YANKEE ATOMIC ELECTRIC COMPANY

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August 31, 2006
BYR 2006-073

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-NOL04-00, the Final Status Survey Report for Survey Area NOL-04

Dear Madam/Sir:

This letter submits YNPS-FSS-NOL04-00, Final Status Survey Report for survey area NOL-04. This report was written in accordance with Section 5 of the YNPS License Termination Plan, "Final Status Survey Plan," and is 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 R. Lynch
Regulatory Affairs Manager

Enclosure: YNPS-FSS-NOL04-00 (2 hard copies plus CDs) cc (w/o encl):

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Yankee Nuclear Plant Station
Final Status Survey Report
For NOL-04

Yankee Atomic Electric Company

YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT

REPORT NO.: YNPS-FSS-NOL-04-00

Prepared by: ______________________ Date: 8-29-06
Michael D. Rennhack, FSS Radiological Engineer

Reviewed by: ______________________ Date: 8-29-06
Christopher C. Messier, FSS Radiological Engineer

Approved by: ______________________ Date: 8/29/06
Martin Erickson, FSS Manager

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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_0 .... 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 NOL-04 in accordance with Yankee Nuclear Power Station's (YNPS) License Termination Plan (LTP). This FSS was conducted as an open land area FSS with soil DCGLs.

1.1 Identification of Survey Area and Units

NOL-04 is the land area within the RCA that is bounded by the NOL-05 on the north, NOL-03 on the east, OOL-10 on the south and west. NOL-04 has a single Survey Unit, NOL-04-01 which is a Class 1 Survey Unit.

1.2 Dates(s) of Survey

Table 1 Date of Surveys

Survey Unit	Survey Start Date	Survey End Date	DQA Date
NOL-04-01	5/17/2006	6/19/2006	7/20/2006

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 20 systematic direct measurement measurements were taken in the Survey Unit, providing data for the non-parametric testing of the Survey Area. In addition to the direct measurement samples, ISOCS and 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. Direct measurement surveys indicated that none of the systematic measurements exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were 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, NOL-04 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, including that from groundwater. 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 direct 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 direct 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

NOL-04 is the land area within the RCA that is bounded by the NOL-05 and the radioactive waste warehouse on the north, NOL-03 on the east, OOL-10 on the south and west.

3.2 History of Survey Area

In addition to the normal migration of minor levels of contamination in the RCA NOL-04 was contaminated by temporary storage of packaged radioactive material awaiting shipment. The Storm Drain System is an affected (contaminated) system that traverses this survey area.

3.3 Division of Survey Area into Survey Units

NOL-04 has a single Survey Unit, NOL-04-01 which is a Class 1 Survey Unit.

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 NOL-04 Survey Area at the time of FSS was a bare ground surface.

4.1.2 Radionuclide Selection and Basis

During the initial DQO process, Cs-137, Co-60, and Ag108m were identified as the radiological nuclides of concern. Characterization survey data from adjacent Survey Units indicated no other LTP-specified radionuclides warrant consideration in the NOL-04 Survey Area, however, the soil samples were evaluated for all LTP listed nuclides.

4.1.3 Scoping & Characterization

Forty samples from the HSA data were used to provide the characterization data for survey unit NOL-04-01. The characterization data weighted sigma is 0.112:

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 NOL-04 is identified as a Class 1 Area.

4.3 Remedial Actions and Further Investigations

Ten investigations were performed in NOL-04-01. Nine ISOCS investigations were performed, along with one direct sample investigation (64k particle found/removed). Scans were performed and all results were well below the DCGLw.

4.4 Unique Features of Survey Area

Survey Area NOL-04 has no unique features; it is an open land area containing soils.

4.5 ALARA Practices and Evaluations

An ALARA evaluation was developed for Survey Area in the NOL-04-01 which concluded that additional remediation was not warranted. This evaluation is 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 NOL-04 Survey Unit 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 below.

Table 2 Survey Area NOL-04 Design Parameters

Survey Unit	Design Parameter	Value	Basis
NOL-04-01	Area	978 m2	Class 1, ≤2,000 m2
	Number of Direct Measurements	15 (calculated) + 5 (added) Total: 20 Bias Samples: 4	α (Type I) = 0.05 β (Type II) = 0.05 σ: 0.123 Relative Shift: 2 Adjusted LBGR: 0.754
	Sample Area	48.9m2	Area / Sample #
	Sample Grid Spacing: Triangular	7.5m	Square Root (Area/(0.866*Sample #))
	Scan area	978 m2	Class 1 Area – 100%
	Scan Investigation Level	Co-60: 2.9E3 dpm/100cm2 Cs-137 : 1.1E4 dpm/100cm2	Soil 1m 180 Degree Calumniator See Appendix D

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

For the final evaluation of the NOL-04 Survey Area and throughout this report, the administrative acceptance criterion of 8.73 mr/yr has been set for Soil LTP-listed radionuclides.

Table 3 Soil DCGL Values

Nuclide	Soil 8.73 mr/yr (pCi/g)	Nuclide	Soil 8.73 mr/yr (pCi/g)
Co-60	1.4E+00	H-3	1.3E+02
Nb-94	2.5E+00	C-14	1.9E+00
Ag-108m	2.5E+00	Fe-55	1.0E+04
Sb-125	1.1E+01	Ni-63	2.8E+02
Cs-134	1.7E+00	Sr-90	6.0E-01
Cs-137	3.0E+00	Tc-99	5.0E+00
Eu-152	3.6E+00	Pu-238	1.2E+01
Eu-154	3.3E+00	Pu-239	1.1E+01
Eu-155	1.4E+02	Pu-241	3.4E+02
Am-241	1.0E+01	Cm-243	1.1E+01

5.1.4 Measurements

Error tolerances and characterization sample population statistics drove the selection of the number of fixed point measurements. 15 measurements were needed in the event the Sign test may have been used. In addition to the 15 statistical measurements needed, 5 additional samples were added to the statistical measurements, 4 biased, 1 recount, 2 split, and 1 investigation samples were also collected.

The direct measurement 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 3 provides a summary of daily activities performed during the Final Status Survey of Survey Units in NOL-04.

Table 4 FSS Activity Summary for NOL-04 Survey Units

Survey Unit	Date	Activity
NOL-04-01	5-16-06	Performed walk-down of Survey Unit
	5-12-06	Established Isolation and Controls
	5-10-06	Performed Job Hazard Analysis
	5-8-06	Performed Unit Classification
	5-11-06	Performed Sample Quantity Calculations, established DQOs
	5-11-06	Generated FFS Sample Plans
	5-17-06 to 6-19-06	Initiated Scans, and Direct measurements.
	7-20-06	Performed DQA, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area NOL-04, 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 Surveillance Resurveys

A resurvey was performed on 08/03/2006 due to non-radioactive contaminant remediation performed post FSS in the southern portion of the area. The resurvey sample results were evaluated against the original FSS sample data and no statistical differences were found. The resurvey demonstrated that there was no change in the Survey Area's status due to the post FSS remediation of the non-radioactive contaminant.

5.3.3 Surveillance Investigations

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

5.4 Survey Results

Direct measurement surveys indicated that NOL-04-01 had no systematic measurements that exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were 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 Units exceeds the release criteria) is rejected.

Table 5 Direct Measurement Summary

Sample Description	Sum of Fractions
NOL-04-01-001-F	0.005
NOL-04-01-002-F	0.008
NOL-04-01-003-F	0.009
NOL-04-01-004-F	0.009
NOL-04-01-005-F	0.011
NOL-04-01-006-F	0.014
NOL-04-01-007-F	0.025
NOL-04-01-008-F	0.005
NOL-04-01-010-F	0.044
NOL-04-01-011-F	0.022
NOL-04-01-012-F	0.003
NOL-04-01-013-F	0.239
NOL-04-01-014-F	0.006
NOL-04-01-015-F	0.165
NOL-04-01-016-F	0.008
NOL-04-01-017-F	0.045
NOL-04-01-018-F	0.001
NOL-04-01-019-F	0.141
NOL-04-01-020-F	0.306
*NOL-04-01-026-F-I	0.054

Maximum Sum of Fractions	0.306
Normalized Standard Deviation	0.074

* Sample NOL-04-01-009 was mislabeled as NOL-04-01-026-I. It is not an investigation, it was mislabeled.

Table 6 ISOCS Scan Summary

Sample Title	Unity	Sample Title	Unity	Sample Title	Unity
NOL-04-01-101-F-G	0	NOL-04-01-144-F-G	0	NOL-04-01-185-F-G-I	0
NOL-04-01-102-F-G	0	NOL-04-01-145-F-G	0.983	NOL-04-01-186-F-G-I	0
NOL-04-01-103-F-G	0	NOL-04-01-146-F-G	0	NOL-04-01-187-F-G-I	0
NOL-04-01-104-F-G	0	NOL-04-01-147-F-G	0.09	NOL-04-01-188-F-G-I	0
NOL-04-01-105-F-G	0	NOL-04-01-148-F-G	0	NOL-04-01-189-F-G-I	0
NOL-04-01-106-F-G	0	NOL-04-01-149-F-G	0	NOL-04-01-190-F-G-I	0
NOL-04-01-107-F-G	0	NOL-04-01-150-F-G	0	NOL-04-01-191-F-G-I	0
NOL-04-01-108-F-G	0.726	NOL-04-01-151-F-G	0	NOL-04-01-192-F-G-I	0.183
NOL-04-01-109-F-G	0.172	NOL-04-01-152-F-G	0.163	NOL-04-01-193-F-G-I	0
NOL-04-01-110-F-G	0	NOL-04-01-153-F-G	0	NOL-04-01-194-F-G-I	0
NOL-04-01-111-F-G	0.663	NOL-04-01-154-F-G	0	NOL-04-01-195-F-G-I	0
NOL-04-01-112-F-G	0	NOL-04-01-155-F-G	0	NOL-04-01-196-F-G-I	0
NOL-04-01-113-F-G	0	NOL-04-01-155-F-G	0	NOL-04-01-197-F-G-I	0
NOL-04-01-114-F-G	0.606	NOL-04-01-156-F-G	0	NOL-04-01-198-F-G-I	0.056
NOL-04-01-115-F-G	0.739	NOL-04-01-157-F-G	0	NOL-04-01-199-F-G-I	0
NOL-04-01-116-F-G	1.022	NOL-04-01-158-F-G	0	NOL-04-01-200-F-G-I	0
NOL-04-01-117-F-G	0	NOL-04-01-159-F-G	0	NOL-04-01-201-F-G-I	0
NOL-04-01-118-F-G	0	NOL-04-01-160-F-G	0.586	NOL-04-01-202-F-G-I	0
NOL-04-01-119-F-G	0	NOL-04-01-161-F-G	0	NOL-04-01-203-F-G-I	0
NOL-04-01-120-F-G	0	NOL-04-01-162-F-G	0.091	NOL-04-01-204-F-G-I	0.045
NOL-04-01-121-F-G	0	NOL-04-01-163-F-G	0	NOL-04-01-205-F-G-I	0
NOL-04-01-122-F-G	0	NOL-04-01-164-F-G	0	NOL-04-01-206-F-G-I	0
NOL-04-01-123-F-G	0	NOL-04-01-165-F-G	0	NOL-04-01-207-F-G-I	0
NOL-04-01-124-F-G	0.192	NOL-04-01-166-F-G	0	NOL-04-01-208-F-G-I	0
NOL-04-01-125-F-G	0	NOL-04-01-167-F-G	0	NOL-04-01-209-F-G-I	0
NOL-04-01-126-F-G	0.396	NOL-04-01-168-F-G	0.114	NOL-04-01-210-F-G-I	0
NOL-04-01-127-F-G	0	NOL-04-01-169-F-G	0	NOL-04-01-211-F-G-I	0
NOL-04-01-128-F-G	0	NOL-04-01-170-F-G	0	NOL-04-01-212-F-G-I	0
NOL-04-01-129-F-G	0	NOL-04-01-170-F-G	0.197	NOL-04-01-213-F-G-I	0
NOL-04-01-130-F-G	0	NOL-04-01-171-F-G	0.214	NOL-04-01-214-F-G-I	0.03
NOL-04-01-131-F-G	0	NOL-04-01-172-F-G	0.734	NOL-04-01-215-F-G-I	0
NOL-04-01-132-F-G	0.61	NOL-04-01-173-F-G-I	0	NOL-04-01-216-F-G-I	0
NOL-04-01-133-F-G	0	NOL-04-01-174-F-G-I	0	NOL-04-01-217-F-G-I	0
NOL-04-01-134-F-G	0	NOL-04-01-175-F-G-I	0	NOL-04-01-218-F-G	0
NOL-04-01-135-F-G	0	NOL-04-01-176-F-G-I	0	NOL-04-01-219-F-G	0
NOL-04-01-136-F-G	0	NOL-04-01-177-F-G-I	0	NOL-04-01-220-F-G	0
NOL-04-01-137-F-G	0	NOL-04-01-178-F-G-I	0.331	NOL-04-01-221-F-G	0
NOL-04-01-138-F-G	0	NOL-04-01-179-F-G-I	0	NOL-04-01-222-F-G	0
NOL-04-01-139-F-G	0	NOL-04-01-180-F-G-I	0	NOL-04-01-223-F-G	0
NOL-04-01-140-F-G	0	NOL-04-01-181-F-G-I	0	NOL-04-01-224-F-G	0.076

Sample Title	Unity	Sample Title	Unity	Sample Title	Unity
NOL-04-01-141-F-G	0	NOL-04-01-182-F-G-I	0	NOL-04-01-225-F-G	0
NOL-04-01-142-F-G	0	NOL-04-01-183-F-G-I	0	NOL-04-01-226-F-G-I	0
NOL-04-01-143-F-G	0	NOL-04-01-184-F-G-I	0		

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, "*Computer Determination of the Number of FSS Samples and Measurements*" and DP-8852, "*Final Status Survey Quality Assurance Project Plan*".

