MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FR-0100 RCA YARD WEST
SURVEY UNIT 1

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A. SURVEY UNIT DESCRIPTION

FR-0100 RCA Yard West Survey Unit 1 occupied the southwest corner of the original Restricted Area "backyard." The 1,845 m^2 area was previously excavated and remediated as part of the decommissioning process. After remediation, the remaining soils were surveyed under final survey packages FR-0111 Survey Units 4, 5, 6 and 7. Following final survey of the excavations, the area was backfilled to grade (approximate 20-ft. El.). Construction debris from Containment demolition activities was temporarily stored in the backfilled area. The debris and approximately 1 to 2 feet of fill material were subsequently removed. The footprint of this area became FR-0100 Survey Unit 1. The southeast portion of this survey unit slopes gently towards the old Forebay area. FR-0100 Survey Unit 1 is located at coordinates 407,450N and 623,650E, using Maine State Coordinate System (West Zone) NAD 1927. The location of the survey unit in relation to the former Containment Building and the surrounding FR 0100 survey units is shown on Map FR0100U1-SITE (Attachment 1).

B. SURVEY UNIT DESIGN INFORMATION

Survey Unit 1 met the LTP Revision 3 definition for a Class 1 survey unit. The survey unit design parameters are shown in Table 1. Given a relative shift of 0.8, it was determined that 40 direct measurements were required for the Sign Test. The measurement locations were based on a systematic square grid with a random start point and are illustrated on map FR0100U1-DIRT (Attachment 1). Direct measurements (soil samples) were collected from required locations and analyzed with laboratory gamma spectroscopy instrumentation.

In accordance with the LTP, scans covering 100% of the 1,845 m^2 area were required for the Class 1 survey unit. This was accomplished by use of an *in situ* gamma spectroscopy detector (ISOCS) configured at a 3-meter distance from the surface to obtain overlapping 28-m^2 fields of view. The detector was positioned perpendicular to the soil surfaces and used a 90-degree collimator to perform the surface scans. Locations of the 94 survey scans are shown on map FR0100U1-SCAN.

The ISOCS scans were configured to ensure 100% scan coverage of all exposed surfaces within Survey Unit 1. The survey instruments used are listed by model and serial number in Attachment 2 (Table 2-1). Scan MDCs are also listed in Attachment 2 (Table 2-2) and are compared to the DCGL, the investigation level, and the $DCGL_{EMC}$. As shown in this table, the scan MDC is less than the scan investigation level, thus providing high confidence (95% or higher) that an elevated area would be detected in the scanning process. Further, since the investigation level was always less than the design $DCGL_{EMC}$, no EMC sample size adjustment was necessary.

TABLE 1

SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area	1,845 m^2	Class 1, < 2,000 m^2
Number of Direct Measurements Required	40	Based on an LBGR of 1.2 pCi/g, sigma[1] of 1.33 pCi/g and a relative shift of 0.8. Type I = Type II = 0.05
Sample Area	46.13 m^2	1,845 m^2 / 40 = 46.13 m^2
Sample Grid Spacing	6.79 m	$(46.13)^{1/2}$
Scan Grid Area	ISOCS scan at 3-meters	Reference 6
Area Factor	1.5	Class 1 Area, LTP Table 6-12
Scan Area	1,845 m^2	Class 1 Area – 100%
Scan Investigation Level	1.0 pCi/g Cs-137 0.36 pCi/g Co-60	ISOCS investigation levels with detector at 3-meter height (Reference 6)
DCGL	2.39 pCi/g Cs-137 0.86 pCi/g Co-60	References 4 and 7
Design $DCGL_{EMC}$	3.59 pCi/g Cs-137 1.29 pCi/g Co-60	DCGL x Area Factor for Class 1 survey unit, per LTP Section 5.6.3

C. SURVEY RESULTS

A total of 40 direct measurements were performed in Survey Unit 1. The results are presented in Table 2. All direct measurements were below the DCGL.

ISOCS gamma scans were performed at 94 locations using an investigation level of 1.0 pCi/g Cs-137 and 0.36 pCi/g Co-60. The gamma scans were performed for a sufficient count time to achieve a Minimum Detectable Activity (MDA) of approximately 40% of the DCGL. All identified scan activity levels were below the investigation levels. Therefore, no investigations were required.

[1] LTP Revision 3, Table 5-1C for RCA Yard West, R0100.

