MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FB-0500 TURBINE BUILDING FOOTPRINT
SURVEY UNIT 4

Prepared By:	for M. Vanags FSS Engineer - Signature George Pillsbury Printed Name	Date: 9/23/04
Reviewed By:	FSS Specialist - Signature Robert Tozzie Printed Name	Date: 10/21/04
Reviewed By:	D. Anderson Independent Reviewer - Signature D. ANDERSON Printed Name	Date: 11/11/04
Approved By:	Superintendent, FSS - Signature George Pillsbury Printed Name	Date: 11/11/04
Approved By:	FSS, MOP - Signature James R. Fowler Printed Name	Date: 11/17/04

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SURVEY UNIT 4

A. SURVEY UNIT DESCRIPTION

Survey area FB-0500 is located in the footprint of the former Turbine Building as shown on site map FB 0500-04 SITE in Attachment 1. The northeast corner of the Turbine Building is located at 407,685 N and 624,185 E using the Maine State Coordinate System (West Zone) NAD 1927. Initially the area consisted of two Class 2 survey units, however upon removal of a Service Water discharge pipe in Survey Unit 3, soil contamination was found and the affected area was designated as a Class 1 area. The reclassified area was designated Survey Unit 4. The area of Survey Unit 4 was 50 m^2. While the survey area was located inside the Industrial Area of the site, it was outside of the plant's radiologically restricted area.

B. SURVEY UNIT DESIGN INFORMATION

Survey Unit 4 consisted of sub-slab soil and concrete footings. In order to conservatively bound the affected area of elevated activity (~ 25 m^2), the survey unit was extended to 50 m^2. Because contamination above the DCGL was found, the area was designated as Class 1.

The survey unit design parameters are summarized in Table 1. Fourteen direct measurements were required for the Sign Test. The starting point of the direct measurement grid was randomly generated and resulted in 18 direct measurement locations shown on map FB 0500-04c (Attachment 1). All direct measurements consisted of soil samples obtained at the required locations. The samples are analyzed with laboratory gamma spectroscopy.

The 100% scan requirement for a Class 1 survey unit was accomplished by scanning all thirteen-grid locations, as shown on map FB 0500-04 (Attachment 1).

The survey instruments used, their MDCs, and scan investigation levels are provided in Attachment 2. Since the design $DCGL_{EMC}$ is greater than the scan MDC, no sample size adjustment is required.

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.

TABLE 1

SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area	50 m^2	Class 1
Number of Direct Measurements Required	14 (18 taken)[1]	Based on an adjusted LBGR of 1.88 pCi/g, sigma[2] of 0.17 pCi/g, and a relative shift of 3.0. Type I = Type II = 0.05
Sample Area	3.57 m^2	50 m^2 / 14
Sample Grid Spacing	1.8 m x 1.8 m	Class 1 Area
Scan Grid Area	4 m^2 maximum	Class 1 Area
Area Factor	4.4	Class 1 Area, LTP Table 6-12
Scan Survey Area	100%	Class 1 Area
Background		
SPA-3 (scan)	Average background $\pm$ 1000 c/m	DI 6-150, EC-009-01, LTP Section 5
Scan Investigation Level	3 sigma of background See Table 2-2	EC-009-01 (Reference 1)
DCGL[3]	2.39 pCi/g	LTP Activated Concrete Amendment (References 3 and 4)
Design $DCGL_{EMC}$	10.5 pCi/g	Class 1 Area

C. SURVEY UNIT RESULTS

As required 18 direct soil samples were obtained. The direct measurement data are presented in Table 2. All direct measurements were below the DCGL.

Of the 13 grids scanned in Survey Unit 4, three grids alarmed and were investigated as discussed in Section D.

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1 This survey unit was initially designed for N = 14 samples. The N = 14 led to a survey unit map with 18 locations on the systematic grid.

2 LTP Table 5-1C, footnote a, R0200 Yard East

3 While this survey unit was outside the plant's RA (as discussed in Section A), the DCGL of 2.39 pCi/g was conservatively selected for the survey unit design due to the possible dose contamination from contaminated service water discharging piping.

