



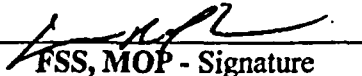


**MAINE YANKEE  
FINAL STATUS SURVEY RELEASE RECORD  
FR-0200 YARD EAST  
SURVEY UNIT 4**

Prepared By:	 FSS Engineer - Signature C.A. Olsen Printed Name	Date: <u>12. may. 2005</u>
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**MAINE YANKEE  
FINAL STATUS SURVEY RELEASE RECORD  
FR-0200 YARD EAST  
SURVEY UNIT 4**

**A. SURVEY UNIT DESCRIPTION**

FR-0200 Yard East Survey Unit 4 was located under a portion of the Turbine Building footprint. The area was previously surveyed as part of FB-0500 Survey Units 1 and 3. The 1363 m<sup>2</sup> area was bordered on the north by FR-0200 Survey Unit 5, on the west by FR-0111 Survey Unit 18, on the south by FR-0200 Survey Unit 3, and on the east by FR-0200 Survey Unit 9. This survey unit is approximately centered near coordinates 624065E and 407515N using the Maine State Coordinate System (West Zone) NAD 1927. The location of the survey unit in relation to the Service Building and the surrounding FR-0200 and FR-0111 survey units is shown on map FR0200-4 REF (Attachment 1).

Survey Unit 4 is an area composed primarily of soil and backfill, and is relatively flat.

**B. SURVEY UNIT DESIGN INFORMATION**

Survey Unit 4 was originally classified per the LTP Revision 4 as a Class 3 survey unit, but was reclassified to Class 1 given its history during decommissioning activities (i.e., located within the expanded Restricted Area boundary).

The survey unit design parameters are shown in Table 1. Given a relative shift of 1.5, eighteen direct measurements would be required for the Sign Test, but 40 were prescribed as a conservative measure. Because the measurement locations were based on a systematic square grid with a random start point, the N=40 design led to a survey unit map with 42 locations which are illustrated on map FR0200-4b (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 1363 m<sup>2</sup> 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<sup>2</sup> fields of view. The ISOCS detector was positioned perpendicular to the surface. Locations of the 69 survey scans are shown on map FR0200-4a and 4c (Attachment 1).

The ISOCS scans were configured to ensure 100% scan coverage of all exposed surfaces within Survey Unit 4. 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<sub>EMC</sub>. 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<sub>EMC</sub>, no EMC sample size adjustment was necessary.

**TABLE 1****SURVEY UNIT DESIGN PARAMETERS**

<b>Survey Unit</b>	<b>Design Criteria</b>	<b>Basis</b>
Area	1363 m <sup>2</sup>	Class 1, < 2,000 m <sup>2</sup>
Number of Direct Measurements Required	18 (40 used)	Based on an LBGR of 2.1 pCi/g, sigma <sup>1</sup> of 1.33 pCi/g, and a relative shift of 1.5. Type I = Type II = 0.05
Sample Area	34 m <sup>2</sup>	1363 m <sup>2</sup> / 40 = 34 m <sup>2</sup>
Sample Grid Spacing	5.8 m	(34) <sup>1/2</sup>
Scan Grid Area	ISOCS scan at 3 meters	See Section B
Area Factor	1.7	Class 1 Area, LTP Table 6-12
Scan Area	1363 m <sup>2</sup>	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 3).
DCGL	4.2 pCi/g Cs-137 1.5 pCi/g Co-60	DCGL applied to surface soils only. (Reference 1)
Design DCGL <sub>EMC</sub>	7.0 pCi/g Cs-137 2.5 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 42 direct measurements were performed in Survey Unit 4. Two samples contained detectable Cs-137 with levels of activity greater than the MDA but below the DCGL. One sample (S032) contained detectable Co-60 activity above the MDA but below the DCGL. All other measurements were below the MDA. The results are presented in Table 2. No investigations were necessary as a result of the direct measurements.

ISOCS gamma scans were performed at 69 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 16% of the DCGL. All identified scan activity levels and MDAs were below the investigation levels. Therefore, no investigation surveys were performed as a result of the scan surveys.

ISOCS scan S069 was added during the course of the survey in order to cover soil exposed from excavating around a Circ Water pipe manway opening. The scan was not intended to survey the pipe itself which was previously surveyed as FD-0500 Survey Unit 2.

