YANKEE ATOMIC ELECTRIC COMPANY

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August 9, 2006
BYR 2006-066

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-001

References: (a) License No. DPR-3 (Docket No. 50-29)

(b) BYR 2004-133, Submittal of Revision 1 to the Yankee Nuclear Power Station's License Termination Plan

(c) Yankee Nuclear Power Station – Issuance of Amendment 158 Re: License Termination Plan

Subject: Submittal of YNPS-FSS-OMB06-00 and YNS-FSS-OOL15-00, the Final Status Survey Reports for Survey Areas OMB-06 and OOL-15, Respectively

Dear Madam/Sir:

This letter submits YNPS-FSS-OMB06-00, Final Status Survey Report for OMB-06, and YNPS-FSS-OOL15-00, Final Status Survey Report for OOL-15. These reports were written in accordance with Section 5 of the YNPS License Termination Plan, "Final Status Survey Plan," and are consistent with the guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

We trust that this information is satisfactory; however if you should have any questions or require any additional information, please contact Alice Carson at (301) 916-3995 or the undersigned at (413)-424-2261.

Sincerely,

YANKEE ATOMIC ELECTRIC COMPANY

Joseph Lynch
Regulatory Affairs Manager

Enclosure: 2 hard copies of YNPS-FSS-OMB06-00 and YNPS-FSS-OOL15-00 plus CDs

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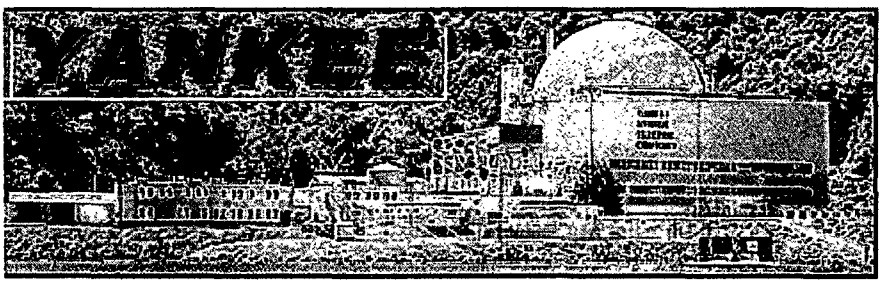
Yankee Nuclear Plant Station
Final Status Survey Report
For OMB-06



Yankee Atomic Electric Company

YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT

REPORT NO.: YNPS-FSS-OMB-06-00

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(In the electronic version, every Table of Contents, Figures, Appendices and Attachments, as well as every mention of a Table, Figure, Appendix or Attachment is a hyperlink to the actual location or document.)

List of Abbreviations and Acronyms

AL	Action Level
ALARA	As Low As Reasonably Achievable
c/d	Counts per Disintegration
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	DCGL for small areas of elevated activity
$DCGL_{W}$	DCGL for average concentration over a wide area, used with statistical tests
DQO	Data Quality Objectives
EMC	Elevated Measurement Comparison
ETD	Easy-to-Detect
FSS	Final Status Survey
FSSP	Final Status Survey Plan
GPS	Global Positioning System
H_o	Null Hypothesis
HSA	Historical Site Assessment
HTD	Hard-to-Detect
ISOCS	*In-situ* Object Counting System®
LBGR	Lower Bound of the Grey Region
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
PAB	Primary Auxiliary Building
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCA	Radiological Controlled Area
RP	Radiation Protection
RSS	Reactor Support Structure
SFP	Spent Fuel Pool
VC	Vapor Container
VCC	Vertical Concrete Cask
VSP	Visual Sample Plan
YNPS	Yankee Nuclear Power Station

1.0 EXECUTIVE SUMMARY

A Final Status Survey (FSS) was performed of Survey Area OMB-06, a Class 1 area, in accordance with Yankee Nuclear Power Station's (YNPS) License Termination Plan (LTP). This FSS was conducted as a structure surface FSS with building occupancy Derived Concentration Guideline Levels (DCGLs) even though the OMB-06 structure will be subsurface at license termination. This practice conservatively implements LTP criteria that subsurface structure surfaces be evaluated for the presence of contamination.

1.1 Identification of Survey Area and Units

Survey Area OMB-06 consists of the remains of the concrete structure located at the discharge end of the circulating water system known as the Seal Pit. OMB-06 has an area of 140 m^2, including walls (floor area: 60 m^2). Survey area OMB-06 is bounded, on the north, by survey area OOL-01, a land survey area (the reservoir). On the south by TBN-01-08, and east and west sides are bounded by OOL-03, a land survey area. The Seal Pit has been extensively characterized with a combination of sediment samples, concrete core samples, gamma scans, beta scans and beta fixed measurements. OMB-06 consists of a single Survey Unit, OMB-06-01

1.2 Dates(s) of Survey

The FSS of the OMB-06 Survey Area was performed between June 13th, 2005, and June 30th, 2005. The DQA of OMB-06 was performed on November 7th, 2005.

1.3 Number and Types of Measurements Collected

Final Status Survey Plan (FSSP) was developed for this Survey Unit in accordance with YNPS LTP and FSS procedures using the MARSSIM protocol. The planning and design of the survey plan employed the Data Quality Objective (DQO) process, ensuring that the type, quantity and quality of data gathered was appropriate for the decision-making process and that the resultant decisions were technically sound and defensible. A total of 15 systematic fixed-point measurements were taken, providing data for the non-parametric testing of the Survey Area. In addition to the 15 systematic fixed-point samples, 3 biased samples were taken. Hand-held survey instrument scans were performed to provide 100 percent coverage of the Survey Area.

1.4 Summary of Survey Results

Following the survey, the data were reviewed against the survey design to confirm completeness and consistency, to verify that the results were valid, to ensure that the survey plan objectives were met and to verify Survey Unit classification. Fixed point surveys indicated none of the measurements exceeded the $DCGL_W$, depicted in Attachment B. A retrospective power curve was generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, OMB-06 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mrem/yr. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mrem/yr limit will also be met.

2.0 FSS PROGRAM OVERVIEW

2.1 Survey Planning

The YNPS FSS Program employs a strategic planning approach for conducting final status surveys with the ultimate objective to demonstrate compliance with the DCGLs, in accordance with the YNPS LTP. The DQO process is used as a planning technique to ensure that the type, quantity, and quality of data gathered is appropriate for the decision-making process and that the resultant decisions are technically sound and defensible. Other key planning measures are the review of historical data for the Survey Unit and the use of peer review for plan development.

2.2 Survey Design

In designing the FSS, the questions to be answered are: "Does the residual radioactivity, if present in the Survey Unit, exceed the LTP release criteria?" and "Is the potential dose from this radioactivity ALARA?" In order to answer these questions, the radionuclides present in the Survey Units must be identified, and the Survey Units classified. Survey Units are classified with respect to the potential for contamination: the greater the potential for contamination, the more stringent the classification and the more rigorous the survey.

The survey design additionally includes the number, type and locations of fixed measurements/samples (as well as any judgmental assessments required), scanning requirements, and instrumentation selection with the required sensitivities or

detection levels. DCGLs are developed relative to the surface/material of the Survey Unit and are used to determine the minimum sensitivity required for the survey. Determining the acceptable decision error rates, the lower bound of the gray region (LBGR), statistical test selection and the calculation of the standard deviation and relative shift allows for the development of a prospective power curve plotting the probability of the Survey Unit passing FSS.

2.3 Survey Implementation

Once the planning and development has been completed, the implementation phase of the FSS program begins. Upon completion of remediation and final characterization activities, a final walk down of the Survey Unit is performed. If the unit is determined to be acceptable (i.e. physical condition of the unit is suitable for FSS), it is turned over to the FSS team, and FSS isolation and control measures are established. After the Survey Unit isolation and controls are in place, grid points are identified for the fixed measurements/samples, using Global Positioning System (GPS) coordinates whenever possible, consistent with the Massachusetts State Plane System, and the area scan grid is identified. Data is collected and any required investigations are performed.

2.4 Survey Data Assessment

The final stage of the FSS program involves assessment of the data collected to ensure the validity of the results, to demonstrate achievement of the survey plan objectives, and to validate Survey Unit classification. During this phase, the DQOs and survey design are reviewed for consistency between DQO output, sampling design and other data collection documents. A preliminary data review is conducted to include: checking for problems or anomalies, calculation of statistical quantities and preparation of graphical representations for data comparison. Statistical tests are performed, if required, and the assumptions for the tests are verified. Conclusions are then drawn from the data, and any deficiencies or recommendations for improvement are documented.

2.5 Quality Assurance and Quality Control Measures

YNPS FSS activities are implemented and performed under approved procedures, and the YNPS Quality Assurance Project Plan (QAPP) assures plans, procedures and instructions have been followed during the course of FSS, as well as providing guidance for implementing quality control measures specified in the YNPS LTP.

3.0 SURVEY AREA INFORMATION

3.1 Survey Area Description

Survey Area OMB-06 consists of the reinforced concrete structure located at the discharge end of the circulating water system known as the Seal Pit. The footprint of OMB-06 is approximately 140 m2. Survey area OMB-06 is bounded, on the north, by survey area OOL-01, a land survey area, on the south by TBN-01-08 and OMB-06 is bounded on the east and west by OOL-3, a land survey area. A map is included in Attachment A.

This structure is partly underground, partly underwater and partly above the ground and water. The aboveground structure was removed to a line that is three feet below grade and then was backfilled with riprap, providing a hard, artificial shoreline facing to reduce erosion.

OMB-06-01 includes the portion of the Seal Pit that remains after the above ground structure was removed to a line that is three feet below grade. It has an area of 140 m2, including walls (floor area: 60 m2). The concrete that was removed was subjected to a free release survey, using the truck monitor.

3.2 History of Survey Area

The interior of Survey Unit 01 received water that was being discharged from the Circulating Water System. The FSS has been completed on the adjacent Circ Water Discharge line. That line carried low-level radioactivity during plant operations that came from the Service Water Discharge line as part of the licensed release path for liquid effluents. After plant operations ceased, an alternate licensed release pathway was established that discharged directly into the Seal Pit. That pathway has been terminated and the line has been removed.

The Seal Pit has been extensively characterized with a combination of sediment samples, concrete core samples, gamma scans, beta scans and beta fixed measurements.

The demolition of the above-grade portion of the Seal Pit occurred after the FSS of OMB-06-01 because the process of demolition would allow most of OMB-06-01 to flood, since it is below the water level of Sherman Pond. A small portion of this unit was completed after the demolition of the upper part began. There is a large gate valve in the second chamber, which was removed after the concrete deck above that chamber was removed. As soon as the gate valve was removed, the surfaces that were newly exposed were scanned, and fixed measurements were taken. The question of possibly compromising the FSS of OMB-06-01 by having debris from the concrete that was removed fall into it was considered. This was not a problem because 100 percent of the debris from the concrete that was removed was assayed to

ODCM environmental and DCGL-based MDCs, thus validating the decision on potential debris contamination. Upon completion of the demolition, an area surveillance resurvey of OMB-06-01 was performed in accordance with DPF-8860.

3.3 Division of Survey Area into Survey Units

Survey Area OMB-06 consists of a single Survey Unit, OMB-06-01.

4.0 SURVEY UNIT INFORMATION

4.1 Summary of Radiological Data Since Historical Site Assessment (HSA)

4.1.1 Chronology and Description of Surveys Since HSA

Isolation and control measures were implemented for the FSS. The condition of OMB-06 Survey Units at the time of FSS was smooth to heavily remediated steel reinforced concrete.

4.1.2 Radionuclide Selection and Basis

During the initial DQO process, Co-60 was identified as the radiological nuclide of concern due to its more restrictive DCGL value when compared to Cs-137 (sampling of soil adjacent to the concrete indicated a relationship of approximately 80% Co-60 to 20% Cs-137). Adjacent soil characterization and survey data indicate no other LTP-specified radionuclides warrant consideration in the OMB-06 Survey Units.

4.1.3 Scoping & Characterization

The Seal Pit has been extensively characterized with a combination of sediment samples, concrete core samples, gamma scans, beta scans and beta fixed measurements. This is based upon the Yankee Atomic Electric Company Sample Plan for the Seal Pit (APF-0831.1), approved 6/1/05. Taking Co-60 as the sole radionuclide of concern is conservative, based upon that data. The sediment that was in the pit was dominated by Co-60, but the only plant-related nuclide in the concrete core samples was Cs-137. Using Cs-137 as the radionuclide-of-concern or using a mix of Co-60 and Cs-137 would have permitted the use of a higher DCGL and a higher calculated source efficiency for the beta measurements.

4.2 Basis for Classification

Based upon the radiological condition of this Survey Area identified in the operating history and as a result of the decommissioning activities performed to date, Survey Area OMB-06 is identified as a Class 1 Area.

4.3 Remedial Actions and Further Investigations

No further investigations or remediation were required for Survey Area OMB-06.

4.4 Unique Features of Survey Unit

Survey Unit OMB-06-01 exhibited surface characteristics ranging from smooth surfaces to heavily remediated irregular surfaces. Most of the pits and irregularities increased the source-to-detector distance by approximately ¼ - ½ inch, although some increase it as much as 1 - 2 inches. These types of irregularities in the concrete surfaces were taken into account through the efficiency factor applied to the measurements collected with the HP-100. Technical report YA-REPT-00-015-04 (Appendix B) provides instrument efficiency factors (ε_i) for various source-to-detector distances. The ε_i value for a source-to-detector distance of 1 inch was selected as a representative efficiency for data collected with the HP-100 from the irregular surfaces because it accounts for the ½ inch stand-off and the most common depth of pits and surface irregularities (¼ - ½ inch). In contrast to the irregular surfaces, the vertical walls of the structures are relatively smooth. Table 4.2 of the YA-REPT-00-015-04 (Appendix B) provides instrument efficiency factors (ε_i) for various source-to-detector distances. Detector efficiencies (HP-100C) were applied as follows: smooth surface 0.0603 c/d, irregular surface 0.0373 c/d.

4.5 ALARA Practices and Evaluations

An ALARA evaluation was developed for OMB-06 Survey Area which concluded that additional remediation was not warranted. These evaluations are found in Appendix C.

5.0 SURVEY UNIT FINAL STATUS SURVEY

5.1 Survey Planning

5.1.1 Final Status Survey Plan and Associated DQOs

The FSS for OMB-06 was planned and developed in accordance with the LTP using the DQO process. Form DPF-8856.1, found in YNPS Procedure 8856, "*Preparation of Survey Plans*," was used to provide guidance and consistency during development of the FSS Plan. The FSS Plan can be found in Appendix A. The DQO process allows for

systematic planning and is specifically designed to address problems that require a decision to be made in a complex survey design and, in turn, provides alternative actions.

The DQO process was used to develop an integrated survey plan providing the Survey Unit identification, sample size, selected analytical techniques, survey instrumentation, and scan coverage. The Sign Test was specified for non-parametric statistical testing for this Survey Unit, if required. The design parameters developed are presented in Table 1.

Table 1 Survey Area OMB-06 Design Parameters

Survey Unit	Design Parameter	Value	Basis
OMB-06-01	Area	140 m2	Class 1, ≤100 m2
	Number of Direct Measurements	15 (calculated) + 0 (added) Total: 15 calculated 3 Biased	α (Type I) = 0.05 β (Type II) = 0.05 σ: 505 Relative Shift: 2 Adjusted LBGR: 6190
	Sample Area	9.33m2	Area / Sample #
	Sample Grid Spacing, triangular pitch	3.3m	Square Root (Area/(0.866*Sample #))
	Scan area	140 m2	Class 1 Area – 100%
	Scan Investigation Level	> Background Audible	SPA-3 & HP-100 Scan

5.1.2 Deviations from the FSS Plan as Written in the LTP

The FSSP design was performed to the criteria of the LTP; therefore, no LTP deviations with potential impact to this Survey Area need to be evaluated.

5.1.3 DCGL Selection and Use

It must be noted that for the final evaluation of OMB-06 and throughout this report, the acceptance criteria of Building Surface LTP-listed DCGL values has been applied. However, given that all of the remaining slab and foundation structure will be at least a few feet subsurface before site grading is complete and will be in such a state at license termination, the LTP, section 5.6.3.1.2, "Exterior Surfaces of Building Foundations," establishes the applicable guidance, as it addresses methods that may be applied to determine if subsurface structure surfaces will be acceptable by meeting LTP-required concrete volumetric DCGLs.

With the established LTP guidance, given that Co-60 and Cs-137 have been found to be the only radionuclides of significance in the area of concern, and conventional hand-held instrument survey criteria techniques being conservatively based on Co-60 beta emissions, performing a Class 1 survey applying Building Surface DCGLs has led to a very conservative approach in determining the final status of the Survey Unit.

$DCGL_W$: 7,200 dpm/100 cm^2
$DCGL_{EMC}$: 10,000 dpm/100 cm^2

5.1.4 Measurements

Error tolerances and characterization sample population statistics drove the selection of the number of fixed point measurements.

The fixed-point sampling grid was developed as a systematic grid with spacing consisting of a triangular pitch pattern with a random starting point. Sample measurement locations are provided in Attachment A.

5.2 Survey Implementation Activities

Table 2 provides a summary of daily activities performed during the Final Status Survey of Survey Units in OMB-06.

Table 2 FSS Activity Summary for OMB-06 Survey Units

Survey Unit	Date	Activity
OMB-06-01	06-13-05	Performed walk-down of Survey Unit, established Isolation and Controls
	06-14-05	Performed Job Hazard Analysis, and Unit Classification
	06-15-05	Performed Sample Quantity Calculations, established DQOs
	06-15-05	Generated FFS Sample Plans
	06-15-05 to 06-17-05	Initiated Scans, and Static measurements.
	11-07-05	DQA Complete, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area OMB-06, the Survey Unit was placed into the program for periodic surveillance surveys on a quarterly basis in accordance with YNPS procedure DP-8860, "*Area Surveillance Following Final Status Survey.*" These surveys provide assurance that areas with successful FSS remain unchanged until license termination.

