in accordance with SOP-009, *Sampling Procedures for Radiological Surveys* (see Appendix B of the management plan [TetraTech 2012a]), and submitted to an off-site laboratory for radiological analysis. One sediment sample per drain will be collected if sediment is present. Analysis of results will be evaluated against soil criteria identified in Table 2.

Media samples will also be obtained at any accessible building outfall locations that would contain liquid runoff from Building 200.

3.0 SITE RESTORATION

Site restoration work is not required at the conclusion of surveying in Building 200.

4.0 BUILDING 200 REPORT

Results of the survey that demonstrate that no single measurement indicating activity greater than the release criteria, and the resultant risk based dose as calculated, will be presented in a survey report. Any conclusion other than a recommendation for unrestricted release will be presented in a Characterization Report.

5.0 QUALITY CONTROL

The data quality objectives for the survey are provided in Table 3.

Definable features of work (DFW) establish the measures required to verify both the quality of work performed and compliance with project requirements. The DFW for this task is radiological surveys. Description of this DFW and the associated phases of quality control are presented in Table 4.

6.0 ENVIRONMENTAL PROTECTION

Environmental protection requirements are addressed in the management plan (TetraTech 2012a).

7.0 REFERENCES

Department of Energy (DOE). 2012. *Visual Sample Plan.* Upgrade version 6.2 released February, 2009. Pacific Northwest National Laboratory.

Gilbert, R., and others. 2001. Visual Sample Plan. Upgrade version 5.9 released October 29, 2009. Pacific Northwest National Laboratory. Principal authors of Version 5.9 Pulsipher, Wilson, and others.

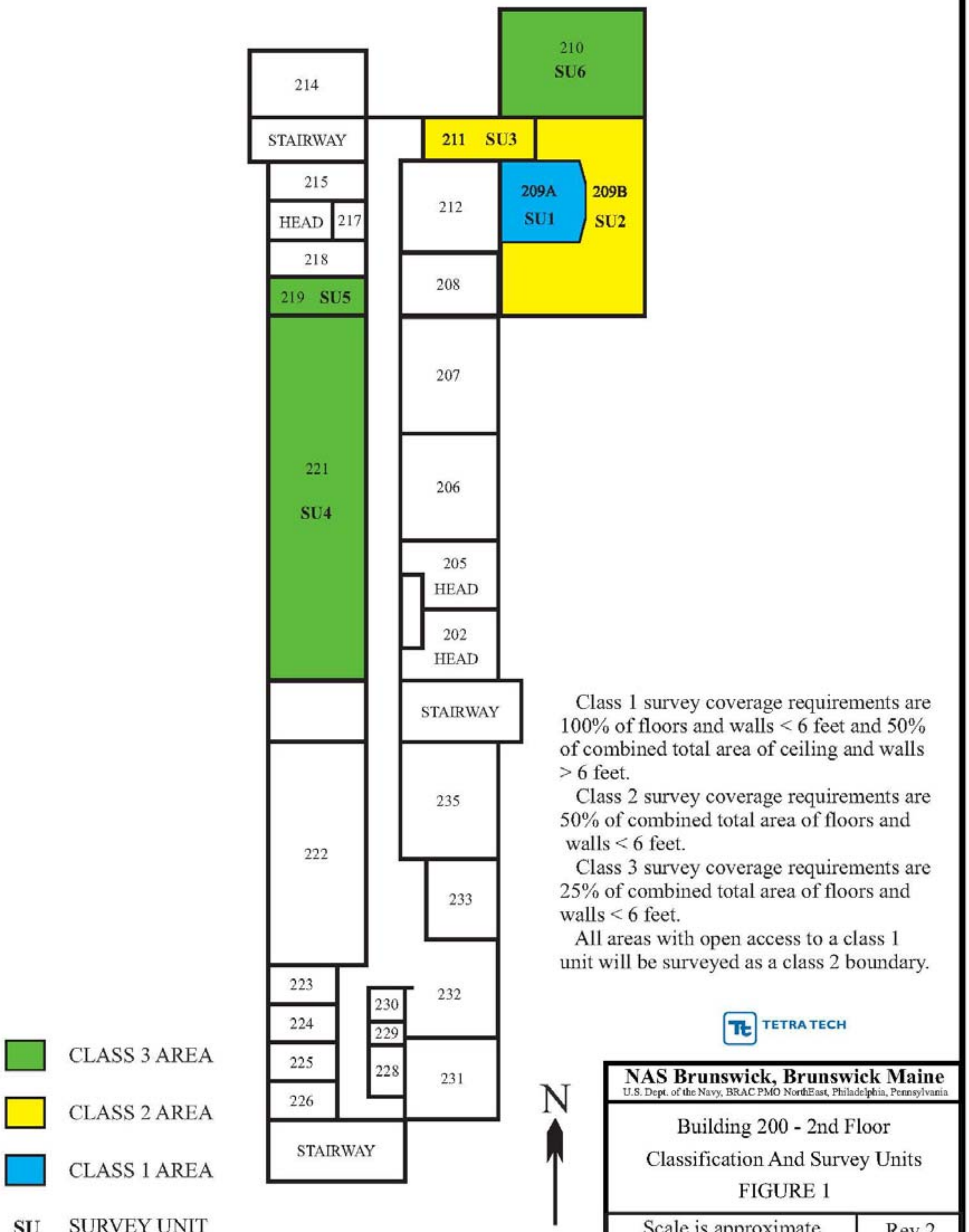
Nuclear Regulatory Commission (NRC). 2000. NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* Rev. 1.