<sup>1</sup> LTP Revision 4, Table 5-1C for RCA Yard West, R0100 (conservative)

**TABLE 2**  
**DIRECT MEASUREMENTS**

Sample Number	Cs-137 (pCi/g)	Uncertainty (pCi/g)	Co-60 (pCi/g)	Uncertainty (pCi/g)	Unitized Value
FR0200041S001	< 4.48E-02		< 4.25E-02		3.90E-02
FR0200041S002	< 4.86E-02		< 5.22E-02		4.64E-02
FR0200041S003	< 4.68E-02		< 4.25E-02		3.95E-02
FR0200041S004	< 4.75E-02		< 5.33E-02		4.68E-02
FR0200041S005	< 5.77E-02		< 6.10E-02		5.44E-02
FR0200041S006	< 4.90E-02		< 4.42E-02		4.11E-02
FR0200041S007	< 4.55E-02		< 4.51E-02		4.09E-02
FR0200041S008	< 4.77E-02		< 5.22E-02		4.62E-02
FR0200041S009	< 4.23E-02		< 4.89E-02		4.27E-02
FR0200041S010	< 4.56E-02		< 4.82E-02		4.30E-02
FR0200041S011	< 3.68E-02		< 4.38E-02		3.80E-02
FR0200041S012	< 6.61E-02		< 6.49E-02		5.90E-02
FR0200041S013	< 4.05E-02		< 4.27E-02		3.81E-02
FR0200041S014	< 4.95E-02		< 5.09E-02		4.57E-02
FR0200041S015	< 3.90E-02		< 4.19E-02		3.72E-02
FR0200041S016	< 4.75E-02		< 5.62E-02		4.88E-02
FR0200041S017	< 4.41E-02		< 4.95E-02		4.35E-02
FR0200041S018	< 4.87E-02		< 5.01E-02		4.50E-02
FR0200041S019	< 4.55E-02		< 4.59E-02		4.14E-02
FR0200041S020	< 5.24E-02		< 5.51E-02		4.92E-02
FR0200041S021	< 4.22E-02		< 4.45E-02		3.97E-02
FR0200041S022	< 5.36E-02		< 5.86E-02		5.18E-02
FR0200041S023	< 5.05E-02		< 5.22E-02		4.68E-02
FR0200041S024	<b>2.11E-01</b>	<b>4.55E-02</b>	< 7.39E-02		9.94E-02
FR0200041S025	< 4.29E-02		< 4.53E-02		4.04E-02
FR0200041S026	< 5.06E-02		< 5.16E-02		4.64E-02
FR0200041S027	< 3.78E-02		< 4.96E-02		4.21E-02
FR0200041S028	< 5.32E-02		< 6.28E-02		5.45E-02
FR0200041S029	< 5.41E-02		< 4.78E-02		4.47E-02
FR0200041S030	< 4.30E-02		< 4.80E-02		4.22E-02
FR0200041S031	< 5.10E-02		< 5.45E-02		4.85E-02
FR0200041S032	< 5.13E-02		<b>1.70E-01</b>	<b>2.72E-02</b>	<b>1.26E-01</b>
FR0200041S033	<b>5.58E-02</b>	<b>3.13E-02</b>	< 8.71E-02		7.14E-02
FR0200041S034	< 3.80E-02		< 4.94E-02		4.20E-02
FR0200041S035	< 4.48E-02		< 4.92E-02		4.35E-02
FR0200041S036	< 5.30E-02		< 5.57E-02		4.98E-02
FR0200041S037	< 4.53E-02		< 4.94E-02		4.37E-02
FR0200041S038	< 3.74E-02		< 4.24E-02		3.72E-02
FR0200041S039	< 4.99E-02		< 5.61E-02		4.93E-02
FR0200041S040	< 4.14E-02		< 4.22E-02		3.80E-02
FR0200041S041	< 4.10E-02		< 4.65E-02		4.08E-02
FR0200041S042	< 5.32E-02		< 5.29E-02		4.79E-02
Mean	5.11E-02		5.43E-02		4.84E-02
Median	4.75E-02		4.96E-02		4.42E-02
Standard Deviation	2.60E-02		2.03E-02		1.62E-02
Range	3.68E-02 to 2.11E-01		4.19E-02 to 1.70E-01		3.72E-02 to 1.26E-01

“<” indicates MDA value. Bold indicates positive detection value

## D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

Based on the scan 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. Positively detected values are bolded in the table. Of the 42 soil samples collected, two identified Cs-137 activity below the DCGL value of 4.2 pCi/g and one sample identified Co-60 activity below the DCGL value of 1.5 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 DCGLs for Cs-137 and Co-60. The average of the unity measurements was 0.048 indicating that the direct measurements averaged 4.8% of the DCGL limit.