5.3.2 Resurveys

The demolition of the above-grade portion of the Seal Pit occurred after the FSS of OMB-06-01 because the process of demolition would allow most of OMB-06-01 to flood, since it is below the water level of Sherman Pond. Upon completion of the demolition, an area surveillance resurvey of OMB-06-01 was performed in accordance with DPF-8860 because the Survey Unit was potentially compromised during the retrieval of concrete debris from the reservoir. The debris and bottom sediments were piled near the FSS survey unit on the east side. A concern was that some incidental amount of the sediment might have fallen within the footprint of the seal pit structure. Steel plating covered by approximately 3 feet of concrete rubble was used as reinforcement for staging a backhoe to facilitate the ongoing retrieval of the concrete debris from the reservoir.

The proof that the interior of the structure was not contaminated is based upon surveys performed on the steel plates and concrete rubble that were placed over the seal pit footprint immediately following FSS activities. Six biased fixed measurements were taken with the HP-100C directly (half inch standoff) on the steel plating. Three of the six fixed measurements were taken along the east side of the Seal Pit and the remaining three-fixed measurements were taken along the southern side of the Seal Pit. The truck monitor was utilized to analyze the concrete debris following its removal from above the steel plating. Soil /pulverized concrete samples were also taken at several biased locations within the excavated area in and around the seal pit footprint.

The samples were analyzed on-site for gamma emitting LTP nuclides of concern (Co-60 and Cs-137). The results from the truck monitor analyses and the soil samples served as an indicator as to whether the FSS of the survey unit had been compromised. The results indicated that the radiological condition of the survey unit had remained unchanged.

5.3.3 Investigations

No additional investigations were required for this Survey Unit due to surveillance surveys.

5.4 Survey Results

Direct measurement surveys indicated that OMB-06-01 had no measurement that exceeded the $DCGL_W$, depicted in Attachment B. A retrospective power curve was generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

Table 3 Systematic Direct Measurement Activity Concentration Summary

Sample ID	Net Activity (dpm/100 cm2)
OMB-06-01-001-F-FM	1602
OMB-06-01-002-F-FM	1768
OMB-06-01-003-F-FM	1668
OMB-06-01-004-F-FM	1884
OMB-06-01-005-F-FM	1072
OMB-06-01-006-F-FM	2282
OMB-06-01-007-F-FM	1884
OMB-06-01-008-F-FM	-288
OMB-06-01-009-F-FM	1635
OMB-06-01-010-F-FM	2315
OMB-06-01-011-F-FM	2348
OMB-06-01-012-F-FM	1718
OMB-06-01-013-F-FM	1420

OMB-06-01-014-F-FM	2215
OMB-06-01-015-F-FM	1453
Average	1665
Standard Deviation	652

Table 4 Biased Direct Measurement Activity Concentration Summary

Sample ID	Net Activity (dpm/100 cm2)
OMB-06-01-016-F-FM-B	1503
OMB-06-01-017-F-FM-B	-1199
OMB-06-01-018-F-FM-B	-685

5.5 Data Quality Assessment

The Data Quality Assessment phase is the part of the FSS where survey design and data are reviewed for completeness and consistency, ensuring the validity of the results, verifying that the survey plan objectives were met, and validating the classification of the Survey Unit.

The sample design and the data acquired were reviewed and found to be in accordance with applicable YNPS procedures DP-8861, "*Data Quality Assessment*"; DP-8856, "*Preparation of Survey Plans*"; DP-8853, "*Determination of the Number and Locations of FSS Samples and Measurements*"; DP-8857, "*Statistical Tests*"; DP-8865, and DP-8852, "*Final Status Survey Quality Assurance Project Plan*".

The Data Quality Assessment power curves, frequency, quantile, and scatter plots are found in Attachment B. There are no data points above DCGLw, so the sign test was not performed. An assessment of the frequency plot exhibits minor bimodality however, upon reviewing the posting plot, there are no clearly revealed systematic spatial trends as shown in Attachment A (posting plot).. The scatter plot indicates a normal dispersion of the data set whose range is within three standard deviations. The Quantile plot displays a slight asymmetry in the lower quartile attributed to a low measurement, however, the value does not question the verification of the statistical test assumptions.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Instrument QC Checks

Operation of the E-600 w/SPA-3 was in accordance with DP-8535,"*Setup and Operation of the Eberline E-600 Digital Survey Instrument,*" with QC checks preformed in accordance with DP-8540, "*Operation and Source Checks of Portable Friskers.*" Instrument response checks were performed prior to and after use for the E-600 w/SPA-3. All instrumentation involved with the FSS of OMB-06 satisfied the above criteria for the survey. QC records are found in Attachment C.

6.2 Split Samples and Recounts

DP-8864,"*Split Sample Assessment for Final Status Survey*" deals strictly with soil samples and provides no criteria for fixed-point measurements therefore no measurement comparison were made.

6.3 Self-Assessments

No self-assessments were performed during the FSS of OMB-06.

7.0 CONCLUSION

The FSS of OMB-06 has been performed in accordance with YNPS LTP and applicable FSS procedures. Evaluation of the fixed-point data has shown that none of the fixed-point measurements exceeded the $DCGL_W$, depicted in Attachment B. A retrospective power curve was generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) is rejected.

OMB-06 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, OMB-06 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mrem/yr. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mrem/yr limit will also be met.

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Final Status Survey Planning Worksheet

GENERAL SECTION	
Survey Area #: OMB-06	Survey Unit #: 01
Survey Unit Name: Seal Pit – Below Grade Structure	
FSSP Number: YNPS-FSSP-OMB-06-01-**01**	**(Rev.1 changes in bold)**

PREPARATION FOR FSS ACTIVITIES

Check marks in the boxes below signify affirmative responses and completion of the action.

1.1 Files have been established for survey unit FSS records. ☑

1.2 ALARA review has been completed for the survey unit. ☑

1.3 The survey unit has been turned over for final status survey. ☑

1.4 An initial DP-8854 walkdown has been performed and a copy of the completed Survey Unit Walkdown Evaluation is in the survey area file. ☑

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☑ CLASS 2 ☐ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 Statement of problem:

Survey Area OMB-06 is the Seal Pit. This structure is partly underground, partly underwater and partly above the ground and water. The plan is to remove the above-ground structure to a line that is three feet below grade and then backfill with riprap. This survey unit includes the part of the structure that will remain. It has an area of 140 m^2, **including walls (floor area: 60 m^2).** The concrete that is removed will either be shipped off site, or subjected to a final status survey (FSS) as a separate unit (OMB-06-02), using the truck monitor. The adjacent Survey Area on the pond side is OOL-01, which will get its FSS later, but before backfilling into the pond.

The demolition of the above-grade portion of the Seal Pit is planned to occur after the FSS of Survey Unit 01. It has to be done this way, because the process of demolition will allow most of Survey Unit 01 to flood, since it is below the water level in Sherman Pond. A small portion of this unit will have to be completed after the demolition of the upper part has begun. There is a large gate valve in the second chamber which will be removed after the concrete deck above that chamber has been removed. As soon as the gate valve is removed, the surfaces that are newly exposed will be scanned, and at least one fixed measurement will be taken. The question of possibly compromising the FSS of Survey Unit 01 by having debris from Survey Unit 02 fall into it has been considered. This is not expected to be a problem because Survey Unit 02 has had much less opportunity to be contaminated than Survey Unit 01. Also, it should be noted that 100 percent of the demolished debris from Unit 02 will be assayed to ODCM environmental and DCGL-based MDCs, thus validating the decision on potential debris contamination.

Upon completion of the demolition, an area surveillance resurvey of Unit 01 will be performed in accordance with DPF-8860. This resurvey will be based upon a study of the debris from Unit 02.

The interior of Survey Unit 01 received water that was being discharged from the Circulating Water System. The FSS has been completed on the adjacent Circ Water Discharge line. That line carried low-level radioactivity during plant operations that came from the Service Water Discharge line as part of the licensed release path for liquid effluents. After plant operations ceased, an alternate licensed release pathway was established that discharged directly into the Seal Pit. That pathway has been terminated and the line has been removed.

The Seal Pit has been extensively characterized with a combination of sediment samples, concrete core samples, gamma scans, beta scans and beta fixed measurements.

The problem at hand is to demonstrate that the years of plant operation did not result in an accumulation of plant-related radioactivity, in the structure, that exceeds the release criterion.

The planning team for this effort consists of the Radiation Protection Manager, Seal Pit Project Manager, FSS Project Manager, FSS Radiological Engineer, FSS Field Supervisor, and FSS Technicians. The FSS Radiological Engineer will make primary decisions with the concurrence of the FSS Project Manager.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed the release criterion? Alternative actions that may be implemented in this effort are investigation, remediation, or removal as radioactive waste.

3.0 Identify the inputs to the decision:

Sample media:

Concrete, if needed for investigation.

Types of measurements:

100% beta scan, biased gamma scans, fixed beta measurements on a grid with a random start point.

Radionuclide-of-concern: Co-60

This is based upon the Yankee Atomic Electric Company Sample Plan for the Seal Pit (APF-0831.1), approved 6/1/05. Taking Co-60 as the sole radionuclide of concern is conservative, based upon that data. The sediment that was in the pit was dominated by Co-60, but the only plant-related nuclide in the concrete core samples was Cs-137. Using Cs-137 as the radionuclide-of-concern or using a mix of Co-60 and Cs-137 would have permitted the use of a higher DCGL and a higher calculated source efficiency for the beta measurements.

Applicable DCGL: 7200 dpm/100 cm^2 (Co-60 – structure surface) (434 cpm, HP-100)
If concrete samples are necessary, the Subsurface Partial Structures DCGLs will apply. These are: H-3: 1.35E2; C-14: 2.34E3; Co-60: 3.45E3; Ni-63: 6.16E4; Sr-90: 1.39E1; Cs-137: 1.45E3; all in pCi/g.

$DCGL_{emc}$:

Area Factor: $AF^{Co\text{-}60} = 1.4$

$DCGL_{emc} = AF x DCGL$

$DCGL_{emc}$ = 10,000 dpm/100 cm^2 (Co-60) (603 cpm, HP-100)

Average Background: 3500 dpm (211 cpm, HP-100)

Standard deviation: 149 dpm (9.0 cpm, HP-100)

Surrogate DCGL: No surrogate DCGL will be used.

Investigation Level for fixed-point measurements: 10,000 dpm/100 cm^2 (603 cpm, HP-100) **–or-** any result that is 7200 dpm/100 cm^2 (434 cpm, HP-100) and differs from the mean of the other results by greater than three standard deviations. This is based on 100% Co-60

Investigation Level for SPA-3 scan: Increase above background using an audible signal and earphones. The initial investigation shall be to resurvey the point(s) of concern to validate the increased meter response. If there is no response above 13,000 cpm, then the investigation results are satisfactory and there is no need for further action. It there is a reproducible response greater than 13,000 cpm, then further investigation is required at the direction of the FSS Rad Engineer.

Investigation Level for HP-100 scan: 10,000 dpm/100 cm^2 (603 cpm above established background, HP-100)

Expected background range for HP-100 scan: 180 cpm to 240 cpm

Radionuclides for analysis: Any concrete samples collected will be analyzed for all seven nuclides for which the LTP lists Subsurface Partial Structures DCGLs.

MDCs for analysis of any concrete samples:

Nuclide	MDC
H-3:	13.5 pCi/g
C-14:	234 pCi/g
Co-60	345 pCi/g
Ni-63:	6160 pCi/g
Sr-90:	1.39 pCi/g
Cs-137:	145 pCi/g

Gross Activity DCGL: The DCGL for the HP-100 is based on the assumption that all of the activity is Co-60. $DCGL_{GA}$ = 7200 dpm/100 cm^2 to achieve less than 10 mrem/y. Using a total efficiency (ϵ_i x ϵ_s) of 0.0603 for the HP-100, and its probe area of 100 cm^2, this comes to 434 cpm.

Background: Based upon characterization data collected using Yankee Atomic Electric Company Sample Plan, Survey Location: Seal Pit, prepared by J. Hummer, dated 6/1/05.

HP-100 background: 211 cpm, with a standard deviation of 9 cpm
SPA-3: 9000 – 12,000cpm

Efficiencies and MDC for HP-100 Fixed Point Measurements: The efficiencies come from YA-REPT-00-015-04.

ϵ_i = 0.2413 (This is the 2π beta efficiency established for this detector at 0.5 inch)
ϵ_s = 0.25 (for beta emitters $\leq$0.400MeV_{max}, e.g., Co-60)

MDC_{fixed} (HP-100): = 1169 dpm/100 cm^2 (70 cpm, HP-100)

Scan coverage: HP-100 scans will be performed over the entire inside surface of the Seal Pit below the cut line.

SPA-3 scans will be biased as described in the General Instructions section.

Scan MDCR (HP-100) : 110.6 cpm

Scan MDC (HP-100)(fDCGL$_{EMC}$): 0.225

Note: MDCR/MDC values for the SPA-3 are not required when it is used as an investigation tool because this is over and above LTP requirements. Gamma scanning will be done only to find any possible elevated areas for further investigation.

Scan MDCR (SPA-3): N/A

Scan MDC (fDCGL): N/A

Background Determination: Background will be determined in the accordance with DP-8866 , using the

guidance for "Ambient Background Measurements."

QC checks and measurements: QC checks for the E-600/HP-100 will be performed in accordance with DP-8504. QC checks for the E-600/SPA-3 will be performed in accordance with DP-8540. No split samples will be collected because samples are not the basis for the FSS.

4.0 Define the boundaries of the survey:

Boundaries of Survey Unit 01are the interior surface of the Seal Pit, up to the cut line. The concrete above the cut line (Unit 02) is expected to go through the truck monitor under a different FSS plan. The attached map shows the surfaces to be surveyed with the walls folded down. There is a shelf, called the Energy Dissipation Basin under the water that is shown on the construction prints for the Seal Pit. This goes along the bottom of Sherman Pond, and will be considered part of Survey Area OOL-01, to be surveyed later.

5.0 Develop a decision rule:

1. If all the fixed measurements, including any investigation measurements resulting from scanning, show that the surface concentrations of radionuclides are below the average background plus the DCGL, reject the null hypothesis (i.e., the Survey Unit meets the release criterion).
2. If any fixed measurements exceed the DCGL, apply the sign test to determine if the null hypothesis is accepted or rejected.
3. If the investigation level is exceeded on any fixed measurement, perform an investigation.
4. If the average of the fixed measurements exceeds the DCGL, then accept the null hypothesis (i.e., the Survey Unit fails to meet the release criterion).

6.0 Specify tolerable limits on decision errors:

Null hypothesis: Residual plant-related radioactivity in the Survey Unit exceeds the release criterion.

Probability of type I error: 0.05

Probability of type II error: 0.05

LBGR: 3600 dpm

7.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑

Basis including background reference location: The average, ambient background, determined in accordance with DP-8866, may be subtracted from the fixed-point measurements.

Number of samples : 15 measurements on the grid established with a random start point. At least one biased measurement will be taken in the area exposed by the removal of the gate valve in the second chamber.

GENERAL INSTRUCTIONS

Final Status Survey

1. Notify QA of date and time of the pre-survey briefing, commencement of background measurements, fixed-point measurements, scanning and any other scheduled activities subject to QA notification.

2. Mark the grid locations as described in Specific Instructions.

3. Scan the following locations with an E-600/SPA-3, moving the probe at 0.25 m/s in a line at a distance no greater than 3 inches from either surface:

   a. Horizontally along the corner between the floor and all four walls in both chambers.

   b. Vertically along the four corners of each chamber, from the floor to approximately six feet above the floor.

c. Along any visible cracks.

4. Take 15 fixed-point measurements with the E-600/HP-100 at the grid locations indicated on the map, in addition to any biased measurements that may be requested by the FSS Rad Engineer.

5. Fixed point measurement location designation:

a. Grid point locations: OMB-06-01-001-F-FM through OMB-06-01-015-F-FM.

b. Biased fixed measurement locations: Continuing the pattern OMB-06-01-XXX-F-FM-B, with the next sequential number in place of the XXX.

6. Scan 100% of the interior surface below the cut lines and including the floor with an E-600 w/HP-100 at no greater than 2 inches/second. Detector should be within ½ inch of the surface.

a. Leave the bermed area in the outer chamber until the rest of the floor in that chamber has been scanned and had fixed point measurements taken. Then create a new berm, just outside the old one and deflect the water that is leaking out of the gate valve to the area outside the berm. Dry vacuum clean the area inside the new berm and scan. After the bermed area is scanned, the deflecting curtain may be removed and the sump pump may be operated as before.

7. Survey instrument operation and source checking of the E-600 w/HP-100 will be in accordance with DP-8504. The instrument response checks shall be performed before issue and after use. Mid-day response checking is recommended to minimize the amount of data that may have to be discarded in case of an instrument failure.

8. The job hazards associated with this survey are addressed in the accompanying JHA for Seal Pit Characterization and FSS.

9. All personnel participating in this survey shall be trained in accordance with DP-8868.

Specific Instructions

1. Collect the ambient background readings in accordance with DP-8866 at the following locations:

a. The northeast, northwest and southwest corners of the second chamber, one meter from each wall and one meter above the floor.

b. The northwest corner of the first chamber, one meter from each wall and one meter above the floor.

c. The approximate center of the first chamber, one meter above the floor.

d. Record these values on the survey map attached to DPF-8866.1.