Upon review of the data set for NOL-04-01, the range of data are within two standard deviation with the exception of one value for each Co-60 and Cs-137 (Co-60= 0.38 pCi/g and Cs-137= 0.46 pCi/g) which were statistically higher than the rest of the data, however, both values were less than their associated DCGLw. The frequency plots show a normal distribution with a slight positive skew. The scatter plots generated graphically illustrate that the data varies about their respective Mean with the exception of the above mentioned two data points. The quantile plots are skewed slightly to the right with some asymmetry in the bottom indicative of a large number of low values in the data set. The posting plots do not clearly reveal any systematic spatial trends. Based upon the graphical representation of the data, the data set verifies the assumptions of the statistical test.

The Data Quality Assessment power curves, scatter, quantile and frequency plots are found in Attachment B. Posting Plots are found in Attachment A.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Instrument QC Checks

Operation of the portable ISOCS was in accordance with DP-8871,"*Operation of the Canberra Portable ISOCS System,*" with QC checks performed in accordance with DP-8869,"*In-situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure*" and DP-8871, "*Operation of the Canberra Portable ISOCS System.*" 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 and once per shift for the Portable ISOCS. Any flags (i.e. anomalies in the QC results) encountered during the ISOCS QC Source Count were corrected/ resolved prior to surveying. All instrumentation involved with the FSS of NOL-04 satisfied the above criteria for the survey. QC records are found in Attachment C.

6.2 Split Samples and Recounts

One recount and two split 'QC" samples were gathered and within tolerable limits in accordance with DP-8864,"*Split Sample Assessment for Final Status Survey*".

6.3 Self-Assessments

No self-assessments were performed during the FSS of NOL-04.

7.0 CONCLUSION

The FSS of NOL-04 has been performed in accordance with YNPS LTP and applicable FSS procedures. Evaluation of the direct measurement data has shown none of the systematic direct measurements exceeded the $DCGL_W$, depicted in Attachment B. Retrospective power curves were 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.

NOL-04 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, NOL-04 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, including that from groundwater. 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.

List of Appendices

List of Attachments

(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.)

GENERAL SECTION	
Survey Area No.: NOL-04	Survey Unit No.: 01
Survey Unit Name: Southwestern Upper RCA Yard	
FSSP Number: YNPS-FSSP-NOL04-01-00	

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. ☑ Refer to YA-REPT-00-003-05

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 NOL-04 consists of the surface area of Southwestern Upper RCA Yard. The open land area is owned by YNPS and is comprised of soil. Survey Unit NOL-04-01 is a sub unit of survey area NOL-04 and is bordered by NOL-05-01 & 02 to its north, NOL-03 to its east and OOL-10-01 to its west and south. It is approximately 978 square meters of surface area.

The problem as defined by this survey plan is to demonstrate that the years of plant operation did not result in an accumulation of plant-related radioactivity that exceeds the release criteria.

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 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 criteria? Alternative actions may include no action, investigation, resurvey, remediation and reclassification.

3.0 Identify the inputs to the decision:

Sample media:	Soil
Types of measurements:	Soil samples, ISOCS Assays and gamma scans
Radionuclides-of-concern:	Cs-137, Co-60, Ag108m

Applicable DCGL:		The DCGLs applied under this survey plan correspond to annual doses of 8.73 mrem/y (the 10-mrem/y DCGL adjusted for the dose contributions from sub-surface concrete structures and tritium in ground water).			
Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)
Co-60	1.4E+0	Eu-152	3.6E+0	Sr-90	6.0E-1
Nb-94	2.5E+0	Eu-154	3.3E+0	Tc-99	5.0E+0
Ag108m	2.5E+0	Eu-155	1.4E+2	Pu-238	1.2E+1
Sb125	1.1E+1	H-3	1.3E+2	Pu-239/240	1.1E+1
Cs-134	1.7E+0	C-14	1.9E+0	Pu-241	3.4E+2
Cs-137	3.0E+0	Fe-55	1.0E+4	Am-241	1.0E+1
		Ni-63	2.8E+2	Cm-243/244	1.1E+1

Forty (40) samples from the HSA data were used to provide the characterization data for survey unit NOL-04-01. The data is sufficient to support FSS planning of Survey Unit NOL-04-01.

Based on a review of the characterization data, Co-60, Cs-137 and Ag-108m are the only plant-related radionuclides that were identified consistently in the characterization samples analyzed. The results from the characterization data are summarized below:

- Co-60 (11 detects) — Co-60 is present in 27.5 % of the characterization samples.
- Cs-137 (16 detects) — Cs-137 is present in 40 % of the characterization samples.
- Ag-108m (3 detects) — Ag-108m is present in 8 % of the characterization samples.
- Other YNPS ETD — There were no other easy to detect nuclides identified >MDA.
- YNPS HTD — There were no hard to detect nuclides identified in the four samples analyzed.

The presence of all LTP-listed radionuclides (gamma-emitters, HTD beta-emitters, and TRUs) in the soil will be evaluated under this survey plan. The YNPS Chemistry Dept. will analyze each FSS soil sample for all LTP-listed gamma-emitting nuclides, except Cm-243/244. In addition, 2 FSS soil samples will be sent to an independent laboratory for analyses of gamma-emitters, HTD beta-emitting radionuclides, and alpha-emitting radionuclides, which will include Cm-243/244.

Survey Design / Release Criteria

Classification:	Class 1
Average Cs-137 concentration:	0.106 pCi/g
Standard deviation Cs-137 (σ):	0.259 pCi/g
Average Co-60 concentration:	0.041pCi/g
Standard deviation Co-60 (σ):	0.118 pCi/g
Average Ag-108m concentration:	0.016 pCi/g

Standard deviation Ag-108m (σ):	0.053 pCi/g
Weighted sum (σ):	0.122
Surrogate DCGL:	N/A (a surrogate DCGL will not be used)
LBGR	Initial = 0.5xDCGL = 0.5 Adjusted = 0.76
Number of Samples	Calculated = 15
Survey Unit Area	978 m^2
Grid Area (A/N)	65.2 m^2
$DCGL_{EMC}$: Cs-137	8.671 pCi/g (based on AF = 2.9)
$DCGL_{EMC}$: Co-60	1.968 pCi/g (based on AF = 1.4)
$DCGL_{EMC}$: Ag-108m	3.046 pCi/g (based on AF = 1.2)

Investigation Level for soil samples:

- >$DCGL_{EMC}$ for either Cs-137, Co-60 or Ag-108m -or-
- A sum of $DCGL_{EMC}$ fractions > 1.0 -or-
- >DCGL for Cs-137, Co-60 or Ag-108m and a statistical outlier as defined in the LTP.

Note: The same criteria will be applied to any other LTP-listed nuclide if identified in the soil samples.

ISOCS Assay Coverage:

100% of the surface area, ensured by overlapping field-of-views using ISOCS in the 1m-detector height with 180° open collimation configuration.

Investigation Level for ISOCS measurements:

- 0.28 pCi/g Co-60
- 1.20 pCi/g Cs-137
- 0.42 pCi/g Ag-108m
- -or- a sum of their fractions >1.0

Note: The investigation levels for the ISOCS assays were derived by multiplying the $DCGL_{EMC}$ associated with a 1m^2 area by the ratio of the MDC for the full field of view (38.5m^2) to the MDC for a 1m^2 area at the edge of the full field of view. Additional details regarding the investigation levels for ISOCS assays can be found in YA-REPT-00-018-05. The investigation levels developed in this manner are sensitive enough to detect the $DCGL_{EMC}$ values based on the grid area.

MDC's for ISOCS measurements:

Nuclide	MDC (pCi/g)	Nuclide	MDC (pCi/g)	Nuclide	MDC (pCi/g)
Co-60	1.97E-1	Sb-125	1.34E+0	Eu-152	4.31E-1
Nb-94	3.03E-1	Cs-134	3.65E-1	Eu-154	4.32E-1
Ag-108m	3.05E-1	Cs-137	8.67E-1	Eu-155	1.67E+1

Note: The MDC's listed in the above table are 10% of the $DCGL_{EMC}$ values (based on nuclide-specific AF value for 75 m^2 from LTP, Appendix 6Q). If the MDC values in the above table cannot be achieved in a reasonable count time, then an MDC no greater than 5X the table value must be achieved.

SPA-3 Gamma Scan Coverage:	SPA-3 scans will be performed for surface soil within the field-of-view of an ISOCS assay or surrounding a FSS sample location that exceeds the investigation criteria. The SPA-3 scan will cover 100% of the ISOCS assay total field-of-view area ($38.5m^2$) or a 1-m radius around the FSS sample location ($3.14m^2$).
Investigation Level for SPA-3 Scans:	Reproducible indication above background using SPA-3 and audible discrimination. The expected background range for SPA-3 scans is between 7,000 cpm and 15,000 cpm.
Radionuclides for analysis:	All LTP nuclides with the focus on Cs-137, Co-60 and Ag-108m
MDCs for gamma analysis of soil samples:	Nuclide — 10% - 50% of DCGL (pCi/g) Co-60 — 1.4E-01 - 7.0E-01 Nb-94 — 2.5E-01 - 1.3E+00 Ag-108m — 2.5E-01 - 1.3E+00 Sb-125 — 1.1E+00 - 5.6E+00 Cs-134 — 1.7E-01 - 8.7E-01 Cs-137 — 3.0E-01 - 1.5E+00 Eu-152 — 3.6E-01 - 1.8E+00 Eu-154 — 3.3E-01 - 1.7E+00 Eu-155 — 1.4E+01 - 6.9E+01 The desired MDCs in the laboratory analyses of FSS soil samples will be the 10% DCGL values. If it is impractical to achieve those, the 50% DCGL values must be achieved in the laboratory analyses of the FSS soil samples.
MDC's for HTD nuclide:	Nuclide — 10% - 50% DCGL (pCi/g) H-3 — 1.3E+01 - 6.4E+01 C-14 — 1.9E-01 - 9.7E-01 Fe-55 — 1.0E+03 - 5.1E+03 Ni-63 — 2.8E+01 - 1.4E+02 Sr-90 — 6.0E-02 - 3.0E-01 Tc-99 — 5.0E-01 - 2.5E+00 Pu-238 — 1.2E+00 - 5.8E+00 Pu-239 — 1.1E+00 - 5.3E+00 Pu-241 — 3.4E+01 - 1.7E+02 Am-241 — 1.0E+00 - 5.1E+00 Cm-243 — 1.1E+00 - 5.6E+00 The MDC values for difficult to detect nuclides will be conveyed to the outside laboratory via the sample chain-of-custody form DPF-8823.1 which will accompany the soil samples.
MDCR for SPA-3:	The accompanying table in Attachment 1 provides MDCR values by various background levels.
MDC ($fDCGL_{surveyor-emc}$) for SPA-3 scans:	The accompanying table in Attachment 1 provides MDC values by various background levels.
QC checks and measurements:	• QC checks for ISOCS will be in accordance with DP-8869 and DP-8871.

- QC checks for the Leica GPS will be performed in accordance with DP-8859.
- QC checks for the SPA-3 will be performed in accordance with DP-8504.
- Two QC split samples will be collected (note: this is in accordance with and exceeds DP-8852 requirements.)
- One QC recount for soil samples will be performed by the YNPS Chemistry Lab (note: this is in accordance with DP-8852 requirements.)

4.0 Define the boundaries of the survey:

- Boundaries of Survey Unit NOL-04-01 are as shown on the attached map. This area is bordered by NOL-05-01 & 02 to its north, NOL-03 to its east and OOL-10-01 to its west and south.
- The survey will be performed under appropriate weather conditions (as defined by instrumentation limitations and human tolerance). Surveys may be performed on any shift of work.