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)<sup>2</sup> for disturbed soil from the survey unit sample mean activity (0.051 pCi/g). This would equate to an annual dose rate of 0.0 mrem/year. Taking into account the average residual contamination for Co-60, the annual dose rate would equate to 0.36 mrem/yr<sup>3</sup>. Also, for purposes of demonstrating compliance with the radiological criteria for license termination and the enhanced State of Maine 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. The direct measurements clearly pass the sign test. The subject release criteria have been satisfied. In addition, the sample standard deviation is smaller than the design sigma; therefore no additional samples were required.

<sup>2</sup> See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 2).

<sup>3</sup> This annual dose is based on LTP Section 6.7, which shows the contaminated soil contribution (for soils contaminated at the DCGL) to be 10 mrem/y. Therefore the annual Co-60 dose rate (using the Co-60 DCGL of 1.5 pCi/g outside the original RA and the mean Co-60 direct activity value of 0.0543 pCi/g) would equate to

$$\text{Annual Dose Rate} = 10 \times \left( \frac{0.0543}{1.5} \right) = 0.36 \text{ mrem / y.}$$

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 below the DCGLs of 4.2 pCi/g (Cs-137) and 1.5 pCi/g (Co-60) for land outside the original Restricted Area where only surface soil contamination is present.
3. A Histogram Plot was also developed. This plot shows a log-normal distribution with two 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 4 was designed, performed, and evaluated in the April 2005- May 2005 time frame. The design was performed to the criteria of the LTP Revision 4 (Reference 1). 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 DCGLs of 4.2 pCi/g Cs-137 and 1.5 pCi/g Co-60. There were no investigations required based on the direct measurements.

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 two outliers.

The scan survey design for this survey unit was developed in accordance with the LTP Revision 4 (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. Therefore, no investigations were required as a result of the scan process.

It is concluded that FR-0200 Survey Unit 4 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

## **J. REFERENCES**

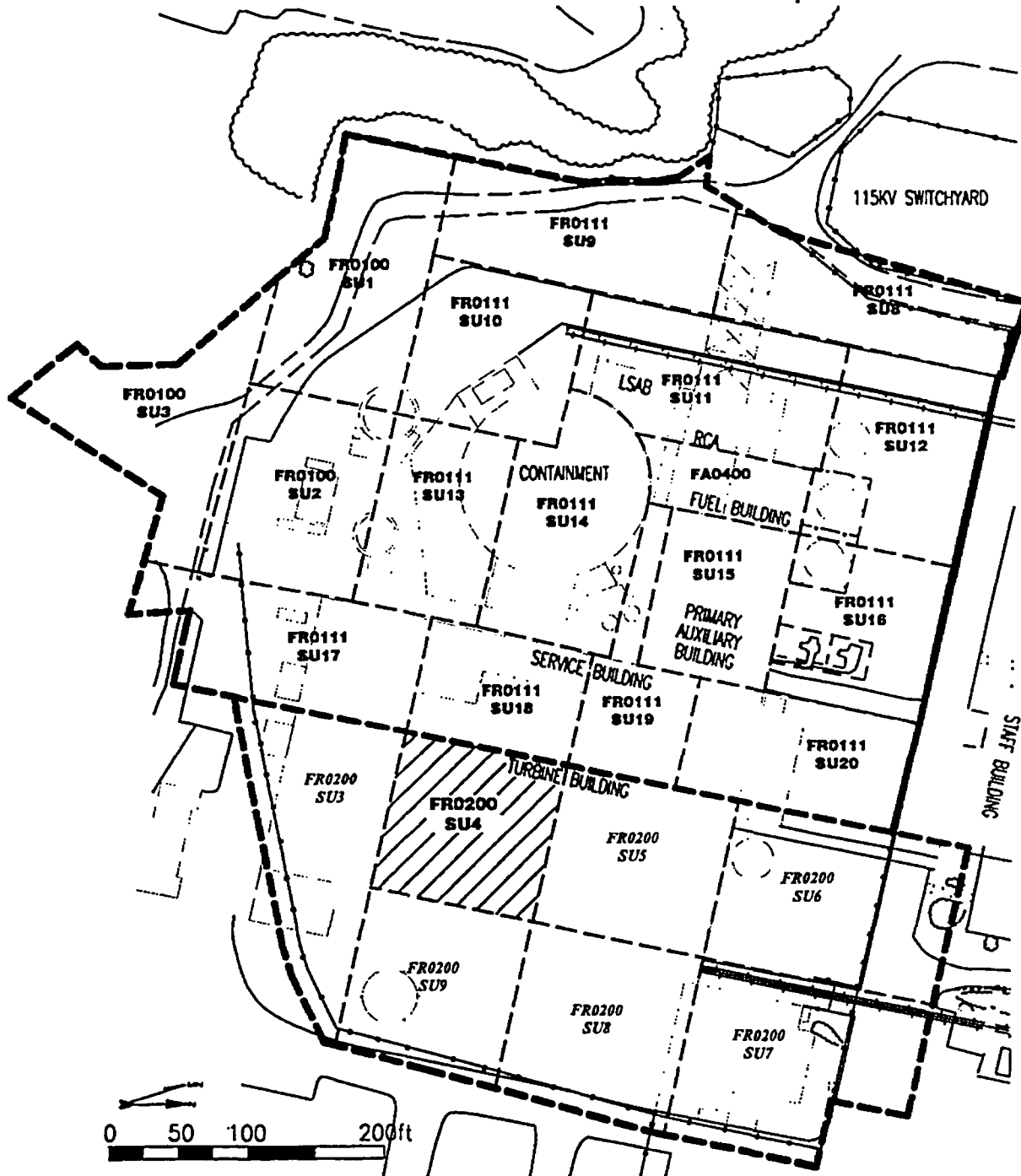
1. Maine Yankee License Termination Plan, Revision 4, February 28, 2005 provided by Maine Yankee letter to the NRC, MN-05-010
2. Maine Yankee Procedure PMP 6.7.8, FSS Data Processing and Reporting, Attachment E, Approach for Dealing With Background Radioactivity for Maine Yankee Final Status Surveys
3. Maine Yankee Calculation No. EC-003-04, Use of Canberra In Situ Object Counting System (ISOCS) for FSS Surveys