TABLE 2
DIRECT MEASUREMENTS

Sample Number	Cs-137(pCi/g)	Uncertainty (pCi/g)
FR0100011S001	< 3.93E-02	
FR0100011S002	< 3.65E-02	
FR0100011S003	< 5.21E-02	
FR0100011S004	< 4.41E-02	
FR0100011S005	< 4.77E-02	
FR0100011S006	< 4.83E-02	
FR0100011S007	< 4.49E-02	
FR0100011S008	**7.18E-02**	2.99E-02
FR0100011S009	< 4.94E-02	
FR0100011S010	**1.98E-01**	3.19E-02
FR0100011S011	< 5.26E-02	
FR0100011S012	**1.68E-01**	3.28E-02
FR0100011S013	< 4.38E-02	
FR0100011S014	< 3.78E-02	
FR0100011S015	< 4.41E-02	
FR0100011S016	< 4.23E-02	
FR0100011S017	< 4.41E-02	
FR0100011S018	< 6.13E-02	
FR0100011S019	< 5.20E-02	
FR0100011S020	< 4.55E-02	
FR0100011S021	< 4.55E-02	
FR0100011S022	< 4.17E-02	
FR0100011S023	< 3.55E-02	
FR0100011S024	< 4.01E-02	
FR0100011S025	< 4.28E-02	
FR0100011S026	< 3.77E-02	
FR0100011S027	**4.59E-01**	5.94E-02
FR0100011S028	**6.27E-02**	2.44E-02
FR0100011S029	**7.69E-02**	2.85E-02
FR0100011S030	< 5.03E-02	
FR0100011S031	< 4.15E-02	
FR0100011S032	< 6.96E-02	
FR0100011S033	< 5.88E-02	
FR0100011S034	< 5.90E-02	
FR0100011S035	**1.01E-01**	3.24E-02
FR0100011S036	**3.52E-01**	5.05E-02
FR0100011S037	< 5.80E-02	
FR0100011S038	< 5.55E-02	
FR0100011S039	< 4.44E-02	
FR0100011S040	**4.29E-01**	5.43E-02
Mean	**8.46E-02**	
Median	**4.89E-02**	
Standard Deviation	**1.01E-01**	
Range	**3.55E-02 to 4.59E-01**	

"<" indicates MDA value. Bold indicates positive detection value.
Samples were also analyzed for Co-60. All were less than MDA.

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

No investigations were required.

E. SURVEY UNIT DATA ASSESSMENT

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, is provided in Table 2. Of the 40 soil samples collected, 9 identified Cs-137 activity below the DCGL value of 2.39 pCi/g. All other values were below the MDA. Identified sample activities or Minimum Detectable Activities are listed in Table 2. The mean and median activities were less than the DCGL for Cs-137. The maximum reported value was less than 20% 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 mean fallout Cs-137 value (0.19 pCi/g)[2] for disturbed soil from the survey unit sample mean activity (0.0846 pCi/g). This would equate to an annual dose rate of 0.0 mrem/year. However, for purposes of demonstrating compliance with the radiological criteria for license termination and the enhanced State criteria, background activity was not subtracted from the sample analysis activity values.

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. The sample standard deviation is smaller than the design sigma; therefore no additional samples were required.

2. The Quantile Plot was generated from the unity data listed in Table 2. The data set and plot are consistent with expectations for a Class 1 survey unit. All of the measurements are well below the DCGL of 2.39 pCi/g for Cs-137 for land inside the restricted area.

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[2] See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 5).

3. A Histogram Plot was also developed based on the unity data values. This plot shows a log normal distribution with several 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.

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

The survey was designed as a Class 1 land survey area; the FSS results were consistent with that classification. The direct measurement sample standard deviation was less than the design sigma. Thus, a sufficient number of sample measurements were taken and 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 the December 2004 and January 2005 time frame. The design was performed to the criteria of the LTP Revision 3 (References 2 and 4). LTP Change No. 05-001 (Reference 7) modified the Table 6-11 "Contaminated Material DCGL" to reflect an increased Deep Soil DCGL of 0.86 pCi/g for Co-60. This change resulted in an increased dose rate of 2.04 mrem/y from RA contaminated soils at depths greater than 15 cm. The LTP change directly impacted the retrospective dose calculation portion of release records dealing with Restricted Area excavations that were necessitated by radiological remediation.

