# MAINE YANKEE
# FINAL STATUS SURVEY RELEASE RECORD
# FR-0400 FOREBAY
# SURVEY UNIT 9

| | | |
|---|---|---|
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# MAINE YANKEE
# FINAL STATUS SURVEY RELEASE RECORD
# FR-0400 FOREBAY
# SURVEY UNIT 9

## A. SURVEY UNIT DESCRIPTION

Survey Unit 9 is located within Survey Area FR-0400, the Forebay. The Forebay is located south of the radiologically Restricted Area of the site at coordinates 407,250N and 623,700E (See Map FR 0400-SITE, Attachment 1). The Forebay is a large, rock-lined basin in which condenser cooling water collected prior to its release through the diffuser system out to the ocean. During plant operation, the Forebay/Diffuser System was the licensed discharge path for liquid, radiological effluent. After plant shutdown, stop logs were set in place at the Forebay end of the diffuser to isolate the Forebay in order to prevent the release of Forebay sediment into the river during remediation activities.

Two earthen dikes make up the north-south running walls of the Forebay with concrete walls at the extreme north and south ends to support the circulating water and diffuser pipes. The dike walls form a V at the southern end of the Forebay (adjacent to Foxbird Island). The diffuser discharge pipes originate at the notch of the V. A concrete dam, or weir, runs in the east west direction at the northern end of the Forebay and creates a small, water-filled area called the sealpit. The sealpit maintained a water seal over the circulating water pipes to prevent loss of flow with tidal fluctuations.

Survey Unit 9 consists of the Circ Water discharge concrete structure (Forebay seal pit) from the 4'6" elevation to the demolition line at the 17' elevation. The Survey Unit has surface area of approximately 58 $m^2$.

## B. SURVEY UNIT DESIGN INFORMATION

The Forebay received the liquid radioactive discharges from the plant. It was known to have been contaminated to levels in excess of the release limits and extensive remediation activities including underwater dredging, underwater vacuuming, and dry surface vacuuming were performed. Given the high probability of residual contamination, the Forebay was classified as Class 1.

Revision three of the Maine Yankee License Termination Plan (LTP)[1] states that the Forebay dose from residual radioactivity "is so insignificant and the probability so low that an individual would be able to successfully place a viable well within the Forebay, survey measurements of the Forebay surfaces including rip-rap will be limited". As a result, the survey design for the Forebay is a reasonable approach to demonstrate compliance with the release criteria while not necessarily meeting all of the requirements for a "MARSSIM" survey.

[1] LTP, Revision 3 refers to the LTP submitted in October 2002 (Reference 1) as amended by the MY's addenda of November 2002 (Reference 2). LTP, Revision 3 was approved by the NRC in February 2003 (Reference 3).

The survey unit design parameters are shown in Table 1. A minimum number of 14 direct samples were required for the Sign Test (18 were taken). Each sample measurement location was determined using a random start point and a square grid. These locations are presented on survey maps FR0400-09c and FR0400-09d (Attachment 1). Once the direct readings were completed, removable contamination samples were obtained at each direct measurement location.

The survey was also designed to include 73 scan grids each of approximately 1 $m^2$ area. Scan grid locations are shown on maps FR0400-09a and FR0400-09b in Attachment 1. Instrument scan setpoints were conservatively set below the $DCGL_{EMC}$, as shown in Table 2-2 (Attachment 2).

To accommodate measurement geometry requirements for surfaces of non-uniform smoothness, the SHP-360 probe was used to augment the 43-68 scan survey. First, a 43-68 scan was performed on all surfaces, including those that were unlikely to meet geometry requirements for that model of probe. Then a repeat scan, using the SHP-360, was performed on areas with surface irregularities that required a smaller probe size.

Background values were established, for each particular instrument probe application based on ambient background values in the survey area and previously established material backgrounds. These background values, listed in Table 1, were used to establish net activity for direct measurements, scan alarm setpoints, and to confirm the scan MDCs used were appropriate.

The instruments used in this survey 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 in all cases, thus providing high confidence (95% or higher) that an elevated area would be detected in the scanning process. Further, since the investigation level at the alarm setpoint 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 | 58 $m^2$ | |
| Number of Direct Measurements Required | 14 | Based on an adjusted LBGR of 17,388 dpm/100 $cm^2$, a sigma[2] of 220 dpm/100 $cm^2$ and a relative shift of 3.0. Type I = Type II = 0.05 |
| Sample Area | 4 $m^2$ | 58 $m^2$/14 samples |
| Sample Grid Spacing | 2.0 m | $(4)^{1/2}$ |
| Area Factor | 12.5 | 50 $m^2$ / 4 $m^2$ (Reference 4) |
| Scan Survey Area | 58 $m^2$ | 100% scan coverage |
| Background | | |
| 1. 43-68 Direct and Scan (flat surfaces) | 3217 dpm/100 $cm^2$ | Ambient and Material |
| 2. SHP-360 Scan (surface irregularities) | 7675 dpm/100 $cm^2$ | Ambient and Material |
| Scan Investigation Level | Less than $DCGL_{EMC}$ | See Table 2-2, Attachment 2 |
| DCGL | 18,000 dpm/100 $cm^2$ | Forebay technical basis document (Reference 4) |
| $DCGL_{EMC}$ | 225,000 dpm/100 $cm^2$ | Area Factor x DCGL |

## C. SURVEY RESULTS

Eighteen direct measurements were made in Survey Unit 9. The direct measurement data are presented in Table 2. All direct measurements were below the DCGL.