5.0 Develop a decision rule:

Upon review of the FSS data collected under this survey plan:

(a) If all the sample data show that the soil concentrations of plant related nuclides are below the 8.73 mrem/year DCGLs and the sum of fractions of nuclides are below unity, then reject the null hypothesis (i.e., Survey Unit NOL-04-01 meets the release criteria).

(b) If the investigation levels are exceeded, then perform an investigation survey.

(c) If the average concentration of any LTP-listed nuclide exceeds its respective $DCGL_w$ or the average sum of fractions for any LTP-listed nuclide exceeds one, then accept the null hypothesis (i.e., Survey Unit NOL-04-01 fails to meet the release criteria).

Note: Alternate actions beyond investigations are not expected to be necessary within this survey unit.

6.0 Specify tolerable limits on decision errors:

Null hypothesis:	Residual plant-related radioactivity in Survey Unit NOL-04-01 exceeds the release criteria.
Probability of type I error:	0.05
Probability of type II error:	0.05
LBGR:	The applicable soil (8.73-mrem/y) DCGL ÷ 2 LBGR = 0.5 (Unity Rule)

7.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑ (background will not be subtracted)

Number and Location of Samples: Twenty (20) soil samples will be collected at locations based on a random start, systematic triangular grid (refer to accompanying DPF-8853.2).

Biased samples: A minimum of four (4) biased sample locations will be selected before, or at the time of sample collection and their locations will be added to the map, with the letter "B" added to the sample number. The addition of these samples and the relocation of any samples may be added to the map without requiring a revision. The coordinates of the biased sample locations will be determined and added to the record.

Biased sample locations: • The four (4) biased sample locations will be determined in the field by the Rad Engineer based on historical data and process knowledge of the area.

GENERAL INSTRUCTIONS

1. Where possible, measurement locations will be identified using GPS in accordance with DP-8859. Each location will be marked to assist in identifying the location. Any locations that are not suitable for soil sampling will be relocated to the nearest suitable location and documented in the field log in accordance with DP-8856.
2. Soil samples will be collected in accordance with DP-8120.
3. Chain of Custody form will be used in accordance with DP-8123 for all soil samples sent to an off-site laboratory.
4. All soil samples will be received and prepared in accordance with DP-8813. Note: Split samples to be sent to an off-site lab will not be dried prior to counting on site or shipping.
5. Collect ISOCS measurements in accordance with DP-8871 to provide 100% scan coverage of the survey unit.
6. Survey instrument: Operation of the E-600 w/SPA-3 will be in accordance with DP-8535 with QC checks performed in accordance with DP-8504. The instrument response checks shall be performed before issue and after use.
7. All SPA-3 scans will be performed with the audible feature activated. FSS Technicians will listen for upscale readings to which they will respond by slowing down or stopping the probe to distinguish between random fluctuations in the background and greater than background readings.
8. The job hazards associated with the Survey described in this package are addressed in the accompanying Job Hazard Assessment (JHA) for NOL-04-01.
9. All personnel participating in this survey shall be trained in accordance with DP-8868.

SPECIFIC INSTRUCTIONS

1. All designated measurement locations will be identified by GPS per DP-8859 or by use of reference points and tape measure as necessary. If a designated sample location is obstructed for any reason, the FSS Radiological Engineer or the FSS Field Supervisor will select an alternate location in accordance with DP-8856. A detailed description of the alternate location will be recorded on form DPF-8856.2, the survey unit map will be annotated appropriately, and the alternate location will be conspicuously marked to facilitate re-visiting to identify and record the coordinates with GPS in accordance with DP-8859 or by measurement from a known reference point when GPS is not available.
2. Sample Requirements:
   - Collect twenty (20) random 1-liter soil samples in accordance with DP-8120. Two (2) of the twenty (20) random soil samples will be analyzed as QC split samples to fulfill the QC requirement of DP-8852. The same QC split samples will also be analyzed for Hard-to-Detect nuclides in accordance with section 5.6.3.2.1 of the LTP and DP-8856.
   - Collect four (4) biased 1-liter soil samples in accordance with DP-8120. The radiological engineer assigned to this survey unit will determine the locations of the biased samples.

3. Soil Sample Designation:

FSS soil samples:	NOL-04-01-001-F through NOL-04-01-020-F corresponding to FSS sample locations 001 through 020.
Biased soil samples:	NOL-04-01-021-F-B through NOL-04-01-024-F-B corresponding to the biased sample locations 021 through 024.
QC split samples:	NOL-04-01-012-F-S and NOL-04-01-020-F-S are to be designated as QC split samples. These samples will be sent to the off-site laboratory as collected from the field (i.e., without drying). YNPS Chemistry will count these samples in the "wet" condition prior to shipment to the offsite laboratory.
Recount samples:	NOL-04-01-006-F-RC is to be counted twice on site. The results will be compared in accordance with DP-8864.

4. Sample Analysis:

- Gamma analysis will be performed on all soil samples. If any of the gamma analyses show that an investigation level has been exceeded an investigation survey will be conducted at that sample location as directed in specific instruction # 6.
- YNPS Chemistry will analyze NOL-04-01-001-F through NOL-04-01-020-F and NOL-04-01-021-F-B through NOL-04-01-024-F-B for gamma-emitting nuclides.
- YNPS Chemistry will analyze NOL-04-01-006-F as a sample recount. The recounted sample will possess the naming convention NOL-04-01-006-F-RC.
- YNPS Chemistry will analyze NOL-04-01-012-F-S and NOL-04-01-020-F-S for gamma-emitting nuclides prior to being sent to the off-site laboratory. These samples will be analyzed for gamma-emitting nuclides and HTD at the off-site laboratory.
- On-site gamma analysis of the FSS samples shall achieve the MDC values stated in the DQO section of this plan. The MDC's will be communicated to the laboratory using an attachment to the Chain-of- Custody form.

5. ISOCS Assays.

- Collect the appropriate number of ISOCS measurements in accordance with DP-8871 to provide 100% scan coverage of the survey unit.
- ISOCS assays are designated as NOL-04-01-xxx -F-G where "xxx" continues sequentially from the last number assigned to an FSS measurement.
- QC checks shall be performed at least once per shift in accordance with DP-8869 and DP-8871. Resolve flags encountered prior to survey.
- ISOCS assays to be performed with 180° collimator at 1m unless otherwise directed by the FSS Engineer. Make note on the daily survey journal (DPF-8856.2) if other geometries are used.
- For ISOCS assay locations shown on map "ISOCS Scans", position the detector downward facing keeping the detector perpendicular to the ground.
- Designate additional assay locations in continuing sequence from the last number assigned to an FSS measurement. Record detailed information about additional assay locations on the daily

survey journal.

- If the results on any ISOCS assay exceed an investigation level, investigate the area within the field of view (7m diameter – 38.5m^2 area for 180°-1m) for that assay as directed in Specific Instruction # 7.

- Remove standing water prior to performance of ISOCS assays. Contact the FSS Engineer for directions if conditions are such that standing water cannot be removed.

6. If the results of any FSS sample (statistical and/or biased points) analysis exceed an investigation level, perform a first level investigation as follows:

   Note: Detailed descriptions of investigation actions shall be recorded in the daily survey journal (DPF-8856.2).

   - Review ISOCS data for assays in which the sample requiring investigation may have been in the field of view.

   - Scan a 1m radius footprint around the sample location with a SPA-3 in rate-meter mode moving the detector at a speed of 0.25m or less per second, keeping the probe at a distance of approximately 3" from the surface and following a serpentine path that includes at least 3 passes across each square meter. The area of scan should be increased as necessary to bound any areas of elevated activity identified.

   - Mark the boundaries around any detected elevated areas in the soil and identify the boundaries on a survey map. Measure the total area of each outlined area in square centimeters.

   - Mark the location of the highest identified activity for each of the elevated areas in the soil and on the survey map.

   - At each of the highest identified activity area

     - Perform and record a 1-minute scaler mode SPA-3 measurement. Designate the reading as "NOL-04-01-xxx-F-SC-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.

     - Obtain a soil sample at the location. Designate the sample as "NOL-04-01-xxx-F-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.

     - Perform and record a post sample 1-minute SPA-3 measurement. Designate the reading as described above.

7. If the results of an ISOCS assay exceed an investigation level, perform a first level investigation as follows:

   Note: Detailed descriptions of investigation actions shall be recorded in the daily survey journal (DPF-8856.2).

   - Scan the ISOCS footprint with a SPA-3 in rate-meter mode moving the detector at a speed of 0.25m or less per second, keeping the probe at a distance of approximately 3" from the surface and following a serpentine path that includes at least 3 passes across each square meter.

   - Mark the boundaries around any detected elevated areas in the soil and identify the boundaries on a survey map. Measure the total area of each outlined area in square centimeters.

- Mark the location of the highest identified activity for each of the elevated areas in the soil and on the survey map.
- At each of the highest identified activity area
  - Perform and record a 1-minute scaler mode SPA-3 measurement. Designate the reading as "NOL-04-01-xxx-F-SC-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.
  - Obtain a soil sample at the location. Designate the sample as "NOL-04-01-xxx-F-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.
  - Perform and record a post sample 1-minute SPA-3 measurement. Designate the reading as described above.
- Re-perform the ISOCS assay. Designate the assay as "NOL-04-01-xxx-F-G-I" where "xxx" continues sequentially from the last number assigned to an FSS measurement.

Prepared by [signature] Date 5/11/06
FSS Radiological Engineer

N. TOZZIE
Reviewed by [signature] Date 5/11/06
FSS Radiological Engineer

Approved by [signature] Date 5/11/06
FSS Project Manager

Attachment 1

SPA-3 Scan Table

BKG(cpm)	MDCR	MDC($fDCGL_{emc}$)
7000	845	6.21E-01
8000	904	6.64E-01
9000	959	7.04E-01
10000	1011	7.42E-01
11000	1060	7.78E-01
12000	1107	8.13E-01
13000	1152	8.46E-01
14000	1196	8.78E-01
15000	1238	9.09E-01
16000	1278	9.39E-01
17000	1318	9.67E-01
18000	1356	9.95E-01
19000	1393	1.02E+00
20000	1429	1.05E+00
21000	1464	1.08E+00
22000	1499	1.10E+00
23000	1533	1.13E+00
24000	1565	1.15E+00

5/11/06

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:	[signature]	Date:	10-7-04
Reviewer:	James R. Hummer	Date:	10/7/04
Approver (Cognizant Manager):	[signature]	Date:	10/7/04

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Tables

Appendix

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}	≤ 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^{TM}) 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^{TM}) 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

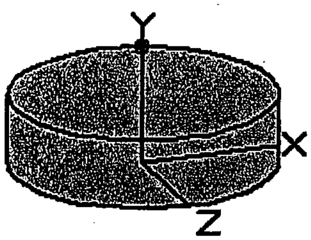
MicroShield v6.02 (6.02-00253)

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

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 E_i Calculation Sheet

	Energy MeV	Energy keV	Exposure Rate (mR/hr 1/pCi/g)	Energy Response (cpm/mR/h)	E_i (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
				(E_i) Total:	**379**

APPENDIX C

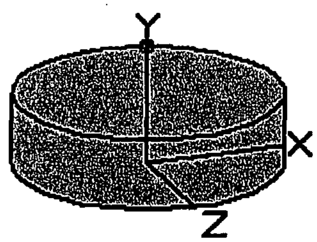
MicroShield v6.02 (6.02-00253)

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**

APPENDIX D

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

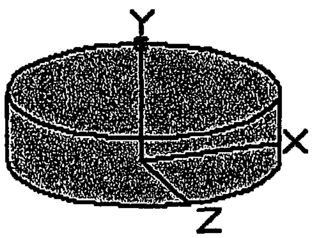
MicroShield v6.02 (6.02-00253)

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

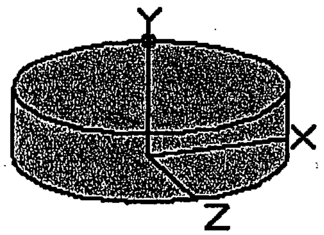
	Ag-108m				
	Microsoft Excel E_i Calculation Sheet				
	Energy MeV	Energy kev	Exposure Rate (mR/hr /pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
3	0.0028	3	1.39E-07		0
3	0.003	3	1.66E-08		0
21	0.021	21	3.01E-07		0
21	0.0212	21	5.74E-07		0
22	0.022	22	8.83E-09		0
22	0.0222	22	1.69E-08		0
24	0.0238	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
				(E_i) 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**

