MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FB-0500 TURBINE BUILDING FOOTPRINT
SURVEY UNIT 1

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A. SURVEY UNIT DESCRIPTION

FB-0500 Survey Unit 1, the Turbine Building Footprint, consists of the soil footprint of the east and south sections of the former Turbine Building (that portion of the slab which contained the extension of the rail spur into the backyard – see map FB0500-01, Attachment 1). The total survey area comprises approximately 2766 m^2 of sub-slab soil and concrete remnants. While the survey area was located inside the Industrial Area of the site, it was outside of the plant's radiologically restricted area (RA) at Maine State Grid Coordinates 624000 E and 407500 N.

B. SURVEY UNIT DESIGN INFORMATION

The Turbine Building was typically maintained as a clean structure during plant operation. However, radioactive material was present in systems and low levels of contamination were found in building sumps and drains. The area around the PCC/SCC pumps was considered to be a Class 1 area so the sub-slab soil within FB-0500 Survey Unit 1 was designated a Class 2 survey unit per the LTP (Table 5-1B).

The survey unit design parameters are summarized in Table 1. Given a relative shift of 3.0, it was determined that 14 direct soil sample points were required for the Sign Test. The soil measurement locations were generated using a random start square grid and are shown on map FB0500-02, (Attachment 1). Direct measurements consisted of soil samples that were analyzed with laboratory gamma spectroscopy instrumentation.

A 10-100% scan coverage of the area was required[1]. Approximately 38% scan coverage of the sub-slab area was used. Scan grids were typically 25 m^2 areas as indicated on the attached survey map (FB0500-03, Attachment 1). Scans were biased to soil areas due to a higher potential for containing residual contamination.

Once the floor slab was removed, several equipment foundation remnants were left as shown on map FB0500-03 by the shaded areas. Structure demolition left the concrete remnants with surfaces too rough to survey as a separate unit. Volumetric concrete samples (15) were taken to augment the soil FSS using a random start, square grid as shown on map FB0500-04.

The survey instruments used, their MDC values, and alarm setpoints are provided in Attachment 2.

Background values were established for the scan measurements, based on local scaler values in the survey unit. These background values were used to establish scan alarm setpoints. See additional discussion in Section D.

[1] LTP Table 5-3

TABLE 1

SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area[2]	2158 m^2	Table 5-2 of the LTP – Class 2
Number of Direct Measurements Required	14	Based on an adjusted LBGR of 3.69 pCi/g, sigma[3] of 0.17 pCi/g and relative shift of 3.0. Type 1 = Type II = 0.05
Sample Area	154 m^2	Class 2 Area
Sample Grid Spacing	12.4 m x 12.4 m	Class 2 Area
Scan Grid Area	5 m x 5 m (except grid 42 at 2.5 m x 10m)	Class 2 Area
Area Factor	N/A	Class 2 Area
Scan Survey Area	1050 m^2	Class 2 Area: 10-100%
Background		
SPA-3 (scan)	Average background ± 1000 c/m	DI 6-150, EC-009-01, LTP Section 5
Scan Investigation Level	3 sigma of background + DCGL. See Table 2-2	EC 009-01 (Reference 1)
DCGL	4.2 pCi/g	LTP Revision 2 (Reference 2)
Design $DCGL_{EMC}$	N/A	Class 2 Area

C. SURVEY UNIT RESULTS

Seventeen direct soil samples were obtained in Survey Unit 1 (conservatively greater than the 14 required). All direct measurements were below the DCGL. The resulting soil sample measurement data are presented in Table 2.

Seventeen alarms were received during scanning which required investigation as discussed in Section D.

In addition, 15 volumetric concrete samples were collected from the foundation remnants and analyzed with no plant-derived activity detected at an MDC of 0.15 pCi/g.

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2 The survey design only considered the sub-slab soil area. This results in a conservative sample area and sample grid spacing.

3 LTP Table 5-1C, footnote a, sigma for R200 yard east

TABLE 2

DIRECT MEASUREMENTS

Sample Number	Cs-137 (pCi/g)
FB-0500-1-S001	< 0.051
FB-0500-1-S002	< 0.050
FB-0500-1-S003	< 0.049
FB-0500-1-S004	< 0.052
FB-0500-1-S005	< 0.050
FB-0500-1-S006	< 0.052
FB-0500-1-S007	< 0.051
FB-0500-1-S008	< 0.049
FB-0500-1-S009	< 0.050
FB-0500-1-S010	< 0.047
FB-0500-1-S011	< 0.047
FB-0500-1-S012	< 0.047
FB-0500-1-S013	< 0.052
FB-0500-1-S014	< 0.052
FB-0500-1-S015	< 0.055
FB-0500-1-S016	< 0.050
FB-0500-1-S017	< 0.050
Mean	**0.050**
Median	**0.050**
Standard Deviation	**0.002**
Range	**0.047 – 0.055**

NOTES
1. Co-60 was analyzed with no positively detected results at an MDC of 0.1 pCi/g.
2. "<" indicates MDC value.