FR-0100-01 consists of surface soils that cover the excavations previously surveyed under FR-0111 Survey Units 4, 5, 6, and 7. The Deep Soil dose for underlying soils was accounted for in the release records of the FR-0111 packages. As a result, the retrospective dose determination for FR-0100 Survey Unit 1 was based only on the contribution from surface soils within the top 15 cm. No subsequent LTP changes with potential impact to this survey unit need to be evaluated.

I. CONCLUSION

The FSS of this survey unit was designed based on the LTP designation as a Class 1 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 2.39 pCi/g Cs-137.

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 log-normal distribution with several outliers.

The scan survey design for this survey unit was developed in accordance with the LTP Revision 3 Addenda (Reference 1) with significant aspects of the design discussed in Section B and Table 1. ISOCS scans performed at a distance of 3 meters in a systematic grid pattern throughout the survey unit did not identify activity above the scan investigation levels of 1.0 pCi/g Cs-137 and 0.36 pCi/g Co-60.

It is concluded that FR 0100 Survey Unit 1 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

J. REFERENCES

1. Maine Yankee License Termination Plan, Revision 3, October 15, 2002 and Addenda provided by Maine Yankee letter to the NRC, MN-02-061, dated November 26, 2002

2. NRC letter to Maine Yankee, dated February 28, 2003

3. Maine Yankee letter to the NRC, MN-03-049, dated September 11, 2003 (LTP Supplement to LTP Revision 3)

4. Issuance of License Amendment No. 170, NRC letter to Maine Yankee, dated February 18, 2004

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

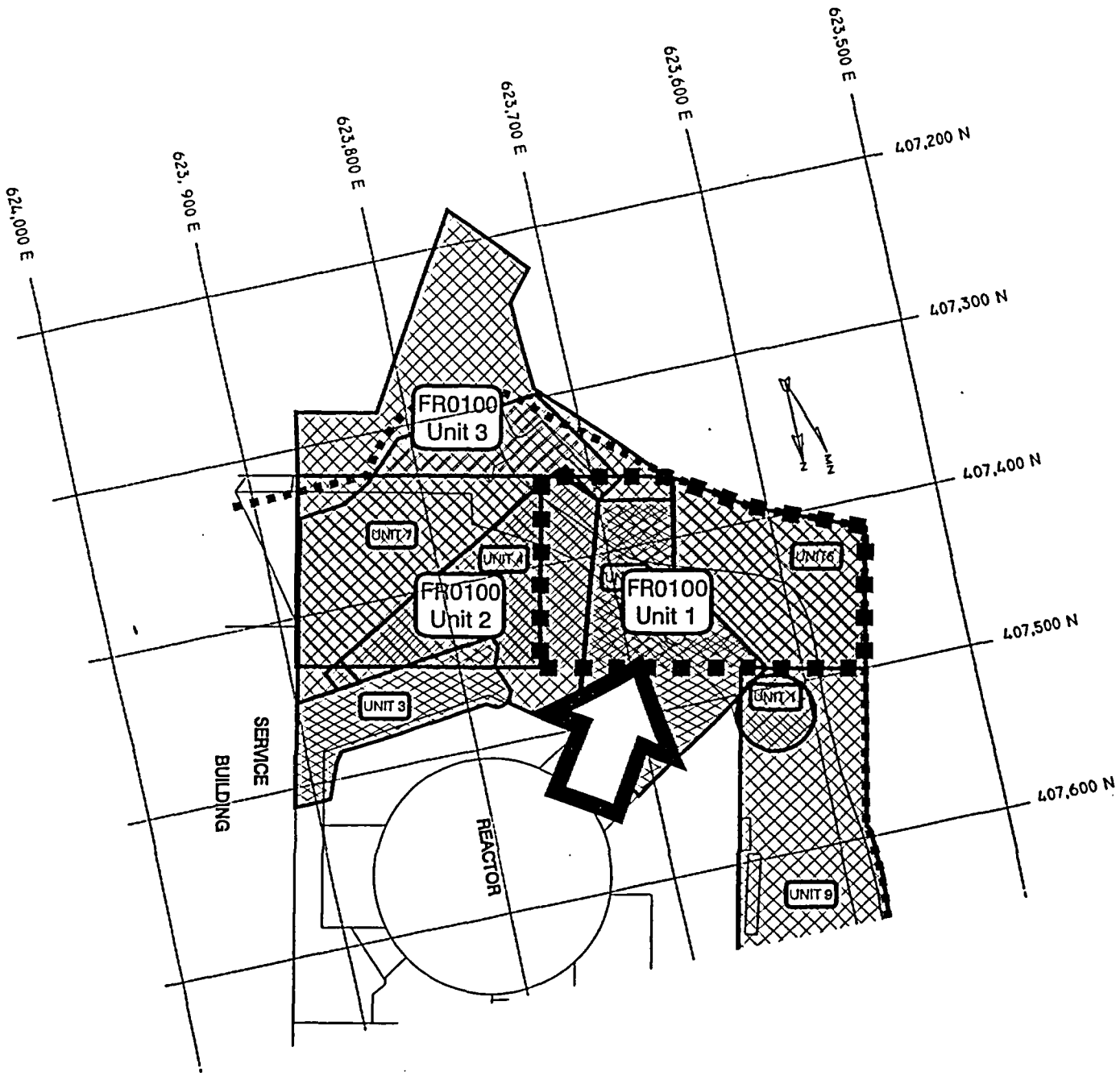
6. Maine Yankee Calculation No. EC-003-04 (MY), Use of In Situ Object Counting System (ISOCS) for FSS Surveys