APPENDIX H

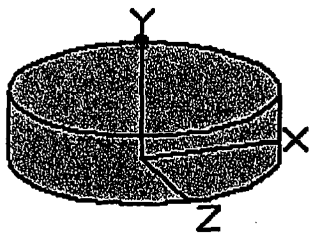
Sb-125					
	Energy Mev	Energy kev	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
4	0.0038	4	1.43E-07	6,618,312	0
27	0.0272	27	2.69E-07	510,290	0
28	0.0275	28	5.07E-07	554,334	0
31	0.031	31	2.00E-07	1,219,281	0
36	0.0355	36	1.17E-07	2,418,948	0
117	0.117	117	5.78E-08	9,167,000	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	0.000003311	1194390	4
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
				(Ei) 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**

APPENDIX J

Cs-134
Microsoft Excel E_i Calculation Sheet

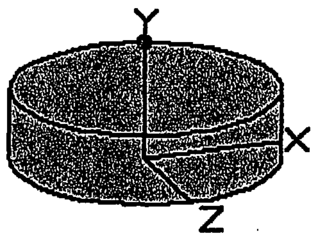
	Energy MeV	Energy keV	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
5	0.0045	5	2.58E-09		0
32	0.0318	32	5.32E-09	1,406.947	0
32	0.0322	32	9.94E-09	1,505.273	0
36	0.0364	36	4.16E-09	2,696.122	0
277	0.2769	277	2.61E-08	3,637.000	0
475	0.4753	475	1.92E-06	1,910.155	4
563	0.5632	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
				(Ei) 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**

APPENDIX L

Cs-137
Microsoft Excel E_i Calculation Sheet

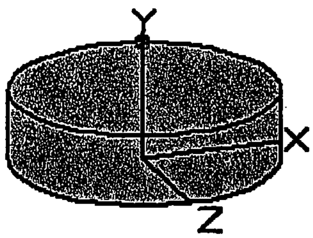
	Energy MeV	Energy kev	Exposure Rate (mR/hr 1/pCi/g)	Energy Response (cpm/mR/h)	E_i (cpm/pCi/g)
5	0.0045	5	2.83E-08		0
32	0.0318	32	4.86E-08	1,406,947	0
32	0.0322	32	9.08E-08	1,505,273	0
36	0.0364	36	3.80E-08	2,696,122	0
662	0.6616	662	1.53E-04	1,228,700	188
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
0		0			0
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:	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

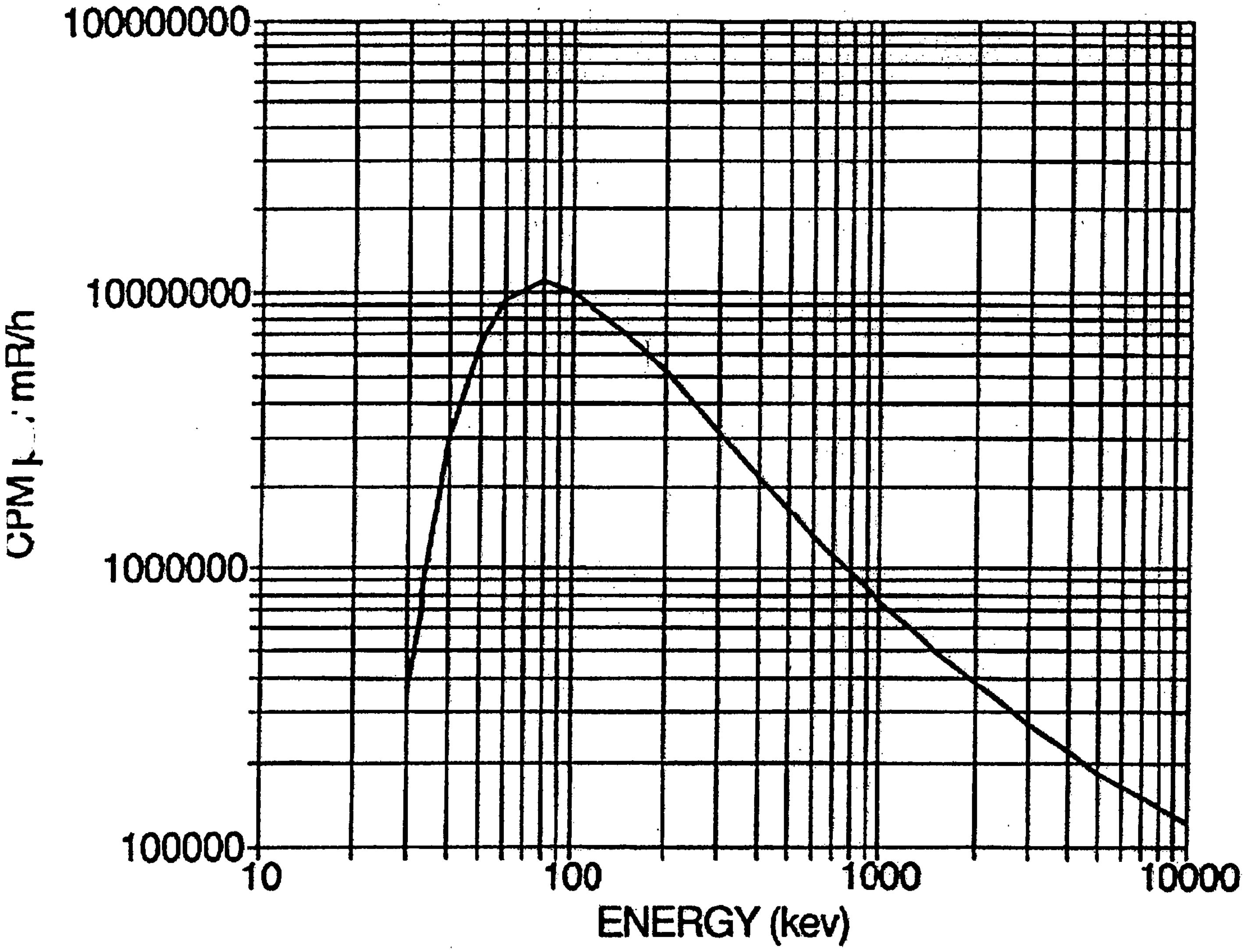
Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.077e+02	2.087e-06	2.146e-06	1.790e-07	1.841e-07
0.04	8.088e+02	3.131e-04	4.331e-04	1.385e-06	1.916e-06
0.05	2.022e+02	1.507e-04	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

	Energy MeV	Energy keV	Exposure Rate (mR/hr-1/pCi/g)	Energy Response (cpm/mR/h)	Ei (cpm/pCi/g)
Eu-152					
15	0.015	15	1.84E-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
				(E) Total:	**344**

APPENDIX O

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



Generic ALARA Evaluation Comparison Worksheet

Survey Area: NOL-04 Survey Unit: 01

Reference Generic ALARA Evaluation No.: YA-REPT-00-003-05

Applicable Generic ALARA AL: 165

	Radionuclide	Average Concentration	DCGL	fraction DCGL
1.	Co-60	0.04	1.4	0.03
2.	Cs-137	0.11	3.0	0.04
3.				
4.				
			Σ(fraction DCGL) =	0.07

If the Σ(fraction DCGL) < the generic ALARA AL, then the generic ALARA evaluation is applicable to the survey unit.

Check one:

_X_ Generic ALARA AL **IS** satisfied.

____ Generic ALARA AL **IS NOT** satisfied.

Prepared by: [signature] Date: 5/8/06
FSS Radiological Engineer

Reviewed by: [signature] Date: 5/10/06
FSS Project Manager

1 of 19

Use Of In-Situ Gamma Spectrum Analysis To Perform
Elevated Measurement Comparisons In Support Of Final Status Surveys

YA-REPT-00-018-05

Approvals	**(Print & Sign Name)**	
Preparer: Greg Astrauckas/	[signature]	Date: 10/10/05
Preparer: Gordon Madison, CHP/	[signature]	Date: 10/11/05
Reviewer: Jim Hummer, CHP/	[signature]	Date: 10/18/05
Approver (FSS Manager): Dann Smith, CHP/	[signature]	Date: 11/4/05

Rev. 0

Technical Report YA-REPT-00-018-05, Rev. 0

Use Of In-Situ Gamma Spectrum Analysis To Perform Elevated Measurement Comparisons In Support Of Final Status Surveys

TABLE OF CONTENTS

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1.0 REPORT

1.1 Introduction

The ISOCS In-Situ Gamma Spectrum detector system manufactured by Canberra Industries is being employed to perform elevated measurement comparison (EMC) surveys in support of the Final Status Surveys at Yankee Atomic's Yankee Rowe facility. This system uses an HPGe detector and specialized efficiency calibration software designed to perform in-situ gamma-spectroscopy assays. The ISOCS system will primarily be employed to evaluate survey units for elevated measurement comparisons. The ISOCS system can obtain a static measurement at a fixed distance from a pre-determined location. Count times can be tailored to achieve required detection sensitivities. Gamma spectroscopy readily distinguishes background activity from plant-related licensed radioactivity. This attribute is particularly beneficial where natural radioactivity introduces significant investigation survey efforts. Additionally, background subtraction or collimation can be employed where background influences are problematic due to the presence of stored spent fuel (ISFSI).

This technical report is intended to outline the technical approach associated with the use of ISOCS for implementing a MARSSIM-based Final Status Survey with respect to scanning surveys for elevated measurement comparisons for both open land areas and building surfaces. While the examples and discussions in this report primarily address open land areas, the same approach and methodology will be applied when deriving investigation levels, grid spacing and measurement spacing for evaluating building surfaces.

Validation of the ISOCS software is beyond the scope of this technical report. Canberra Industries has performed extensive testing and validation on both the MCNP-based detector characterization process and the ISOCS calibration algorithms associated with the calibration software. The full MCNP method has been shown to be accurate to within 5% typically. ISOCS results have been compared to both full MCNP and to 119 different radioactive calibration sources. In general, ISOCS is accurate to within 4-5% at high energies and 7-11% at 1 standard deviation for low energies. Additionally, the ISOCS technology has been previously qualified in Yankee Atomic Technical Report YA-REPT-00-022-04, "Use Of Gamma Spectrum Analysis To Evaluate Bulk Materials For Compliance With License Termination Criteria."

1.2 Discussion

1.2.1 <u>Detector Description</u>

Two ISOCS-characterized HPGe detectors manufactured by Canberra Industries have been procured. Each detector is a reverse-electrode HPGe detector rated at 50% efficiency (relative to a NaI detector). Resolution for these detectors is 2.2 keV @ 1332 keV. As the project progresses, other ISOCS detectors (e.g. standard electrode coaxial), if available, may be used to increase productivity. The key element regarding the use of other types of ISOCS® detectors is that specific efficiency calibrations will be developed to account for each detector's unique characteristics.

The HPGe detector is mounted on a bracket designed to hold the detector / cryostat assembly and associated collimators. This bracket may be mounted in a wheeled cart or in a cage-like frame. Both the wheeled cart and frame permit the detector to be oriented (pointed) over a full range from a horizontal to vertical position. The frame's design allows the detector to be suspended above the ground. Photographs of the frame-mounted system are presented in Attachment 1. During evaluations of Class1 areas for elevated radioactivity, the detector will generally be outfitted with the 90-degree collimator. Suspending the detector at 2 meters above the target surface yields a nominal field-of-view of 12.6 m^2.

The InSpector (MCA) unit that drives the signal chain and the laptop computer that runs the acquisition software (Genie-2000) are mounted either in the frame or on the wheeled cart. These components are battery powered. Back-up power supplies (inverter or UPS) are available to support the duty cycle. A wireless network has been installed at the site so that the laptop computers used to run the systems can be completely controlled from any workstation at the facility. This configuration also enables the saving of data files directly to a centralized file server. Radio communication will be used to coordinate system operation.

1.2.2 Traditional Approach

With respect to Class 1 Survey Units, small areas of elevated activity are evaluated via the performance of scan surveys. The size of the potential area of elevated activity affects the $DCGL_{EMC}$ and is typically determined by that area bounded by the grid points used for fixed measurements. This area in turn dictates the area factor(s) used for deriving the associated $DCGL_{EMC}$.

These scan surveys are traditionally conducted with hand-held field instruments that have a detection sensitivity sufficiently low to identify areas of localized activity above the $DCGL_{EMC}$. Occasionally, the detection sensitivity of these instruments is greater than the $DCGL_{EMC}$. In order to increase the $DCGL_{EMC}$ to the point where hand-held instrumentation can be reasonably employed, the survey design is augmented to require additional fixed-point measurements. The effect of these additional measurement points is to tighten the fixed measurement grid spacing, thus reducing the area applied to deriving the $DCGL_{EMC}$ and increasing the detection sensitivity criteria.