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

Each grid exhibiting an alarm was re-scanned to determine the location of the highest count rate. At the highest count rate location a one-minute scaler count, GR-130 gamma spectroscopy (used for information only) measurement and a soil sample were taken to determine whether the alarm was caused by plant-derived radioactive material. The investigations showed no evidence of plant-derived radioactive material (Table 3-1, Attachment 3).

During the time of the FB-0500 survey, the scan methodology changed as a result of detailed investigation into the data processing mechanism of the E-600 data logger. Key program changes resulting from the E600 investigation were the elimination of the DCGL term and the use of local scaler background measurements in establishing the investigation level.

As a result of the above-mentioned work with the E600 instrument, a review of Survey Unit 1 background and scan data was conducted. A revised alarm setpoint (14,800 cpm) was calculated based on the latest scan methodology. This review indicated that one additional scan grid (FB0500-1-S0035) may have alarmed had the revised setpoint been used. No further investigation was considered warranted for the following reasons.

1. The scan grids for this Class 2 area are relatively small (25 m^2).

2. Soil samples S004 and S005 were taken to the north and south of grid 35 with no evidence of plant derived nuclides.

3. Adjacent grids S034 and S028 did receive alarms and were investigated; no plant derived nuclides were detected.

4. All direct and investigation soil samples elsewhere in the survey unit indicated < MDA values (Table 3-1, Attachment 3).

Therefore, additional investigation of scan grid FB0500-1-S0035 would not likely reveal the presence of plant-derived activity above background.

E. SURVEY UNIT DATA ASSESSMENT

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, are provided in Table 2. None of the samples had activity above the MDA. Both the mean and the median activities were less than the DCGL assuming activity was present at the MDA. The maximum soil result for Cs-137 was approximately 1.3 percent of the DCGL.

For illustrative purposes, as indicated in LTP Section 5.9.3, a simplified general retrospective dose estimate can be calculated from the average residual contamination level by subtracting the established mean fallout Cs-137 background value[4] (0.19 pCi/g) for disturbed soil from the survey unit sample mean activity (0.050 pCi/g). The result is a net value of –0.14 pCi/g. This would equate to an annual dose rate of 0.0 mrem/y. However, for the purposes of demonstrating compliance with the radiological criteria for license termination and the enhanced State Criteria, background activity is not subtracted from the soil sample analysis activity values.

[4] See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 3)

F. ADDITIONAL DATA EVALUATION

Attachment 4 provides additional data evaluation associated with this Survey Unit, including relevant statistical information. Based on survey unit direct measurement data, this attachment provides the Sign Test Summary, Quantile Plot, Histogram, and Retrospective Power Curve.

1. The Sign Test Summary provides an overall summary of design input (Table 1) and resulting calculated values used to determine the required number (N) of direct measurements (per LTP Section 5.4.2). The Sign Test Summary is a separate statistical analysis that also calculates the mean, median, and standard deviation of the direct measurements.

   The critical value and the result of the Sign Test are provided in the Sign Test Summary table, as well as a listing of the key release criteria. As is shown in the table, all of the key release criteria were clearly satisfied for the FSS of this survey unit.

2. The Quantile Plot was generated from direct measurement data listed in Table 2. The data set and plot are consistent with expectations for a Class 2 survey unit. All of the measurements are well below the DCGL of 4.2 pCi/g.

3. A Histogram Plot was also developed based on the direct measurement values. This plot shows that the direct data were essentially a normal distribution with no outliers.

4. A Retrospective Power Curve was constructed, based on FSS results. The curve shows that this survey unit having a mean residual activity at a small fraction of the DCGL has a high probability ("power") of meeting the release criteria. Thus, it can be concluded that the direct measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

As mentioned in Section B, concrete volumetric samples were obtained from foundation remnants to demonstrate that demolition activities did not contaminate the concrete surfaces. Laboratory gamma spectroscopy analysis on the samples determined that none of the concrete samples had plant-derived activity detected at an MDC of 0.15 pCi/g.

G. CHANGES IN INITIAL SURVEY UNIT ASSUMPTIONS ON EXTENT OF RESIDUAL ACTIVITY

The survey was designed as a Class 2 area; the FSS results were consistent with that classification. The direct measurement sample standard deviation was less than the design sigma. Thus, no additional measurements were required.

H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 1 was designed, performed and evaluated in late 2001. The design was performed to the criteria of the LTP, Revision 2 (Reference 2). As discussed and reviewed in Section D of this Release Record, scan methodology changes were made during this time frame, relating to the use of the E600 instrument.

LTP changes have been made subsequent to the completion of this survey. Those LTP changes with potential for impact to this survey unit are listed below.

1. Requirement to check background $\pm$ 1000 cpm prior to the scan of each grid. (LTP 5.5.2.f; LTP Revision 3 Addenda, References 4, 5 and 6).