7. Maine Yankee LTP Change No. 05-001, Deep Soil Co-60 DCGL

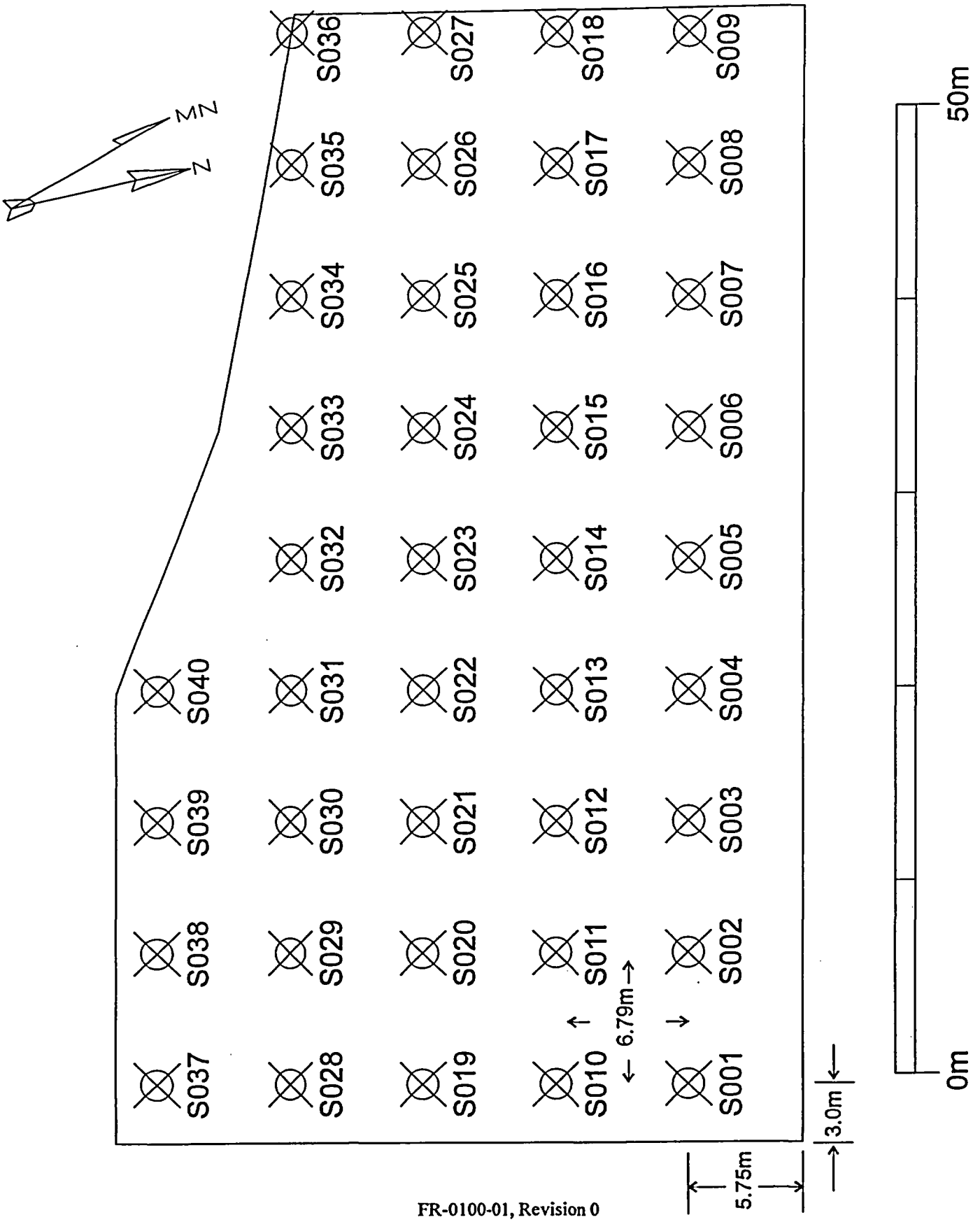
Attachment 1

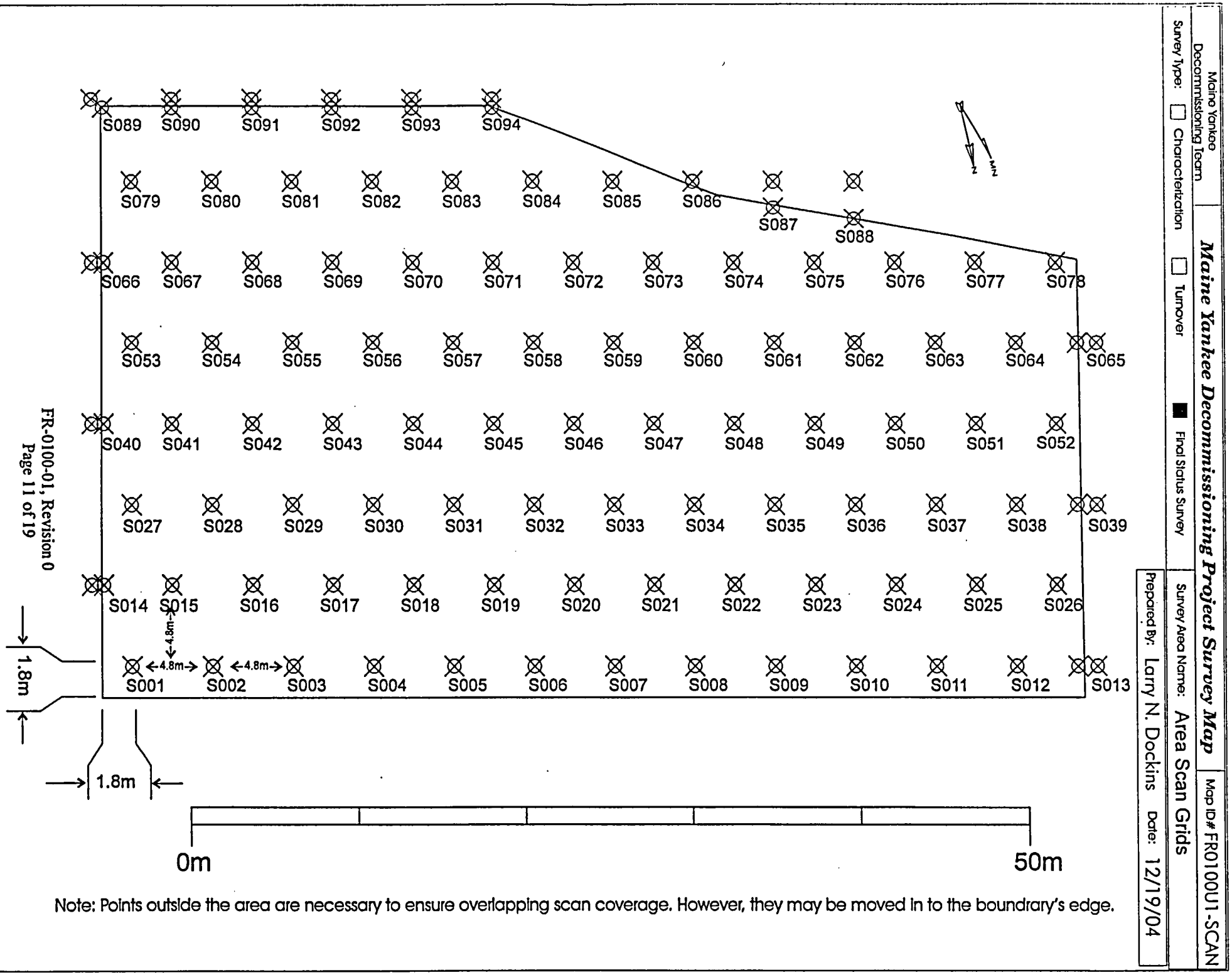
Survey Unit Maps

Maine Yankee Decommissioning Team	***Maine Yankee Decommissioning Project Survey Map***	Map ID# FR0100U1-SITE
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Site Locator	
	Prepared By: Larry N. Dockins Date: 12/19/04	



Maine Yankee Decommissioning Team	**Maine Yankee Decommissioning Project Survey Map**	Map ID# FR0100U1-DIRT
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Directs	
	Prepared By: Larry N. Dockins Date: 12/19/04	





Note: Points outside the area are necessary to ensure overlapping scan coverage. However, they may be moved in to the boundrary's edge.

Attachment 2

Survey Unit Instrumentation

TABLE 2-1

INSTRUMENT INFORMATION

ISOCS Detectors (Field Measurements)

Detector No.	MDC (pCi/g)
7722	0.14 to 0.75