**Attachment 1**  
**Survey Unit Maps**



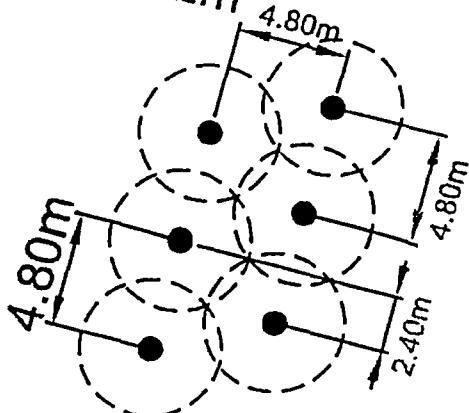
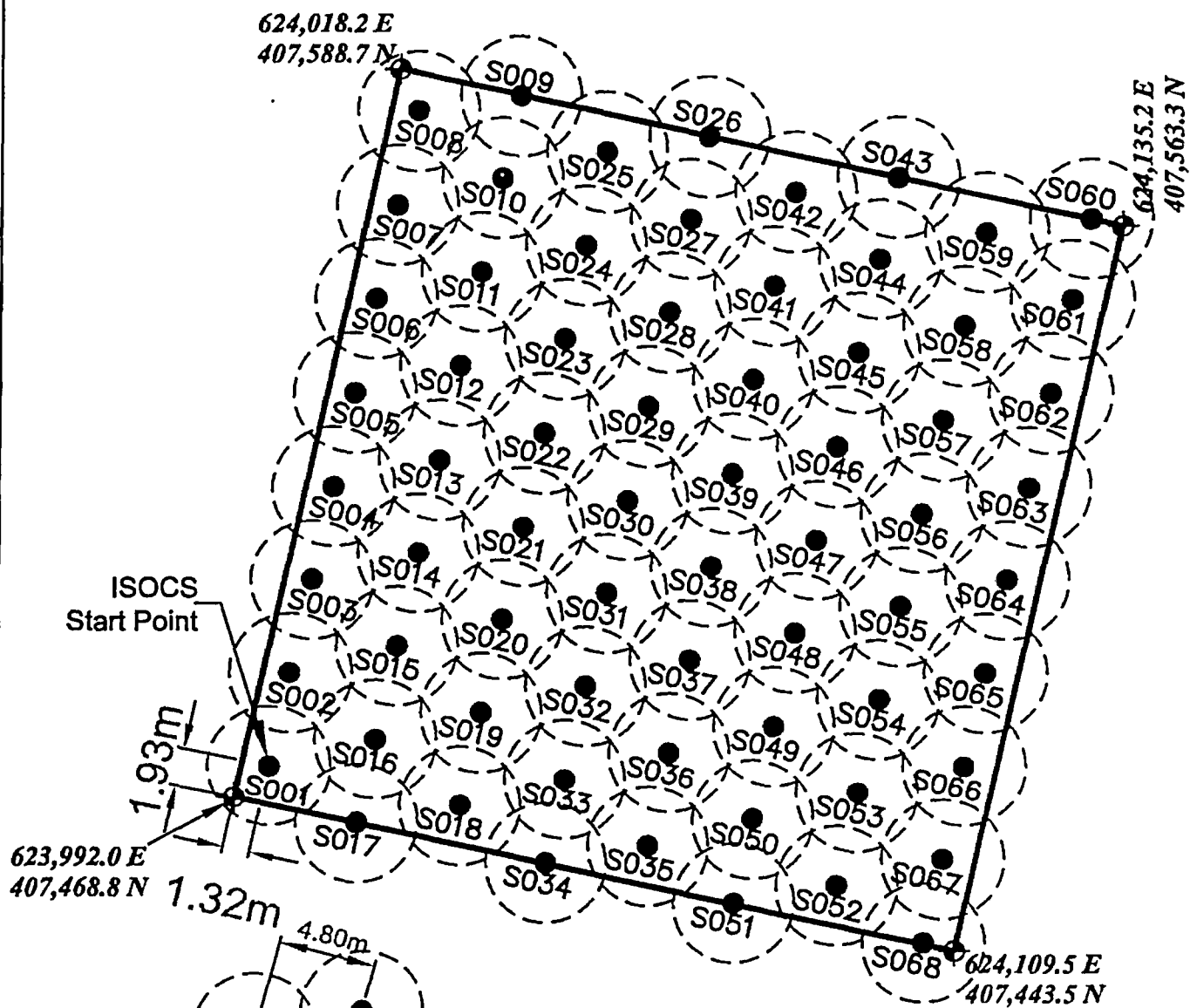
Survey Type:  Characterization  Turnover  Final Status Survey | Survey Area Name: Yard East Soils