Tetra Tech, Inc. (TetraTech). 2012a. *Basewide Radiological Management Plan, Naval Air Station Brunswick, Brunswick, Maine.* April.

Tetra Tech, Inc. (TetraTech). 2012b. *Health and Safety Plan for Basewide Radiological Surveys, Naval Air Station, Brunswick, Maine.* April.

Tetra Tech, Inc. (TetraTech). 2012c. *Historical Radiological Assessment, Naval Air Station Brunswick, History of the Use of General Radioactive Materials, 1943-2011.* April.

FIGURES

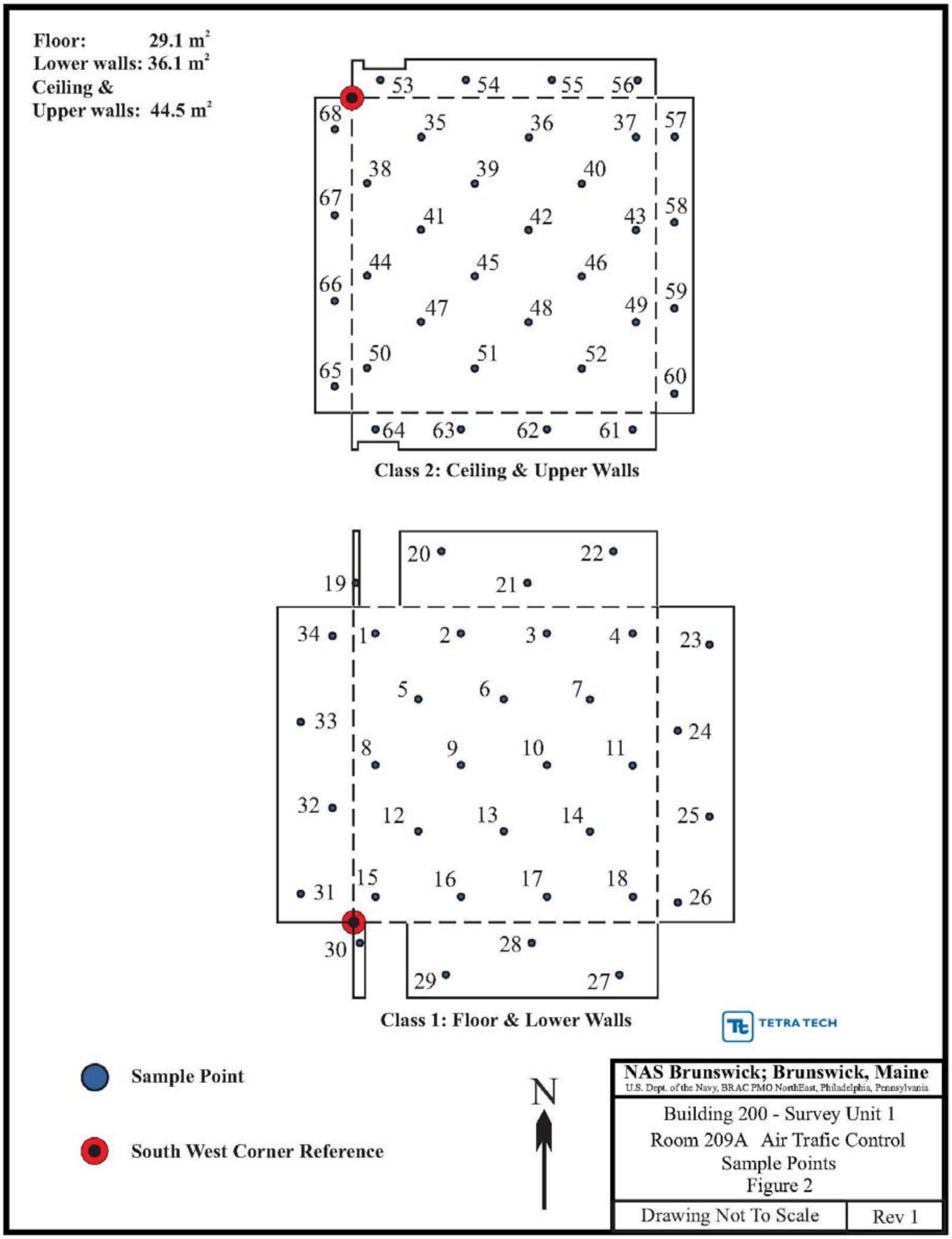


Class 1 survey coverage requirements are 100% of floors and walls < 6 feet and 50% of combined total area of ceiling and walls > 6 feet.