TABLE 2

DIRECT MEASUREMENTS

Sample Number	Cs-137 (pCi/g)	Uncertainty	Co-60 (pCi/g)	Uncertainty	Unitized Value of Unity Rule
FB0500-04-1-S001SS	< 2.57E-02	N/A	< 2.77E-02	N/A	4.30E-02
FB0500-04-1-S002SS	**1.11E-01**	± 2.67E-02	**2.68E-01**	± 2.63E-02	3.58E-01
FB0500-04-1-S003SS	**1.77E-01**	± 2.70E-02	**4.22E-01**	± 3.13E-02	5.65E-01
FB0500-04-1-S004SS	**1.81E-01**	± 3.09E-02	**4.68E-01**	± 3.74E-02	6.20E-01
FB0500-04-1-S005SS	< 3.00E-02	N/A	< 2.31E-02	N/A	3.94E-02
FB0500-04-1-S006SS	< 2.74E-02	N/A	< 3.62E-02	N/A	5.36E-02
FB0500-04-1-S007SS	< 3.17E-02	N/A	< 3.53E-02	N/A	5.43E-02
FB0500-04-1-S008SS	< 2.13E-02	N/A	**4.66E-02**	± 1.45E-02	6.31E-02
FB0500-04-1-S009SS	< 3.01E-02	N/A	**1.96E-02**	± 9.54E-03	3.54E-02
FB0500-04-1-S010SS	< 3.12E-02	N/A	< 3.34E-02	N/A	5.19E-02
FB0500-04-1-S011SS	< 3.35E-02	N/A	< 3.48E-02	N/A	5.45E-02
FB0500-04-1-S012SS	< 2.99E-02	N/A	< 3.63E-02	N/A	5.47E-02
FB0500-04-1-S013SS	**2.30E-02**	± 1.25E-02	< 3.01E-02	N/A	4.46E-02
FB0500-04-1-S014SS	< 3.17E-02	N/A	< 3.32E-02	N/A	5.19E-02
FB0500-04-1-S015SS	< 2.27E-02	N/A	**3.19E-02**	± 1.17E-02	4.66E-02
FB0500-04-1-S016SS	< 2.90E-02	N/A	< 2.85E-02	N/A	4.53E-02
FB0500-04-1-S017SS	< 3.34E-02	N/A	**8.18E-02**	± 1.55E-02	1.09E-01
FB0500-04-1-S018SS	< 3.25E-02	N/A	< 3.74E-02	N/A	5.71E-02
Mean	**5.00E-02**		**9.40E-02**		**1.30E-01**
Median	**3.10E-02**		**3.50E-02**		**5.39E-02**
Standard Deviation	**5.10E-02**		**1.40E-01**		**1.84E-01**
Range	**0.021 – 0.181**		**0.020 – 0.468**		**0.035 – 0.620**

NOTES

1. The Co-60 DCGL of 0.86 pCi/g is an "adjusted DCGL" and can be derived from the unitized dose for surface soil, LTP Table 6-7 and the updated dose model in the activated concrete related license amendment (References 3 and 4). The Co-60 DCGL for surface soil is 1 pCi/g x 10/6.58 mrem/y (from LTP Table 6-7) or 1.5 pCi/g Co-60. This DCGL is further limited by the dose contribution allowed for surface soil only in the basement fill model per LTP Section 6 Attachment IX (revised LTP Table 6-11), in the activated concrete license amendment. Thus, the Co-60 adjusted DCGL is 1.5 pCi/g x 5.63/10 mrem/y or 0.86 pCi/g.

2. "<" indicates MDC value.

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

Three grids alarmed and required investigation (Grids 4, 5 and 11). The investigation consisted of re-scanning the grid and taking a soil sample at the highest count-rate location. The soil samples were analyzed by gamma spectroscopy, and one (S004) had detectable quantities of Co-60 and Cs-137 but none exceeded the DCGL of 0.86 pCi/g for Co-60 and 2.39 pCi/g for Cs-137. The results of the investigation measurements are tabulated in Attachment 3.

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 on Table 2. The mean and median activities were less than the DCGL for both Co-60 and Cs-137. The highest reported value for Cesium-137 was 7.6 % of the DCGL (2.39 pCi/g), and the highest reported value for Co-60 was 54.4% of the DCGL (0.86 pCi/g). The combined concentrations of Cs-137 and Co-60 in the samples met the unity rule. Traces of Sb-125 were detected in S002, S003, S004, and investigation sample S004. This is similar to the Sb-125 seen in Survey Unit 3. If the Sb-125 default DCGL from NUREG-1727 was converted to a value consistent with the soil dose fraction of 5.63 mrem/y, the unity values for Sb-125 would range from 0.014 to 0.052 and the combined unity rule would still be met.