### Final Status Survey FR0200 SU4 Reference Map



Survey Type:  Characterization  Turnover  Final Status Survey | Survey Area Name: Yard East Soils

### Final Status Survey FR0200 SU4: Yard East Soils ISOCS Scans S001 - S068

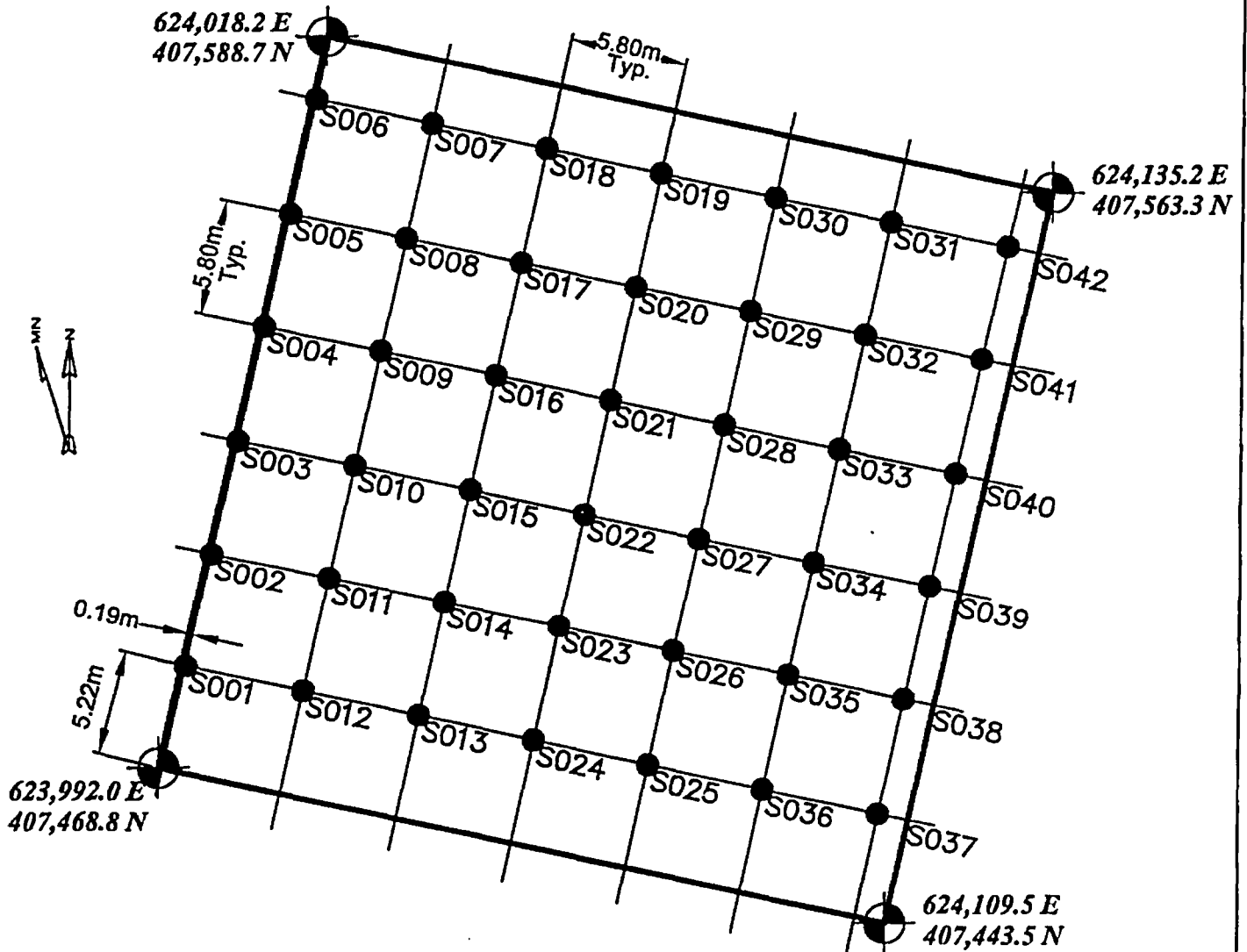


**Typical ISOCS Spacing  
(Maximum)**

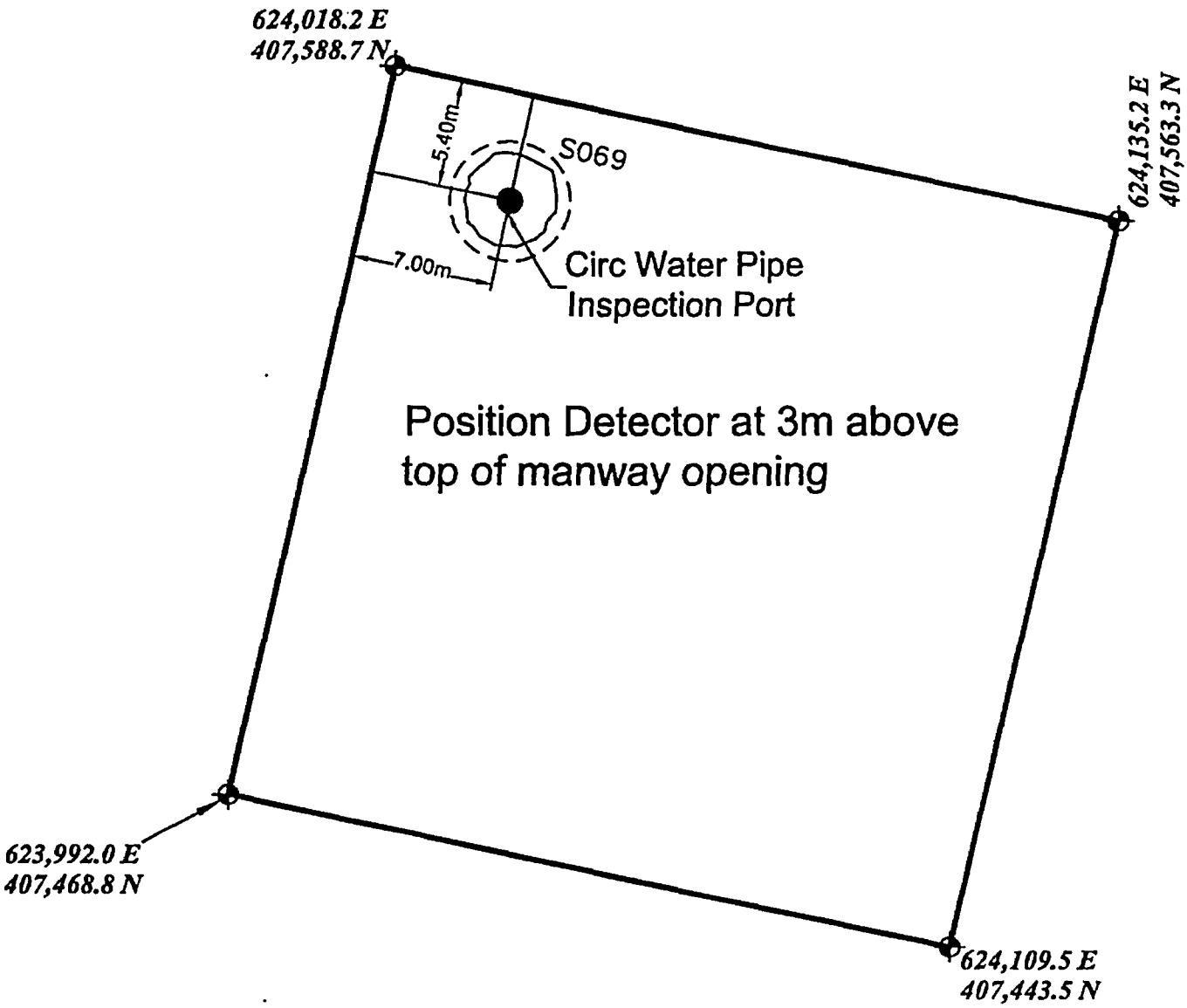


Survey Type:  Characterization  Turnover  Final Status Survey | Survey Area Name: Yard East Soils

### Final Status Survey FR0200 SU4: Yard East Soils Direct Points S001 - S042



### Final Status Survey FR0200 SU4: Yard East Soils ISOCS Scans S069



**Attachment 2**  
**Survey Unit Instrumentation**

**TABLE 2-1**

**INSTRUMENT INFORMATION**

**ISOCS Detectors (Field Measurements)**

Detector No.	MDC (pCi/g)
7607	0.11 to 0.35
7780	0.15 to 0.30
7897	0.10 to 0.31

**HPGe Detectors (Laboratory Analysis)**

Detector No.	MDC (pCi/g)
FSS1	0.04 to 0.09
FSS2	0.04 to 0.06

**TABLE 2-2**

**INSTRUMENT SCAN MDC, DCGL,  
INVESTIGATION LEVEL AND DCGL<sub>EMC</sub>**

Parameter	Instrument: ISOCS	Comments
Scan MDC	0.16 to 0.35 pCi/g Cs-137 0.10 to 0.24 pCi/g Co-60	~ 16% DCGL
DCGL	4.2 pCi/g Cs-137 1.5 pCi/g Co-60	Approved DCGL for land areas inside the Restricted Area, (Reference 1)
Investigation Level (ISOCS @ 3 m)	1.0 pCi/g Cs-137 0.36 pCi/g Co-60	(Reference 3)
Design DCGL <sub>EMC</sub>	7.0 pCi/g Cs-137 2.5 pCi/g Co-60	DCGL x Area Factor for Class 1 survey unit, per LTP Section 5.6.3