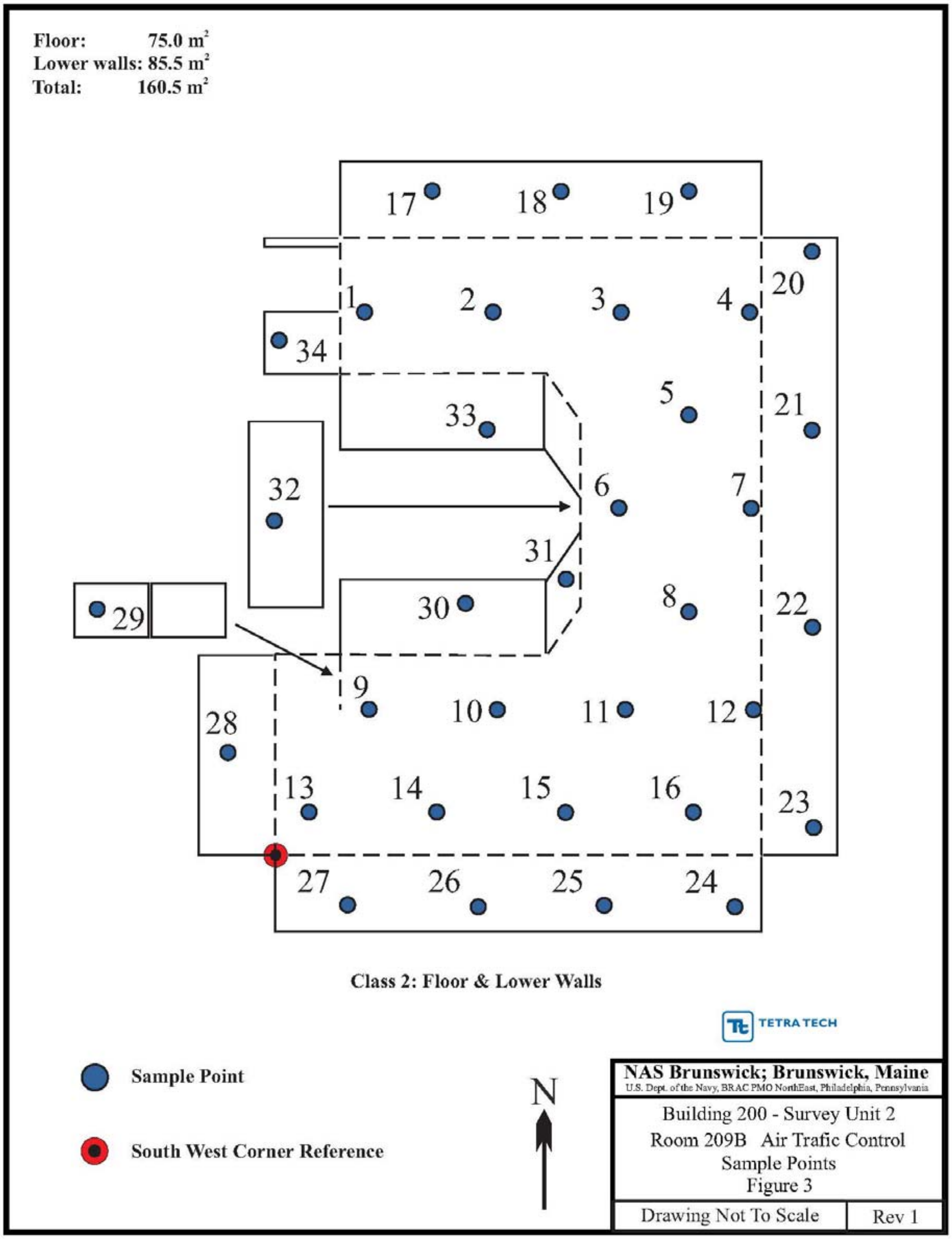
Class 2 survey coverage requirements are 50% of combined total area of floors and walls < 6 feet.