2. Increased Scan MDC to 5.9 pCi/g (LTP Revision 3 Addenda, References 4, 5 and 6).

3. Change in alarm setpoint methodology during the evolution of the use of E600 (use of scaler vs. peak values to establish the investigation level and deletion of the DCGL term).

4. LTP changes in the activated concrete license amendment (References 7 and 8).

5. The procedural commitment to the State of Maine of limiting grid size to 10 m^2 (Reference 9).

These LTP changes were evaluated and found to have no impact on the results or conclusions of the FSS of FB-0500 Survey Unit 1.

I. CONCLUSION

The FSS of this survey unit was designed based on the LTP designation as a Class 2 area. The survey design parameters are presented in Table 1. The required number of direct measurements was determined for the Sign Test in accordance with the LTP. As presented in Table 2, all direct measurements were less than the DCGL of 4.2 pCi/g.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The direct measurement sigma was determined to be less than that used for design, thus indicating that a sufficient number of samples was taken.

The Retrospective Power Curve shown in Attachment 4 confirmed that sufficient samples were taken to support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and the data quality objectives were met. Attachment 4 also revealed that direct measurement data represented essentially a normal distribution, with no outliers.

The scan survey design for this survey unit was developed in accordance with the LTP with significant aspects of the design discussed in Section B and Table 1. Scanning resulted in 17 verified alarms (Section D) for evaluation. Investigations showed no evidence of plant-derived radionuclides above background.

It is concluded that FB-0500, Survey Unit 1, met the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

J. REFERENCES

1. Maine Yankee Engineering Calculation, EC 009-01

2. Maine Yankee LTP, Revision 2, Maine Yankee letter to the NRC, MN-01-032, August 13, 2001

3. Approach for Dealing with Background Radioactivity for Maine Yankee Final Status Surveys, Attachment E to Maine Yankee Procedure, FSS Data Processing and Reporting, PMP 6.7.8

4. Maine Yankee License Termination Plan, Revision 3, Maine Yankee letter to the NRC, MN-02-048, dated October 15, 2002

5. Maine Yankee License Termination Plan, Revision 3 Addenda, Maine Yankee letter to the NRC, MN-02-061, dated November 26, 2002

6. NRC letter to Maine Yankee, dated February 28, 2003, Approval of LTP Rev. 3 and Addenda

7. MY letter to the NRC, MN-03-049, dated September 11, 2003, "Proposed Change: Revised Activated Concrete DCGL and More Realistic Activated Concrete Dose Modeling"

8. NRC Letter to Maine Yankee dated February 18, 2004, Approval of Activated Concrete Amendment

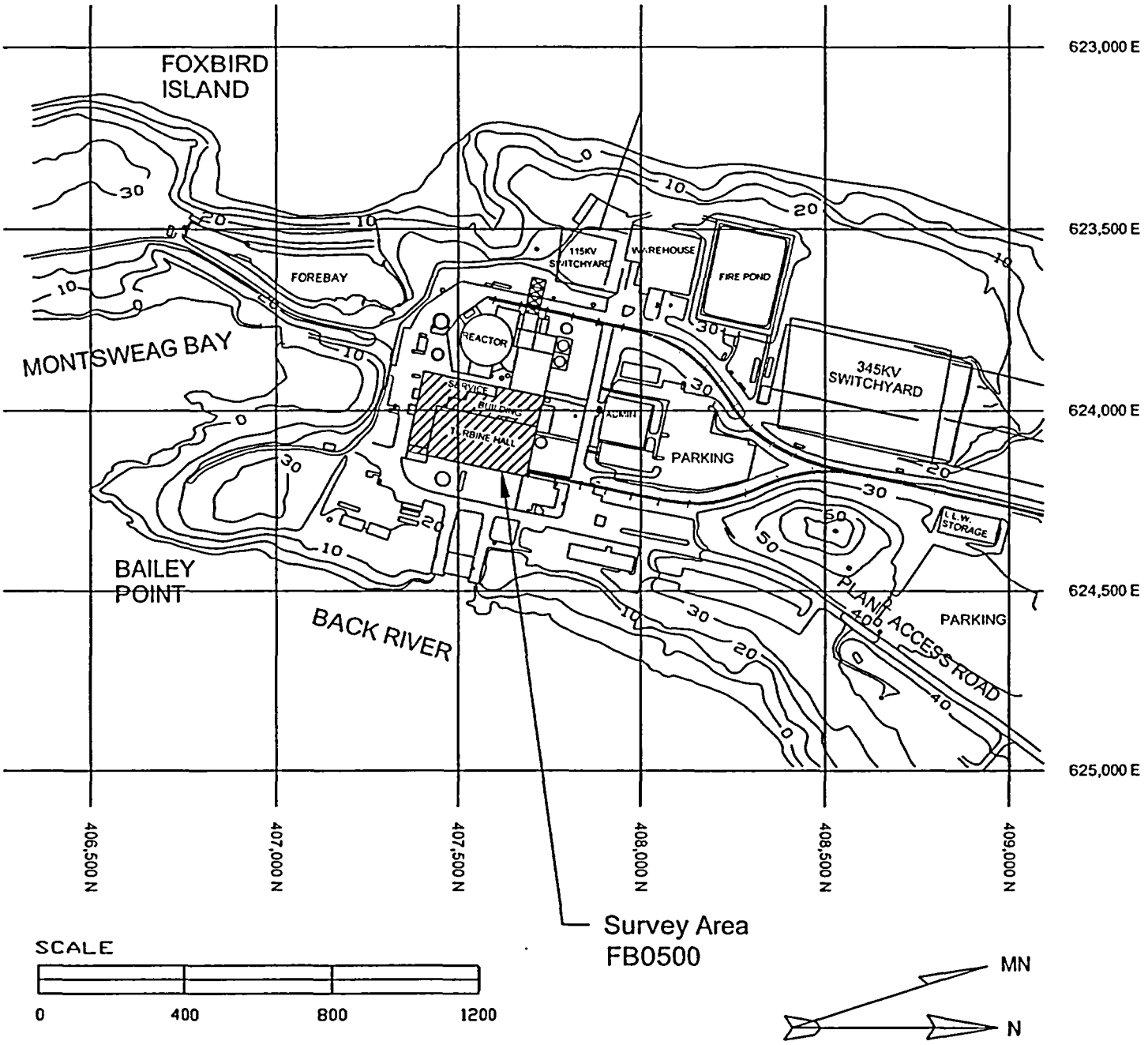
9. MY Letter to the NRC, MN-03-009, February 26, 2003