**Attachment 3**  
**Investigation Table**  
**(None Required)**

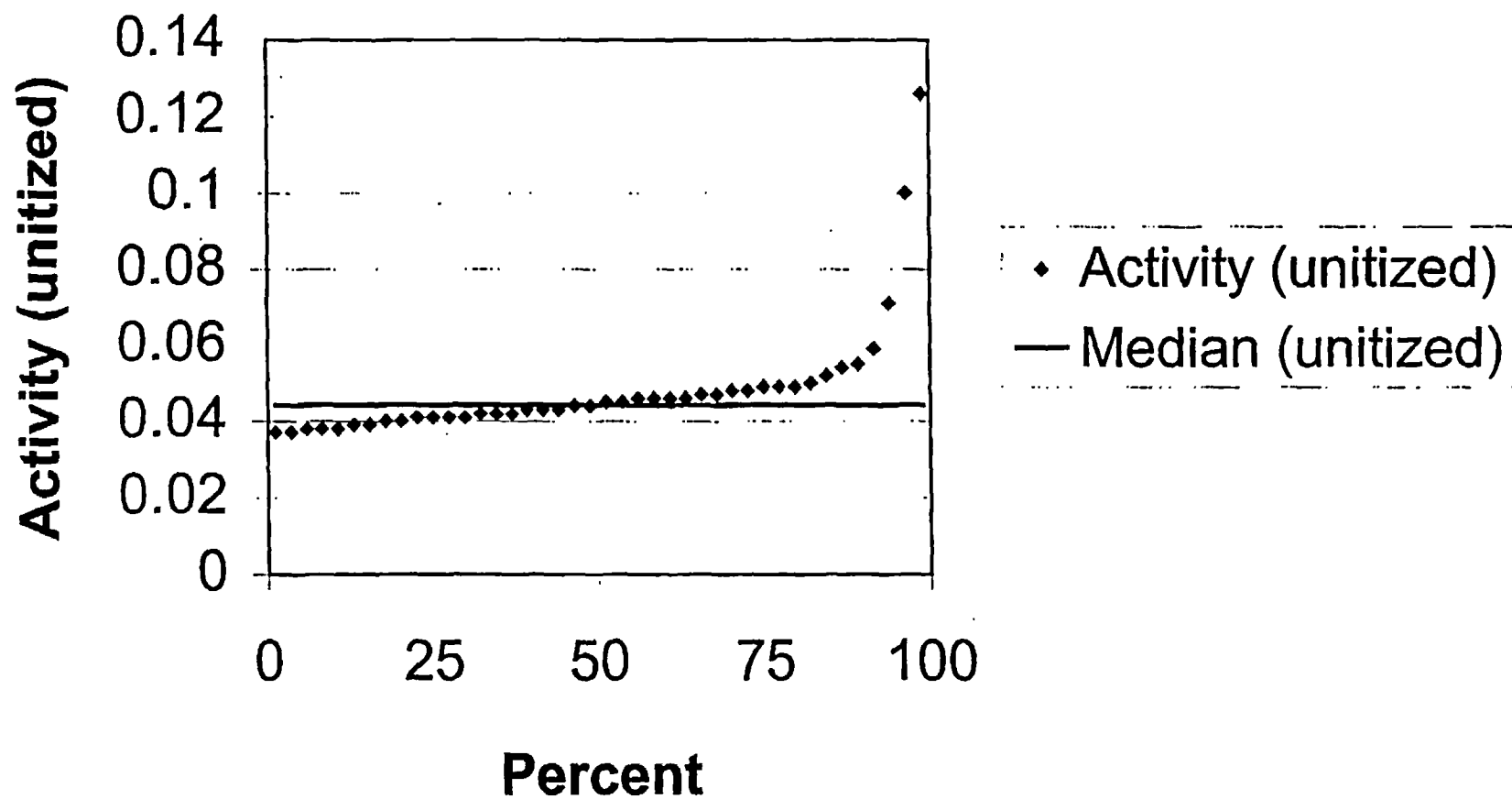
**Attachment 4**  
**Statistical Data**



### Survey Package FR0200 Unit 4 UNITY Soil Sign Test Summary

Survey Package:	FR0200	
Survey Unit:	04	
Evaluator:	Andy Olsen	
DCGL <sub>w</sub> :	1.00E+00	Unity
DCGL <sub>emc</sub> :	1.70E+00	AF = 1.7
LBGR:	5.00E-01	
Sigma:	3.20E-01	(1.33 pCi/g /4.2 pCi/g)
Type I error:	0.05	
Type II error:	0.05	
Nuclide:	UNITY	
Soil Type:	N/A	
Z <sub>1-α</sub> :	1.645	
Z <sub>1-β</sub> :	1.645	
Sign p:	0.933193	
Calculated Relative Shift:	1.5	
Relative Shift Used:	1.5	Uses 3.0 if Relative Shift is >3
N-Value:	15	
N-Value+20%:	18	
Number of Samples:	42	
Median:	4.42E-02	
Mean:	4.84E-02	
Net Sample Standard Deviation:	1.62E-02	