Seventy-three grids were scanned with a 43-68. Three grids received additional scans with the SHP-360 due to surface condition. The scan process resulted in no verified scan alarms. Consequently, no investigations were required.

Approximately 10 meters of 90-degree junctures were not separately surveyed. However, the flat surface surveys demonstrated that there was no plant related residual activity above background. Therefore, there is good assurance that the junctures were consistent with the remainder of the concrete surfaces and do not affect the conclusion on the survey unit results.

[2] Sigma was determined during the background evaluation performed for FR-0400, Survey Unit 3.

## TABLE 2

### DIRECT MEASUREMENTS

| Sample Location | Gross Activity (dpm/100 cm$^2$) | Net Activity (Table 1 Background Subtracted) (dpm/100 cm$^2$) |
|---|---|---|
| FR0400-9-C001 | 3,376 | 159 |
| FR0400-9-C002 | 3,504 | 287 |
| FR0400-9-C003 | 3,547 | 330 |
| FR0400-9-C004 | 2,961 | -256 |
| FR0400-9-C005 | 3,284 | 67 |
| FR0400-9-C006 | 2,991 | -226 |
| FR0400-9-C007 | 3,016 | -201 |
| FR0400-9-C008 | 2,723 | -495 |
| FR0400-9-C009 | 3,095 | -122 |
| FR0400-9-C010 | 2,759 | -458 |
| FR0400-9-C011 | 3,168 | -49 |
| FR0400-9-C012 | 2,955 | -263 |
| FR0400-9-C013 | 2,888 | -330 |
| FR0400-9-C014 | 3,425 | 208 |
| FR0400-9-C015 | 2,882 | -336 |
| FR0400-9-C016 | 3,327 | 110 |
| FR0400-9-C017 | 3,046 | -171 |
| FR0400-9-C018 | 2,674 | -543 |
| **Sample Mean** | **3,090** | -127 |
| **Median** | **3,031** | -186 |
| **Standard Deviation** | 269 | 269 |
| **Sample Range** | **2,674 – 3,547** | -543 – 330 |

## D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

No investigations were required.

## E. SURVEY UNIT DATA ASSESSMENT RESULTS

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, are provided in Table 2. Without subtracting a background, all sample measurement results were less than the DCGL. The mean value of background-subtracted activity is –127 dpm/100 cm$^2$. This is equivalent to an annual dose rate of 0 mrem/y[3]. The maximum direct sample result is equivalent to 1.9% of the DCGL. The sample standard deviation is larger than the design sigma, however, no additional measurements were required due to the power of the Sign Test (i.e., relative shift unaffected).

The scan measurements produced no verified alarms. Consequently, no alarm investigations were required.

[3] This annual dose equivalent is based on LTP Table 6-11, which shows the contaminated concrete dose contribution (for surfaces contaminated at the $DCGL_W$) is 0.301 mrem/y.

## 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, except for the final sigma, were clearly satisfied for the FSS of this survey unit. Although the design sigma was less than the final standard deviation, the relative shift was unaffected and the number of samples remained adequate for the Sign Test.

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 of 18,000 dpm/100 $cm^2$.

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, removable contamination samples were obtained at each (direct) measurement location. In that this survey unit did not involve a standing building, the removable contamination measurements were not applicable to release decisions for the survey unit. However, the samples were obtained and evaluated, indicating alpha activity less than the MDA values (i.e., < 5.5 dpm/100 $cm^2$) and the beta activity less than the MDA values (i.e., < 4.2 dpm/100 $cm^2$). Thus, in comparison with the mean survey unit net activity (Table 2), the removable contamination sampling effort indicated that the majority of activity is fixed.

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

This survey was designed as a Class 1 area. The FSS results were consistent with that classification. As discussed previously, the final standard deviation was greater than the design sigma. However, the survey design was not adversely affected. Thus, a sufficient number of samples were taken.

## H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 9 was designed and performed using the criteria of the approved Forebay Technical Basis (Reference 4) and LTP (Revision 3 Addenda). Subsequent LTP changes have been evaluated and have no impact on the design, conduct, or assessment of the final status survey of this Survey Unit.

## 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 beta direct measurements were less than the DCGL of 18,000 dpm/100 $cm^2$.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The sample standard deviation is larger than the design sigma, however, no additional measurements were required due to power of sign test.

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 variance consistent with expectations for a Class 1 survey unit.

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 no verified alarms, therefore no investigations were required.

In addition, while not part of the release decision criteria, removable contamination sampling confirmed that the majority of remaining activity in this survey unit was fixed.