Attachment 1

Survey Unit Maps

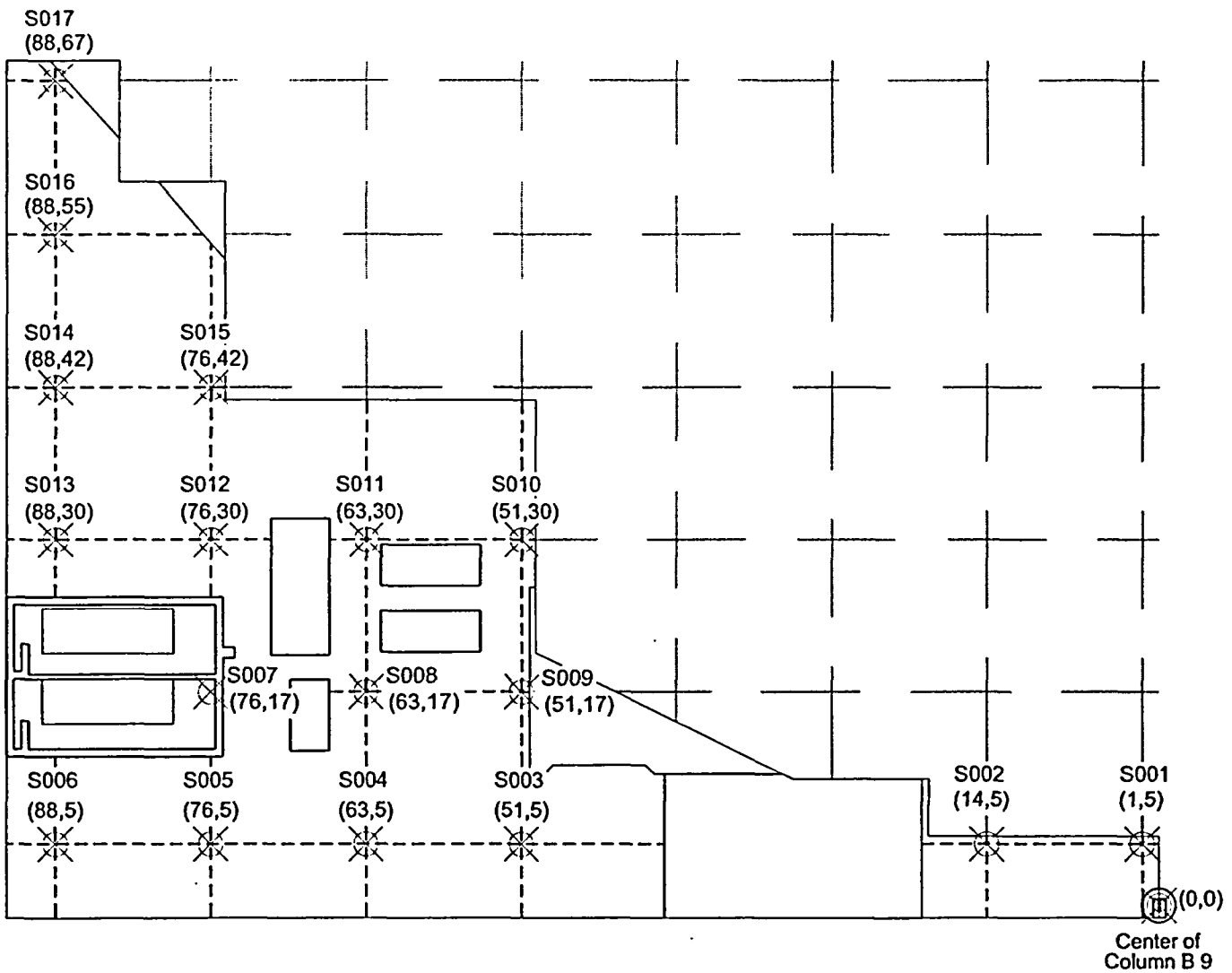
Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB0500-01

Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: Turbine/Service Building Slab



Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB0500-02
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Turbine/Service Bldg Sub Slab	

Turbine/Service Building Sub Slab Unit 1 Soil Sample Locations

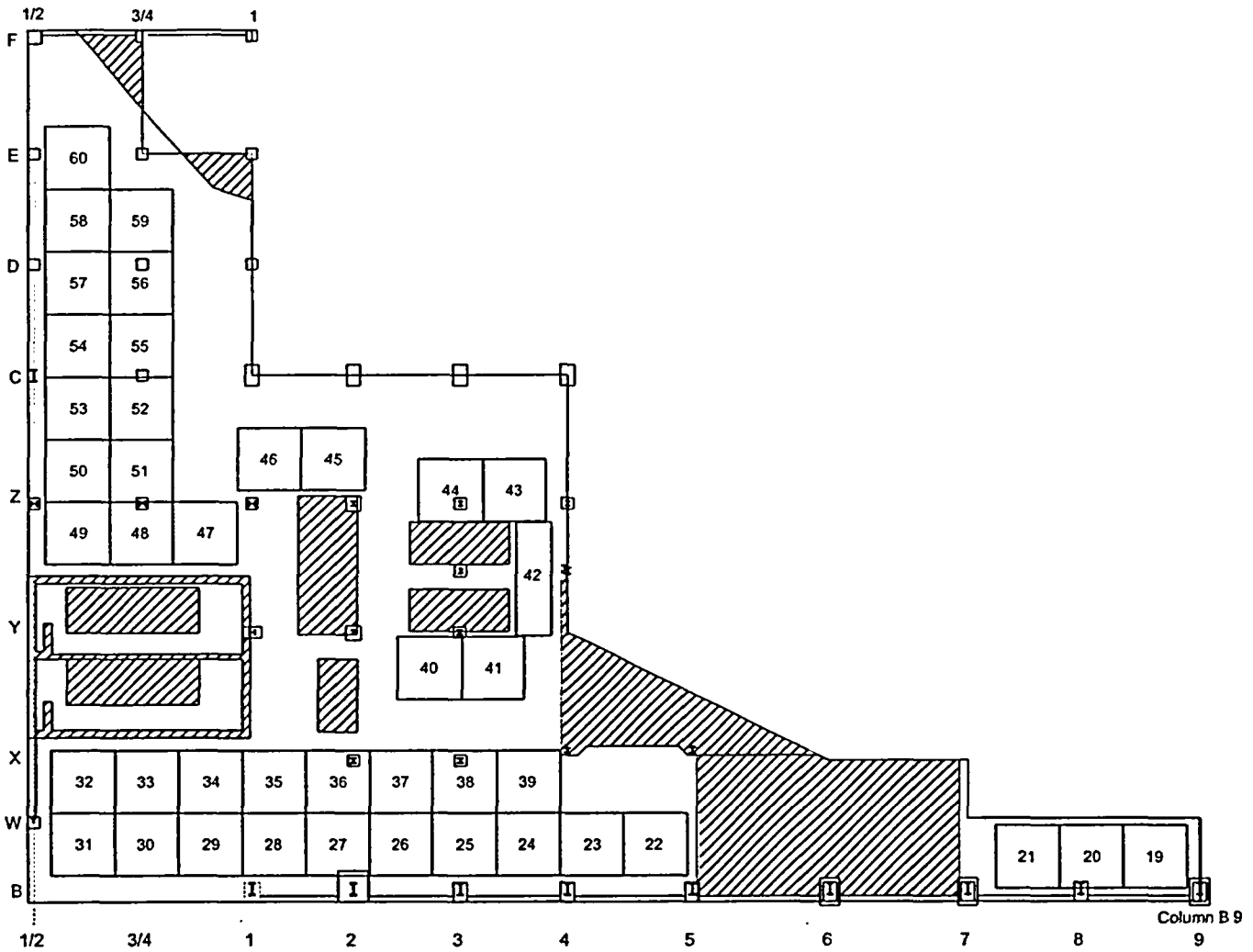


(S,W) - Sample Location as measured from Column B 9 South and West

NOTE: Measurements are in meters.