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 (0.05 pCi/g). The result is a net value of –0.14 pCi/g or 0.0 mrem/y. The Co-60 activity results in an annual dose of 0.62 mrem/year[5]. 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.

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 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, except the design sigma was less than the actual, were clearly satisfied for the FSS of this survey unit.

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4 See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 5)

5 Co-60 dose = (0.094/0.86) x 5.63 mrem/year

Note that since the soil direct measurements included positive Co-60 results, a unitized Sign Test was performed. The unitized sigma was greater than the design sigma. However, the increase in sigma would have had no affect on the relative shift had the LBGR been set equal to the survey unit mean. Therefore, the results of the Sign Test indicated no additional samples were required to reject the null hypothesis.

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 1 survey unit. All of the measurements are well below the DCGL unity value.

3. A Histogram Plot was also developed based on the direct measurement values. This plot shows that the direct data were essentially a log-normal distribution with three 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 unity value 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 area; the FSS results were consistent with that classification. Because the survey unit was adjacent to potential source contributions from buried pipe, a design DCGL of 2.39 pCi/g was used.

H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 4 was designed and performed using the criteria of the approved LTP Revision 3 Addenda (Reference 2). The survey design also the incorporated the proposed changes provided in the license amendment related to modifications of the activated concrete remediation plan submitted September 11, 2003 (References 3 and 4). There are no other LTP changes requiring evaluation.

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 unity value. The presence of Sb-125 was detected at low levels. Even though Sb-125 is not a typical soil nuclide, its unitized activity was evaluated and found to still meet the unity rule.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The direct measurement sigma was determined to be greater than that used for design; however, 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 three 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 three verified alarms. Investigations were conducted and the soil concentrations were less than the DCGL.

It is concluded that FB0500 Survey Unit 4 meets 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 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

3. 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"

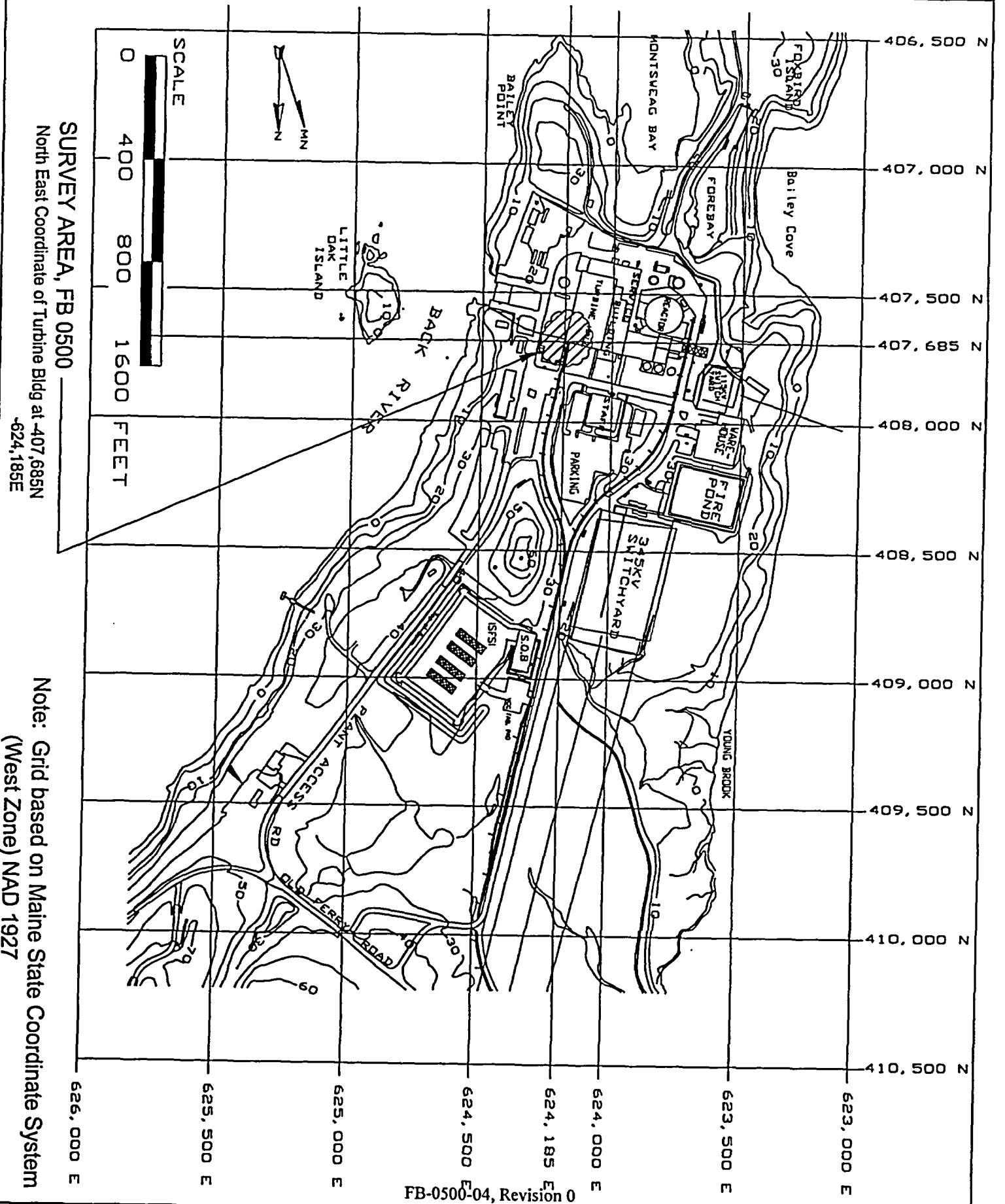
4. NRC Letter to Maine Yankee dated February 18, 2004, Approval of Activated Concrete Amendment