2. Mark the grid locations for the fixed-point measurements as shown on the attached map. Marks should be small but distinct. **Any grid point that falls at a location that is unsuitable for a fixed measurement because of localized surface roughness that is not representative of the surface should be relocated in accordance with DP-8856 to the nearest suitable location within one meter.**

3. Perform the fixed-point measurements with the E-600/HP-100 in the scalar mode, collecting 1-minute readings within ½ inch of the surface. Even if the data is logged in the instrument, manually record each reading. At each grid location, set the probe against the surface just off the mark so that the material used to make the mark (e.g., paint) does not provide any shielding. To do this consistently, turn the probe so that the area counted is south of the mark for all floor locations and just below the mark on the walls. For any wall locations that are too close to the floor, place the probe just to the right of the mark.

4. Scan 100% of the surface with the HP-100 detector ½" from the surface at a rate no greater than 2" per second, listening for an increased count rate using earphones. Pause at any upscale reading and allow the detector to stabilize. If the reading is more than 603 cpm above the established background, mark the location for investigation and log the finding.

5. Investigate any locations marked during scanning by taking a one-minute fixed measurement, in the scalar mode, and logging the results, using the next consecutive sample location number and appending

the letter "I" to the end.

6. The FSS Rad Engineer will investigate any fixed measurements that exceed the investigation level.

NOTIFICATION POINTS

QA notification point(s)* (y/n) y

Specify:	QA Signature/Date:
1. Date/time of initial pre-survey briefing	Dida Trudeau 6/15/05
2. Date/time of commencement of background readings	Dida Trudeau 6/15/05
3. Date/time of commencement of SPA-3 scan	Dida Trudeau 6/15/05
4. Date/time of commencement of fixed measurements	Dida Trudeau 6/15/05
5. Date/time of first scan measurements – E600/HP-100	Dida Trudeau 6/16/05

E-mail notification to trudeau@yankee.com with a copy to calsyn@yankee.com satisfies this step*

FSI point(s) (y/n) n

Specify:	Field Supervisor Signature/Date:
1.	
2.	

Prepared by J. Hummer FSS Radiological Engineer Date 6/15/05

Reviewed by J. Brien FSS Radiological Engineer Date 6/16/05

Approved by D. C. Smith FSS Project Manager Date 6/16/05

GENERAL SECTION	
Survey Area #: OMB-06	Survey Unit #: 02
Survey Unit Name: Seal Pit above waterline	
FSSP Number: YNPS-FSSP-OMB-06-02-00	

PREPARATION FOR FSS ACTIVITIES

Check marks in the boxes below signify affirmative responses and completion of the action.

1.1 Files have been established for survey unit FSS records. ☒

1.2 ALARA review has been completed for the survey unit. ☒

1.3 The survey unit has been turned over for final status survey. ☒

1.4 An initial DP-8854 walkdown has been performed and a copy of the completed Survey Unit Walkdown Evaluation is in the survey area file. ☒

1.5 Activities conducted within area since turnover for FSS have been reviewed. ☒

Based on reviewed information, subsequent walkdown: ☒ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented per DP-8854. ☐

OR

The basis has been provided to and accepted by the FSS Project Manager for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☒

Classification: CLASS 1 ☐ CLASS 2 ☒ CLASS 3 ☐

DATA QUALITY OBJECTIVES (DQO)

1.0 State the problem: Survey area OMB-06 consists of two areas, OMB-06-01 and OMB-06-02. This survey plan addresses OMB-06-02, the upper concrete portion of the Seal Pit. Survey Unit OMB-06-02 is located outside of the security fence at the edge of Sherman Reservoir and lies adjacent to the Screenwell Pump House. During plant operations the Seal Pit received the discharge of the circulating water system. The circwater system received the discharge from the service water system, which was a pathway for monitored plant releases of radioactive liquid. A sediment sample was collected from within the lower portion of the structure for an initial historical assessment. The sediment sample yielded levels of residual plant related radioactivity.

Subsequently characterization surveys were performed for survey unit OMB-06-02 consisting of fixed-point readings and core sampling. The results of these surveys indicated no levels of plant related residual activity present on the structure above the LLDs. During the demolition process of the concrete walls it is anticipated that some of the demolition debris will fall into Survey Unit OMB-06-01 (the lower portion of the Seal Pit). This concrete will be retrieved and passed through the Truck Monitor. Characterization sampling/surveys of the lower portion indicate that levels of residual radioactivity are well below the LLD values and therefore would pose no danger of cross-contamination of the

concrete.

The FSS Report for this survey unit will be comprised of survey data from truck monitoring and other associated sampling/surveying of OMB-06-02.

The estimated total volume of concrete debris from OMB-06-02 is 90 cubic yards equating to about 10 truckloads of concrete.

Final Status Survey of the OMB-06-02 concrete debris will be performed utilizing a multiple intrinsic germanium gamma spectroscopy system (Bulk Material Assay System), as outlined in section 5.6.3.1.4 of the Yankee Rowe License Termination Plan, and concrete sampling to evaluate the survey unit relative to the applicable release criteria.

The problem, therefore, is to demonstrate that the concrete from Survey Unit OMB-06-02 meets the release criterion. The selected alternative action is disposal of the concrete debris.

The planning team for this effort consists of the FSS Project Manager, FSS Radiological Engineer, FSS Field Supervisor, and FSS Technicians. The FSS Radiological Engineer will make primary decisions with concurrence of the FSS Project Manager.

2.0 Identify the decision:

Now that the characterization survey of OMB-06-02 has been completed, the determination must be made, has the site-specific release guideline been met allowing the concrete debris to be used as fill material? Therefore, the decision to be made can be stated: "Does OMB-06-02 concrete debris meet the site specific acceptance criteria"? The null hypothesis (H_o), as required by the LTP, is stated and tested in the negative form: "The concrete debris does not meet the site specific release criteria".

The selected alternative action for the concrete debris if residual plant related activity exceeds the release criteria is disposal.

3.0 Identify the inputs to the decision:

Sample media: concrete debris

Types of measurements: Concrete sampling and Bulk Material assaying

DCGL determination:

DCGL values were determined for all of the LTP hard-to-detect isotopes and all of the easy-to-detect isotopes that we might ascertain through ISOCS bulk material assaying. The modeling was performed utilizing RESRAD to a dose of 23.73 mrem/yr. These values were then scaled to an 8.73 mrem/yr value for the DCGLs. The DCGL values for the nuclides of concern for the Seal Pit concrete debris are found in Table 1.

Table 1
DCGL Values for Use with Seal Pit Debris

Radionuclide	Concrete DCGL (pCi/gm)
H^3	103
Co^{60}	1.6
Nb^{94}	2.6
Ag^{108m}	2.6
Sb^{125}	11.4
Cs^{134}	1.8
Cs^{137}	2.5
Eu^{152}	3.5
Eu^{154}	3.3
Eu^{155}	139.8
C-14	2.6
Fe-55	51.5
Ni-63	36.8
Sr-90	0.3
Tc-99	22.4
Pu-238	3.5
Pu-239, 240	3.2
Pu-241	51.5
Am-241	1.5
Cm-243, 244	1.7

Radionuclides for analysis: All LTP nuclides with the focus on Cs-137

Data sensitivity: Sensitivity refers to the ability to detect a minimal amount of a substance, and is typically expressed as the method detection limit, practical quantization limit, or reporting limit. The Cs-134 and Cs-137 LLDs selected for this survey plan designate the smallest concentration of radioactive material that will yield a net count above system background that will be detected with 95 percent probability (environmental LLDs). The target LLDs selected for this survey plan reflects the environmental levels for Cs-137 and Cs-134 with the remainder of the radionuclides having an equivalently low LLD thus, meeting or improving upon the environmental LLDs.

LLDs for gamma analysis of concrete:

Table 2

Easy-to-detect LLDs

Nuclide	LLD (pCi/gm)
Nb-94	1.3
Ag-108m	1.3
Sb-125	5.7
Cs-134	.15*
Cs-137	.18*
Eu-152	1.8
Eu-154	1.7
Eu-155	70
Co-60	0.16

* LLD values are the environmental LLDs in the ODCM

Note: Cm-243 was removed from the truck monitor library since the half life is so long (as to yield immeasurably low activities unless it was present as a weight percent of the sample), its potential formation pathway is low and other methods of analysis (i.e., alpha spectroscopy) are more appropriate for analysis. Therefore Cm-243 will be analyzed via laboratory analysis and will be included in the list of hard-to-detect nuclides.

LLDs for HTD nuclides: In addition to the LLD values listed in Table 2, the following table lists the LLD values that will be transmitted to the off-site laboratory via the chain-of-custody form accompanying the FSS concrete samples.

Table 3

Hard-to-detect LLDs

Nuclide	LLD (pCi/gm)
H-3	1.00 ~~10.5~~ 9/28/05
C-14	0.26
Fe-55	5.15
Ni-63	3.68
Sr-90	0.03
Tc-99	2.24
Pu-238	0.35
Pu-239, 240	0.32
Pu-241	5.15
Am-241	0.15

Cm-243, 244	0.17

ISOCS Measurements **:** As referenced in YNPS LTP, a Bulk Spectroscopy Monitor may be employed to assay materials as a component of the final status survey program. It is the intent of YNPS to utilize the ISOCS gamma spectrum assay system to analyze, via *in-situ* gamma spectroscopy, Seal Pit debris for the decision-making process in accordance with DP-8870. The ISOCS system is technically capable of evaluating bulk materials in large containers with respect to concentration-based radioactivity (pCi/gm) as outlined in Technical Basis Document YA-REPT-01-022-04. The ISOCS receives inputs such as:

- Material weight
- Container used (i.e. intermodal, rolloff, articulated dump truck)

The Canberra software then renders a total gamma activity value for each of the easy-to-detect radionuclides.Only previously modeled containers with concrete will be assayed under this Final Status Survey Plan. Each container will be assayed and the results compared with the LLDs. Should an individual load of material result in values less than the LLDs then the load of material will be considered to be acceptable and the null hypothesis will be rejected resulting in the material being acceptable for use as fill material. If the load of material is greater than the LLDs then the null hypothesis will be accepted and the material will not be designated for on-site fill material. The respective LLDs are, in effect, the release criterion. In order to effectively evaluate the presence of plant related radioactivity at or above the very low LLDs, the background subtract feature should be enabled for this application. If an environmental background is used, an environmental background appropriate to the condition will be used.

QC checks and measurements: The FSS activities under this survey plan are implemented and performed under approved YNPS procedures. Review and validation of results ensure laboratory-sampling accuracy. Quality Assurance and Quality Control of the Truck Monitor is maintained and governed by DP-8870, DP-8869 and Technical Basis Document (YA-REPT-01-022-04). One sample will be designated as QC recount sample and a QC split sample.

4.0 Define the boundaries of the survey:

This survey is limited to the concrete debris from Survey Unit OMB-06-02.

The survey is scheduled for early summer; therefore weather conditions should not cause delays in the surveying process. As scheduled, concrete debris assaying will be performed on a two shift per day timeline. Adequate lighting should be maintained in the area of the Truck Monitor to allow for safe and timely ingress and egress of the monitor.

Once assayed, the debris suitable for use as fill material will be deposited into an area where FSS isolation and controls are in effect. Debris that is rejected will be placed in a separate pile awaiting final disposition. Individual dump trucks will bear a FSS posting.

5.0 Develop a decision rule:

The null hypothesis (H_o) is: The survey unit exceeds the release criteria. This hypothesis may be either accepted or rejected based upon the data collected. During the course of data assessment, decision-making rests on the premise that the null hypothesis is true and that sufficient evidence must be provided for rejection.

Therefore:

If an individual truckload of material assays below the respective LLDs then the null hypothesis (H_o) will be rejected and the concrete debris may be retained on-site and utilized as fill material. If an individual truckload of material exceeds an LLD for any LTP-listed radionuclide, then the null hypothesis (H_o) is accepted and concrete debris will not be used as fill material.

6.0 Specify tolerable limits on decision errors:

Probability of type I (α) error: 0.05
Probability of type II (β) error: 0.05

7.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☐

Basis including background reference location if WRS test is specified: _____

No statistical testing of the data in this survey plan is required. Any material that exceeds the acceptance criteria will be rejected.

GENERAL INSTRUCTIONS

1. Notify QA of date and time of the pre-survey briefing, commencement of RSS concrete assaying/sampling and any other scheduled activities subject to QA notification that are currently known.
2. The ISOCS Truck Monitor will assay all concrete considered for use as on-site grading material.
   a. Containers of concrete assayed by the Truck Monitor will bear a unique FSS numbering system (e.g. OMB-06-02-xxx (sequential number)-TM(for Truck Monitor assays).
   b. Truck Monitor assay numbers will be recorded on DPF-8870.6
   c. The ~~last~~ FIRST truckload through the monitor will require a recount and will be performed in accordance with DP-8864, and will bear the numbering designation of: OMB-06-02-001-TM-RC(for recount). 9/27/05
   d. Only containers that have been previously modeled and approved for counting concrete will be utilized for the Truck Monitor assaying process.
3. Collect 1 sample for off-site hard-to-detect analyses.
   a. Prepare the concrete sample in accordance with DP-8813. Concrete samples will be analyzed "as received" (i.e. no sample drying is required).
   b. The concrete sample will be taken either off the truck or when dumped (whichever method is the safest) and placed into a plastic bag with the sample number written on the bag. The bag will be delivered to the sample prep. trailer for preparing.

Enough concrete will be taken to fill the 1-liter marinelli and 60 gms for the lab analysis after crushing. Once crushed, the sample will be passed through a #8 sieve prior to placing in the glass jar.

c. Chain-of-Custody form will be used in accordance with DP-8123

d. A minimum of 60 grams of sample should be prepared and packaged in a glass container for shipment to the off-site laboratory and analysis for hard-to-detect nuclides.

e. Split samples will be prepared in a one-liter marinelli beaker for gamma spec analysis.

f. The sample will be numbered OMB-~~01~~ 06-02-001-F-CR. Additional samples, if required, will be numbered OMB-~~01~~ 06-02-XXX-F-CR with "XXX" being the sequential number of the sample. 9/27/05

g. All samples taken will be designated as recount samples and will bear a "RC" designation after the "CR".

h. Presently truckload number ~~7~~ 1 is designated to be sampled. Additional samples, if required, will be designated by the FSS Engineer. 9/21/05

i. If a load, designated to be sampled, fails, then the next load that is accepted will be sampled in its place. Failed loads will not be sampled.

j. The number of samples is based on an estimated total of 10 truckloads. If more truckloads are monitored the sample number will be adjusted accordingly.

The job hazards associated with the FSS in Survey Unit 02 are addressed in the accompanying JHA for OMB-06-02.

All samples taken will be split samples and will be indicated with the designation "S" after the "CR" The splits will be sent to the off-site and onsite laboratory for gamma analysis to:

1.) Compare with the off-site laboratory results in accordance with DP-8864.

2.) Evaluate the performance of the Bulk Assay Monitor

Operation of the Truck Monitor, QC Source Counts, and QC Background Counts will be performed in accordance with DP-8870.

All personnel participating in this survey shall be trained in accordance with DP-8868

SPECIFIC INSTRUCTIONS

1. Any flags encountered during either the QC Source Count or the QC Background Count must be corrected/resolved prior to assaying concrete for disposition. If anomalies cannot be corrected or resolved, contact the Cognizant FSS Engineer for assistance.
2. Should a significant shift in the QC background Count be encountered, a Cognizant FSS Engineer will evaluate the need for a new Environmental Background Count.
3. All unidentified peaks indicated on an assay report must be resolved prior to assigning disposition to the load of concrete.
4. All sample analysis will achieve the LLD values stated in the DQO section of this plan.

If a load fails and the Cs-137 and Co-60 concentrations are <0.2 pCi/gm then the failure will be

notated on the report and in the truck monitor logbook. If a load fails and either Cs-137 or Co-60 concentration is >0.2 pCi/gm or any other table 2 nuclide is identified then the failure will be notated on the report, notated in the logbook and the FSS Project Manager, or his designee, will be notified.

If a truckload of material is rejected, the truck will be assayed empty prior to reloading.

PRESCREENING OF THE TRUCK AND LOADER IS REQUIRED PRIOR TO LOADING SEAL PIT CONCRETE.
9/27/05

NOTIFICATION POINTS

QA notification point(s) (y/n) *y QA Signature/Date:

(1) Date/time of initial pre-survey briefing /

(2) Date/time of commencement of Bulk Material monitoring /

(3) /

(4) /

* Email notification to trudeau@yankee.com with a copy to calsyn@yankee.com satisfies this step

FSI point(s) (y/n) n FSS Radiological Engineer Signature/Date:

(1) /

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TECHNICAL REPORT TITLE PAGE

COPY

Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at Yankee Rowe

Title

YA-REPT-00-015-04
REV. 0

Technical Report Number

Approvals	(Print & Sign Name)	
Preparer:		Date: 10-7-04
Reviewer:	James R. Hummer	Date: 10/7/04
Approver (Cognizant Manager):		Date: 10/7/04

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1.0 Executive Summary:

The minimum detectable concentration (MDC) of the field survey instrumentation is an important factor affecting the quality of the final status survey (FSS). The efficiency of an instrument inversely impacts the MDC value. The objective of this report is to determine the instrument and source efficiency values used to calculate MDC. Several factors were considered when determining these efficiencies and are discussed in the body of this report. Instrument efficiencies (ε_i), and source efficiencies (ε_s), for alpha beta detection equipment under various field conditions, and instrument conversion factors (E_i), for gamma scanning detectors were determined and the results are provided herein.