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB0500-03
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Turbine/Service Bldg Sub Slab	

Turbine/Service Building Sub Slab Unit 1 Soil Scan Locations

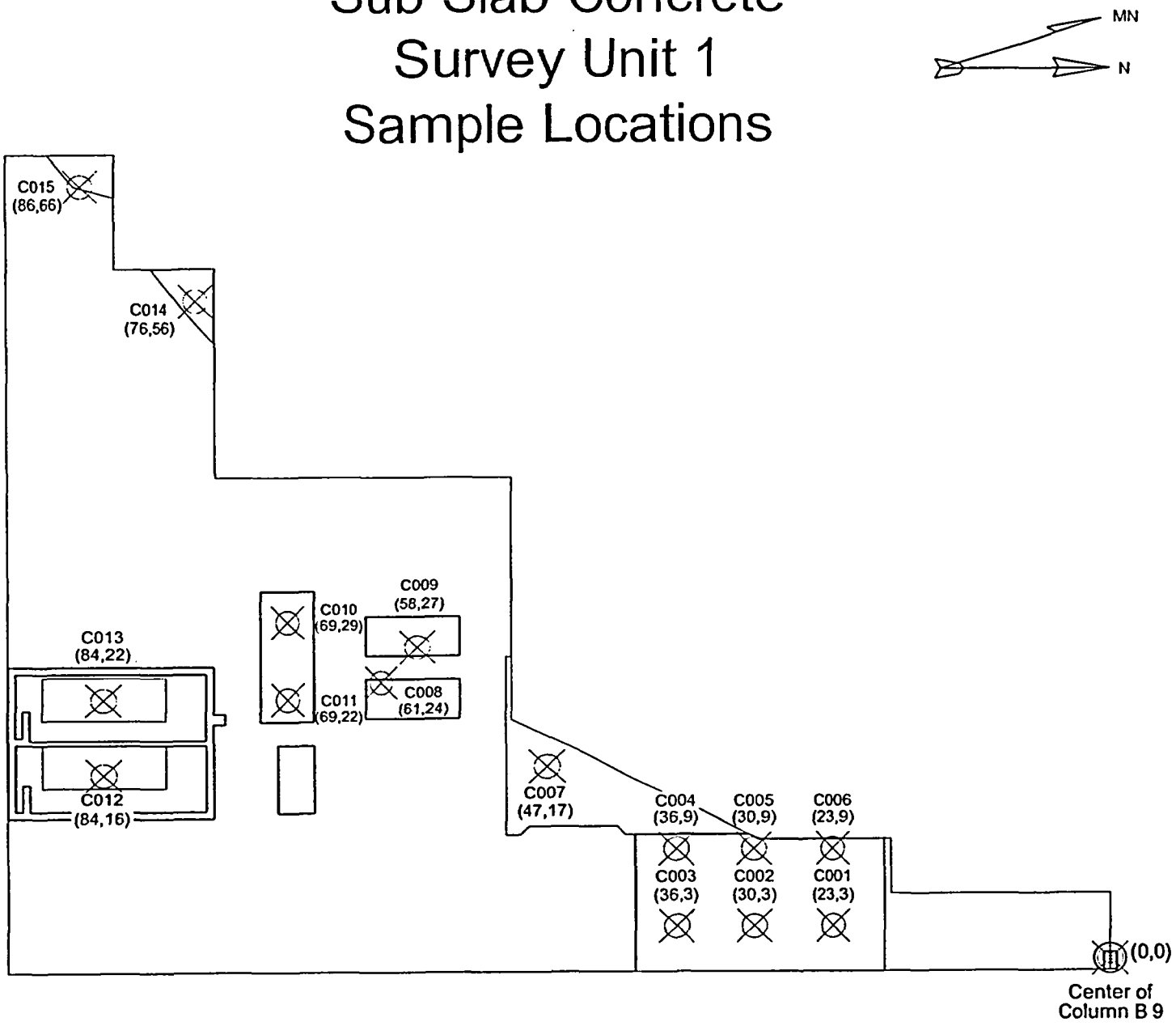


Note: Scan locations are 25 square meters.

- Concrete

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB0500-04
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Turbine/Service Bldg Sub Slab	

Turbine/Service Building Sub Slab Concrete Survey Unit 1 Sample Locations



(S,W) - Sample Location as measured from Column B 9 South and West
NOTE: Measurements are in meters.

Attachment 2

Survey Unit Instrumentation

TABLE 2-1

INSTRUMENT INFORMATION

E-600 S/N	Probe S/N (type)
1606	725332 (SPA-3)
1606	725328 (SPA-3)
1606	726554 (SPA-3)
1606	726560 (SPA-3)
1625	726554 (SPA-3)
1625	726560 (SPA-3)
1647	725328 (SPA-3)
1631	726560 (SPA-3)

HPGe Detectors for Lab Analysis of Volumetric Samples

Detector Number	MDC (pCi/g)
FSS-1	0.05 to 0.11
FSS-2	0.05 to 0.11
DET 2	0.15
DET 3	0.15

TABLE 2-2

INSTRUMENT SCAN MDC, DCGL, AND INVESTIGATION LEVEL

Detector	SPA-3	Comments
Scan MDC (pCi/g)	5.9	LTP Table 5-6, Design Scan MDC (LTP Revision 3 Addenda, Reference 5)
DCGL (pCi/g)	4.2	DCGL for land areas outside the Restricted Area applied (LTP Revision 3 Addenda, Reference 5)
Investigation Level (Alarm Setpoint) cpm	14,900	3.0 sigma of background + DCGL EC-009-01 (Reference 1)