5. Maine Yankee Procedure PMP 6.7.8, Attachment E

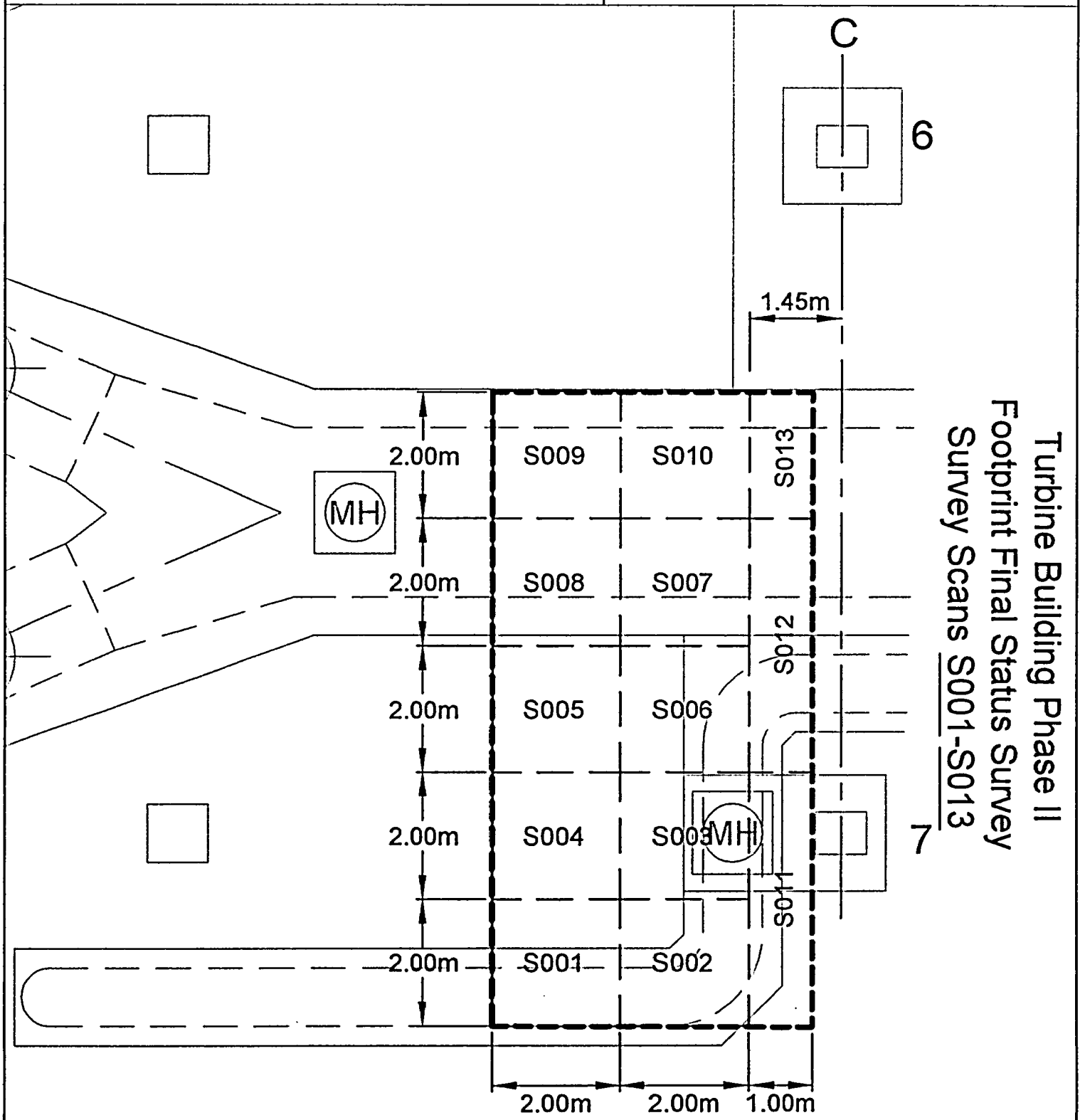
Attachment 1

Survey Unit Maps

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB 0500-04 SITE Revised: 12-09-03
Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey	Survey Area Name: Turbine Building Phase II	