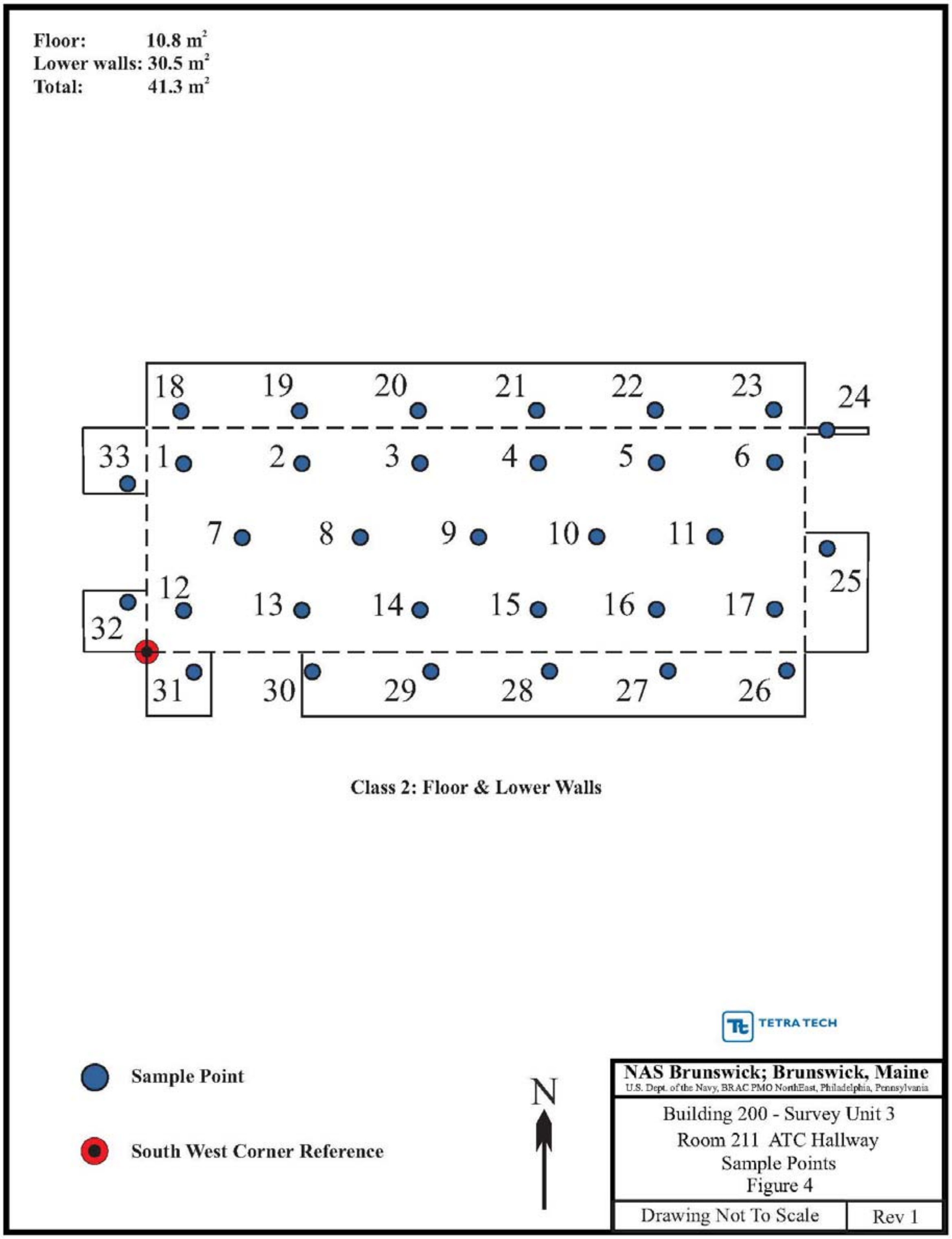
Class 3 survey coverage requirements are 25% of combined total area of floors and walls < 6 feet.

All areas with open access to a class 1 unit will be surveyed as a class 2 boundary.