2.0 Introduction:

Before performing Final Status Surveys of building surfaces and land areas, the minimum detectable concentration (MDC) must be calculated to establish the instrument sensitivity. Table 5.4 of the License Termination Plan (LTP) [8.6] lists the available instrumentation and nominal detection sensitivities; however for the purposes of this basis document, efficiencies for the 100cm^2 gas proportional and the 2"x2" NaI (Tl) detectors will be determined. Efficiencies for the other instrumentation listed in the LTP shall be determined on an as needed basis. The 100 cm^2 gas proportional probe will be used to perform surveys (i.e. fixed point measurements). A 2" x2" NaI (Tl) detector will be used to perform gamma surveys (i.e., surface scans) of portions of land areas and possibly supplemental structural scans at the Yankee Rowe site. Although surface scans and fixed point measurements can be performed using the same instrumentation, the calculated MDCs will be quite different. MDC is dependent on many factors and may include but is not limited to:

- instrument efficiency
- background
- integration time
- surface type
- source to detector geometry
- source efficiency

A significant factor in determining an instrument MDC is the total efficiency, which is dependent on the instrument efficiency, the source efficiency and the type and energy of the radiation. MDC values are inversely affected by efficiency, as efficiencies increase, MDC values will decrease. Accounting for both the instrument and source components of the total efficiency provides for a more accurate assessment of surface activity.

3.0 Calibration Sources:

For accurate measurement of surface activity it is desirable that the field instrumentation be calibrated with source standards similar to the type and energy of the anticipated contamination. The nuclides listed in Table 3.1 illustrate the nuclides found in soil and building surface area DCGL results that are listed in the LTP.

Instrument response varies with incident radiations and energies; therefore, instrumentation selection for field surveys must be modeled on the expected surface activity. For the purposes of this report, isotopes with max beta energies less than that of C-14 (0.158 MeV) will be considered difficult to detect (reference table 3.1). The detectability of radionuclides with max beta energies less than 0.158 MeV, utilizing gas proportional detectors, will be negligible at typical source to detector distances of approximately 0.5

inches. The source to detector distance of 1.27 cm (0.5 inches) is the distance to the detector with the attached standoff (DP-8534 "Operation and Source Checks of Proportional Friskers")[8.5]. Table 3.1 provides a summary of the LTP radionuclides and their detectability using Radiological Health Handbook [8.4] data.

Table 3.1
Nuclides and Major Radiations: Approximate Energies (Reference 8.4)

Nuclide	α Energy (MeV)	$E_{\beta max}$ (MeV)	Average E_β (MeV)	Photon Energy (MeV)	α Detectable w/ Gas Proportional	β Detectable w/ Gas Proportional	γ Detectable w/ NaI 2x2"
H-3		0.018	0.005				
C-14		0.158	0.049				
Fe-55				0.23 (0.004%) bremsstrahlung			
Co-60		0.314	0.094	1.173 (100%), 1.332 (100%)		√	√
Ni-63		0.066	0.017				
Sr-90		0.544 2.245 (Y-90)	0.200 0.931			√	
Nb-94		0.50	0.156	0.702 (100%), 0.871 (100%)		√	√
Tc-99		0.295	0.085			√	
Ag-108m		1.65 (Ag-108)	0.624 (Ag-108)	0.434 (0.45%), 0.511 (0.56%) 0.615 (0.18%), 0.632 (1.7%)			√
Sb-125		0.612	0.084	0.6, 0.25, 0.41, 0.46, 0.68, 0.77, 0.92, 1.10, 1.34		√	√
Cs-134		1.453	0.152	0.57 (23%), 0.605 (98%) 0.796 (99%), 1.038 (1.0%) 1.168 (1.9%), 1.365 (3.4%)		√	√
Cs-137		1.167	0.195	0.662 (85%) Ba-137m X-rays		√	√
Eu-152		1.840	0.288	0.122 (37%), 0.245 (8%) 0.344 (27%), 0.779 (14%) 0.965 (15%), 1.087 (12%) 1.113 (14%), 1.408 (22%)		√	√
Eu-154		1.850 (10%)	0.228				
Eu-155		0.247	0.044	0.087 (32%), 0.105 (20%)		√	
Pu-238	5.50 (72%) 5.46 (28%)			0.099 (8E-3%) 0.150 (1E-3%) 0.77 (5E-5%)	√		
Pu-239	5.16 (88%) 5.11 (11%)			0.039 (0.007%), 0.052 (0.20%), 0.129 (0.005%)...	√		
Pu-241	4.90 (0.0019%) 4.85 (0.0003%)	0.021	0.005	0.145 (1.6E-4%)			
Am-241	5.49 (85%) 5.44 (13%)			0.060 (36%), 0.101 (0.04%)...	√		
Cm-243	6.06 (6%) 5.99 (6%) 5.79 (73%) 5.74 (11.5%)			0.209 (4%), 0.228 (12%), 0.278 (14%)	√		

NUREG-1507 and ISO 7503-1 provide guidance for selecting calibration sources and their use in determining total efficiency. It is common practice to calibrate instrument efficiency for a single beta energy; however the energy of this reference source should not be significantly greater than the beta energy of the lowest energy to be measured.

Tc-99 (0.295 MeV max) and Th-230 (4.68 MeV at 76% and 4.62 MeV at 24%) have been selected as the beta and alpha calibration standards respectively, because their energies conservatively approximate the beta and alpha energies of the plant specific radionuclides.

4.0 Efficiency Determination:

Typically, using the instrument 4π efficiency exclusively provides a good approximation of surface activity. Using these means for calculating the efficiency often results in an under estimate of activity levels in the field. Applying both the instrument 2π efficiency and the surface efficiency components to determine the total efficiency allows for a more accurate measurement due to consideration of the actual characteristics of the source surfaces. ISO 7503-1 [8.2] recommends that the total surface activity be calculated using:

$$A_s = \frac{R_{S+B} - R_B}{(\varepsilon_i)(W)(\varepsilon_s)},$$

where:
A_s is the total surface activity in dpm/cm^2,
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
ε_i is the instrument or detector 2π efficiency
ε_s is the efficiency of the source
W is the area of the detector window (cm^2)

4.1 Alpha and Beta Instrument Efficiency (ε_i):

Instrument efficiency (ε_i) reflects instrument characteristics and counting geometry, such as source construction, activity distribution, source area, particles incident on the detector per unit time and therefore source to detector geometry. Theoretically the maximum value of ε_i is 1.0, assuming all the emissions from the source are 2π and that all emissions from the source are detected. The ISO 7503-1 methodology for determining the instrument efficiency is similar to the historical 4π approach; however the detector response, in cpm, is divided by the 2π surface emission rate of the calibration source. The instrument efficiency is calculated by dividing the net count rate by the 2π surface emission rate ($q_{2\pi}$) (includes absorption in detector window, source detector geometry). The instrument efficiency is expressed in ISO 7503-1 by:

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi}}$$

where:
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
$q_{2\pi}$ is the 2π surface emission rate in reciprocal seconds

Note that both the 2π surface emission rate and the source activity are usually stated on the certification sheet provided by the calibration source manufacturer and certified as National Institute of Standards and Technology (NIST) traceable. Table 4.1 depicts instrument efficiencies that have been determined during calibration using the 2π surface emission rate of the source.

Table 4.1
Instrument Efficiencies (ε_i)

Source	Emission	Active Area of Source (cm^2)	Effective Area of Detector	100 cm^2 Gas Proportional HP-100 Instrument Efficiency (ε_i) (Contact)
Tc-99	β	*15.2*	100 cm^2	0.4148
Th-230	α	*15.2*	100 cm^2	0.5545

4.2 Source to Detector Distance Considerations:
A major factor affecting instrument efficiency is source to detector distance. Consideration must be given to this distance when selecting accurate instrument efficiency. The distance from the source to the detector shall to be as close as practicable to geometric conditions that exist in the field. A range of source to detector distances has been chosen, taking into account site specific survey conditions. In an effort to minimize the error associated with geometry, instrument efficiencies have been determined for source to detector distances representative of those survey distances expected in the field. The results shown in Table 4.2 illustrate the imposing reduction in detector response with increased distance from the source. Typically this source to detector distance will be 0.5 inches for fixed point measurements and 0.5 inches for scan surveys on flat surfaces, however they may differ for other surfaces. Table 4.2 makes provisions for the selection of source to detector distances for field survey conditions of up to 2 inches. If surface conditions dictate the placement of the detector at distances greater than 2 inches instrument efficiencies will be determined on an as needed basis.

4.2.1 Methodology:
The practical application of choosing the proper instrument efficiency may be determined by averaging the surface variation (peaks and valleys narrower than the length of the detector) and adding 0.5 inches, the spacing that should be maintained between the detector and the highest peaks of the surface. Select the source to detector distance from Table 4.2 that best reflects this pre-determined geometry.

Table 4.2
Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters

Source to Detector Distance (cm)	**Instrument Efficiency (ε_i)**	
	Tc-99 Distributed	**Th-230 Distributed**
Contact	0.4148	0.5545
1.27 (0.5 in)	0.2413	0.1764
2.54 (1 in)	0.1490	0.0265
5.08 (2 in)	0.0784	0.0002

4.3 Source (or Surface) Efficiency (ε_s) Determination:

Source efficiency (ε_s), reflects the physical characteristics of the surface and any surface coatings. The source efficiency is the ratio between the number of particles emerging from surface and the total number of particles released within the source. The source efficiency accounts for attenuation and backscatter. ε_s is nominally 0.5 (no self-absorption/attenuation, no backscatter)–backscatter increases the value, self-absorption decreases the value. Source efficiencies may either be derived experimentally or simply selected from the guidance contained in ISO 7503-1. ISO 7503-1 takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. However, this approach may prove to be too conservative for radionuclides with max beta energies that are marginally lower than 0.400 MeV, such as Co-60 with a βmax of 0.314 MeV. In this situation, it may be more appropriate to determine the source efficiency by considering the energies of other beta emitting radionuclides. Using this approach it is possible to determine weighted average source efficiency. For example, a source efficiency of 0.375 may be calculated based on a 50/50 mix of Co-60 and Cs-137. The source efficiencies for Co-60 and Cs-137 are 0.25 and 0.5 respectively, since the radionuclide fraction for Co-60 and Cs-137 is 50% for each, the weighted average source efficiency for the mix may be calculated in the following manner:

$$(0.25)(0.5)+(0.5)(0.5)=0.375$$

Table 4.3 lists guidance on source efficiencies from ISO 7503-1.

Table 4.3
Source Efficiencies as listed in ISO 7503-1

	$> 0.400\ MeV_{max}$	$\leq 0.400\ MeV_{max}$
Beta emitters	$\varepsilon_s = 0.5$	$\varepsilon_s = 0.25$
Alpha emitters	$\varepsilon_s = 0.25$	$\varepsilon_s = 0.25$

It should be noted that source efficiency is not typically addressed for gamma detectors as the value is effectively unity.

5.0 Instrument Conversion Factor (E) (Instrument Efficiency for Scanning):

Separate modeling analysis (Microshield™) was conducted using the common gamma emitters with a concentration of 1 pCi/g of uniformly distributed contamination throughout the volume. MicroShield is a comprehensive photon/gamma ray shielding and dose assessment program, which is widely used throughout the radiological safety community. An activity concentration of 1 pCi/g for the nuclides was entered as the source term. The radial dimension of the cylindrical source was 28 cm, the depth was 15 cm, and the dose point above the surface was 10 cm with a soil density of 1.6 g/cm^3. The instrument efficiency when scanning, E_i, is the product of the modeled exposure rate (MicroShield™) in mRhr^{-1}/pCi/g for and the energy response factor in cpm/mR/hr as derived from the energy response curve provided by Eberline Instruments (Appendix O). Table 5.1 demonstrates the derived efficiencies for the major gamma emitting isotopes listed in Table 3.1.

TABLE 5.1
Energy Response and Efficiency for Photon Emitting Isotopes

Isotope	Calculations for E_i See appendix A through L	E_i (cpm/pCi/g)
Co-60	See Appendix Aand B	**379**
Nb-94	See Appendix C and D	**416**
Ag-108m	See Appendix E and F	**637**
Sb-125	See Appendix G and H	**210**
Cs-134	See Appendix I and J	**506**
Cs-137	See Appendix K and L	**188**
Eu-152	See Appendix M and N	**344**

When performing gamma scan measurements on soil surfaces the effective source to detector geometry is as close as is reasonably possible (less than 3 inches).

6.0 Applying Efficiency Corrections Based on the Effects of Field Conditions for Total Efficiency:

The total efficiency for any given condition can now be calculated from the product of the instrument efficiency ε_i and the source efficiency ε_s.

$$\varepsilon_{tot} = \varepsilon_i \times \varepsilon_s$$

The following example illustrates the process of determining total efficiency. For this example we will assume the following:

- Surface activity readings need to be made in the Primary Auxiliary Building (PAB) on the concrete wall surfaces using the E-600 and C-100 gas proportional detector.
- Data obtained from characterization results from the PAB indicate the presence of beta emitters with energies greater than 0.400 Mev.
- The source (activity on wall) to detector distance is 1.27 cm (0.5 in detector stand off). To calculate the total efficiency, ε_{tot}, refer to Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters" to obtain the appropriate ε_i value.
- Contamination on all surfaces is distributed relative to the effective detector area.

- When performing fixed point measurements with gas proportional instrumentation the effective source to detector geometry is representative of the calibrated geometries listed in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters".
- Corrections for temperature and pressure are not substantial.

In this example, the value for ε_i is 0.2413 as depicted in Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α- β Emitters". The ε_s value of 0.5 is chosen refer to Table 4.3 "Source Efficiencies as listed in ISO 7503-1". Therefore the total efficiency for this condition becomes $\varepsilon_{tot} = \varepsilon_i \times \varepsilon_s = 0.2413 \times 0.5 = 0.121$ or 12.1%.

7.0 Conclusion:

Field conditions may significantly influence the usefulness of a survey instrument. When applying the instrument and source efficiencies in MDC calculations, field conditions must be considered. Tables have been constructed to assist in the selection of appropriate instrument and source efficiencies. Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for α-β Emitters" lists instrument efficiencies (ε_i) at various source to detector distances for alpha and beta emitters. The appropriate ε_i value should be applied, accounting for the field condition, i.e. the relation between the detector and the surface to be measured.

Source efficiencies shall be selected from Table 4.3 "Source Efficiencies as listed in ISO 7503-1". This table lists conservative ε_s values that correct for self-absorption and attenuation of surface activity. Table 5.1 "Energy Response and Efficiency for Photon Emitting Isotopes" lists E_i values that apply to scanning MDC calculations. The Microshield™ model code was used to determine instrument efficiency assuming contamination conditions and detector geometry cited in section 5.6.2.4.4 "MDCs for Gamma Scans of Land Areas" of the License Termination Plan [8.6].

Detector and source conditions equivalent to those modeled herein may directly apply to the results of this report.

8.0 References

8.1 NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," 1998

8.2 ISO 7503-1, "Evaluation of Surface Contamination – Part I: Beta Emitters and Alpha Emitters," 1988-08-01.

8.3 ISO 8769, "Reference Sources for the Calibration of Surface Contamination Monitors-Beta-emitters (maximum beta energy greater 0.15MeV) and Alpha-emitters," 1988-06-15.

8.4 "Radiological Health Handbook," Revised Edition 1970.