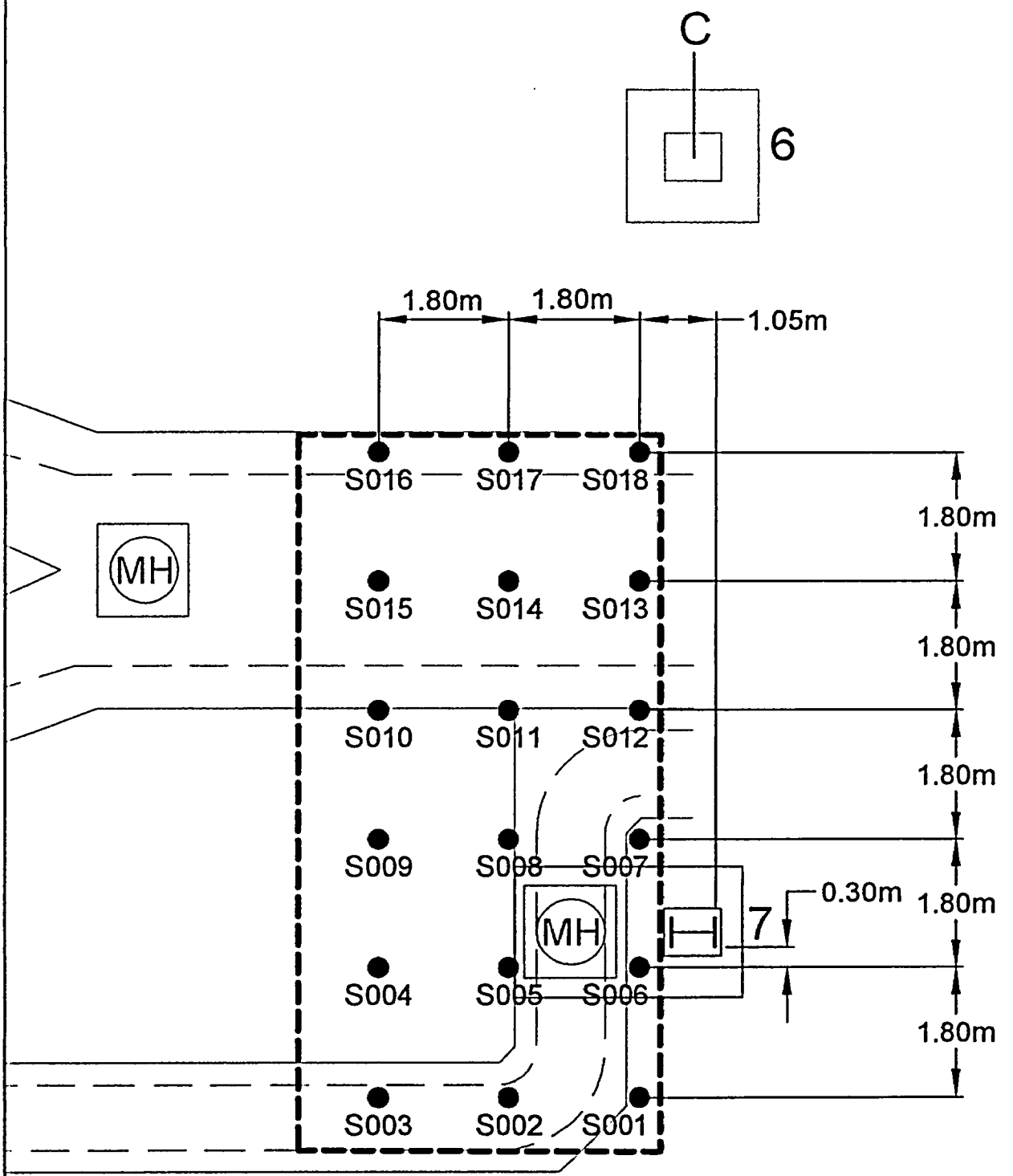


Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB 0500-04 Revised: 11-9-04
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Turbine Building Phase II	



Total Area = 50 sq-m

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FB 0500-04c Revised: 11-9-04
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Turbine Building Phase II	



Turbine Building Phase II
Footprint Final Status Survey
Direct Points S001-S018

L = 1.8m N = 14 Total Area = 50 sq-m

Attachment 2

Survey Unit Instrumentation

Attachment 3

Investigation Table

TABLE 3-1

INVESTIGATION TABLE

Original Survey Results				Investigation Results				
Grid	**Reason**	**Alarm Setpoint (cpm)**	**Scan Measurement (cpm)**	**Scan Measurement* (cpm)**	**Sample ID**	**Co-60 (pCi/g)**	**Cs-137 (pCi/g)**	**$DCGL_{EMC}$ Comparison**
S004	ALARM	13,880	14,700	14,660	XB0500-04-1-S004-SS000	**1.06E-01**	**4.96E-02**	N/A (< DCGL)
S005	ALARM	13,880	14,660	15,270	XB0500-04-1-S005-SS000	< 3.96E-02	< 3.97E-02	N/A (< DCGL)
S011	ALARM	13,880	14,590	14,280	XB0500-04-1-S011-SS000	< 3.14E-02	< 2.71E-02	N/A (< DCGL)
						SU – Unitized Average		**0.130**
						Total		**0.130**