Background influences (from the ISFSI) and natural terrestrial sources further impact the sensitivity of these instruments. To address these impacts, the fixed-point grid spacing would again need to be reduced (requiring even more samples) in order to increase the $DCGL_{EMC}$ to the point where hand-held instrumentation can be used. Generally, the collection of additional fixed measurements (i.e. samples) increases project costs.

Survey designs for Class 2 and Class 3 survey units are not driven by the elevated measurement comparison because areas of elevated activity are not expected. In Class 2 areas, any indication of activity above the $DCGL_W$ requires further investigation. Similarly, in Class 3 areas, any positive indication of licensed radioactivity also requires further investigation. Because the $DCGL_{EMC}$ is not applicable to Class 2 or Class 3 areas, adjustments to grid spacing do not occur. However, the increased field-of-view associated with the in-situ gamma spectroscopy system improves the efficiency of the survey's implementation.

1.2.3 Innovative Approach

In-situ assays allow fixed-point grid spacing to be uncoupled from the derivation of applicable investigation levels. In contrast to the traditional approach where the $DCGL_{EMC}$ (based on grid size) determines both investigation levels and detection sensitivities, the use of this technology provides two independent dynamics as follows:

- Detection sensitivity is determined by the $DCGL_{EMC}$ associated with the (optimal) fixed-point grid spacing.
- Investigation levels are based on the detector's field-of-view and adjusted for the smallest area of concern (i.e. 1 m^2).

1.2.4 Investigation Level

Development of the investigation (action) levels applied to in-situ assay results is a departure from the traditional approach for implementing a MARSSIM survey. Examples are provided for both open land areas (i.e. soil) and for building surfaces, however the approach for both is identical.

To support the use of in-situ spectroscopy to evaluate areas of elevated activity the HPGe detector's field-of-view was characterized. Attachment 2 presents data from the field-of-view characterization for a detector configured with a 90-degree collimator positioned 2 meters from the target surface. Alternate configurations will be evaluated in a similar manner before being employed. As exhibited in Attachment 2, when the detector is positioned at 2 meters above the target surface the field-of-view has a radius of at least 2.3

meters. This value was rounded down to 2.0 meters for implementation purposes, introducing a conservative bias (approximately 9%) in reported results. The example provided in this technical report assumes a 2-meter source-to-detector distance, yielding a nominal field-of-view surface area of 12.6 m^2.

Occasionally, alternate source-to-detector distances (using the 90-degree collimator) may be employed, particularly in a characterization or investigation capacity. In such cases, the detector's field-of-view will be calculated by setting the radius equal to the source-to-detector distance, thereby maintaining the conservative attribute previously described. If alternative collimator configurations are used to perform elevated measurement comparisons, then specific evaluations will be documented in the form of a technical evaluation or similar. Associated investigation levels will be derived using the same approach and methodology outlined below in this section.

After the detector's field-of-view is determined, an appropriate investigation level is developed to account for a potential one-meter square area of elevated activity. $DCGL_{EMC}$ values for a one-square meter area are presented in Table 1.

TABLE 1, SOIL $DCGL_{EMC}$ FOR 1 m^2

	Soil $DCGL_W$ (pCi/g) (NOTE 1)	Soil $DCGL_W$ (pCi/g) (NOTE 2)	Area Factor for 1 m^2 (NOTE 3)	$DCGL_{EMC}$ for 1 m^2 (pCi/g) (NOTE 4)
Co-60	3.8	1.4	11	15
Ag-108m	6.9	2.5	9.2	23
Cs-134	4.7	1.7	16	28
Cs-137	8.2	3.0	22	66

NOTE 1 – LTP Table 6-1
NOTE 2 – Adjusted to 8.73 mRem/yr
NOTE 3 – LTP Appendix 6Q
NOTE 4 – Soil $DCGL_W$ (adjusted to 8.73 mRem/yr) for a 1 m^2 area

The ${}^{1m2}DCGL_{EMC}$ values listed in Table 1 do not account for a source positioned at the edge of the field-of-view. Therefore, the ${}^{1m2}DCGL_{EMC}$ values are adjusted via a correction factor. To develop this correction factor, a spectrum free of plant-related radioactivity was analyzed using two different efficiency calibrations (i.e. geometries). The first scenario assumes radioactivity uniformly distributed over the detector's 12.6 m^2 field-of-view. The second scenario assumes radioactivity localized over a 1 m^2 situated at the edge of the detector's field-of-view. The resultant MDC values were compared to characterize the difference in detection efficiencies between the two scenarios. As expected, the condition with localized (1 m^2) radioactivity at the edge of the detector's field-of-view yielded higher MDC values. The ratio between the reported MDC values for the two scenarios is used as a correction factor. This correction factor is referred to as the offset geometry adjustment factor. The investigation levels for soils presented in Table 2 were calculated as follows:

$$\text{Nuclide Investigation Level (pCi/g)} = (DCGL_{EMC}) * CF$$

Where: $DCGL_{EMC} = (DCGL_W \text{ or } DCGL_{SURR}) * AF_{(1\ m^2)}$, and
CF = Mean offset geometry adjustment factor

TABLE 2, SOIL INVESTIGATION LEVEL DERIVATION

	MDC pCi/g (NOTE 1)	MDC pCi/g (NOTE 2)	RATIO (NOTE 3)	$DCGL_{EMC}$ for 1 m² (NOTE 5)	INVESTIGATION LEVEL pCi/g (NOTE 6)
Co-60	0.121	1.86	0.0651	15	1.0
Ag-108m	0.184	2.82	0.0652	23	1.5
Cs-134	0.189	2.90	0.0652	28	1.8
Cs-137	0.182	2.78	0.0655	66	4.3
Offset Geometry Adjustment Factor (NOTE 4)			**0.0653**		

NOTE 1 – Assumed activity distributed over the 12.6 m² field-of-view.
NOTE 2 – Efficiency calibration modeled for a 1 m² area situated (off-set) at the edge of the detector's field-of-view. The model assumes that all activity is distributed within the 1 m².
NOTE 3 – Ratio = (12.6 m² MDC ÷ 1 m² MDC).
NOTE 4 – The mean value of the ratios is applied as the off-set geometry adjustment factor.
NOTE 5 – $DCGL_{EMC}$ values for 1 m² (from Table 1)
NOTE 6 – Investigation levels derived by applying of the off-set geometry adjustment factor (e.g. 0.0653) to the $DCGL_{EMC}$ for a 1 m² area for each radionuclide.

With respect to building surfaces, the development of the investigation level is identical to that for soil surfaces. The one-meter square $DCGL_{EMC}$ for building surfaces are presented in Table 3.

TABLE 3, BUILDING SURFACE $DCGL_{EMC}$ FOR 1 m²

	Bldg $DCGL_W$ (dpm/100m²) (NOTE 1)	Bldg $DCGL_W$ (dpm/100cm²) (NOTE 2)	Area Factor For 1 m² (NOTE 3)	$DCGL_{EMC}$ For 1 m² (dpm/100cm²) (NOTE 4)
Co-60	18,000	6,300	7.3	46,000
Ag-108m	25,000	8,700	7.2	62,600
Cs-134	29,000	10,000	7.4	74,000
Cs-137	63,000	22,000	7.6	167,000

NOTE 1 – LTP Table 6-1
NOTE 2 – Adjusted to 8.73 mRem/yr
NOTE 3 – LTP Appendix 6S
NOTE 4 – Building $DCGL_W$ (adjusted to 8.73 mRem/yr) for a 1 m² area

Using the same approach described for soils, a correction factor to account for efficiency differences due to geometry considerations is developed the one-meter square $DCGL_{EMC}$. ISOCS efficiency calibrations for activity distributed over the detector's field-of-view and for activity within one-square meter located at the edge of the detector's field-of-view were developed. The MDC values for these two geometries were compared to characterize the difference in detection efficiencies. As expected, the condition with localized (1 m²) radioactivity at the edge of the detector's field-of-view yielded higher MDC values. The ratio between the reported MDC values for the two scenarios is used as the offset geometry adjustment factor. The MDC values, the associated ratios, and the derived investigation level for building surfaces are presented in Table 4.

TABLE 4, BUILDING SURFACE INVESTIGATION LEVEL DERIVATION

	12.6 m^2 MDC (dpm/100cm²) (NOTE 1)	1 m^2 MDC (dpm/100cm²) (NOTE 2)	RATIO (NOTE 3)	$DCGL_{EMC}$ For 1 m^2 (dpm/100cm²) (NOTE 5)	BUILDING SURFACE INVESTIGATION LEVEL (dpm/100cm²) (NOTE 6)
Co-60	785	12,400	0.0633	46,000	2,900
Ag-108m	839	13,000	0.0645	62,600	3,900
Cs-134	900	14,200	0.0634	74,000	4,700
Cs-137	922	14,600	0.0632	167,000	10,600
Offset Geometry Adjustment Factor (NOTE 4)			**0.0636**		

NOTE 1 – Assumed activity distributed over the 12.6 m² field-of-view.
NOTE 2 – Efficiency calibration modeled for a 1 m² area situated (off-set) at the edge of the detector's field-of-view. The model assumes that all activity is distributed within the 1 m².
NOTE 3 – Ratio = (12.6 m² MDC ÷ 1 m² MDC).
NOTE 4 – The mean value of the ratios is applied as the off-set geometry adjustment factor.
NOTE 5 – $DCGL_{EMC}$ values for 1 m² (from Table 3)
NOTE 6 – Investigation levels derived by applying of the off-set geometry adjustment factor (e.g. 0.0636) to the one-square meter $DCGL_{EMC}$.

In summary, effective investigation levels for both open land areas (i.e. soils) and for building surfaces can be derived and applied to in-situ gamma spectroscopy results. Note the MDC values associated with the detector's field-of-view were well below the derived investigation levels.

The investigation levels presented in Table 2 and Table 4 do not address the use of surrogate DCGLs. Use of surrogate DCGLs will be addressed in Final Status Survey Plans, particularly where it is necessary to evaluate non-gamma emitting radionuclides on building surfaces. When surrogate DCGLs are employed, investigation levels will be developed on a case-by-case basis using the approach outlined in this document. Similarly, the offset geometry adjustment factor presented in Table 2 and Table 4 will vary for different geometries. Although unlikely, if different geometries are employed, this value will be determined on a case-by-case basis using the methodology reflected in Table 2 and will be documented in the applicable Final Status Survey Plan.

For both open land areas and for building surfaces, when an investigation level is encountered, investigatory protocols will be initiated to evaluate the presence of elevated activity and bound the region as necessary. Such evaluations may include both hand-held field instrumentation as well as the in-situ HPGe detector system. After investigation activities are completed, subsequent (follow-up) scanning evaluations will most likely be conducted using the in-situ gamma spectroscopy system.

1.2.5 Detector Sensitivity

For Class 1 scan surveys, the minimum detectable concentration is governed by the $DCGL_{EMC}$ associated with the grid area used to locate fixed-point measurements. The system's count time can be controlled to achieve the required detection sensitivity. Therefore, the grid spacing for the fixed-point measurements can be optimized thus eliminating unnecessary increases to the number of fixed-point measurements while ensuring that elevated areas between fixed measurement locations can be identified and evaluated.

Based on preliminary work, it has been determined that a count time of 900 seconds will yield an acceptable sensitivity for many areas on the site. This count time provides MDC values well below the investigation levels presented in Table 2 and Table 4. Count times will be adjusted as necessary as survey unit-specific investigation levels are derived or where background conditions warrant to ensure that detection sensitivities are below the applicable investigation level. Since each assay report includes a report of the MDC values achieved during the assay, this information is considered technical support that required MDC values were met.

1.2.6 Area Coverage

Based on the nominal 12.6 m^2 field-of-view, a 3-meter spacing between each survey point will result in well over 100% of the survey unit to be evaluated for elevated activity. This spacing convention typically employs a grid pattern that is completely independent from the grid used to locate fixed-point measurements. An example of the grid pattern and spacing is presented in Attachment 3.

Alternate spacing conventions may be applied on a case-by-case basis. For instance, spacing may be decreased when problematic topographies are encountered. Note that decreased grid spacing in this context is not associated to the fixed-point measurements. Occasionally it may be necessary to position the detector at one meter or less from the target surface to evaluate unusual (e.g. curved) surfaces or to assist in bounding areas of elevated activity. In cases where it may be desirable to increase the field-of-view via collimator or source-to-detector distances, grid-spacing conventions (and applicable investigation levels) will be determined using the approach described in this document.

1.2.7 Moisture Content in the Soil Matrix

In-situ gamma spectroscopy of open land areas is inherently subject to various environmental variables not present in laboratory analyses. Most notably is the impact that water saturation has on assay results. This impact has two components. First, the total activity result for the assay is assigned over a larger, possibly non-radioactive mass introduced by the presence of water. Secondly, water introduces a self-absorption factor.