8.5 DP-8534, "Operation and source Checks of Portable Friskers".

8.6 Yankee Nuclear Plant Site License Termination Plan, Rev.0, November 2003.

APPENDIX A

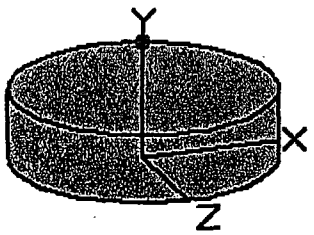
MicroShield v6.02 (6.02-00253)

Page	:1		
DOS File	:SPA3-EFF-Co-60.ms6	**File Ref**	:
Run Date	: September 10, 2004	**Date**	:
Run Time	: 8:56:50 AM	**By**	:
Duration	: 00:00:00	**Checked**	:

Case Title: SPA3-EFF-Co-60
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Co-60
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Co-60	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.6938	2.230e-01	9.055e-06	1.590e-05	1.748e-08	3.070e-08
1.1732	1.367e+03	1.098e-01	1.669e-01	1.962e-04	2.982e-04
1.3325	1.367e+03	1.293e-01	1.904e-01	2.244e-04	3.303e-04
Totals	**2.734e+03**	**2.391e-01**	**3.573e-01**	**4.205e-04**	**6.286e-04**

APPENDIX B

Co-60
Microsoft Excel Ei Calculation Sheet

	Energy MeV	Energy keV	Exposure Rate (mR/hr/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
694	0.6938	694	3.07E-08	1,112.630	0
1173	1.1732	1,173	2.98E-04	660.557	197
1333	1.3325	1,333	3.30E-04	552.233	182
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(Ei) Total:	379

APPENDIX C

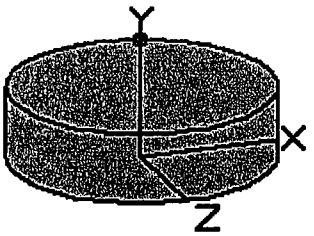
MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Nb-94.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:22:38 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Nb-94
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Nb-94
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Nb-94	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0023	9.067e-02	1.391e-10	1.430e-10	1.861e-10	1.913e-10
0.0174	4.834e-01	8.762e-09	9.129e-09	4.729e-10	4.927e-10
0.0175	9.260e-01	1.719e-08	1.792e-08	9.104e-10	9.491e-10
0.0196	2.720e-01	7.924e-09	8.356e-09	2.925e-10	3.085e-10
0.7026	1.367e+03	5.643e-02	9.872e-02	1.088e-04	1.904e-04
0.8711	1.367e+03	7.464e-02	1.228e-01	1.405e-04	2.312e-04
Totals	**2.736e+03**	**1.311e-01**	**2.216e-01**	**2.493e-04**	**4.216e-04**

Nb-94					
	Energy MeV	Energy keV	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	E (cpm/pCi/g)
2	0.0023	2	1.91E-10		0
17	0.0174	17	4.93E-10		0
18	0.0175	18	9.49E-10		0
20	0.0196	20	3.09E-10		0
703	0.7026	703	1.90E-04	1,110,370	211
871	0.8711	871	2.31E-04	884,689	205
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	416

APPENDIX E

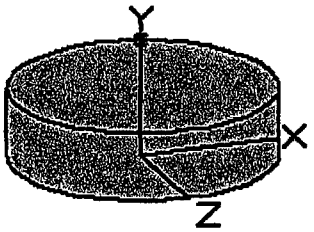
MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Ag-108m.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:30:40 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Ag-108m
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Ag-108m
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ag-108m	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0028	6.580e+01	1.252e-07	1.287e-07	1.351e-07	1.388e-07
0.003	7.853e+00	1.568e-08	1.612e-08	1.612e-08	1.657e-08
0.021	2.491e+02	9.534e-06	1.015e-05	2.824e-07	3.007e-07
0.0212	4.727e+02	1.862e-05	1.985e-05	5.389e-07	5.744e-07
0.022	7.024e+00	3.202e-07	3.434e-07	8.233e-09	8.831e-09
0.0222	1.330e+01	6.251e-07	6.714e-07	1.568e-08	1.685e-08
0.0238	1.501e+02	9.273e-06	1.010e-05	1.863e-07	2.029e-07
0.0249	4.289e+00	3.145e-07	3.464e-07	5.492e-09	6.050e-09
0.0304	2.902e-04	4.431e-11	5.248e-11	4.230e-13	5.010e-13
0.0792	9.687e+01	2.008e-04	4.802e-04	3.190e-07	7.629e-07
0.4339	1.229e+03	2.705e-02	5.514e-02	5.294e-05	1.079e-04
0.6144	1.236e+03	4.282e-02	7.808e-02	8.347e-05	1.522e-04
0.7229	1.237e+03	5.300e-02	9.194e-02	1.019e-04	1.768e-04
Totals	**4.768e+03**	**1.231e-01**	**2.257e-01**	**2.398e-04**	**4.389e-04**

APPENDIX F

Ag-108m
Microsoft Excel E Calculation Sheet

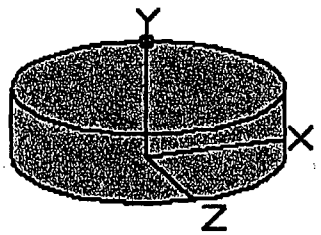
Energy MeV	Energy keV	Exposure Rate (mR/hr 1/pCi/g)	Energy Response (cpm/mR/h)	E1 (cpm/pCi/g)
3	0.0028	3	1.39E-07	0
3	0.003	3	1.66E-08	0
21	0.021	21	1.30E-07	0
21	0.0212	21	5.74E-07	0
22	0.022	22	8.83E-09	0
22	0.0222	22	1.69E-08	0
24	0.0238	24	2.03E-07	0
25	0.0249	25	6.05E-09	0
30	0.0304	30	5.01E-13	1086720	0
79	0.0792	79	7.63E-07	11696000	9
434	0.4339	434	1.08E-04	2061265	222
614	0.6144	614	1.52E-04	1402440	213
723	0.7229	723	1.77E-04	1086291	192
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	637

APPENDIX G

MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Sb-125.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:34:07 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Sb-125
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Sb-125
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	Becquerels	µCi/cm³	Bq/cm³
Sb-125	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0038	6.762e+01	1.708e-07	1.756e-07	1.388e-07	1.427e-07
0.0272	1.748e+02	1.785e-05	2.020e-05	2.376e-07	2.689e-07
0.0275	3.262e+02	3.453e-05	3.922e-05	4.461e-07	5.067e-07
0.031	1.132e+02	1.857e-05	2.221e-05	1.670e-07	1.997e-07
0.0355	5.693e+01	1.492e-05	1.918e-05	9.090e-08	1.169e-07
0.117	3.568e+00	1.380e-05	3.715e-05	2.146e-08	5.778e-08
0.159	9.531e-01	5.634e-06	1.499e-05	9.416e-09	2.505e-08
0.1726	2.478e+00	1.634e-05	4.295e-05	2.787e-08	7.326e-08
0.1763	9.422e+01	6.392e-04	1.674e-03	1.096e-06	2.870e-06
0.2041	4.410e+00	3.630e-05	9.230e-05	6.435e-08	1.636e-07
0.2081	3.324e+00	2.805e-05	7.103e-05	4.994e-08	1.264e-07
0.2279	1.796e+00	1.708e-05	4.229e-05	3.098e-08	7.670e-08
0.321	5.701e+00	8.474e-05	1.899e-04	1.620e-07	3.632e-07
0.3804	2.045e+01	3.792e-04	8.052e-04	7.364e-07	1.564e-06
0.408	2.486e+00	5.051e-05	1.049e-04	9.853e-08	2.047e-07
0.4279	4.009e+02	8.668e-03	1.774e-02	1.695e-05	3.470e-05
0.4435	4.130e+00	9.356e-05	1.894e-04	1.832e-07	3.709e-07
0.4634	1.415e+02	3.395e-03	6.781e-03	6.658e-06	1.330e-05
0.6006	2.430e+02	8.174e-03	1.501e-02	1.595e-05	2.930e-05
0.6066	6.864e+01	2.340e-03	4.283e-03	4.564e-06	8.355e-06
0.6359	1.548e+02	5.609e-03	1.012e-02	1.091e-05	1.967e-05
0.6714	2.478e+01	9.640e-04	1.710e-03	1.867e-06	3.311e-06
Totals	**1.916e+03**	**3.060e-02**	**5.901e-02**	**6.046e-05**	**1.158e-04**

Sb-125

	Energy MeV	Energy keV	Exposure Rate (mR/h - 1 pCi/g)	Energy Response (cpm/mR/h)	E_i (cpm/pCi/g)
4	0.0038	4	1.43E-07	6,618,312	0
27	0.0272	27	2.69E-07	510,290	0
28	0.0275	28	5.07E-07	554,834	0
31	0.031	31	2.00E-07	1,219,281	0
36	0.0355	36	1.17E-07	2,418,948	0
117	0.117	117	5.78E-08	9,167,000	1
159	0.159	159	2.51E-08	8917000	0
173	0.1726	173	7.33E-08	6859000	1
176	0.1763	176	2.87E-06	6192600	18
204	0.2041	204	1.64E-07	6011300	1
208	0.2081	208	1.26E-07	4073050	1
228	0.2279	228	7.67E-08	3110500	0
321	0.321	321	3.63E-07	3000500	1
380	0.3804	380	0.000001564	2348000	4
408	0.408	408	2.047E-07	2155800	0
428	0.4279	428	0.0000347	2083165	72
444	0.4435	444	3.709E-07	2026225	1
463	0.4634	463	0.0000133	1953590	26
601	0.6006	601	0.0000293	1452810	43
607	0.6066	607	0.000008355	1430910	12
636	0.6359	636	0.00001967	1323965	26
671	0.6714	671	0.0000033	194390	4
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E_i) Total	**210**

APPENDIX I

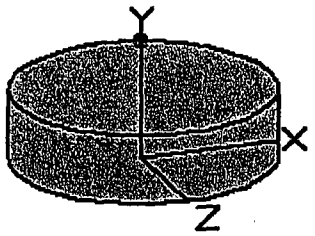
MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Cs-134.ms6	**Date**	:
Run Date	: September 16, 2004	**By**	:
Run Time	: 3:39:09 PM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Cs-134
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Cs-134
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Cs-134	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0045	1.222e+00	3.658e-09	3.760e-09	2.507e-09	2.577e-09
0.0318	2.931e+00	5.271e-07	6.386e-07	4.391e-09	5.320e-09
0.0322	5.407e+00	1.014e-06	1.236e-06	8.157e-09	9.943e-09
0.0364	1.968e+00	5.611e-07	7.321e-07	3.188e-09	4.160e-09
0.2769	4.839e-01	5.931e-06	1.391e-05	1.113e-08	2.610e-08
0.4753	1.996e+01	4.950e-04	9.808e-04	9.712e-07	1.924e-06
0.5632	1.146e+02	3.545e-03	6.648e-03	6.940e-06	1.302e-05
0.5693	2.109e+02	6.619e-03	1.237e-02	1.295e-05	2.421e-05
0.6047	1.334e+03	4.529e-02	8.300e-02	8.836e-05	1.619e-04
0.7958	1.167e+03	5.668e-02	9.564e-02	1.079e-04	1.820e-04
0.8019	1.193e+02	5.852e-03	9.853e-03	1.113e-05	1.874e-05
1.0386	1.367e+01	9.377e-04	1.472e-03	1.717e-06	2.696e-06
1.1679	2.461e+01	1.964e-03	2.990e-03	3.514e-06	5.349e-06
1.3652	4.156e+01	4.055e-03	5.936e-03	6.993e-06	1.024e-05
Totals	**3.058e+03**	**1.254e-01**	**2.189e-01**	**2.405e-04**	**4.202e-04**

Cs-134
Microsoft Excel E_i Calculation Sheet

	Energy MeV	Energy keV	Exposure Rate (mR/hr / pCi/g)	Energy Response (cpm/mR/h)	E_i (cpm/pCi/g)
5	0.0045	5	2.58E-09		0
32	0.0318	32	5.32E-09	1,406,947	0
32	0.0322	32	9.94E-09	1,505,273	0
36	0.0364	36	4.16E-09	2,696,122	0
277	0.2759	277	2.61E-08	3,637,000	0
475	0.4753	475	1.92E-06	1,910,155	4
563	0.5632	563	1.30E-05	1,589,320	21
569	0.5693	569	2.42E-05	1,567,055	38
605	0.6047	605	1.62E-04	1,437,845	233
796	0.7958	796	1.82E-04	998,082	182
802	0.8019	802	1.87E-05	939,149	18
1039	1.0386	1,039	2.70E-06	752,085	2
1168	1.1679	1,168	5.35E-06	664,161	4
1365	1.3652	1,365	1.02E-05	573,136	6
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E_i) Total:	**506**

APPENDIX K

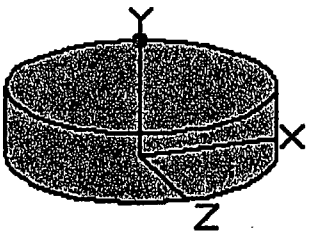
MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Cs-137.ms6	**Date**	:
Run Date	: September 10, 2004	**By**	:
Run Time	: 8:52:18 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA3-EFF-Cs-137
Description: SPA-3 Soil scan - 28 cm radius 1pCi/cm3 Cs-137 and Daughters
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)



Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	3.4950e-008	1.2932e+003	9.4600e-007	3.5002e-002
Cs-137	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0045	1.342e+01	4.020e-08	4.133e-08	2.755e-08	2.833e-08
0.0318	2.677e+01	4.815e-06	5.834e-06	4.011e-08	4.860e-08
0.0322	4.939e+01	9.260e-06	1.129e-05	7.452e-08	9.084e-08
0.0364	1.797e+01	5.126e-06	6.688e-06	2.912e-08	3.800e-08
0.6616	1.164e+03	4.442e-02	7.913e-02	8.611e-05	1.534e-04
Totals	**1.271e+03**	**4.444e-02**	**7.915e-02**	**8.628e-05**	**1.536e-04**

Cs-137
Microsoft Excel E Calculation Sheet

	Energy MeV	Energy kev	Exposure Rate (mR/hr 1 pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
5	0.0045	5	2.83E-08		0
32	0.0318	32	4.86E-08	1,406,947	0
32	0.0322	32	9.08E-08	1,505,273	0
36	0.0364	36	5.80E-08	2,696,122	0
662	0.6616	662	1.53E-04	1,228,700	188
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
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0		0			0
0		0			0
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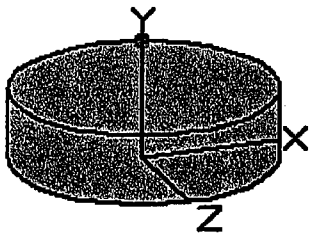
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E) Total:	188

APPENDIX M

MicroShield v6.02 (6.02-00253)

Page	:1	**File Ref**	:
DOS File	:SPA3-EFF-Eu-152.ms6	**Date**	:
Run Date	: October 7, 2004	**By**	:
Run Time	: 11:25:11 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: SPA-3-EFF-Eu-152
Description: SPA-3 Soil scan - 28cm radius 1 pCi/cm3 Eu-152
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions:

Height	15.0 cm	(5.9 in)
Radius	28.0 cm	(11.0 in)

Dose Points

A	X	Y	Z
# 1	0 cm	25 cm	0 cm
	0.0 in	9.8 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	1.6
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Eu-152	3.6945e-008	1.3670e+003	1.0000e-006	3.7000e-002

Buildup : The material reference is - Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.077e+02	2.087e-06	2.146e-06	1.790e-07	1.841e-07
0.04	8.088e+02	3.131e-04	4.331e-04	1.385e-06	1.916e-06
0.05	2.022e+02	1.507e-04	2.467e-04	4.014e-07	6.572e-07
0.1	3.887e+02	1.189e-03	3.118e-03	1.819e-06	4.770e-06
0.2	1.024e+02	8.207e-04	2.097e-03	1.448e-06	3.700e-06
0.3	3.696e+02	5.029e-03	1.151e-02	9.540e-06	2.184e-05
0.4	8.590e+01	1.701e-03	3.555e-03	3.314e-06	6.926e-06
0.5	7.711e+00	2.043e-04	3.984e-04	4.010e-07	7.819e-07
0.6	5.797e+01	1.948e-03	3.579e-03	3.802e-06	6.985e-06
0.8	2.434e+02	1.190e-02	2.005e-02	2.263e-05	3.813e-05
1.0	5.849e+02	3.820e-02	6.058e-02	7.042e-05	1.117e-04
1.5	3.171e+02	3.490e-02	4.999e-02	5.871e-05	8.411e-05
Totals	**3.376e+03**	**9.635e-02**	**1.556e-01**	**1.740e-04**	**2.817e-04**

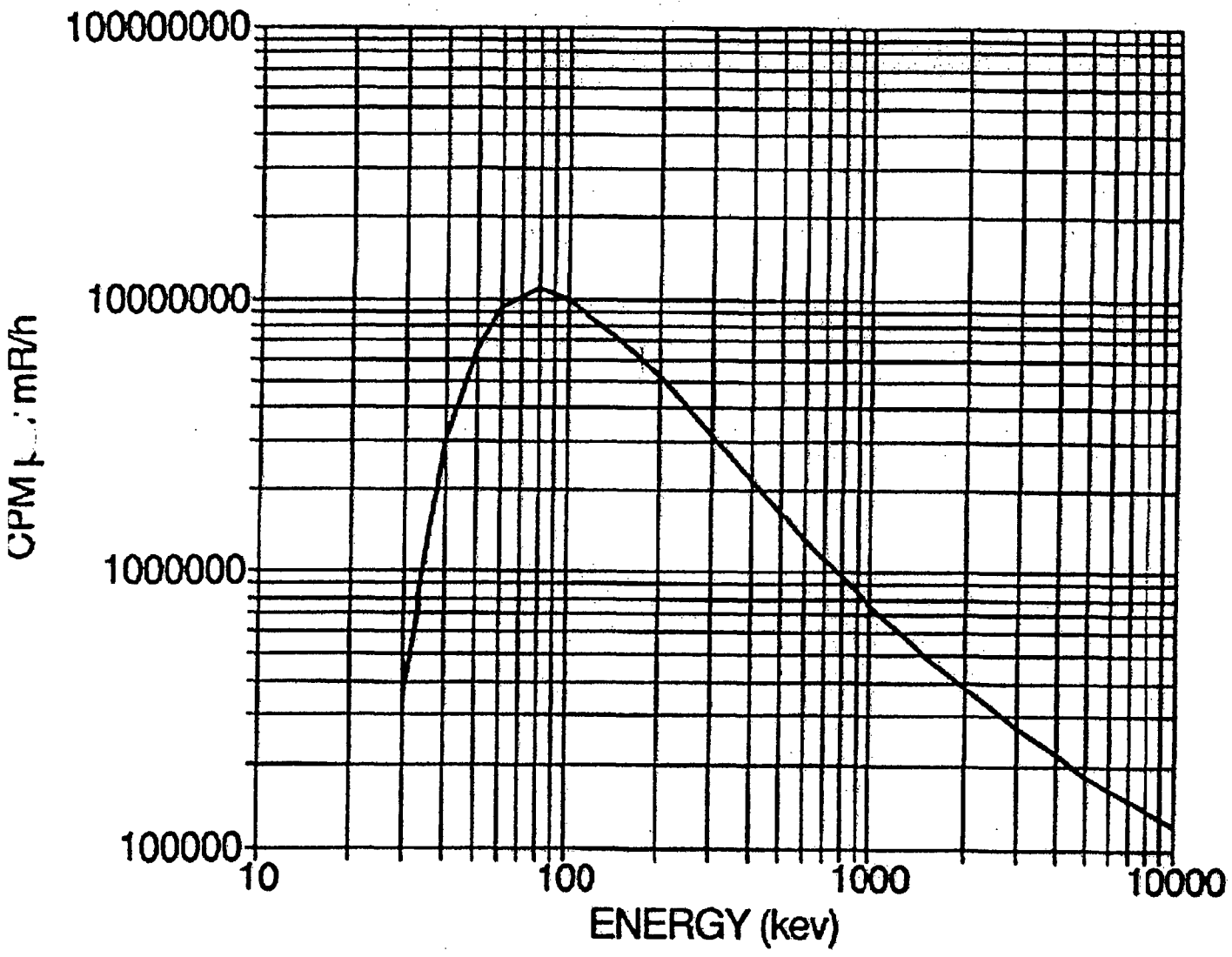
APPENDIX N

Eu-152

	Energy MeV	Energy keV	Exposure Rate (µR/hr (1 µCi/g)	Energy Response (cpm/µR/h)	E_i (cpm/µCi/g)
15	0.015	15	4.84E-07		0
40	0.04	40	1.92E-06	3,897,600	7
50	0.05	50	6.57E-07	6,500,000	4
100	0.1	100	4.77E-06	9,958,333	48
200	0.2	200	3.70E-06	4,850,000	18
300	0.3	300	2.18E-05	3,200,000	70
400	0.4	400	6.93E-06	2,185,000	15
500	0.5	500	7.82E-07	1,820,000	1
600	0.6	600	6.99E-06	1,455,000	10
800	0.8	800	3.81E-05	993,000	38
1000	1	1,000	1.12E-04	783,019	87
1500	1.5	1,500	8.41E-05	530,000	45
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(E_i) Total:	**344**

APPENDIX O

Calculated Energy Response
(Eberline Instruments)
CPM/mR/h



ALARA Analysis Worksheet

Survey Area: OMB - 06 **Survey Unit:** 01

A. Estimation of Total Cost ($Cost_T$)

1. Cost of performing remediation work ($Cost_R$)	$ 2000
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume 2.8 m^3 b. cost of waste disposal 670 $/m^3	$ 1876
3. Cost of workplace accident ($Cost_{ACC}$) = \$3,000,000 $person^{-1}$ · $4.2x10^{-8}$ h^{-1} · (3.a) a. time to perform remediation action 120 person-hours	$ 15
4. Cost of traffic fatality ($Cost_{TF}$) = {\$3,000,000 · $3.8x10^{-8}$ km^{-1} · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment 4100 km b. waste volume per shipment 13.6 m^3, if unknown, use 13.6m^3 as a default value	$ 3
5. Cost of worker dose ($Cost_{WDose}$) = \$2,000 per person-rem · (5.a) · (5.b) a. worker TEDE 0 rem/h b. remediation exposure time n/a person-hour	$ 0
$Cost_T$	$ 8894

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. Cs-137	a. 25,000	b. 1	c. 30.17	d. 0.0230
2.	a.	b.	c.	d.
3.	a.	b.	c.	d.
4.	a.	b.	c.	d.
5.	a.	b.	c.	d.
6.	a.	b.	c.	d.
7.	a.	b.	c.	d.
8.	a.	b.	c.	d.