Attachment 3

Investigation Table

TABLE 3-1

INVESTIGATION RESULTS

Original Scan Results		Investigation Results		
Investigation Location	Scan Alarm Value (cpm)	Investigation Number	Maximum Scan Value (cpm)	Investigation Result Cs-137 (pCi/g)
28	15700	XB-0500-1-S001	14200	< 0.047
32	32500	XB-0500-1-S002	12800	< 0.043
33	23300	XB-0500-1-S003	12700	< 0.054
34	17100	XB-0500-1-S004	18900	< 0.046
48	14900	XB-0500-1-S005	13500	< 0.053
49	15000	XB-0500-1-S006	13600	< 0.047
50	15400	XB-0500-1-S007	13400	< 0.040
51	15700	XB-0500-1-S008	13800	< 0.043
52	15000	XB-0500-1-S009	13500	< 0.040
53	15400	XB-0500-1-S010	14800	< 0.046
54	16000	XB-0500-1-S011	14500	< 0.046
55	15000	XB-0500-1-S012	14200	< 0.050
56	15400	XB-0500-1-S013	13800	< 0.047
57	15900	XB-0500-1-S014	15400	< 0.054
58	16100	XB-0500-1-S015	14600	< 0.048
59	15900	XB-0500-1-S016	13500	< 0.046
60	16600	XB-0500-1-S017	19100	< 0.045

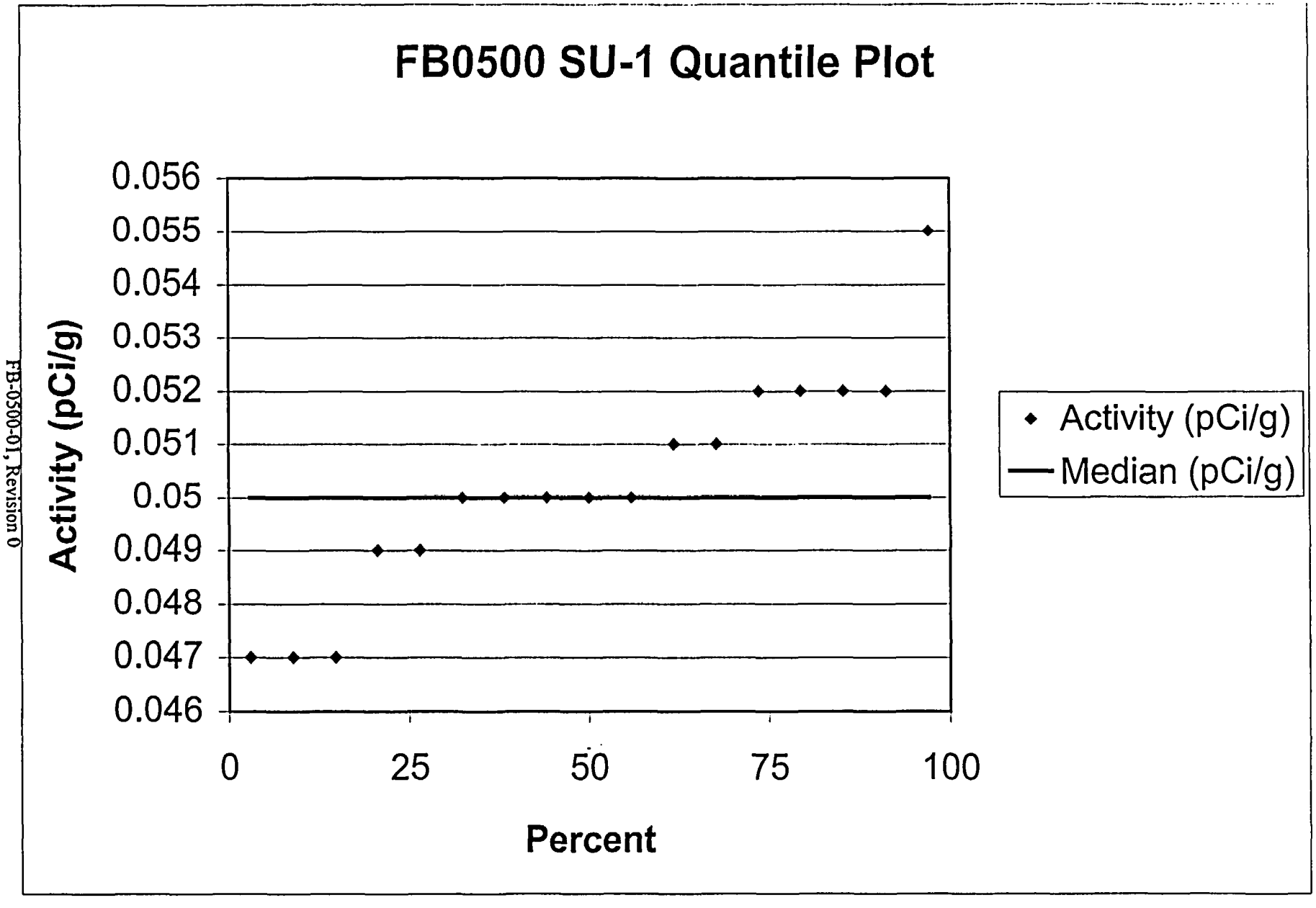
NOTE: All samples were evaluated to be < MDC for Co-60 (i.e., < 0.1 pCi/g)