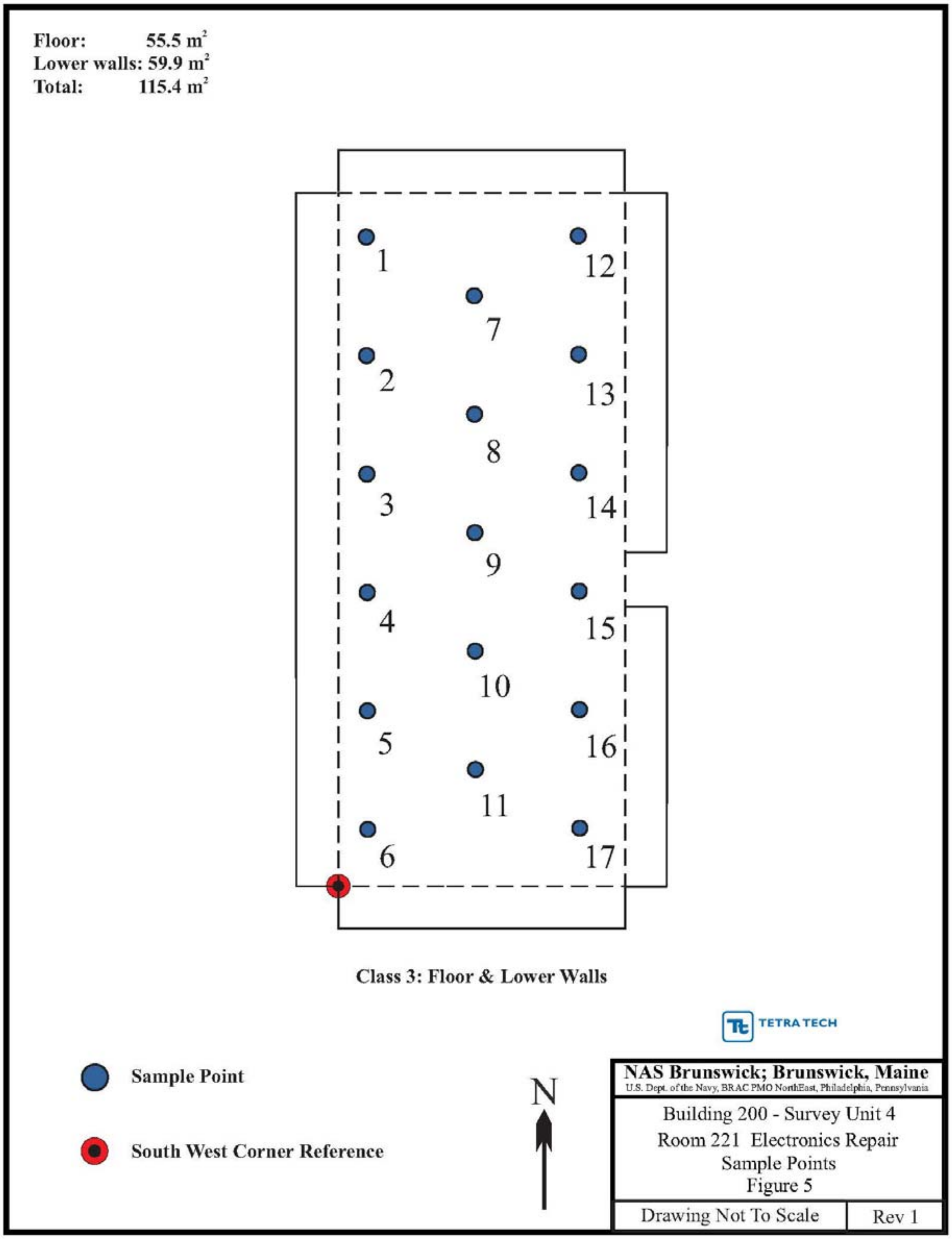


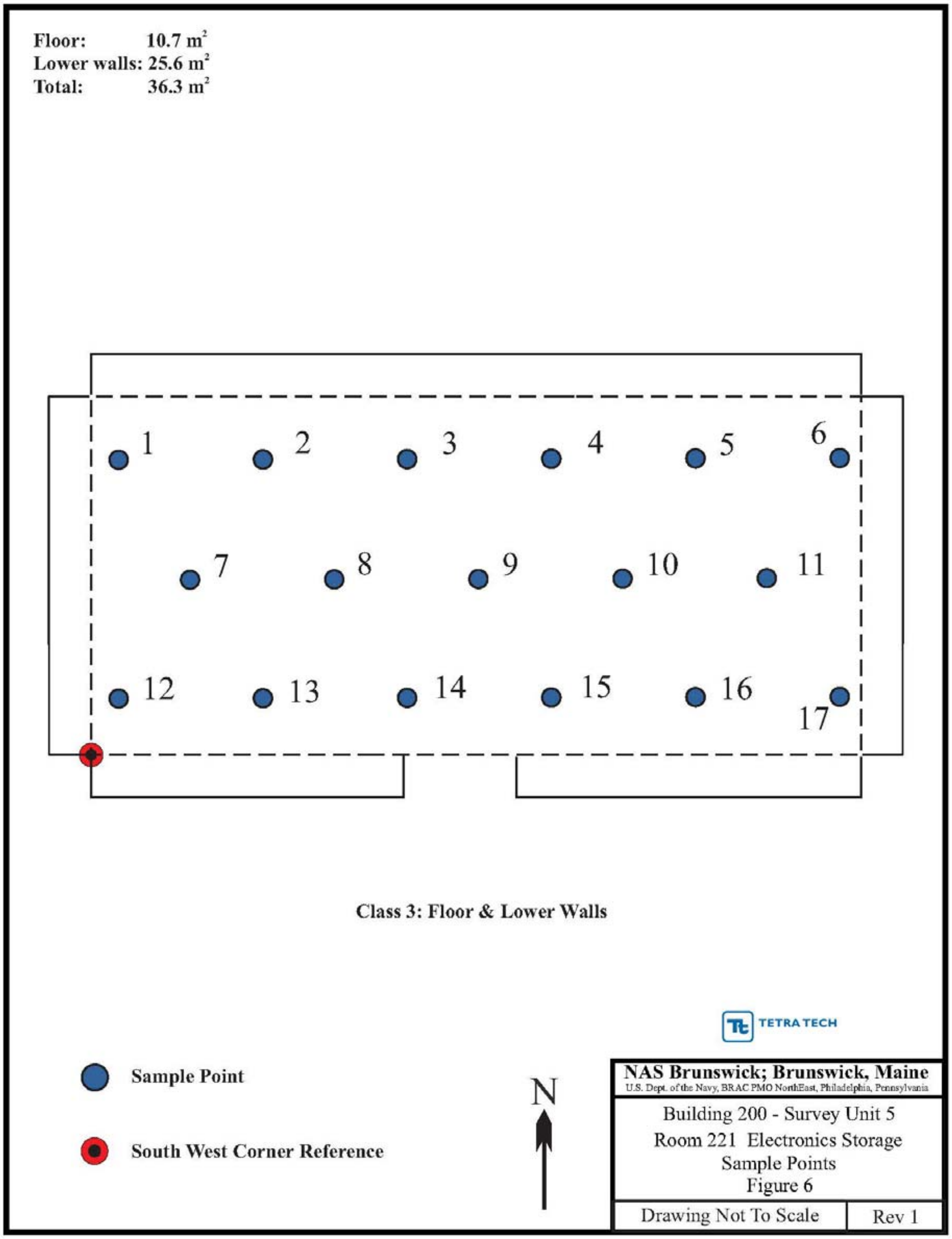
Floor: 29.1 m²
Lower walls: 36.1 m²
Ceiling &
Upper walls: 44.5 m²
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
Class 2: Ceiling & Upper Walls
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
Class 1: Floor & Lower Walls
TETRA TECH
Sample Point
South West Corner Reference
N
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 1
Room 209A Air Trafic Control
Sample Points
Figure 2
Drawing Not To Scale
Rev 1