It is concluded that FR0400 Survey Unit 9 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

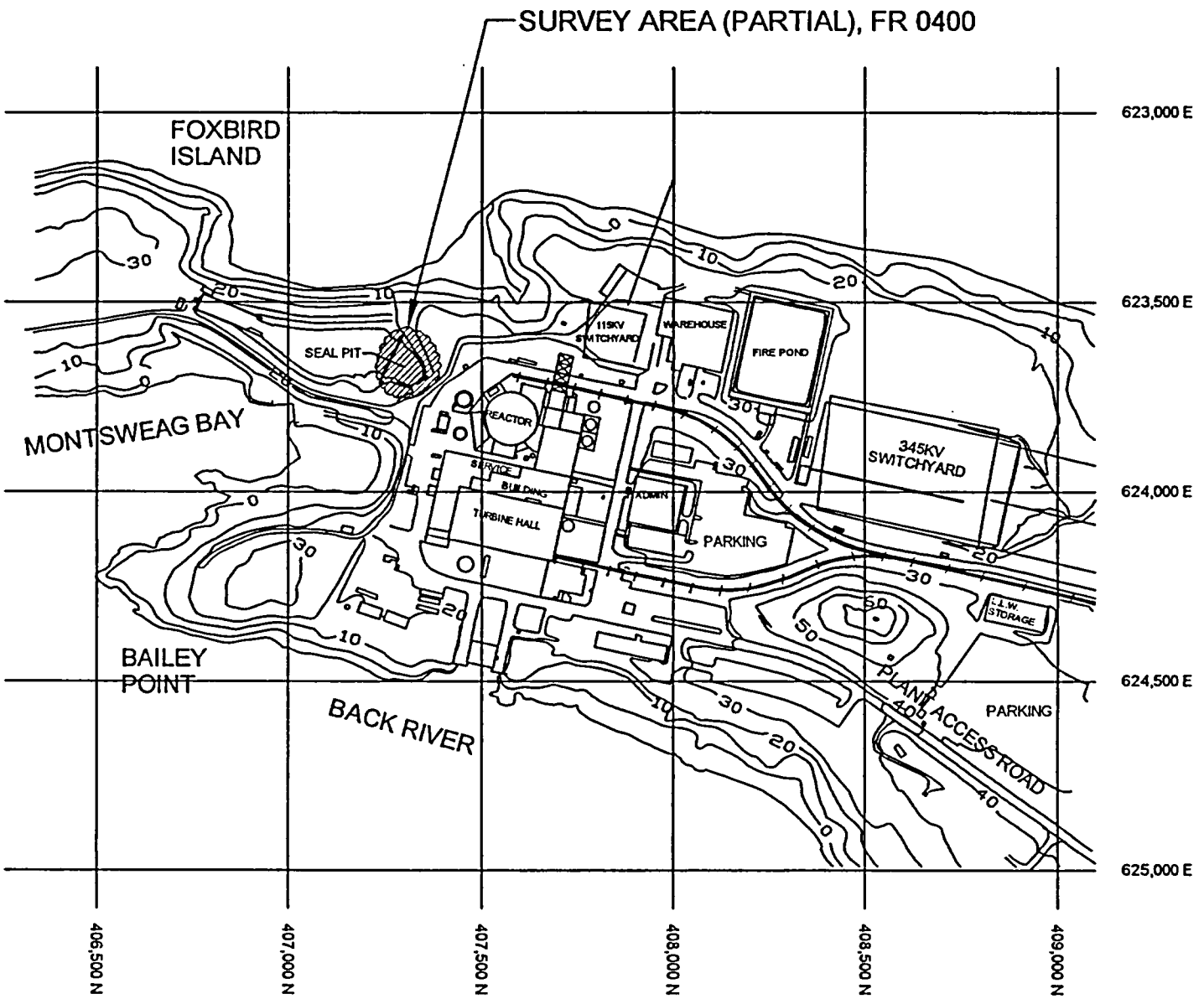
## J. REFERENCES


1. Maine Yankee License Termination Plan, Revision 3, October 15, 2002
2. Maine Yankee letter to the NRC, MN-02-061, dated November 26, 2002
3. NRC letter to Maine Yankee, dated February 28, 2003
4. Maine Yankee letter to the NRC, MN-03-051, "Forebay Technical Basis Document," dated September 3, 2003

# Attachment 1

# Survey Unit Maps

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR 0400-SITE |
|---|---|---|
| Survey Type: ☐ Remediation ☐ Turnover ■ Final Status Survey | Survey Area Name: Forebay Seal Pit Site Map | |