Attachment 4

Statistical Data

Survey Package FB0500 Unit 1 Soil Sign Test Summary

Evaluation Input Values		Comments
Survey Package:	FB0500	Turbine Building Sub-Slab Soil
Survey Unit:	01	
Evaluator:	GP	
$DCGL_w$:	4.20E+00	
$DCGL_{emc}$:	4.20E+00	
LBGR:	2.10E+00	
Sigma:	1.70E-01	
Type I error:	0.05	
Type II error:	0.05	
Nuclide:	CS-137	
Soil Type:	N/A	
Calculated Values		**Comments**
$Z_{1-\alpha}$:	1.645	
$Z_{1-\beta}$:	1.645	
Sign p:	0.99865	
Calculated Relative Shift:	12.3	
Relative Shift Used:	3.0	Uses 3.0 if Relative Shift is >3
N-Value:	11	
N-Value+20%:	14	
Sample Data Values		**Comments**
Number of Samples:	17	
Median:	5.00E-02	
Mean:	5.02E-02	
Net Sample Standard Deviation:	2.11E-03	
Total Standard Deviation:	2.11E-03	SRSS
Maximum:	5.50E-02	
Sign Test Results		**Comments**
Adjusted N Value:	17	
S+ Value:	17	
Critical Value:	12	
Sign test results:	Pass	
Criteria Satisfaction		**Comments**
Sufficient samples collected:	Pass	
Maximum value <$DCGL_w$:	Pass	
Median value <$DCGL_w$:	Pass	
Mean value <$DCGL_w$:	Pass	
Maximum value <$DCGL_{emc}$:	Pass	
Total Standard Deviation <=Sigma:	Pass	
Criteria comparison results:	Pass	
Final Status		**Comments**
The survey unit passes all conditions:	Pass	


FB0500 SU-1 Quantile Plot
Activity (pCi/g)
0.056
0.055
0.054
0.053
0.052
0.051
0.05
0.049
0.048
0.047
0.046
0
25
50
75
100
Percent
Activity (pCi/g)
Median (pCi/g)

One-Sample T-Test Report

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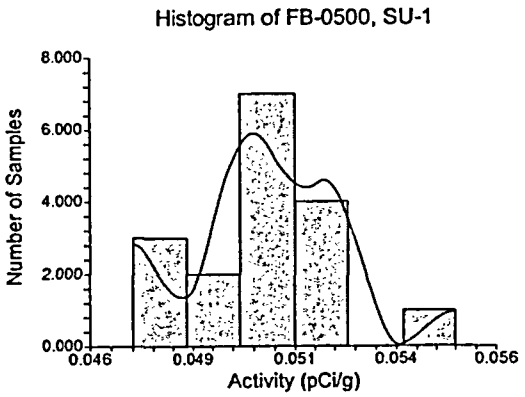
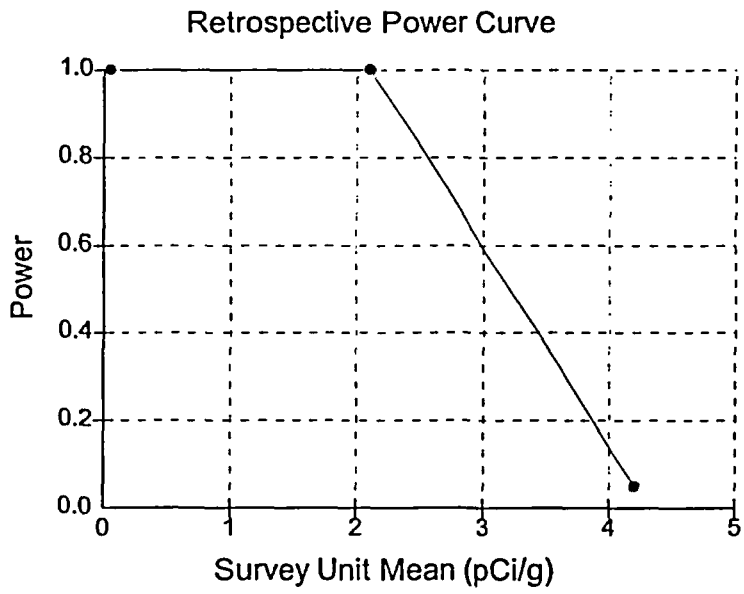
Plots Section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