The increase in sample mass due to the presence of water is addressed by the application of a massimetric efficiency developed by Canberra Industries. Massimetric efficiency units are defined as [counts per second]/[gammas per second per gram of sample]. Mathematically, this is the product of traditional efficiency and the mass of the sample. When the efficiency is expressed this way, the efficiency asymptotically approaches a constant value as the sample becomes very large (e.g. infinite). Under these conditions changes in sample size, including mass variations from excess moisture, have little impact on the counting efficiency. However, the massimetric efficiency does not completely address attenuation characteristics associated with water in the soil matrix.

To evaluate the extent of self-absorption, (traditional) counting efficiencies were compared for two densities. Based on empirical data associated with the monitoring wells, typical nominally dry in-situ soil is assigned a density of 1.7 g/cc. A density of 2.08 g/cc, obtained from a technical reference publication by Thomas J. Glover, represents saturated soil. A density of 2.08 g/cc accounts for a possible water content of 20%. A summary of this comparison is presented in Table 5.

TABLE 5, COUNTING EFFICIENCY COMPARISONS

keV	Efficiencies		Deviation due to density increase (excess moisture)
	1.7 g/cc	2.08 g/cc	
434	3.3 E-6	2.7 E-6	-18.7%
661.65	2.9 E-6	2.4 E-6	-17.5%
1173.22	2.5 E-6	2.1 E-6	-15.4%
1332.49	2.4 E-6	2.1 E-6	-14.8%

In cases when the soil is observed to contain more than "typical" amounts of water, potential under-reporting can be addressed in one of two manners. One way is to adjust the investigation level down by 20%. The second way is to reduce the sample mass by 20%. Either approach achieves the same objective: to introduce a conservative mechanism for triggering the investigation level where the presence of water may inhibit counting efficiency. The specific mechanism to be applied will be prescribed in implementing procedures.

The presence of standing water (or ice or snow) on the surface of the soil being assayed will be accounted for in customized efficiency calibrations applied during data analysis activities.

1.2.8 Discrete Particles in the Soil Matrix

Discrete particles are not specifically addressed in the License Termination Plan. However, an evaluation was performed assuming all the activity in the detector's field-of-view, to a depth of 15 cm, was situated in a discrete point-source configuration. A concentration of 1.0 pCi/g (Co-60), corresponding to the investigation level presented in Table 2, correlates to a discrete point-source of approximately 3.2 μCi. This activity value is considered as the discrete particle of concern. Since the presence of any discrete particles will most likely be accompanied by distributed activity, the investigation level may provide an opportunity to detect discrete particles below 3.2 μCi.

Discrete particles exceeding this magnitude would readily be detected during characterization or investigation surveys. The MDCs associated with hand-held field instruments used for scan surveys are capable of detecting very small areas of elevated radioactivity that could be present in the form of discrete point sources. The minimum detectable particle activity for these scanning instruments and methods correspond to a small fraction of the TEDE limit provided in 10CFR20 subpart E. Note that the MDC values presented in Table 2 are significantly lower than those published in Table 5-4 of the License Termination Plan.

When the investigation level in a Class 1 area is observed, subsequent investigation surveys will be performed to include the use of hand-held detectors. The detection sensitivities of instruments used for these surveys have been previously addressed in the LTP. Furthermore, discrete point sources do not contribute to the uniformly distributed activity of the survey unit. It is not expected that such sources at this magnitude would impact a survey unit's ability to satisfy the applicable acceptance criteria.

Noting that Class 2 or Class 3 area survey designs do not employ elevated measurement comparisons, associated investigation levels are based on positive indications of licensed radioactivity above the $DCGL_W$ or above background. Because such areas are minimally impacted or disturbed, potential discrete particles would most likely be situated near the soil surface where detection efficiencies are highest.

1.2.9 Procedures And Guidance Documents

General use of the portable ISOCS system is administrated by departmental implementing procedures that address the calibration and operation activities as well as analysis of the data. These procedures are listed as follows:

- DP-8869, "In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure."
- DP-8871, "Operation Of The Canberra Portable ISOCS Assay System."
- DP-8872, "ISOCS Post Acquisition Processing And Data Review."

Where the portable ISOCS® system is used for Final Status Surveys, the applicable FSS Plan will address detector and collimator configurations, applicable (surrogated) investigation levels, MDC requirements, and appropriate Data Quality Objectives, as applicable.

A secondary application of the portable ISOCS® system is to assay surfaces or bulk materials for characterization or unconditional release evaluations. Use of the portable ISOCS® system for miscellaneous evaluations will be administrated under a specific guidance document (e.g. Sample Plan, etc.). Operating parameters such as physical configuration, efficiency calibrations, count times, and MDCs will be applied so as to meet the criteria in the associated controlling documents. Such documents will also address any unique technical issues associated with the application and may provide guidance beyond that of procedure AP-0052, "Radiation Protection Release of Materials, Equipment and Vehicles."

1.2.10 Environmental Backgrounds

If background subtraction is used, an appropriate background spectrum will be collected and saved. Count times for environmental backgrounds should exceed the count time associated with the assay. In areas where the background radioactivity is particularly problematic (e.g. ISFSI), the background will be characterized to the point of identifying gradient(s) such that background subtractions are either appropriate or conservative. Documentation regarding the collection and application of environmental backgrounds will be provided as a component of the final survey plan.

1.2.11 Quality Control

Quality Control (QC) activities for the ISOCS system ensure that the energy calibration is valid and detector resolution is within specifications. A QC file will be set up for each detector system to track centroid position, FWHM, and activity. Quality Control counts will be performed on a shiftly basis prior to the system's use to verify that the system's energy calibration is valid. The Na-22 has a 1274.5 keV photon which will be the primary mechanism used for performance monitoring. If the energy calibration is found to be out of an acceptable tolerance (e.g. greater than ±4 channels), then the amplifier gain may be adjusted and a follow-up QC count performed. If the detector's resolution is found to be above the factory specification, then an evaluation will be performed to determine if the detector should be removed from service and/or if the data is impacted. Evaluations associated with QC counts shall be documented. Such documentation may be limited to a remark directly on the applicable QC report or in a logbook if the resolution does not render the system out of service. Otherwise the evaluation should be separately documented (e.g. Condition Report, etc.) so as to address the impact of any assay results obtained since the last acceptable QC surveillance.

Where it is determined that background subtraction is necessary, a baseline QC background will be determined specific to that area or region. When background subtraction is required, a QC background surveillance will be performed before a set of measurements are made to verify the applicability of the background to be subtracted. Due to the prevailing variability of the background levels across the site, the nature and extent of such surveillances will be on a case-by-case basis and should be addressed in the documentation associated with the applicable survey plan(s).

In addition to the routine QC counts, each assay report is routinely reviewed with respect to K-40 to provide indications where amplifier drift impacts nuclide identification routines. This review precludes the necessity for specific (i.e. required) after-shift QC surveillances. It also minimizes investigations of previously collected data should the system fail a before-use QC surveillance on the next day of use.

1.2.12 Data Collection

Data collection to support FSS activities will be administered by a specific Survey Plan. Survey Plans may include an index of measurement locations with associated spectrum filenames to ensure that all the required measurements are made and results appropriately managed. Personnel specifically trained to operate the system will perform data collection activities.

Data collection activities will address environmental conditions that may impact soil moisture content. Logs shall be maintained so as to provide a mechanism to annotate such conditions to ensure that efficiency calibration files address the in-situ condition(s). In extreme cases (e.g. standing water, etc.) specific conditions will be addressed to ensure that analysis results reflect the conditions. As previously discussed with respect to water, when unique environmental conditions exist that may impact analysis results, conservative compensatory factors will be applied to the analysis of the data.

1.2.13 Efficiency Calibration

The central feature of the portable ISOCS technology is to support in-situ gamma spectroscopy via the application of mathematically derived efficiency calibrations. Due to the nature of the environment and surfaces being evaluated (assayed), input parameters for the ISOCS efficiency calibrations will be reviewed on a case-by-case basis to ensure the applicability of the resultant efficiency. Material densities applied to efficiency calibrations will be documented. In practice, a single efficiency calibration file may be applied to the majority of the measurements.

The geometry most generally employed will be a circular plane assuming uniformly distributed activity. Efficiency calibrations will address a depth of 15 cm for soil and a depth up to 5 cm for concrete surfaces to account for activity embedded in cracks, etc. Other geometries (e.g. exponential circular plane, rectangular plane, etc.) will be applied if warranted by the physical attributes of the area or surface being evaluated. Efficiency calibrations are developed by radiological engineers who have received training with respect to the ISOCS® software. Efficiency calibrations will be documented in accordance with procedure DP-8869, "In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure."

1.2.14 Data Management

Data management will be implemented in various stages as follows:

- An index or log will be maintained to account for each location where evaluations for elevated activity are performed. Raw spectrum files will be written directly or copied to a central file server.

- Data Analysis – After the spectrum is collected and analyzed, a qualified Radiological Engineer will review the results. The data review process includes application of appropriate background, nuclide libraries, and efficiency calibrations. Data reviews also verify assay results with respect to the applicable investigation levels and the MDCs achieved. Data reviews may include monitoring system performance utilizing K-40. When the data analysis is completed, the analyzed data file will be archived to a unique directory located on a central file server.

- Data Reporting – The results of data files whose reviews have been completed and are deemed to be acceptable may be uploaded to a central database for subsequent reporting and statistical analysis.

- Data Archiving – Routinely (daily) the centralized file server(s) where the raw and analyzed data files are maintained will be backed up to tape.

1.3 Conclusions/Recommendations

The in-situ gamma spectroscopy system is a cost-effective technology well-suited to replace traditional scanning survey techniques to evaluate areas for elevated radioactivity. The static manner in which this system is operated eliminates many variables and limitations inherent to hand-held detectors moving over a surface. This system provides a demonstrably lower detection sensitivity than those offered by hand-held field instruments. This attribute qualifies this system as an alternative technology in lieu of hand-held NaI field instruments in areas where background radiation levels would prohibit the use of such detectors to evaluate for elevated gross activity. The MDC to which this system will be operated satisfies (or exceeds) criteria applied to traditional scan surveys using hand-held field instruments.

Effective investigation levels for both open land areas (i.e. soils) and for building surfaces can be derived and applied to in-situ gamma spectroscopy results. Where surrogate DCGLs are employed, investigation levels will developed on a case-by-case basis using the approach outlined in this document.

The manner in which investigation levels are derived employs several conservative decisions and assumptions. Additionally, adequate spacing applied to scanning survey locations yields an overlap in surface coverage providing 100-percent coverage of Class 1 areas and redundant opportunities in a significant portion of the survey area to detect localized elevated activity.

1.4 <u>References</u>

1. YNPS License Termination Plan, Revision 1
2. Multi-Agency Radiation Survey And Site Investigation Manual (MARSSIM) Revision 1, 2000
3. Canberra User's Manual Model S573 ISOCS Calibration Software, 2002
4. Decommissioning Health Physics - A Handbook for MARSSIM Users, E.W. Abelquist, 2001
5. Canberra's Genie 2000 V3.0 Operations Manual, 2004
6. In-Situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure DP-8869, Revision 0
7. Operation of the Canberra Portable ISOCS Assay System DP-8871 Revision 0
8. Technical Ref., by Thomas J. Glover.

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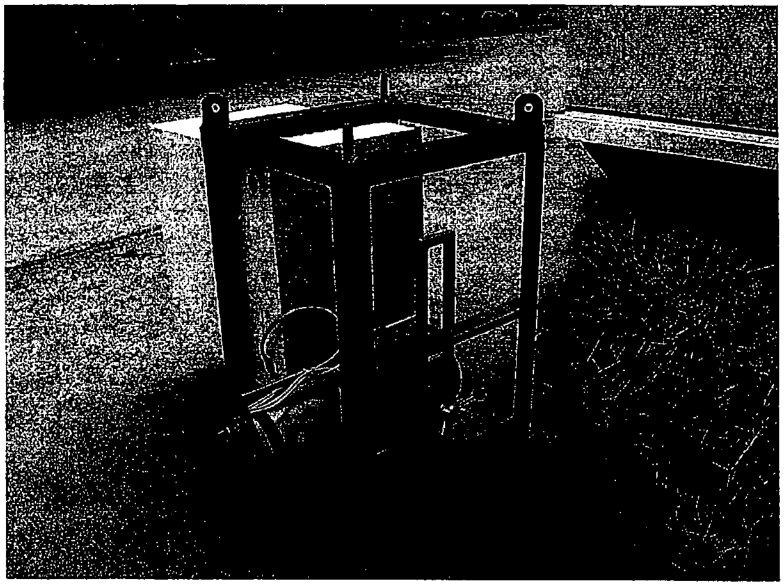
Attachment 1
Portable ISOCS® Detector System Photos



Attachment 2
Field-Of-View Characterization

Generally, the HPGe detector will be outfitted with a 90-degree collimator situated at 2 meters perpendicular to the surface being evaluated. Note that characterizing the detector's field-of-view could be performed without a source by comparing ISOCS-generated efficiencies for various geometries. If a different collimator configuration is to be employed, a similar field-of-view characterization will be performed.