Total Concentration: 25,000

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated 1

2. Monetary discount rate 0.07 y^{-1}

3. Number of years over which the collective dose is calculated 20 y

4. Population density for the critical group 0.0004 people/m^2

5. Area being evaluated 140 m^2

6. AL for each radionuclide-of-interest:

a. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1..d) \cdot C.3}\} \cdot \{B.1.b\} =$ 296

b. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2..d) \cdot C.3}\} \cdot \{B.2.b\} =$ _____

c. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3..d) \cdot C.3}\} \cdot \{B.3.b\} =$ _____

d. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4..d) \cdot C.3}\} \cdot \{B.4.b\} =$ _____

e. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5..d) \cdot C.3}\} \cdot \{B.5.b\} =$ _____

f. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6..d) \cdot C.3}\} \cdot \{B.6.b\} =$ _____

g. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7..d) \cdot C.3}\} \cdot \{B.7.b\} =$ _____

h. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8..d) \cdot C.3}\} \cdot \{B.8.b\} =$ _____

7. ..... Sum of ALs (= ALARA AL) = 296

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. Cs-137	a 25,000	b. (B.1.a)/(D.1.a) = 1
2. _____	a. _____	b. (B.2.a)/(D.3.a) = _____
3. _____	a. _____	b. (B.3.a)/(D.4.a) = _____
4. _____	a. _____	b. (B.4.a)/(D.5.a) = _____
5. _____	a. _____	b. (B.5.a)/(D.6.a) = _____
6. _____	a. _____	b. (B.7.a)/(D.7.a) = _____
7. _____	a. _____	b. (B.8.a)/(D.8.a) = _____
8. _____	a. _____	b. (B.9.a)/(D.9.a) = _____

9. ..... Sum of DCGL Fractions = 1

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL ✓ Sum of the DCGL Fractions > ALARA AL ____

11. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

Prepared by J. Hummer Date 6/14/05
FSS Radiological Engineer

Reviewed by D.C. Smith Date 6/14/05
FSS Project Manager/Radiation Protection Manager

Bases for ALARA Analysis of Survey Area OMB-06, Unit 01

General: OMB-06, Unit 01 consists of the below-grade portion of the Seal Pit. It is a structure, and therefore will use the DCGL associated with a building that could be occupied by non-radiation workers. In fact, it will backfilled with rip rap and most of it will be under water, which will prevent such occupancy. The following facts and assumptions underlie the bases used for this ALARA Evaluation.

1. Sediment has been removed and surfaces have been pressure-washed.
2. The characterization surveys show very little residual activity (<DCGL) on the inside surfaces
3. Concrete core bores have shown only Cs-137 at levels that are a small fraction of the DCGL and only in the one inch closest to the surface.
4. It will be assumed that the outer two centimeters contain Cs-137 at DCGL for the purpose of this calculation.
5. Further remediation would require mechanical removal of the outer two centimeters of surface, e.g., scabbling, because washing will have already been done.
6. Assume that scabbling would take 40 machine-hours.
7. Assume that the operating equipment requires three men.
8. Assume that the cost to the project is $50 per man-hour.
9. Assume that equipment rental would cost $1000.
10. Assume that this process would remove 100% of the remaining activity.
11. Since no people will actually be able to occupy the structure, assume that the population density for open land applies, instead of that for buildings.
12. The volume of solid waste removed would be 140 m^2 times 0.02 meter, or 2.8 m^3.

Bases:

1. Cost of remediation (Item A.1. on worksheet)
   3 men x 40 hours x $50/man-hour = $6,000
2. Cost of waste disposal (A.2.b.)
   $19/cubic foot, from Generic ALARA Review, YA-REPT-00-003-05
   $19/cubic foot x (35.3 cubic feet/cubic meter) = $671/cubic meter
3. Shipping distance (A.4.a)
   ~4100 round-trip from Rowe, MA to Memphis, TN, which is the nearest place that such waste is likely to be shipped. (Data from Yahoo! Maps)
4. Worker Dose (A.5.a.)
   No measurable worker dose will be picked up because this is not in a radiation area.
5. Default population density for open land areas is 0.0004 person/m2, from procedure DP-8867. (C.4.)
6. All other values used in the calculation will be the default values provided in DP-8867.

ALARA Analysis Worksheet

Survey Area: OMB-06 **Survey Unit:** 02

A. Estimation of Total Cost ($Cost_T$)

1. Cost of performing remediation work ($Cost_R$)	$ _____
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) · (2.b) a. estimated waste volume _____ m^3 b. cost of waste disposal _____ $\$/m^3$	$ _____
3. Cost of workplace accident ($Cost_{ACC}$) = \$3,000,000 $person^{-1}$ · $4.2x10^{-8}$ h^{-1} · (3.a) a. time to perform remediation action _____ person-hours	$ _____
4. Cost of traffic fatality ($Cost_{TF}$) = {\$3,000,000 · $3.8x10^{-8}$ km^{-1} · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment _____ km b. waste volume per shipment _____ m^3, if unknown, use 13.6m^3 as a default value	$ _____
5. Cost of worker dose ($Cost_{WDose}$) = \$2,000 per person-rem · (5.a) · (5.b) a. worker TEDE _____ rem/h b. remediation exposure time _____ person-hour	$ _____
$Cost_T$	$ _____

SEE ATTACHED JUSTIFICATION

B. Survey Unit Radiological Information

Radionuclide	Average Concentration	Relative Fraction[a]	Half-Life (y)	Decay Constant[b] (y^{-1})
1. _____	a. _____	b. _____	c. _____	d. _____
2. _____	a. _____	b. _____	c. _____	d. _____
3. _____	a. _____	b. _____	c. _____	d. _____
4. _____	a. _____	b. _____	c. _____	d. _____
5. _____	a. _____	b. _____	c. _____	d. _____
6. _____	a. _____	b. _____	c. _____	d. _____
7. _____	a. _____	b. _____	c. _____	d. _____
8. _____	a. _____	b. _____	c. _____	d. _____

Total Concentration: _____

[a] Relative fraction = average concentration divided by the total concentration.
[b] Decay constant = 0.693 divided by half-life.

C. Calculation of ALARA Action Level (AL)

1. Removable fraction for remediation action being evaluated _____

2. Monetary discount rate _____ y^{-1}

3. Number of years over which the collective dose is calculated _____ y

4. Population density for the critical group _____ people/m^2

5. Area being evaluated _____ m^2

6. AL for each radionuclide-of-interest:

a. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.1.d)/(1-e^{-(C.2+B.1..d) \cdot C.3}\} \cdot \{B.1.b\} =$ _____

b. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.2.d)/(1-e^{-(C.2+B.2..d) \cdot C.3}\} \cdot \{B.2.b\} =$ _____

c. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.3.d)/(1-e^{-(C.2+B.3..d) \cdot C.3}\} \cdot \{B.3.b\} =$ _____

d. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.4.d)/(1-e^{-(C.2+B.4..d) \cdot C.3}\} \cdot \{B.4.b\} =$ _____

e. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.5.d)/(1-e^{-(C.2+B.5..d) \cdot C.3}\} \cdot \{B.5.b\} =$ _____

f. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.6.d)/(1-e^{-(C.2+B.6..d) \cdot C.3}\} \cdot \{B.6.b\} =$ _____

g. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.7.d)/(1-e^{-(C.2+B.7..d) \cdot C.3}\} \cdot \{B.7.b\} =$ _____

h. $AL = \{Cost_T/(\$2000 \cdot C.4 \cdot 0.025 \cdot C.1 \cdot C.5)\} \cdot \{(C.2 + B.8.d)/(1-e^{-(C.2+B.8..d) \cdot C.3}\} \cdot \{B.8.b\} =$ _____

7. ..... Sum of ALs (= ALARA AL) = _____

ATTACHED JUSTIFICATION

D. ALARA Evaluation

Radionuclide	DCGL	DCGL Fraction[a]
1. _____	a _____	b. (B.1.a)/(D.1.a) = _____
2. _____	a. _____	b. (B.2.a)/(D.3.a) = _____
3. _____	a. _____	b. (B.3.a)/(D.4.a) = _____
4. _____	a. _____	b. (B.4.a)/(D.5.a) = _____
5. _____	a. _____	b. (B.5.a)/(D.6.a) = _____
6. _____	a. _____	b. (B.7.a)/(D.7.a) = _____
7. _____	a. _____	b. (B.8.a)/(D.8.a) = _____
8. _____	a. _____	b. (B.9.a)/(D.9.a) = _____

9. .....Sum of DCGL Fractions = _____

[a] DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):

Check one: Sum of the DCGL Fractions < ALARA AL _____ Sum of the DCGL Fractions > ALARA AL _____

11. **Decision Criteria**: If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions > AL, then additional remediation is cost beneficial.

Check one: Additional remediation **IS NOT** cost beneficial ✓

Additional remediation **IS** cost beneficial _____

SEE ATTACHED JUSTIFICATION

Prepared by Martin C. Smith Date 6/13/05
FSS Radiological Engineer

Reviewed by D.C. Smith Date 6/13/05
FSS Project Manager/Radiation Protection Manager

ALARA Justification

FSS of the Seal Pit will be performed utilizing the Bulk Material Assay System (Truck Monitor). Each container of concrete from the Seal Pit will be monitored to a predetermined lower level of detection (LLD). Any load of concrete found to have levels of activity greater than the respective LLDs for the individual LTP radionuclides (i.e. detectable) will be rejected and deemed not suitable for use as fill material. This release criterion is in accordance with the Commonwealth of Massachusetts DPH. Since the acceptance criteria is no activity above the LLD no amount of remediation can be warranted for the concrete of the Seal Pit.