7607	0.14 to 0.75

HPGe Detectors (Laboratory Analysis)

Detector No.	MDC (pCi/g)
FSS1	0.03 to 0.075
FSS2	0.03 to 0.075

TABLE 2-2

INSTRUMENT SCAN MDC, DCGL, INVESTIGATION LEVEL AND $DCGL_{EMC}$

Parameter	Instrument: ISOCS	Comments
Scan MDC	0.14 to 0.75 pCi/g	~ 40% DCGL
DCGL	2.39 pCi/g Cs-137 0.86 pCi/g Co-60	Approved DCGL for land areas inside the Restricted Area, (References 4 and 7)
Investigation Level (ISOCS @ 3 m)	1.0 pCi/g Cs-137 0.36 pCi/g Co-60	(Reference 6)
Design $DCGL_{EMC}$	3.59 pCi/g Cs-137 1.29 pCi/g Co-60	DCGL x Area Factor for Class 1 survey unit, per LTP Section 5.6.3

NOTE: ISOCS scan MDCs were adjusted based on a thin layer of snow within the survey unit. As a conservative measure, a snow layer equivalent to 4 inches of water (worst case) was added to the ISOCS configuration to determine the resulting instrument MDCs. The ISOCS MDCs in Tables 2-1 and 2-2 reflect the conservative adjustment.