SCALE

0 400 800 1200

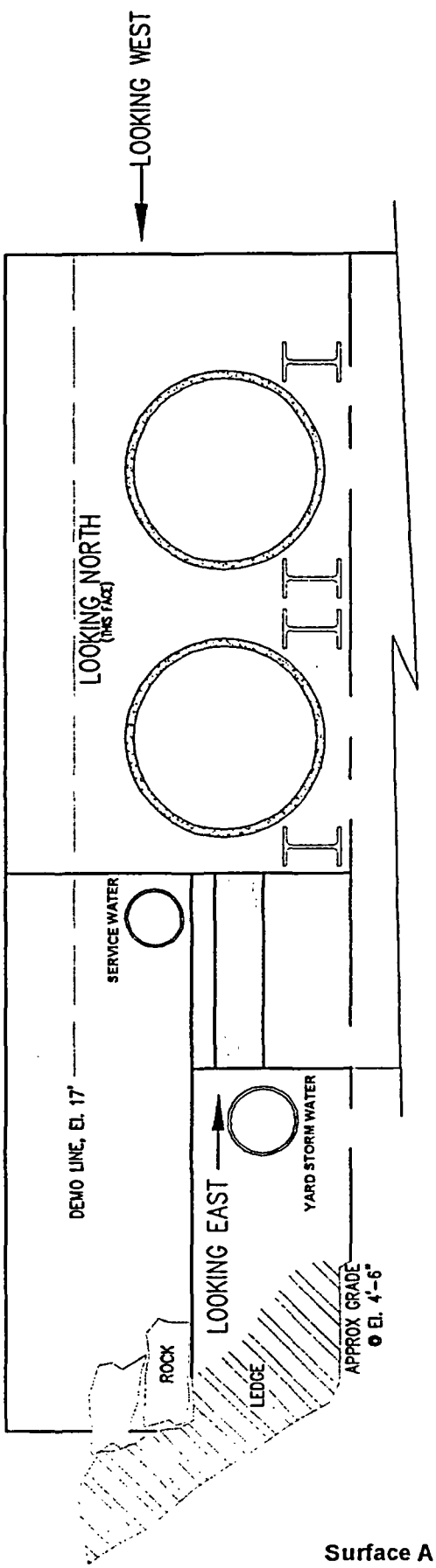
MN

N

Note: Grid based on Maine State Coordinate System (West Zone) NAD 1927

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09 REF<br>Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

# FR 0400: FOREBAY, SEAL PIT
## Survey Unit 9: Circ Water Discharge
## Reference Map

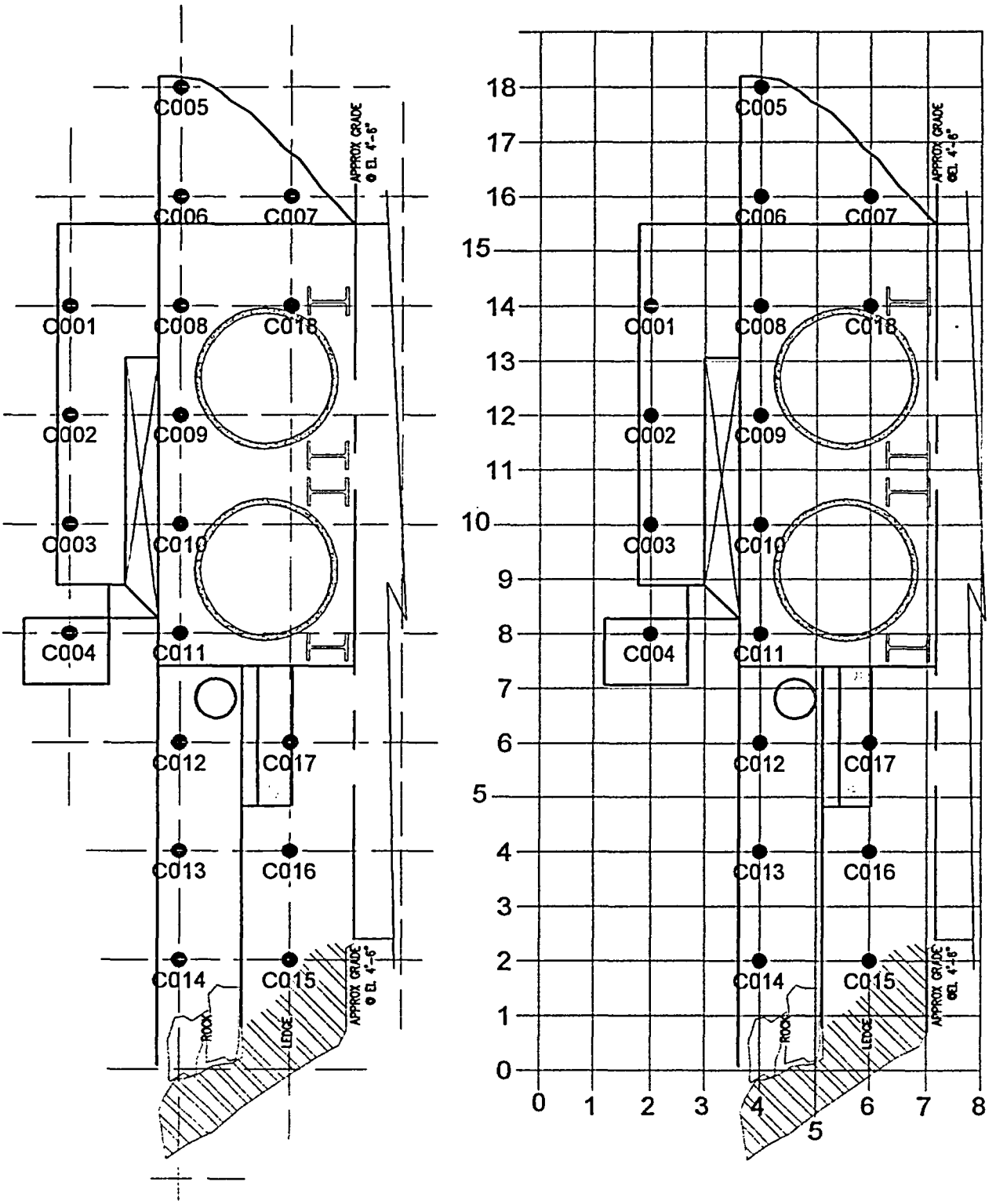





**Surface Area = 58 sq-m (Thrust Block only)**

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09 DP REF<br>Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