Attachment A – Maps and Posting Plots

List of Figures

Figure Page

FIGURE 1 OMB-06 RELATIVE TO STRUCTURES 2
FIGURE 2 OMB-06-01 SURVEY UNIT 3
FIGURE 4 OMB-06-01 POSTING PLOT 4

Figure 1 OMB-06 Relative to Structures

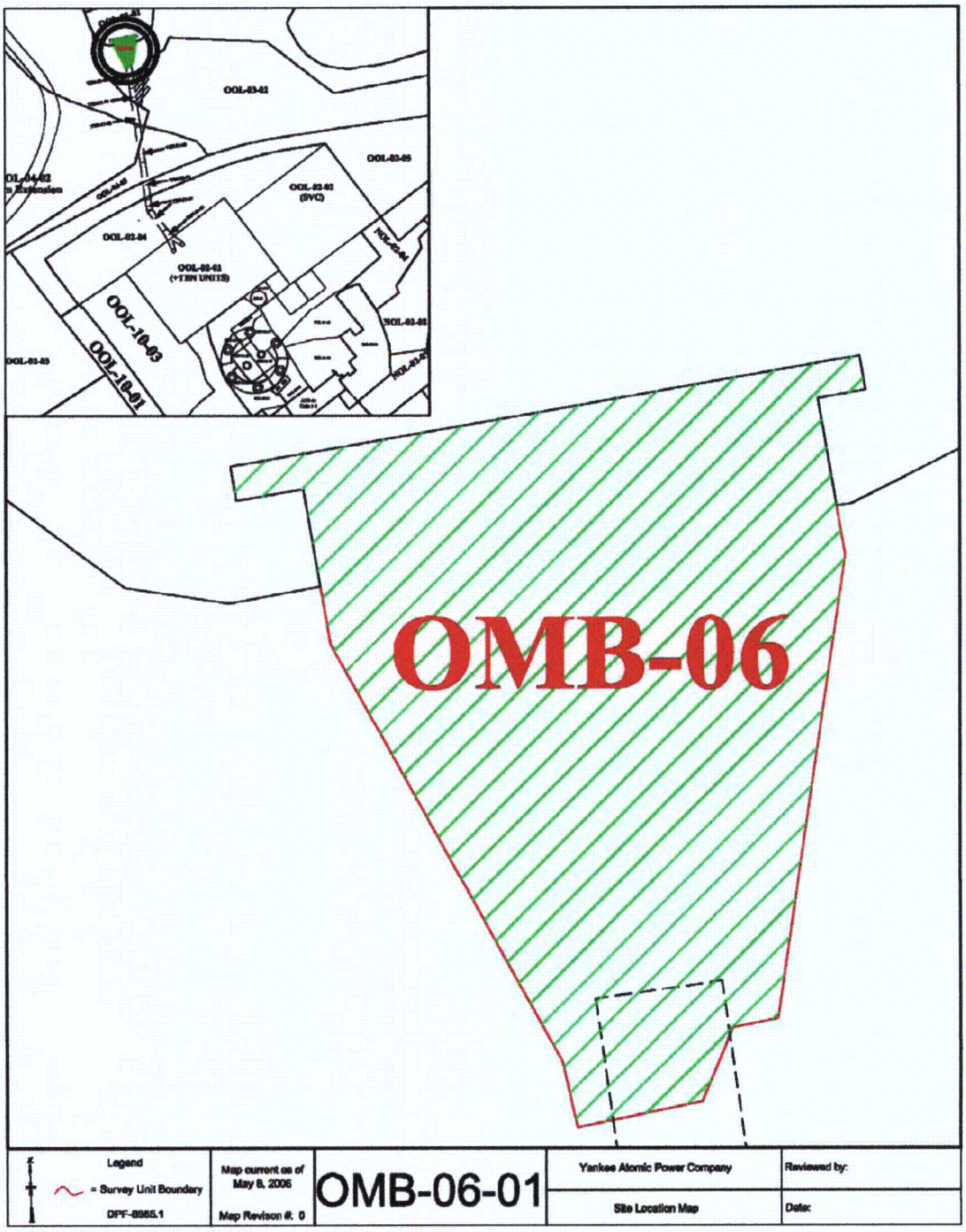
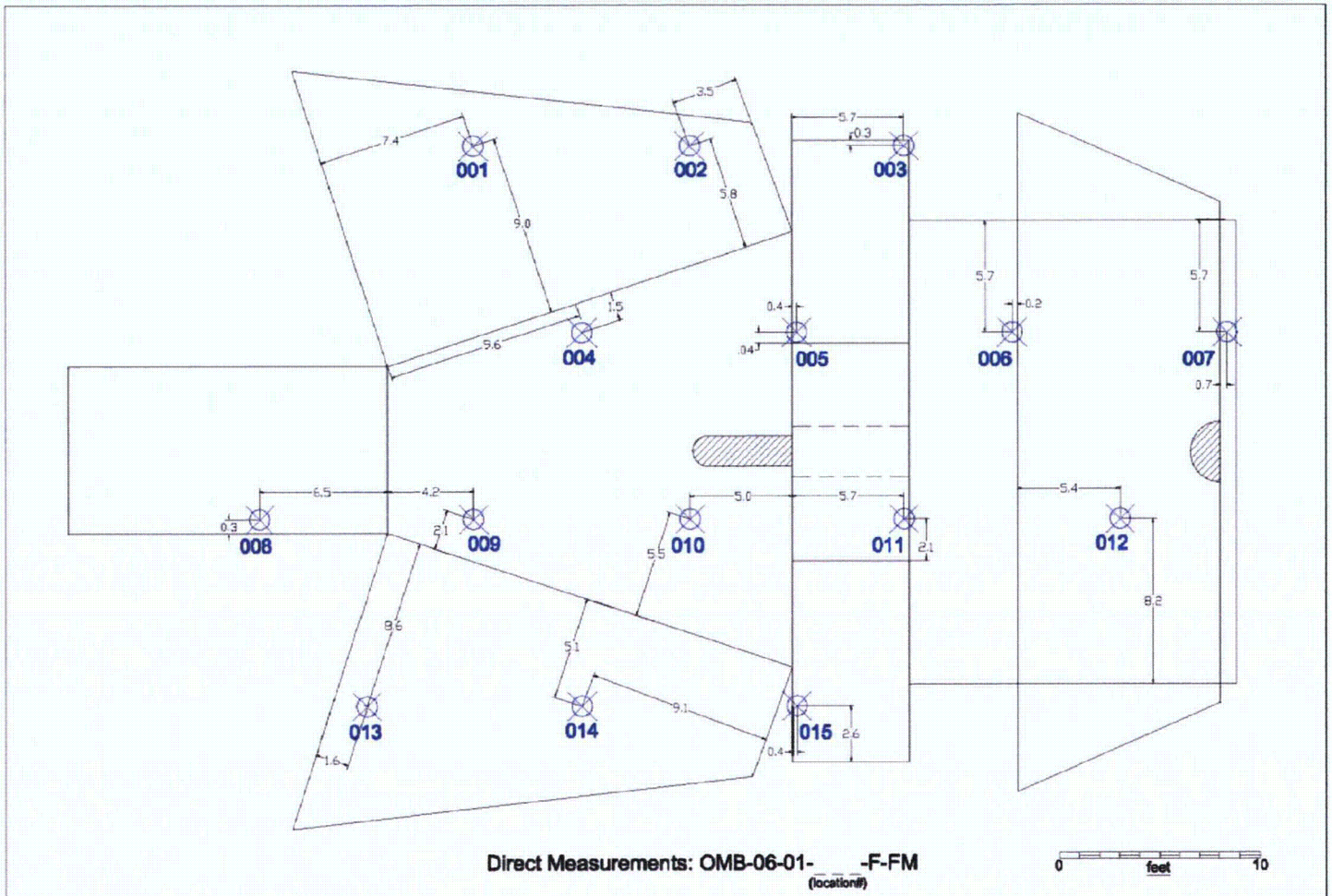
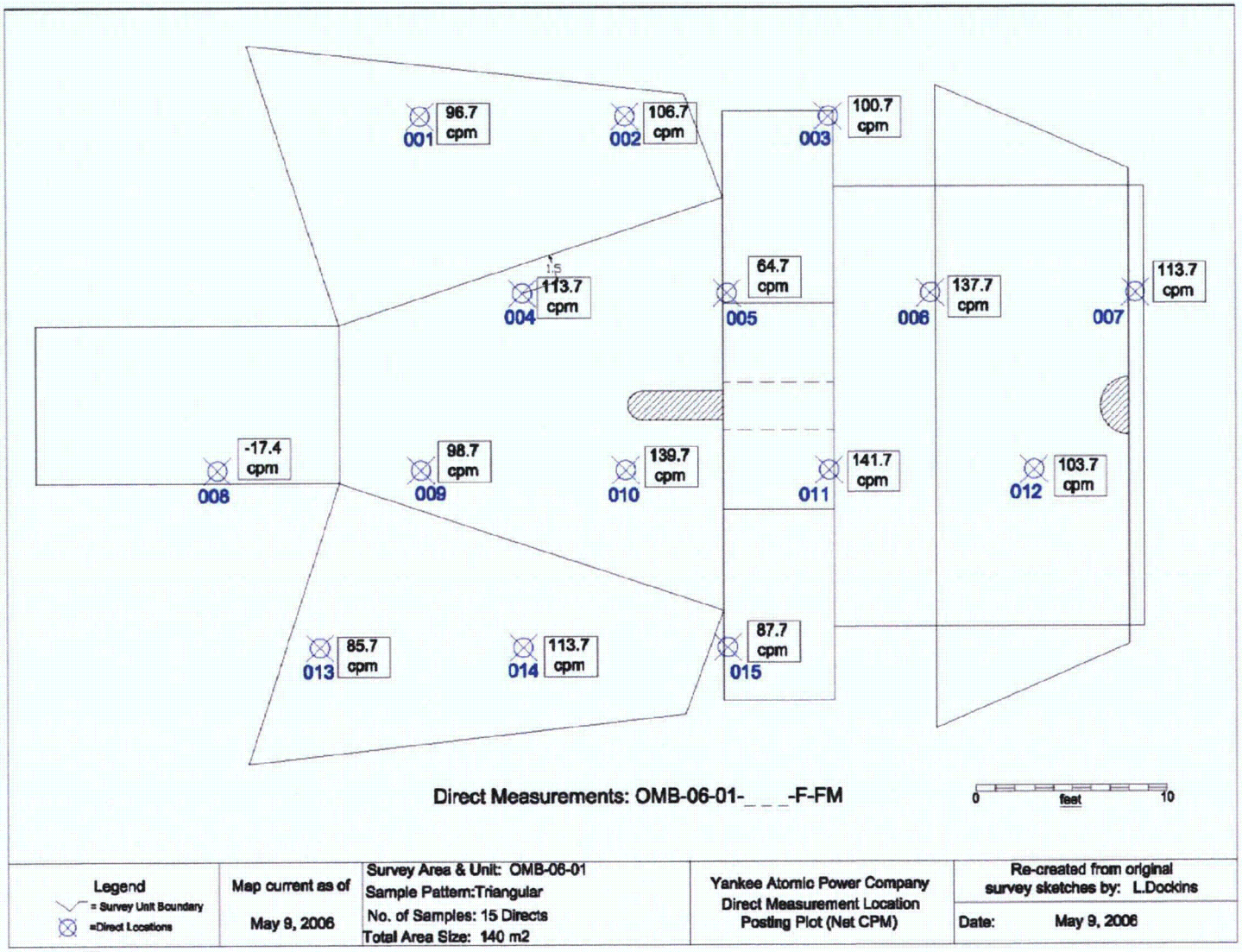


Figure 2 OMB-06-01 Survey Unit



Legend	Map current as of	Survey Area & Unit: OMB-06-01 Sample Pattern:Triangular No. of Samples: 15 Directs Total Area Size: 140 m2	Yankee Atomic Power Company	Re-created from original survey sketches by: L.Dockins
= Survey Unit Boundary =Direct Locations	May 9, 2006		Direct Measurement Location	Date: May 9, 2006

Figure 3 OMB-06-01 Posting Plot



Legend = Survey Unit Boundary =Direct Locations	Map current as of May 9, 2006	Survey Area & Unit: OMB-06-01 Sample Pattern:Triangular No. of Samples: 15 Directs Total Area Size: 140 m2	Yankee Atomic Power Company Direct Measurement Location Posting Plot (Net CPM)	Re-created from original survey sketches by: L.Dockins Date: May 9, 2006

Attachment B

Data Quality Assessment Plots and Curves

List of Figures

Figure Page

FIGURE 1 OMB-06-01 PROSPECTIVE POWER CURVE 2
FIGURE 2 OMB-06-01 RETROSPECTIVE POWER CURVE 3
FIGURE 3 OMB-06-01 DATA REVIEW 4
FIGURE 4 OMB-06-01 FREQUENCY PLOT 5
FIGURE 5 OMB-06-01 SAMPLE RESULTS SCATTER PLOT 5
FIGURE 6 OMB-06-01 QUANTILE PLOT 6

Figure 1 OMB-06-01 Prospective Power Curve

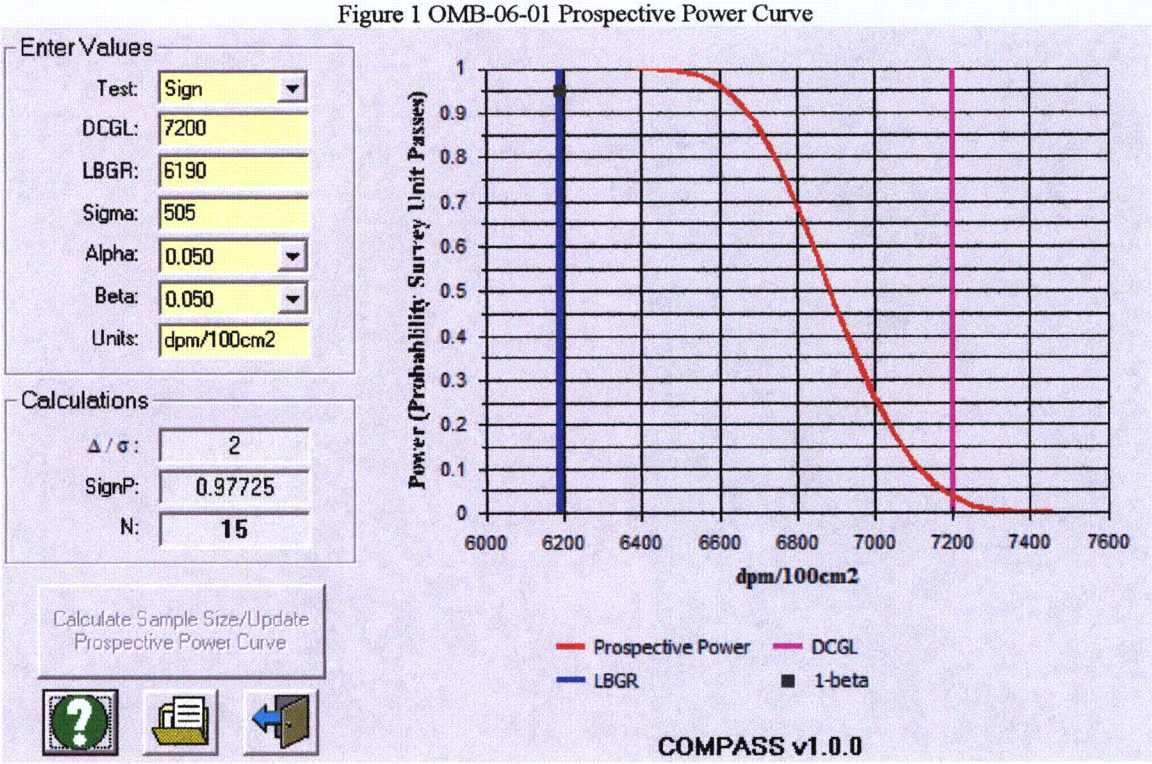


Figure 2 OMB-06-01 Retrospective Power Curve

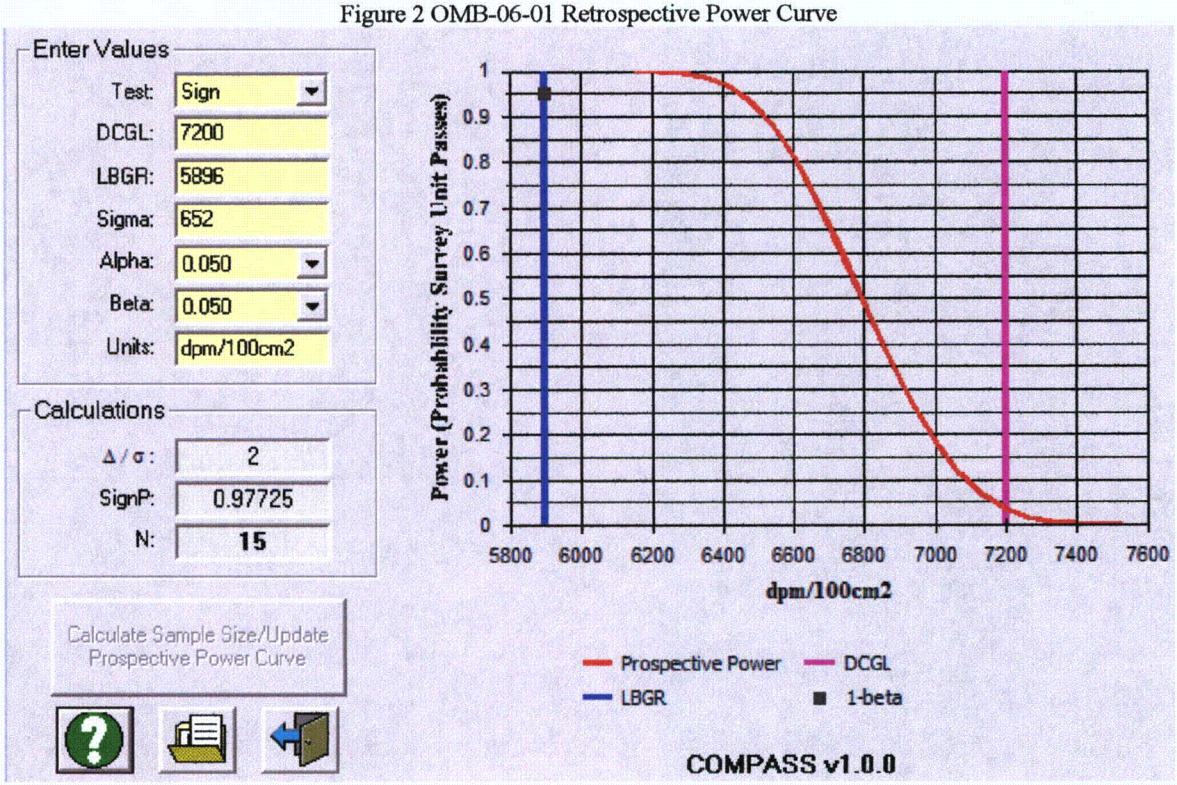


Figure 3 OMB-06-01 Data Review

Survey Unit:	OMB-06-01
Survey Unit Name:	Seal Pit - Below Grade Structure
Classification:	1
Survey Media:	Building Surface
Type of Survey:	Final Status Survey
Type of Measurement:	Fixed Point
Number of Measurements:	15
Operational DCGL (dpm):	7200
$DCGL_{emc}$ (dpm):	10,000

BASIC STATISTICAL QUANTITIES

	Gr Count Rate (cpm)	Net Activity (dpm)
RANGE Minimum Value:	228	-288
Maximum Value:	387	2348
Mean:	345.8	1665
Median:	349	1718
Standard Deviation:	39.3	652
Mean Ambient Background:	245.4	
Total Efficiency (c/d):	0.0603	

ACTIVITY CONCENTRATION

NUMBER	Gross (cpm/100 cm2)	Net Count Rate (cpm/100 cm2)	Net Activity (dpm/100 cm2)	fDCGL
OMB-06-01-001-F-FM	342	96.7	1602	0.22
OMB-06-01-002-F-FM	352	106.7	1768	0.25
OMB-06-01-003-F-FM	346	100.7	1668	0.23
OMB-06-01-004-F-FM	359	113.7	1884	0.26
OMB-06-01-005-F-FM	310	64.7	1072	0.15
OMB-06-01-006-F-FM	383	137.7	2282	0.32
OMB-06-01-007-F-FM	359	113.7	1884	0.26
OMB-06-01-008-F-FM	228	-17.4	-288	-0.04
OMB-06-01-009-F-FM	344	98.7	1635	0.23
OMB-06-01-010-F-FM	385	139.7	2315	0.32
OMB-06-01-011-F-FM	387	141.7	2348	0.33
OMB-06-01-012-F-FM	349	103.7	1718	0.24
OMB-06-01-013-F-FM	331	85.7	1420	0.20
OMB-06-01-014-F-FM	379	133.7	2215	0.31
OMB-06-01-015-F-FM	333	87.7	1453	0.20