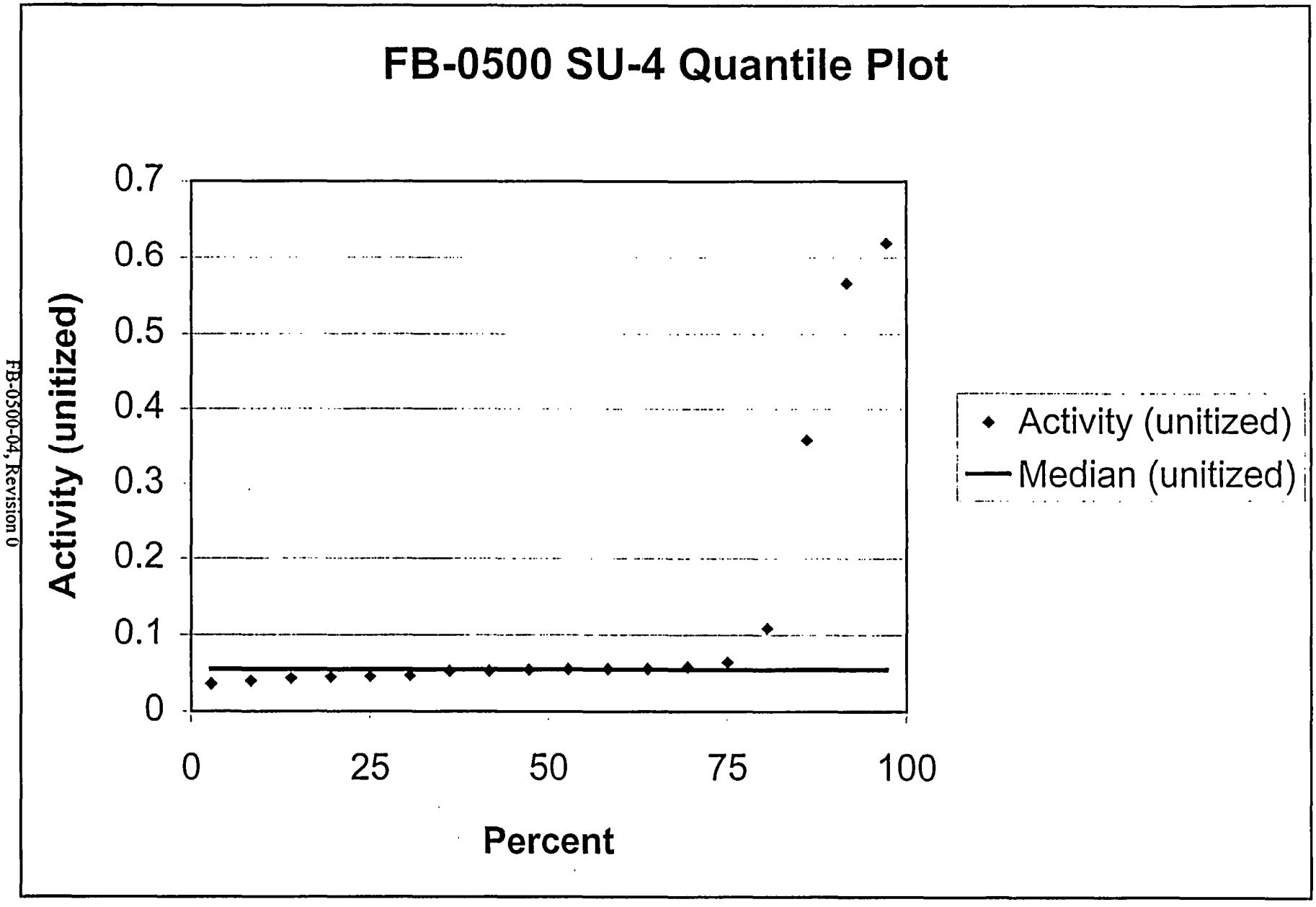
"<" indicates MDA value
* Highest scan alarm

Attachment 4

Statistical Data

Survey Package FB0500 Unit 4 Soil Sign Test Summary

Evaluation Input Values		Comments
Survey Package:	FB0500	Turbine Building Sub-Slab Soil
Survey Unit:	04	
Evaluator:	GP	
$DCGL_w$:	1.00E+00	
$DCGL_{emc}$:	1.00E+00	
LBGR:	5.00E-01	
Sigma:	7.00E-02	unitized
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:	7.1	
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:	18	
Median:	5.40E-02	
Mean:	1.30E-01	
Net Sample Standard Deviation:	1.84E-01	
Total Standard Deviation:	1.84E-01	Sigma of unitized samples only