**FR 0400: FOREBAY, SEAL PIT**
**Survey Unit 9: Circ Water Discharge**
**Direct Point Reference Map**

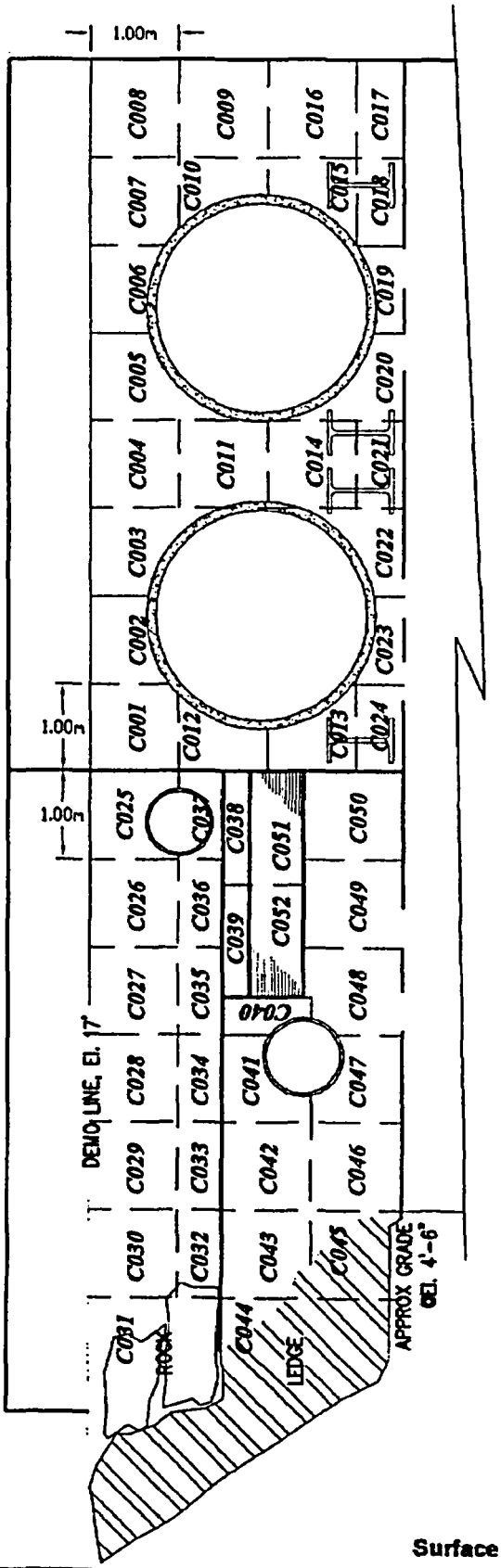



N = 14 L = 2.0

**Surface Area = 58 sq-m (Thrust Block only)**

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09a Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

**FR 0400: FOREBAY, SEAL PIT**
**Survey Unit 9: Circ Water Discharge**
**Concrete Survey Scans C001 - C052**

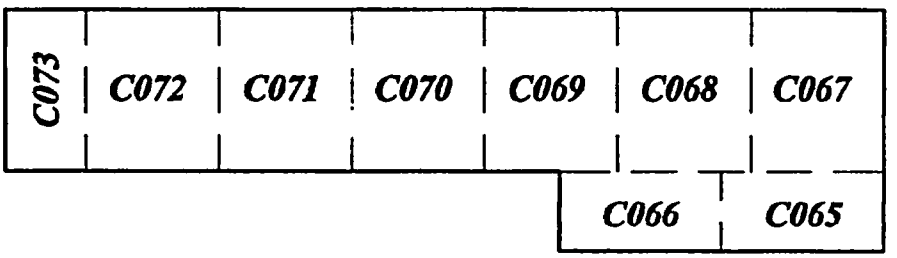




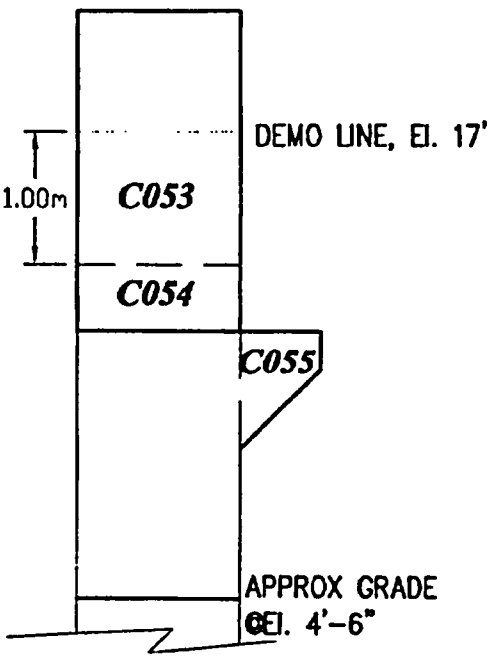

**Surface Area ≈ 58 sq-m (Thrust Block only)**

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09b Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

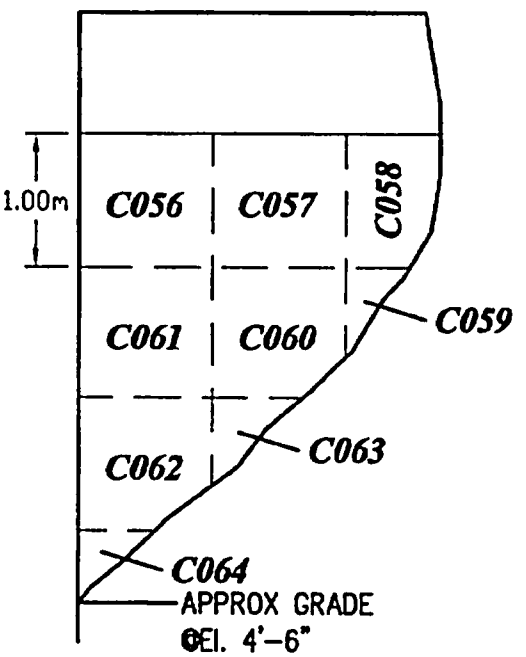
# FR 0400: FOREBAY, SEAL PIT
## Survey Unit 9: Circ Water Discharge
## Concrete Survey Scans C053 - C073