Figure 4 OMB-06-01 Frequency Plot

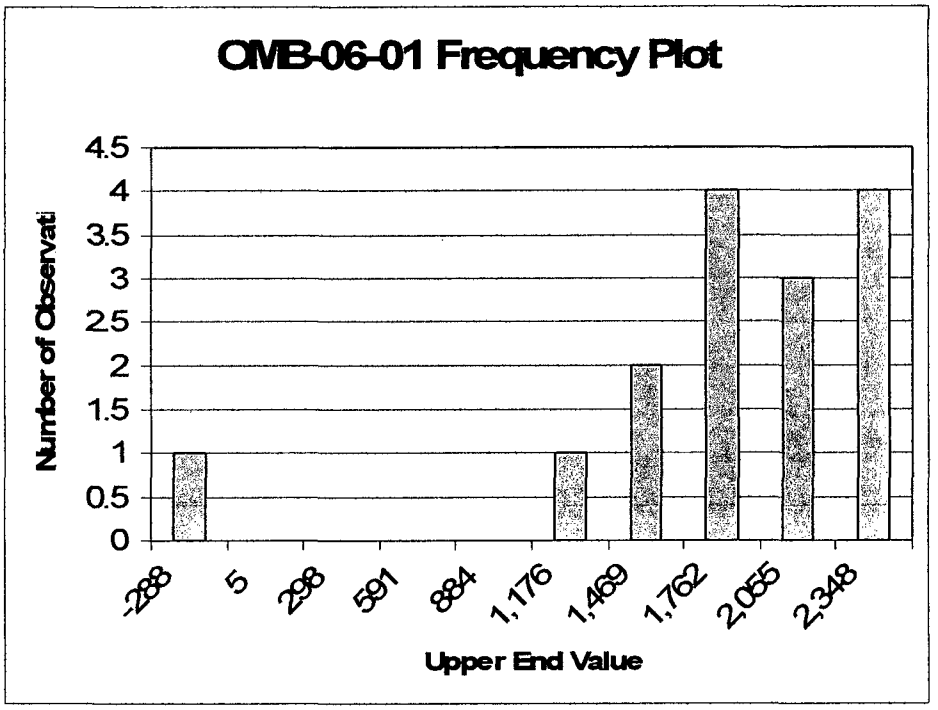


Figure 5 OMB-06-01 Sample Results Scatter Plot

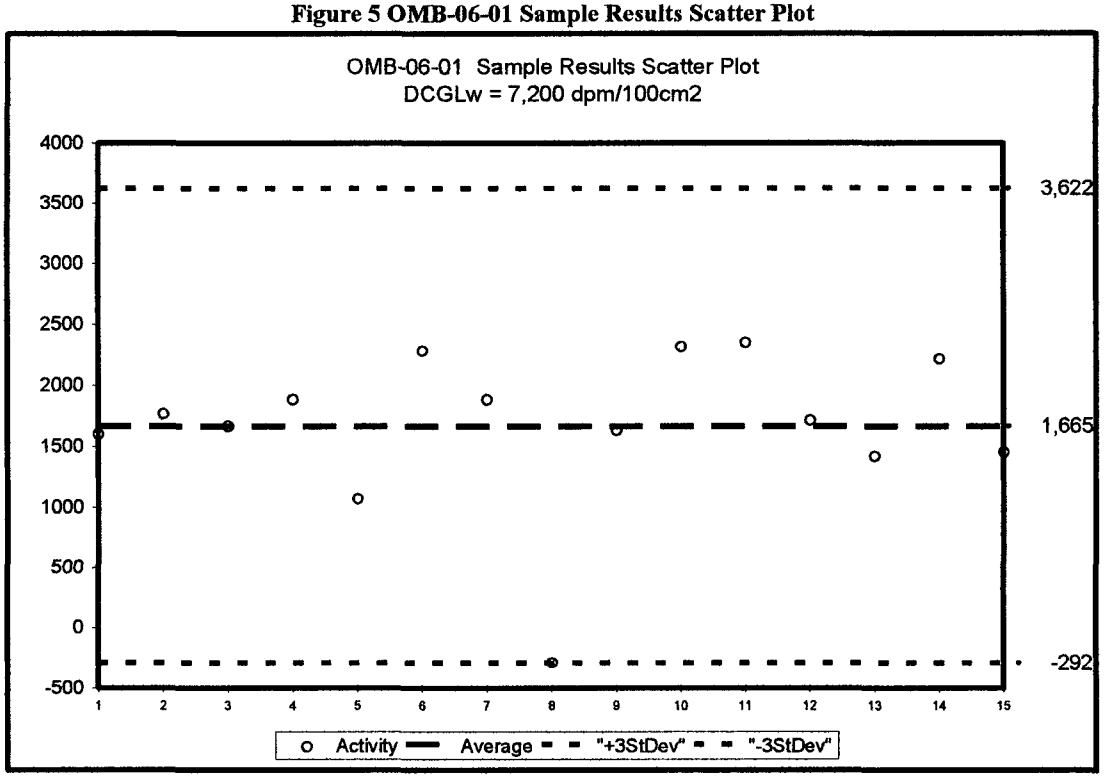
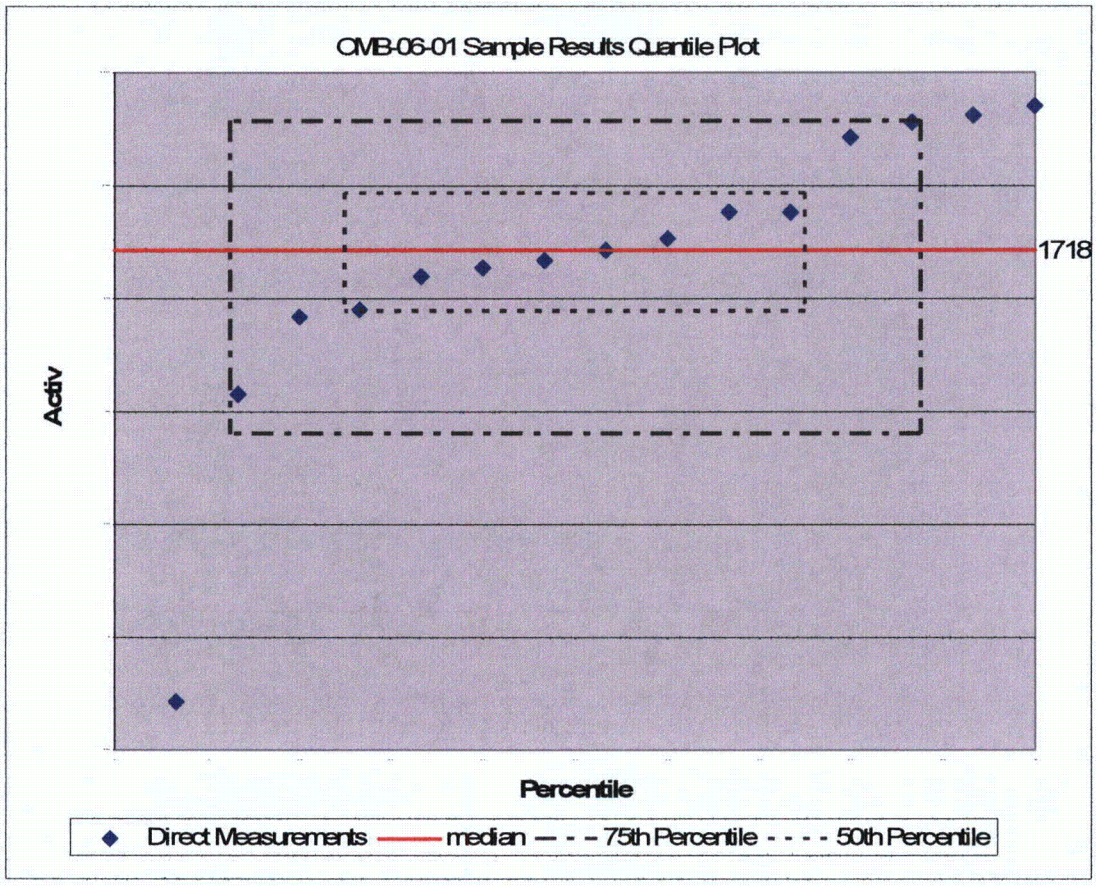


Figure 6 OMB-06-01 Quantile Plot



CONTROL POINT

PORTABLE INSTRUMENT ACCOUNTABILITY FORM

nstrument Type & YAEC or DE&S #	Batt ✓	Cal Due ✓	Src ✓ Out	Location and/or Reason For Use	Date and Time Out	Tech Name	Date and Time In	Srce ✓ In
E600# 5133 SPA-3# 51846	✓	✓	✓					*
E600# 5135 SPA-3# 51837	✓	✓	✓					*
E600# 5143 SPA-3# E1012	✓	✓	✓					*
E600# 5138 HP100C# 51587	✓	✓	✓	Seal Pit	6-16-05/0630	White	6-16-05 1150	✓
E600# 5153 HP100C# 51596	✓	✓	✓	Seal Pit	6-16-05/0630	Erickson	6-16-05 1120	✓
E600# 5142 42-37# 70034	✓	✓	✓	Rowste	6-16-05/1100	Conant	6-17-05 0630	✓
E600# 5133 HP100C# 51456	✓	✓	✓	Rowste Pad	6-16-05/0730	Scarberry	6-16-05 1120	✓
E600# 5152 HP100C# 51596	✓	✓	✓	Seal Pit	6-16-05/1120	Erickson	6-17-05/0625	✓
E600# 5138 HP100C# 51587	✓	✓	✓	Seal Pit	6-16-05/1150	White	6-17-05/0620	✓

RP Supervisor Review _____

* Instrument not Issued.

DPF-8504.1
Rev. 16

COPY

PORTABLE/GAMMA FRISK SOURCE CHECK FORM

E600	SPA-3	61012	277	239033	358549
Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-1-05	0620	SAT	N/A	8320	286000	277680	DN	6-1-05	1600	SAT	N/A	7220	285000	277780	DN
6-2-05	0555	SAT	N/A	8100	308000	299900	DN	6-2-05	1345	SAT	N/A	7730	286000	278270	DN
6-6-05	0640	SAT	N/A	7990	319000	311010	DN	6-6-05	1600	SAT	N/A	8110	277000	268890	DN
6-7-05	0610	SAT	N/A	7720	298000	290280	DN	6-7-05	1630	SAT	N/A	7410	298000	290590	DN
6-9-05	0620	SAT	N/A	7210	292000	284790	DN	6-9-05	1600	SAT	N/A	7490	279000	271510	DN
6-10-05	0615	SAT	N/A	6800	285000	278200	DN	6-10-05	1615	SAT	N/A	7470	296000	288530	DN
6-11-05	0615	SAT	N/A	8090	280000	269910	DN								*
6-14-05	0615	SAT	N/A	8910	299000	290090	DN	6-14-05	1605	SAT	N/A	7870	281000	273130	DN
6-21-05	0610	SAT	N/A	7360	298000	290640	DN	6-21-05	1530	SAT	N/A	7490	277000	269510	DN
6-22-05	0630	SAT	N/A	7810	280000	272190	DN	6-22-05	1210	SAT	N/A				**
									A						
							N								

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*Instrument Not Issued.

**Smart Pac Failed.

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PORTABLE/GAMMA FRISK SOURCE CHECK FORM

Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%
E600.	HP-100C	51587	E-21	~~20038~~ 20044 DN 10.12.05	~~30058~~ 30066 DN 10.12.05

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-6-05	1450	SAT	N/A	144	21900	21756	DN	6-7-05	0645	SAT	N/A	272	25100	24828	DN
6-7-05	0645	SAT	N/A	272	25100	24828	DN	6-7-05	1630	SAT	N/A	301	25500	25199	DN
6-8-05	0635	SAT	N/A	293	25300	25007	DN	6-8-05	1000	SAT	N/A	287	24400	24113	DN
6-8-05	1000	SAT	N/A	287	24400	~~24117~~ DN 6-8-05 24113	DN	6-8-05	1600	SAT	N/A	217	24800	24583	DN
6-10-05	0625	SAT	N/A	282	24800	24518	DN	6-10-05	0800	SAT	N/A	247	24000	23753	DN
6-11-05	0650	SAT	N/A	290	24600	24310	DN	6-11-05	1200	SAT	N/A	262	24100	23838	DN
6-11-05	1200	SAT	N/A	262	24100	23838	DN	6-11-05	1430	SAT	N/A	297	25300	25003	DN
6-15-05	0610	SAT	N/A	301	25500	25199	DN	6-15-05	1420	SAT	N/A	207	23300	23093	DN
6-15-05	1420	SAT	N/A	207	23300	23093	DN	6-15-05	1600	SAT	N/A	222	23100	22878	DN
6-16-05	0625	SAT	N/A	279	25100	24821	DN	6-16-05	1150	SAT	N/A	269	25500	25231	DN
6-16-05	1150	SAT	N/A	269	25500	25231	DN	6-17-05	0620	SAT	N/A	273	24600	24327	DN

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PORTABLE/GAMMA FRISK SOURCE CHECK FORM

E600	HP-100C	51587	E-21	~~20038~~ 20044	~~30058~~ 30066
Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%

DN 10.12.05 DN 10.12.05

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-6-05	1450	SAT	N/A	144	21900	21756	DN	6-7-05	0645	SAT	N/A	272	25100	24828	DN
6-7-05	0645	SAT	N/A	272	25100	24828	DN	6-7-05	1630	SAT	N/A	301	25500	25199	DN
6-8-05	0635	SAT	N/A	293	25300	25007	DN	6-8-05	1000	SAT	N/A	287	24400	24113	DN
6-8-05	1000	SAT	N/A	287	24400	~~24117~~ DN 6-8-05 24113	DN	6-8-05	1600	SAT	N/A	217	24800	24583	DN
6-10-05	0625	SAT	N/A	282	24800	24518	DN	6-10-05	0800	SAT	N/A	247	24000	23753	DN
6-11-05	0650	SAT	N/A	290	24600	24310	DN	6-11-05	1200	SAT	N/A	262	24100	23838	DN
6-11-05	1200	SAT	N/A	262	24100	23838	DN	6-11-05	1430	SAT	N/A	297	25300	25003	DN
6-15-05	0610	SAT	N/A	301	25500	25199	DN	6-15-05	1420	SAT	N/A	207	23300	23093	DN
6-15-05	1420	SAT	N/A	207	23300	23093	DN	6-15-05	1600	SAT	N/A	222	23100	22878	DN
6-16-05	0625	SAT	N/A	279	25100	24821	DN	6-16-05	1150	SAT	N/A	269	25500	25231	DN
6-16-05	1150	SAT	N/A	269	25500	25231	DN	6-17-05	0620	SAT	N/A	273	24600	24327	DN

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PORTABLE/GAMMA FRISK SOURCE CHECK FORM

E600	HP100C	51596	E-21	20592	30888
Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-1-05	0635	SAT	N/A	252	24700	24448	DN	6-2-05	0600	SAT	N/A	293	24900	24607	DN
6-2-05	0600	SAT	N/A	293	24900	24607	DN	6-2-05	1200	SAT	N/A	253	23100	22847	DN
6-2-05	1200	SAT	N/A	253	23100	22847	DN	6-2-05	1330	SAT	N/A	235	24000	23765	DN
6-16-05	0620	SAT	N/A	239	24400	24161	DN	6-16-05	1120	SAT	N/A	239	24400	24161	DN
6-16-05	1120	SAT	N/A	288	25100	24812	DN	6-17-05	0625	SAT	N/A	283	25100	24817	DN
6-27-05	0705	SAT	N/A	219	23000	22781	DN	6-27-05	1000	SAT	N/A	179	20900	20721	DN
6-27-05	1000	SAT	N/A	179	20900	20721	DN	6-27-05	1530	SAT	N/A	240	22500	22260	DN
DN 6-28-05											N/A				
									A						
								N							

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CONTROL POINT

PORTABLE INSTRUMENT ACCOUNTABILITY FORM

nstrument Type & YAEC or DE&S #	Batt ✓	Cal Due ✓	Src ✓ Out	Location and/or Reason For Use	Date and Time Out	Tech Name	Date and Time In	Srce ✓ In
E600# 5143 SPA-2 # 61012	✓	✓	✓					*
E600# 5153 HP100C # 51596	✓	✓	✓					*
E600# 5138 HP100C # 51587	✓	✓	✓	SEAL PIT	6-17-05/0635	White	6-17-05 0845	✓
E600# 5142 43-37 # 70034	✓	✓	✓	RADWASTE	6-17-05/0840	CONANT	6-17-05 1510	✓
E600# 5138 43-37 # 62064	✓	✓	✓	Fire WATER TANK	6-17-05/0950	White	6-18-05 0600	✓
E600# 5135 ~~SHP100C~~ # 51837	✓	✓	✓	North Road	6-17-05/0640	Moyers	6-17-05 1600	✓
D 6-17 # SPA-3								
E600# 5138 43-37 # 62064	✓	✓	✓	West Gate	~~6-18-05~~ 6-17-05 ~~6-18-05~~ DN 6-18-05/1830	Parker	6-18-05 0600	✓

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* Instrument not issued.

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PORTABLE/GAMMA FRISK SOURCE CHECK FORM

DN 10-12-05

E600	HP100C	51587	E-21	20044	~~30044~~ 30066
Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-17-05	0620	SAT	N/A	273	24600	24327	DN	6-17-05	0830	SAT	N/A	223	23300	23077	DN

N/A

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CONTROL POINT

PORTABLE INSTRUMENT ACCOUNTABILITY FORM

nstrument Type & YAEC or DE&S #	Batt ✓	Cal Due ✓	Src ✓ Out	Location and/or Reason For Use	Date and Time Out	Tech Name	Date and Time In	Srce ✓ In
E600# 5133 SPA-3# 51646	✓	✓	✓	North Road	6-27-05/0710	Moyers	6-27-05 1600	✓
E600# 5153 HP100c# 51596	✓	✓	✓	Waste PAD	6-27-05/0830	Erickson	6-27-05 1000	✓
E600# 5138 43-37# 62064	✓	✓	✓	North Road	6-27-05/0700	Moyers	6-27-05 1530	✓
E600# 5142 SPA-3 # 61034	✓	✓	✓	Waste Pad	6-27-05/0715	Erickson	6-27-05 1615	✓
E600# 5143 SPA-3# 61012	✓	✓	✓	Waste Pad	6-27-05/0720	Erickson	6-27-05 1605	✓
E600# 5153 HP100c# 51596	✓	✓	✓	North Road	6-27-05/1000	Moyers	6-27-05 1530	✓

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PORTABLE/GAMMA FRISK SOURCE CHECK FORM

E600	HP100C	51596	E-21	20592	30888
Meter Type	Detector Type	Detector Number	Source ID	Net Acceptance Criteria - 20%	Net Acceptance Criteria + 20%

PRE USE CHECKS								POST USE CHECKS							
Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int	Date	Time	Audible Check	Alarm Check	BKG Counts	SRC Counts	Net Counts	Int
6-1-05	0635	SAT	N/A	252	24700	24448	DN	6-2-05	0600	SAT	N/A	293	24900	24607	DN
6-2-05	0600	SAT	N/A	293	24900	24607	DN	6-2-05	1200	SAT	N/A	253	23100	22847	DN
6-2-05	1200	SAT	N/A	253	23100	22847	DN	6-2-05	1330	SAT	N/A	235	24000	23765	DN
6-16-05	0620	SAT	N/A	239	24400	24161	DN	6-16-05	1120	SAT	N/A	239	24400	24161	DN
6-16-05	1120	SAT	N/A	288	25100	24812	DN	6-17-05	0625	SAT	N/A	283	25100	24817	DN
6-27-05	0705	SAT	N/A	219	23000	22781	DN	6-27-05	1000	SAT	N/A	179	20900	20721	DN
6-27-05	1000	SAT	N/A	179	20900	20721	DN	6-27-05	1530	SAT	N/A	240	22500	22260	DN
DN 6-28-05											N/A				
								N	A						

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