Maximum:	6.20E-01	
Sign Test Results		**Comments**
Adjusted N Value:	18	
S+ Value:	18	
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:	Investigate	See section F.
Criteria comparison results:	Investigate	See section F.
Final Status		**Comments**
The survey unit passes all conditions:	Investigate	Passes


FB-0500 SU-4 Quantile Plot
Activity (unitized)
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0.6
0.5
0.4
0.3
0.2
0.1
0
0
25
50
75
100
Percent
Activity (unitized)
Median (unitized)

One-Sample T-Test Report

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Plots Section

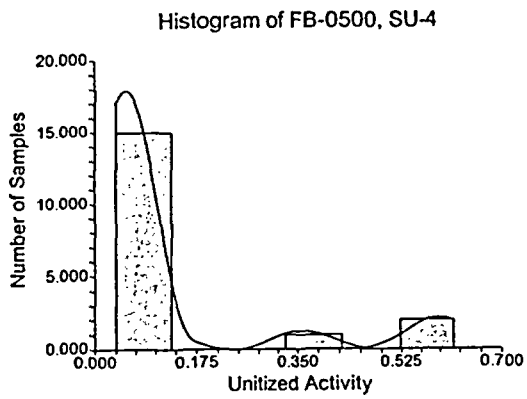

Chart Section