**TOP VIEW**
(Walkway)




**EAST VIEW**



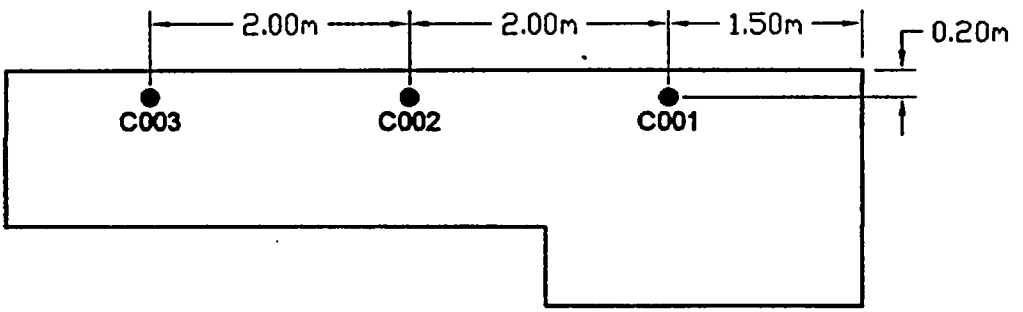

**WEST VIEW**



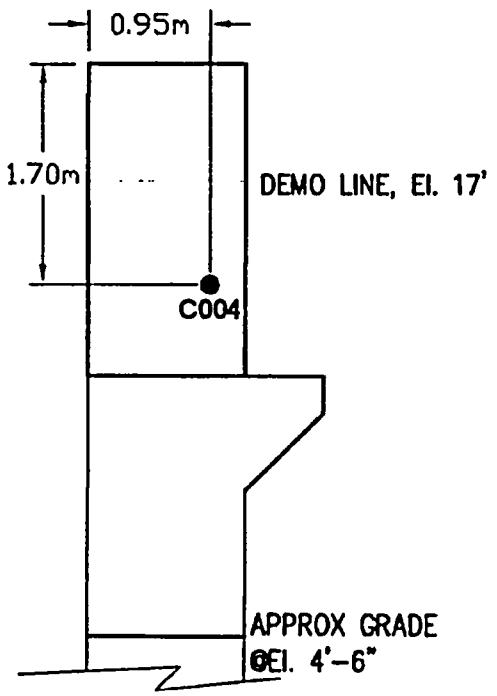
**Surface Area = 58 sq-m (Thrust Block only)**

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09c Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

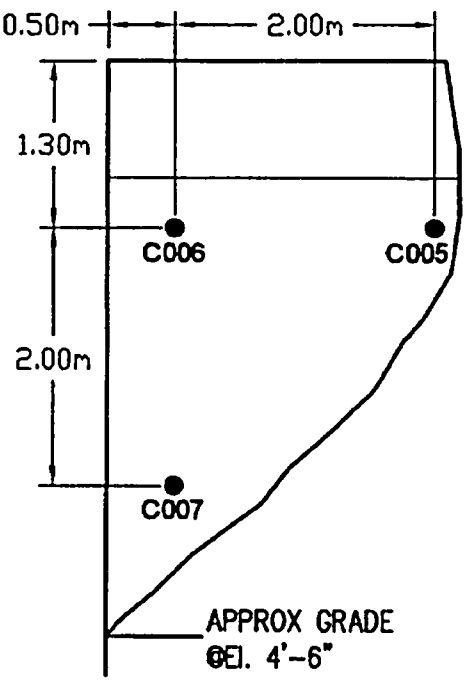
# FR 0400: FOREBAY, SEAL PIT
## Survey Unit 9: Circ Water Discharge
## Concrete Direct Points C001 - C007