Attachment 3

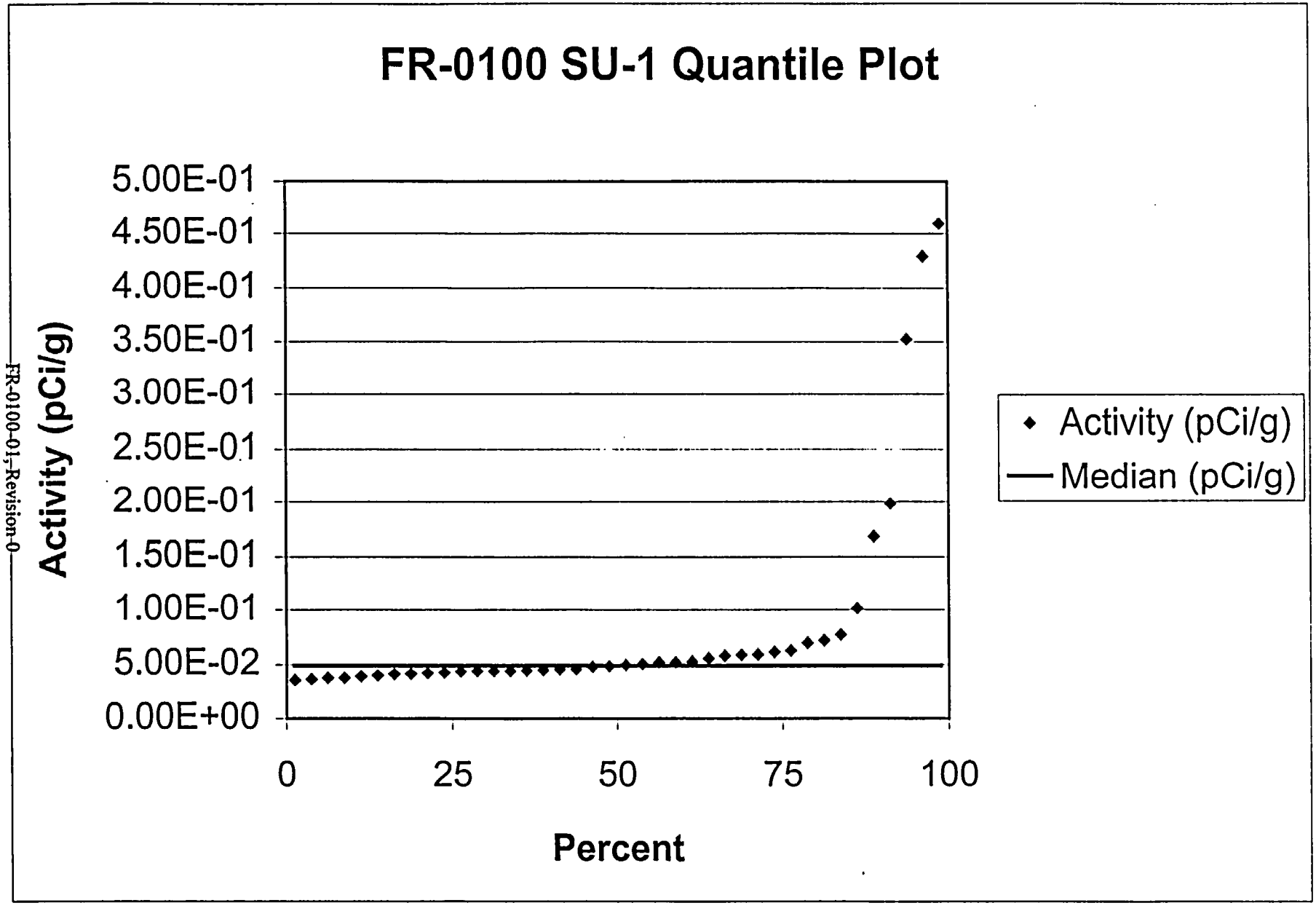
Investigation Table
(No Investigations Performed)

Attachment 4

Statistical Data

Survey Package FR 0100 Unit 1 Soil Sign Test Summary

Evaluation Input Values		Comments
Survey Package:	FR 0100	RCA Yard West
Survey Unit:	01	
Evaluator:	DA	
$DCGL_w$:	2.39E+00	Cs-137 DCGL
$DCGL_{emc}$:	3.59E+00	AF x DCGL
LBGR:	1.20E+00	50% of DCGL
Sigma:	1.33E+00	LTP Rev 3, Table 5-1C for RCA Yd. W
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:	0.788145	
Calculated Relative Shift:	0.8	
Relative Shift Used:	0.8	Uses 3.0 if Relative Shift is >3
N-Value:	33	
N-Value+20%:	40	
Sample Data Values		**Comments**