To qualify the field-of-view for this configuration, a series of measurements were made at various off-sets relative to the center of the reference plane. The source used for these measurements was a 1.2 μCi Co-60 point-source with a physical size of approximately 1 cm^3. Each spectrum was analyzed as a point source both with and without background subtract. It was observed that the detector responded quite well to the point source.

Figure 1 presents the results with background subtraction applied. Note that there is a good correlation with the expected nominal activity and that outside the 2-meter radius of the "working" field-of-view (i.e. at 90 inches) some detector response occurs. This validates that the correct attenuation factors are applied to the algorithms used to compute the efficiency calibration.

FIGURE 1

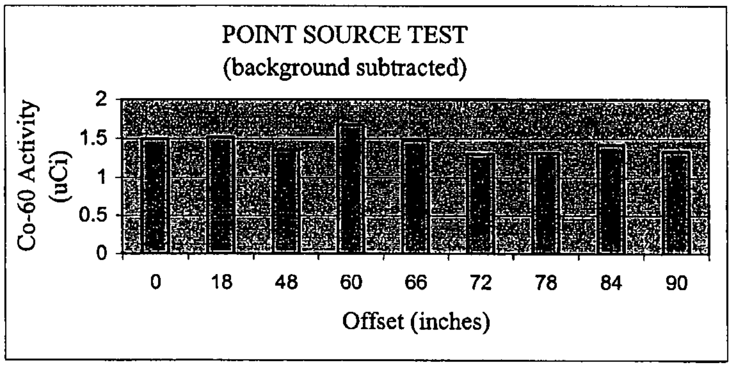
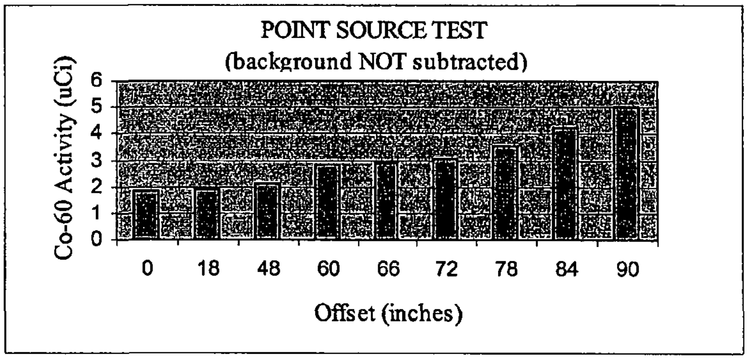
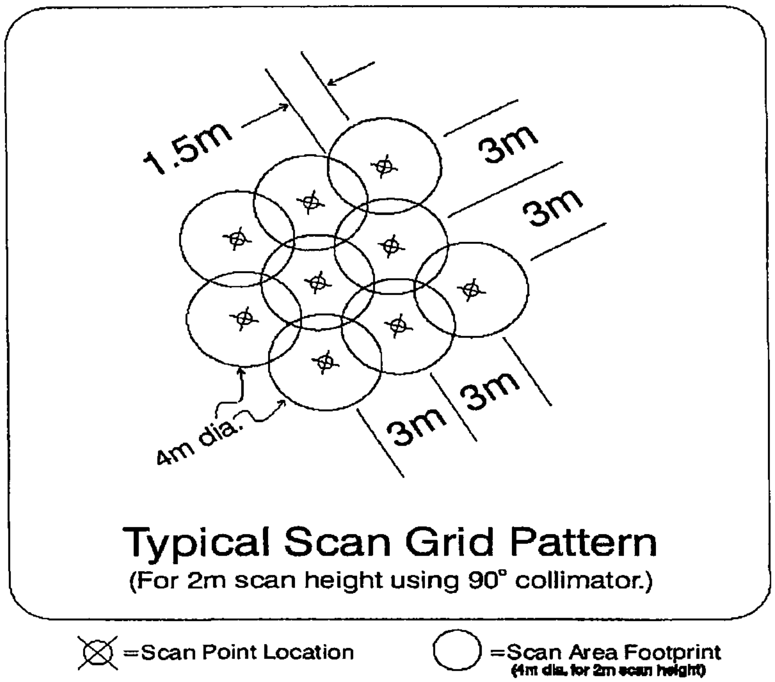


Figure 2 shows the effect of plant-derived materials present in the reference background, which indicates an increasing over-response the further the point source is moved off center. Detector response outside the assumed (i.e. 2-meter) field-of-view would yield conservative results. Normally, source term adjacent to the survey units should be reduced to eliminate background interference.

FIGURE 2


POINT SOURCE TEST
(background NOT subtracted)
Co-60 Activity (uCi)
0
1
2
3
4
5
6
0
18
48
60
66
72
78
84
90
Offset (inches)

Attachment 3
Typical Grid Pattern For In-Situ Gamma Spectroscopy

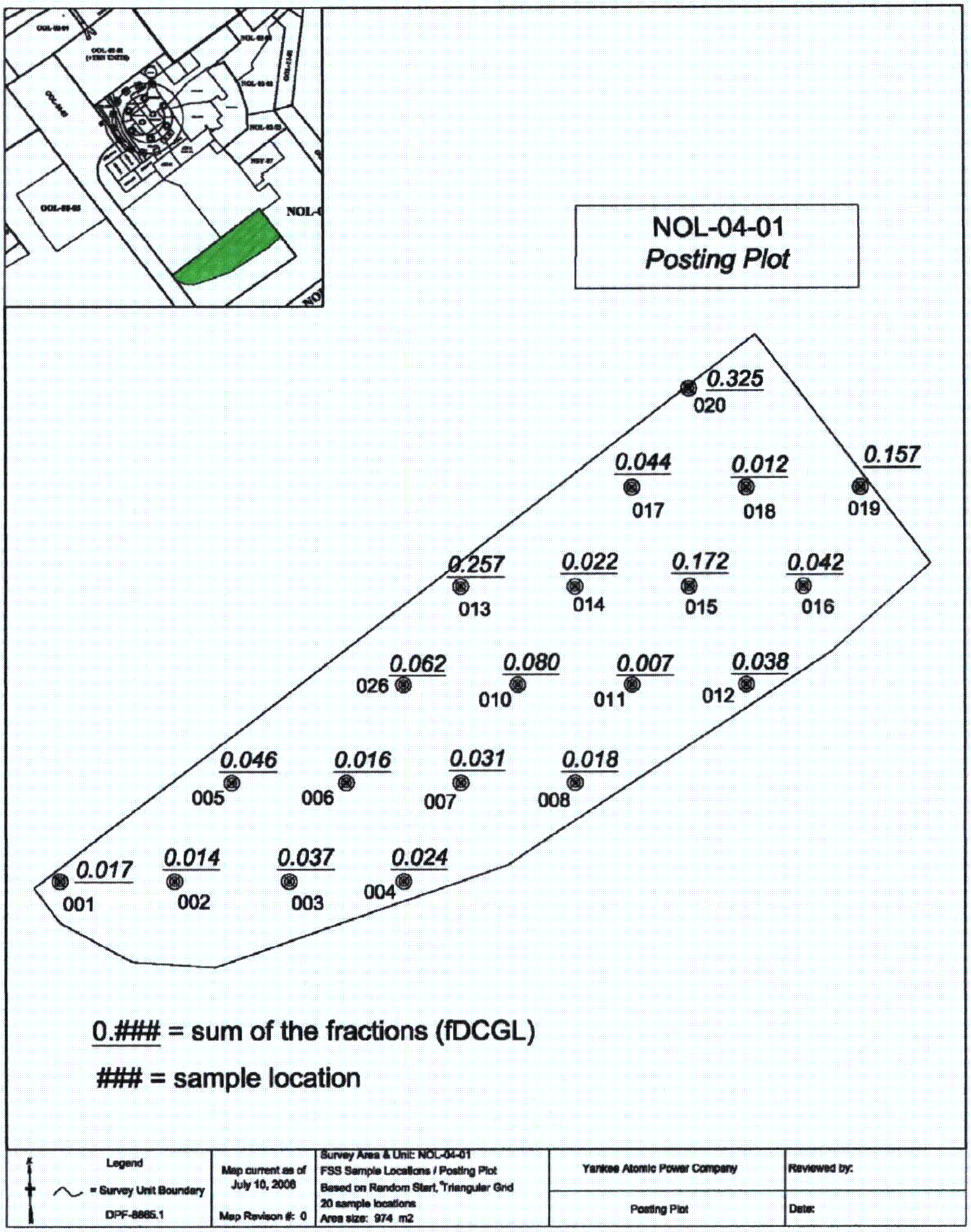


Typical Scan Grid Pattern
(For 2m scan height using 90° collimator.)

Attachment A – Maps and Posting Plots

List of Figures

Figure 1 NOL-04-01 Posting Plot



Attachment B

Data Quality Assessment Plots and Curves

List of Figures

The LBGR on the Power Curves have been adjusted to demonstrate the actual power of the survey.