**TOP VIEW**
**(Walkway)**




**LOOKING EAST**




**LOOKING WEST**

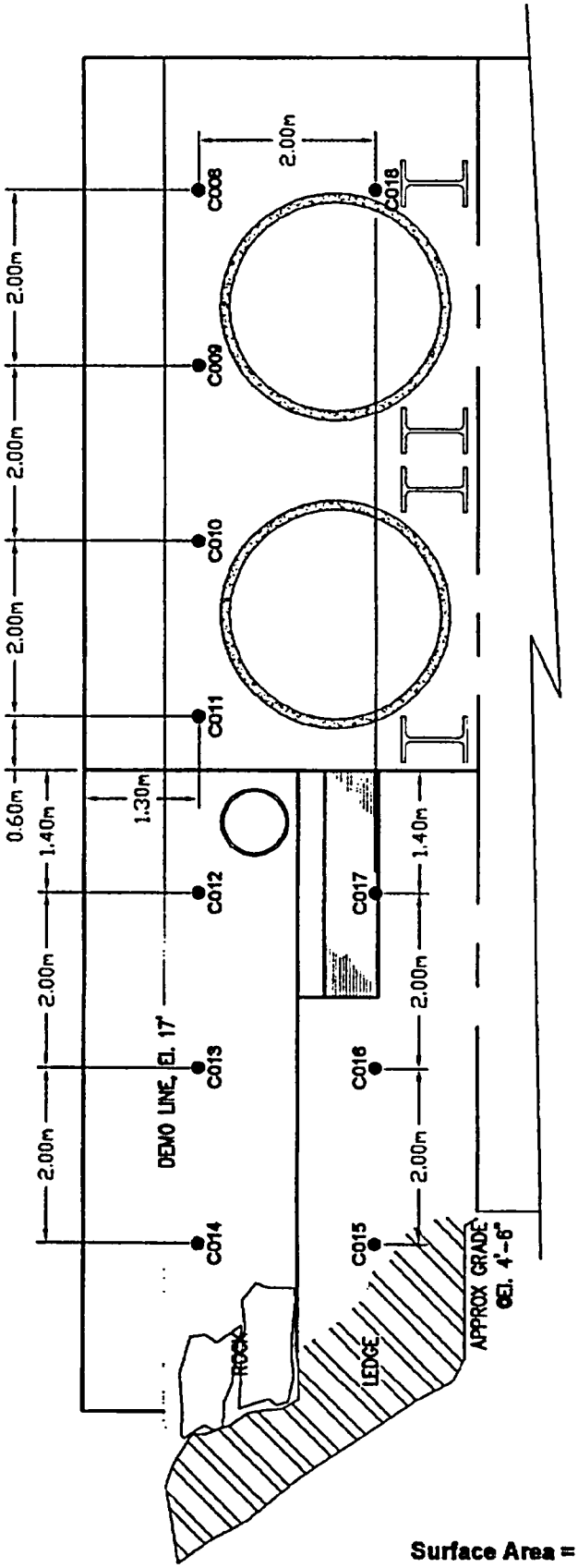


**N = 14 L = 2.0**

**Surface Area = 58 sq-m (Thrust Block only)**

| Maine Yankee Decommissioning Team | *Maine Yankee Decommissioning Project Survey Form* | Map ID #: FR0400-09d Revised : 3-1-04 |
|---|---|---|
| Survey Type: ☐ Characterization ☐ Turnover ■ Final Status Survey | Survey Area Name: ForeBay Seal Pit | |

**FR 0400: FOREBAY, SEAL PIT**
**Survey Unit 9: Circ Water Discharge**
**Concrete Direct Points C008 - C018**




N = 14 L = 2.0

Surface Area = 58 sq-m (Thrust Block only)

# Attachment 2

# Survey Unit Instrumentation

## TABLE 2-1

## INSTRUMENT INFORMATION

| E-600 S/N | Probe S/N (type) |
|---|---|
| 2617 | 149071 (43-68) |
| 2618 | 148932 (43-68) |
| 2619 | 149071 (43-68) |
| 2488 | 463 (SHP-360) |
| 2617 | 467 (SHP-360) |
| 2620 | 460 (SHP-360) |
| 2617 | 148937 (43-68) |

## TABLE 2-2

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

| Detector | 43-68 | SHP-360 |
|---|---|---|
| Scan MDC ($dpm/100\ cm^2$) | 1,832 (LTP Table 5-6) | 10,484 (LTP Table 5-6) |
| DCGL ($dpm/100\ cm^2$) | 18,000 | 18,000 |
| Investigation Level (Alarm Setpoint) ($dpm/100\ cm^2$) | 18,773 (~ DCGL plus material background) | 109,649 (~ 50% $DCGL_{EMC}$) |
| Design $DCGL_{EMC}$ ($dpm/100\ cm^2$) (from Release Record Table 1) | 225,000 | 225,000 |