Number of Samples:	40	
Median:	4.89E-02	
Mean:	8.46E-02	
Net Sample Standard Deviation:	1.01E-01	
Total Standard Deviation:	1.01E-01	
Maximum:	4.59E-01	
Sign Test Results		**Comments**
Adjusted N Value:	40	
S+ Value:	40	
Critical Value:	25	
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	Survey Unit Passes


FR-0100 SU-1 Quantile Plot
Activity (pCi/g)
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
0
25
50
75
100
Percent
Activity (pCi/g)
Median (pCi/g)

One-Sample T-Test Report

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Variable	C2

Plots Section

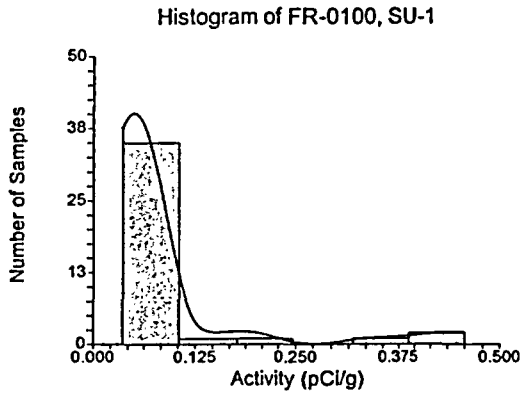

Chart Section