Total Standard Deviation:	1.62E-02	Sum of samples and reference
Maximum:	1.26E-01	
Adjusted N Value:	42	
S+ Value:	42	
Critical Value:	26	
Sign test results:	Pass	
Sufficient samples collected:	Pass	
Maximum value <DCGL <sub>w</sub> :	Pass	
Median value <DCGL <sub>w</sub> :	Pass	
Mean value <DCGL <sub>w</sub> :	Pass	
Maximum value <DCGL <sub>emc</sub> :	Pass	
Total Standard Deviation <=Sigma:	Pass	
Criteria comparison results:	Pass	
The survey unit passes all conditions:	Pass	Survey Unit Passes

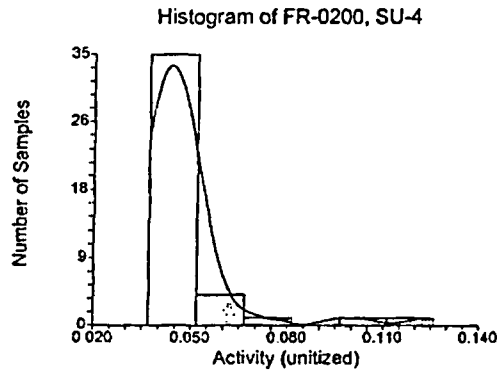
# FR0200 SU-4 Quantile Plot



**One-Sample T-Test Report**

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Database  
Variable C2

**Plots Section**



One-Sample T-Test Power Analysis

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Chart Section