Floor: 75.0 m²
Lower walls: 85.5 m²
Total: 160.5 m²
17
18
19
1
2
3
4
20
34
5
21
33
32
6
7
31
30
8
22
29
9
10
11
12
28
13
14
15
16
23
27
26
25
24
Class 2: Floor & Lower Walls
Sample Point
South West Corner Reference
N
TETRA TECH
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 2
Room 209B Air Trafic Control
Sample Points
Figure 3
Drawing Not To Scale
Rev 1

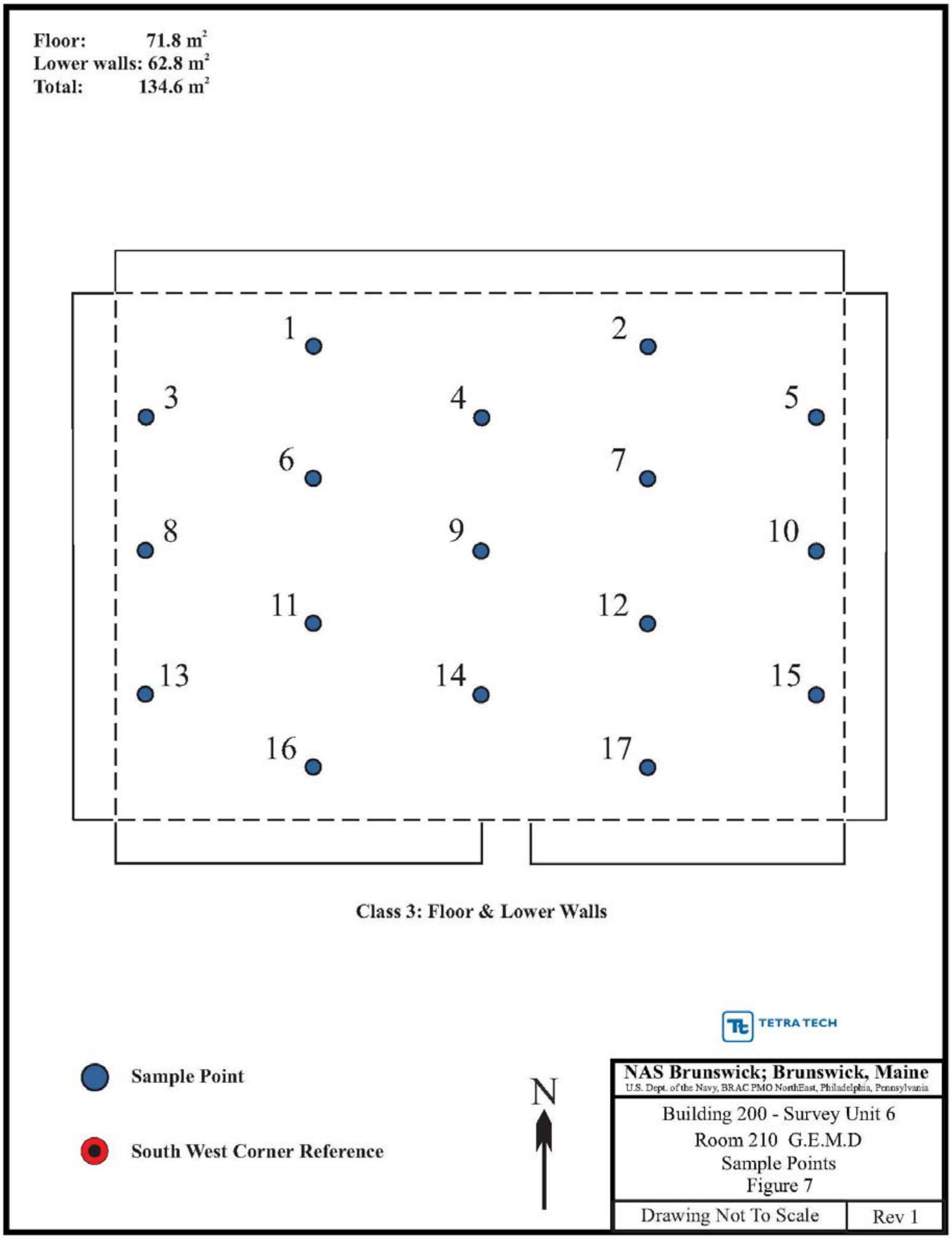


Floor: 10.8 m²
Lower walls: 30.5 m²
Total: 41.3 m²
18 19 20 21 22 23 24
33 1 2 3 4 5 6
7 8 9 10 11
25
12 13 14 15 16 17
32
31 30 29 28 27 26
Class 2: Floor & Lower Walls
TETRA TECH
Sample Point
South West Corner Reference
N
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 3
Room 211 ATC Hallway
Sample Points
Figure 4
Drawing Not To Scale
Rev 1


Floor: 55.5 m²
Lower walls: 59.9 m²
Total: 115.4 m²
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Class 3: Floor & Lower Walls
TETRA TECH
Sample Point
South West Corner Reference
N
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 4
Room 221 Electronics Repair
Sample Points
Figure 5
Drawing Not To Scale
Rev 1



Floor: 10.7 m²
Lower walls: 25.6 m²
Total: 36.3 m²
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Class 3: Floor & Lower Walls
TETRA TECH
Sample Point
South West Corner Reference
N
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 5
Room 221 Electronics Storage
Sample Points
Figure 6
Drawing Not To Scale
Rev 1



Floor: 71.8 m²
Lower walls: 62.8 m²
Total: 134.6 m²
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Class 3: Floor & Lower Walls
TETRA TECH
Sample Point
South West Corner Reference
N
NAS Brunswick; Brunswick, Maine
U.S. Dept. of the Navy, BRAC PMO NorthEast, Philadelphia, Pennsylvania
Building 200 - Survey Unit 6
Room 210 G.E.M.D
Sample Points
Figure 7
Drawing Not To Scale
Rev 1

TABLES

TABLE 1 BUILDING 200 APPLICABLE STANDARD OPERATING PROCEDURES

Procedure	Title	Rev
SOP 002	Radiation Work Permits	0