# Attachment 3

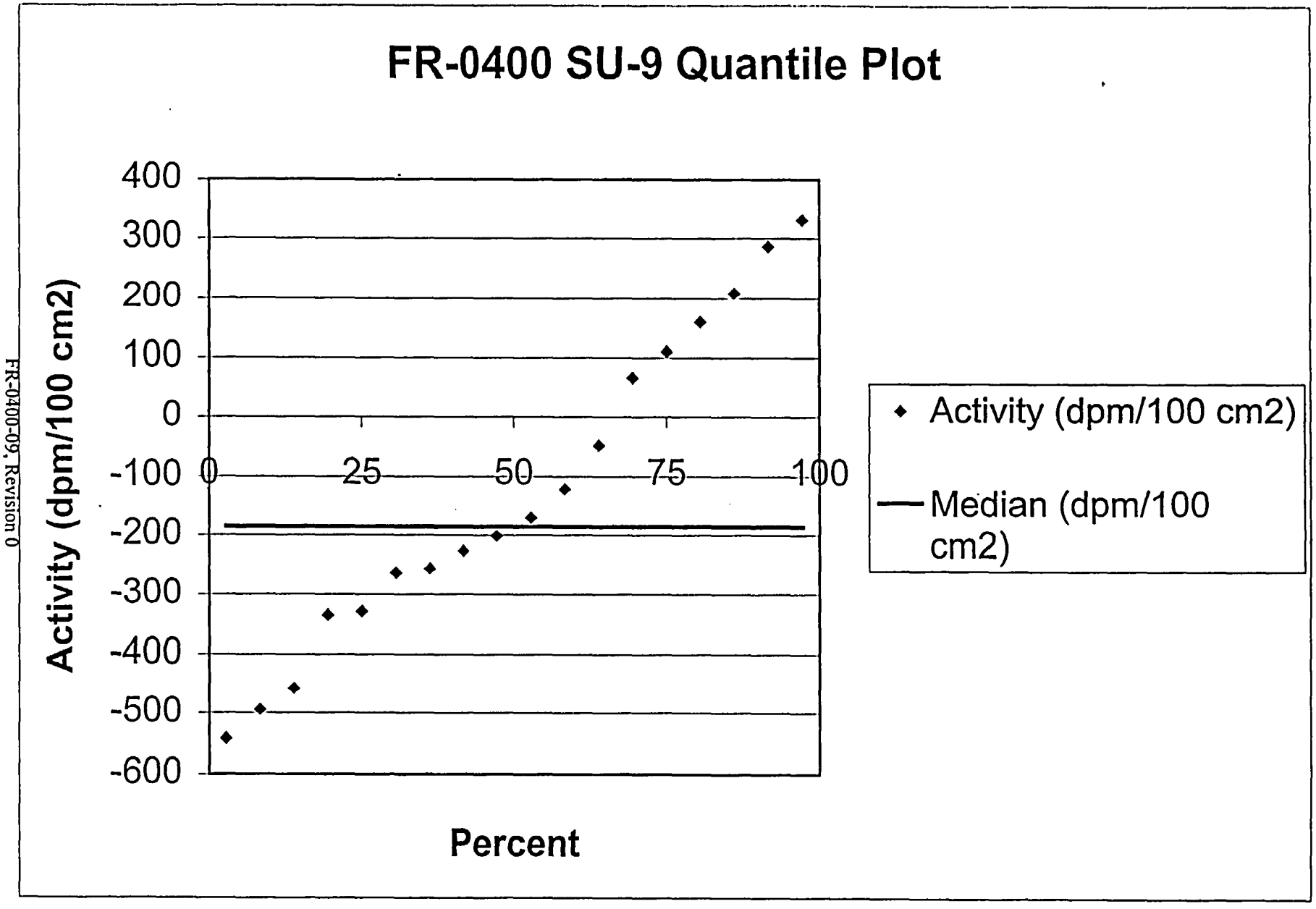
# Investigation Table
# (No Investigations Required)

# Attachment 4

# Statistical Data

# Survey Package FR0400 Unit 9 Surface Sign Test Summary

| Evaluation Input Values | | Comments |
|---|---|---|
| Survey Package: | FR0400 | Seal Pit Concrete Thrust block |
| Survey Unit: | 09 | |
| Evaluator: | DR | |
| $DCGL_w$: | 18,000 | |
| $DCGL_{emc}$: | 225,000 | |
| LBGR: | 9,000 | |
| Sigma: | 220 | SU3 BKG converted to DPM |
| Type I error: | 0.05 | |
| Type II error: | 0.05 | |
| Total Instrument Efficiency: | 13.0% | |
| Detector Area ($cm^2$): | 126 | |
| Material Type: | Concrete Unpainted | Choosing 'N/A' sets material background to "0" |
| **Calculated Values** | | **Comments** |
| $Z_{1-\alpha}$: | 1.645 | |
| $Z_{1-\beta}$: | 1.645 | |
| Sign p: | 0.99865 | |
| Calculated Relative Shift: | 40.9 | |
| Relative Shift Used: | 3.0 | Uses 3.0 if Relative Shift >3 |
| N-Value: | 11 | |
| N-Value+20%: | 14 | |
| **Static Data Values** | | **Comments** |
| Number of Samples: | 18 | |
| Median: | -183 | |
| Mean: | -124 | |
| Net Static Data Standard Deviation: | 269 | |
| Total Standard Deviation: | 330 | SRSS |
| Maximum: | 333 | |
| **Sign Test Results** | | **Comments** |
| Adjusted N Value: | 18 | |
| S+ Value: | 18 | |
| Critical Value: | 12 | |
| **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 E of Release Record |
| Sign test results: | Pass | |
| **Final Status** | | **Comments** |
| The survey unit passes all conditions: | Investigate | Survey unit passes |


FR-0400 SU-9 Quantile Plot
Activity (dpm/100 cm2)
400
300
200
100
0
-100
-200
-300
-400
-500
-600
0
25
50
75
100
Percent
Activity (dpm/100 cm2)
Median (dpm/100 cm2)

**One-Sample T-Test Report**

| | |
|---|---|
| Page/Date/Time | 2 10/19/04 2:43:10 PM |
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| Variable | C2 |

**Plots Section**

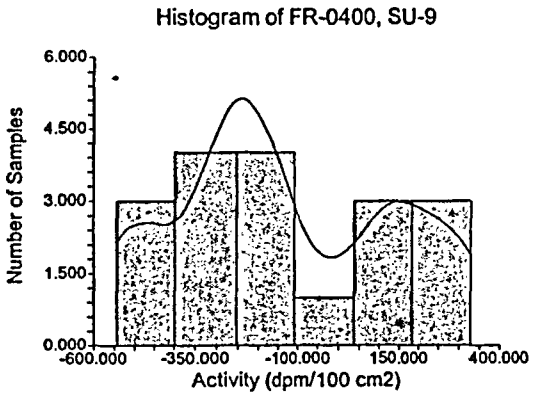

**Chart Section**