SOP 004	Project Dosimetry	0
SOP 006	Radiation and Contamination Surveys	0
SOP 007	Preparation of Portable Radiation and Contamination Survey Meters for Field Use	0
SOP 008	Air Sampling and Sample Analysis	0
SOP 009	Sampling Procedures for Radiological Surveys	0
SOP 010	RCA Posting and Access Control	0
SOP 011	Control of Radioactive Materials	0
SOP 012	Release of Materials and Equipment	0
SOP 016	Decontamination of Equipment and Tools	0
SOP 022	Radiological Clothing Selection, Monitoring and Decontamination	0
SOP 023	Source Control	0
SOP 024	Occurrence Reporting	0
RP-OP-017	Operation of the Ludlum Model 2929 Dual Scaler	0
RP-OP-025	Operation of the Ludlum Model 2221	0
RP-OP-026	Operation of the Ludlum Model 19	0
SCM-OPS-01	Position Sensitive Proportional Counters Purging	0
SCM-OPS-02	Position Sensitive Proportional Counters Plateau Determination	0
SCM-OPS-03	Position Sensitive Proportional Counters Position Calibration	1
SCM-OPS-04	Encoder Calibration	0
SCM-OPS-05	Position Sensitive Proportional Counters Efficiency Calibration	0
SCM-OPS-06	Position Sensitive Proportional Counters Quality Assurance	1
SCM-SETUP-01	Position Sensitive Proportional Counters Repair	0
SCM-SETUP-02	Hardware Setup	0
SCM-SETUP-03	Quality Assurance Testing of SCM	0

TABLE 2 BUILDING 200 PRIMARY RADIATION PROPERTIES AND RELEASE CRITERIA FOR RADIONUCLIDES OF CONCERN

	Primary Radiation Properties		Release Criteria[a]				
			Materials & Equipment		Building Surfaces		Soil[b]
Radionuclide	Half-Life	Type	Total Surface Activity	Removable Activity	Total Surface Activity	Removable Activity	Activity (pCi/g)
Co-60	5.27E00 years	Beta	5,000	1,000	5,000	1,000	2.28
Cs-137	3.01E01 years	Beta	5,000	1,000	5,000	1,000	
Ra-226	1.60E03 years	Alpha	100	20	100	20	1

Notes:

a Units are disintegrations per minute per 100 square centimeters, unless otherwise specified.

b Criteria is above background for those radionuclides found in background soils.

Source: TetraTech 2012a. Basewide Radiological Management Plan, Naval Air Station Brunswick, Brunswick, Maine. April.

TABLE 3 SUMMARY OF DATA QUALITY OBJECTIVES

STEP 1 Statement of Problem	STEP 2 Decisions	STEP 3 Inputs to the Decisions	STEP 4 Boundaries of Study	STEP 5 Decision Rules	STEP 6 Limits on Decision Errors	STEP 7 Optimizing the Sampling Design
Building 200 is listed in the HRA as an area impacted by radiological activities. The isotopes of concern are Co-60, Cs-137, , and Ra-226. It must be determined if the site-specific release criteria for these isotopes have been met or if remediation or further survey is warranted.	The primary use of the data expected to result from completion of this TSP is to support the Scoping Survey of Building 200. Therefore the decision to be made can be stated as "Do the results of the survey indicate activity above background or meet the release criteria?"	Radiological surveys required to support the Final Status Survey of Building 200 will include: • 100 percent scan surveys of Class 1 area • 50 percent scan survey of Class 2 areas • 25 percent scan surveys of Class 3 areas • A minimum of 17 systematic static measurements will be performed in all survey unit areas • One swipe per 1,000 square feet in all survey units areas • One sediment sample will be collected from each drain if available. • One swipe at each systematic sample location	The lateral and vertical spatial boundaries for this survey effort are confined designated impacted areas as shown in Figure 1.	If the concentration of radioactivity on building surfaces, paved areas, or in sediment samples is less than the release criteria, then no further measurements are required. If the results of the survey exceed the release criteria, then the building will be investigated further.	Limits on decision errors are set at 5 percent as specified in the management plan (TetraTech 2012a).	Operational details for the radiological survey process have been developed. The theoretical assumptions are based on guidelines contained in MARSSIM (NRC 2000). Specific assumptions regarding types of radiation measurements, instrument detection capabilities, quantities and locations of data to be collected, and investigation levels are contained in this TSP and the management plan (TetraTech 2012a)

Notes:

Co-60	Cobalt 60
Cs-137	Cesium 137
HRA	Historical Radiological Assessment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NRC	Nuclear Regulatory Commission
Ra-226	Radium 226
TSP	Task Specific Plan

TABLE 4 DEFINABLE FEATURES OF WORK FOR RADIOLOGICAL SURVEYS

ACTIVITY	PREPARATORY (Prior to initiating survey activity)	DONE	INITIAL (At onset of survey activities)	DONE	FOLLOW-UP (Ongoing during survey activities)	DONE
Radiological Surveys	• Verify that an approved TSP is in place. • Verify that the Remedial Project Manager and the Caretaker Site Office are notified about mobilization. • Verify that an approved Radiation Work Permit, if required, is available and has been read and signed by assigned personnel. • Verify that the management plan, HASP and TSP, have been reviewed. • Verify that personnel assigned are trained and qualified. • Verify that personnel have been given an emergency notification procedure. • Verify that workers assigned dosimeter have completed NRC Form 4. • Verify that relevant SOPs are available and have been reviewed for equipment to be used. • Verify that equipment is on site and in working order (initial daily check).		• Verify that radiological instruments are as specified in the management plan (TetraTech 2012a) and TSP. • Inspect Training Records. • Verify that reference area measurements have been obtained in accordance with the management plan (TetraTech 2012a). • Verify that daily checks were performed on all survey instruments. • Verify that instrument calibration and setup are current. • Verify that required dosimeter is being worn. • Verify that field logbooks and proper forms are in use. • Verify that samples and measurements are being collected in accordance with the TSP, management plan and applicable SOPs. • Verify the sample handling is in accordance with the management plan (TetraTech 2012a) and applicable SOPs.		• Verify that the site is properly posted and secured. • Conduct ongoing inspections of material and equipment. • Verify that daily instrument checks were obtained and documented. • Verify that survey results were documented. • Inspect chain-of-custody and survey logs for completeness. • Verify that survey activities conform to the TSP. • Verify that survey instruments are recalibrated after repairs or modifications.	

Notes:

HASP Health and Safety Plan
NRC Nuclear Regulatory Commission
SOP Standard Operating Procedure
TSP Task Specific Plan