Figure 1 NOL-04-01 Prospective Power Curve

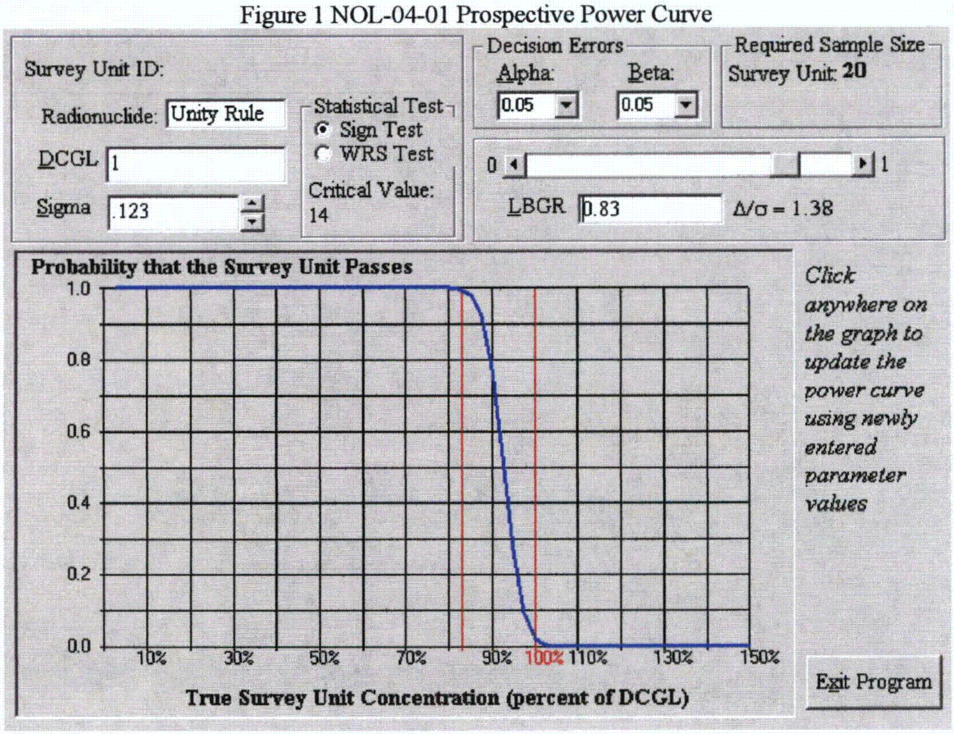


Figure 2 NOL-04-01 Retrospective Power Curve

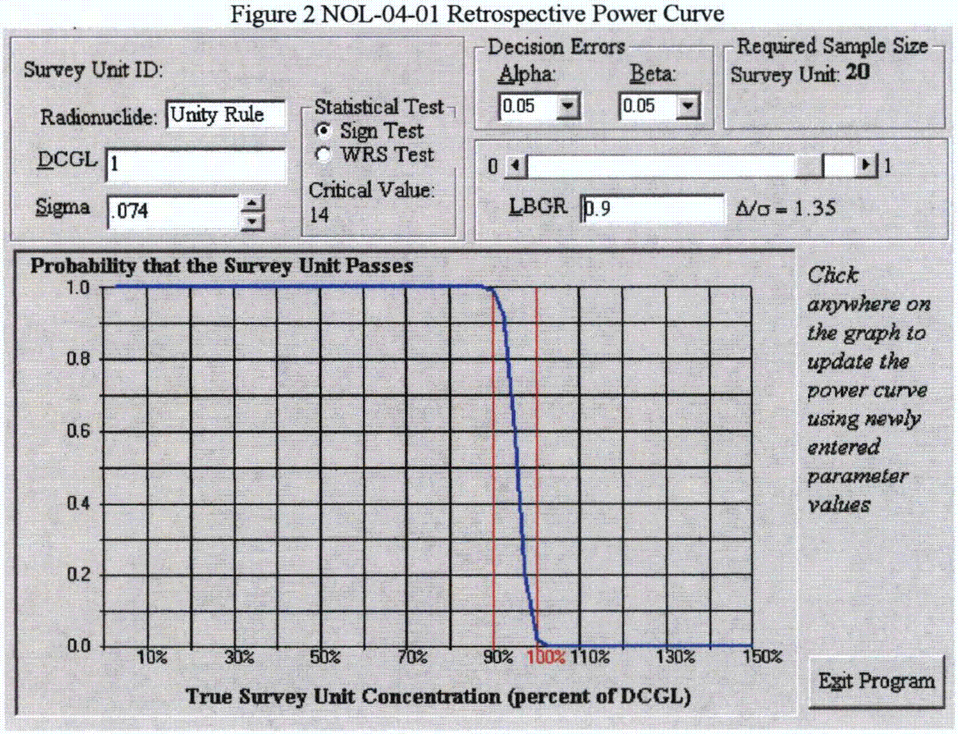


Figure 3 NOL-04-01Sum of Fractions Scatter Plot

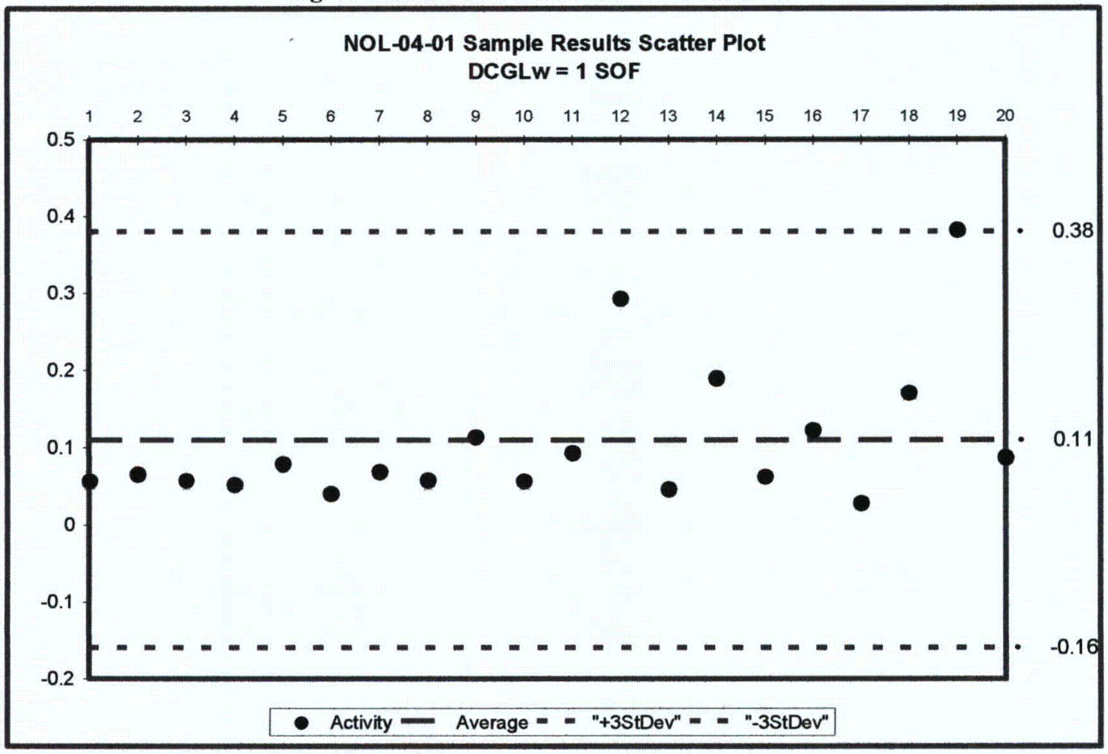


Figure 4 NOL-04-01 Sum of Fractions Quantile Plot

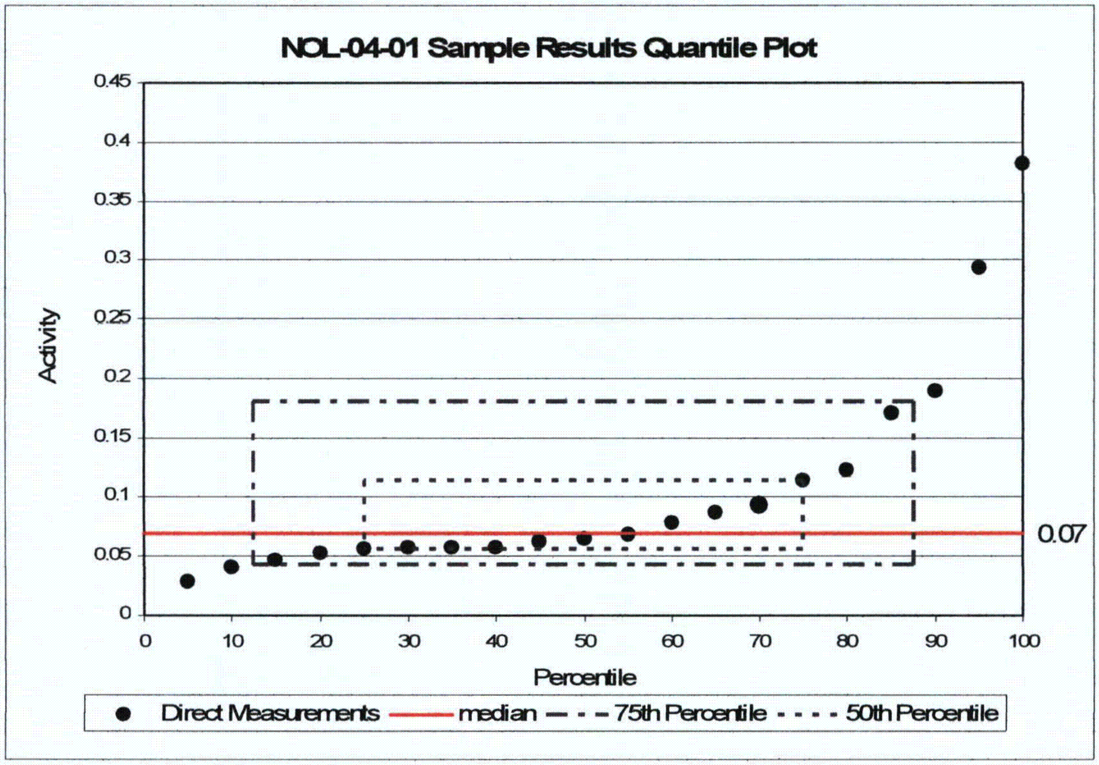
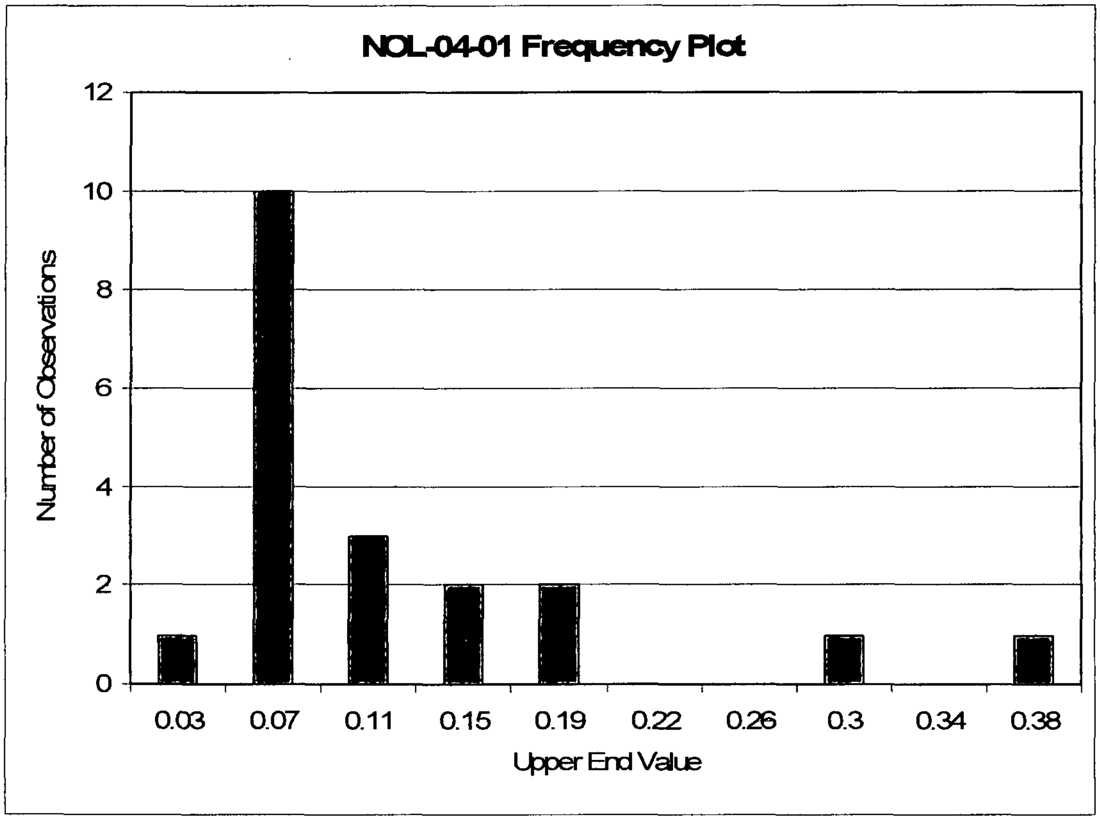
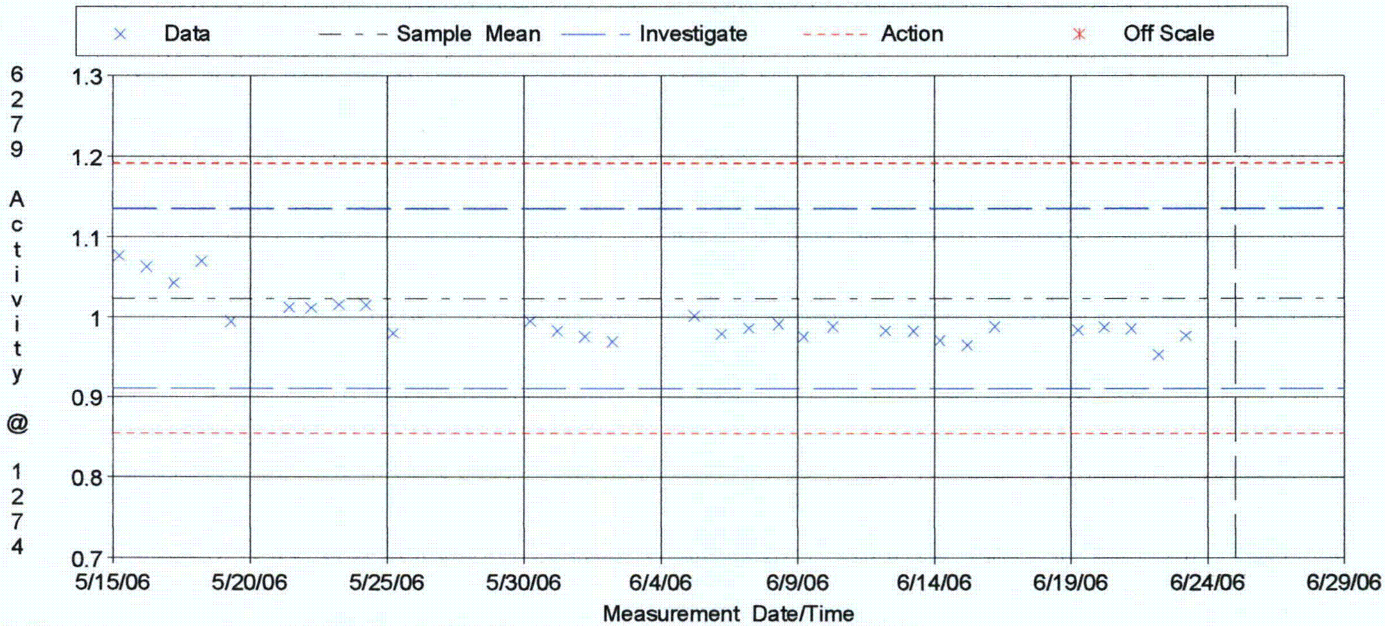


Figure 5 NOL-04-01 Sum of Fractions Frequency Plot





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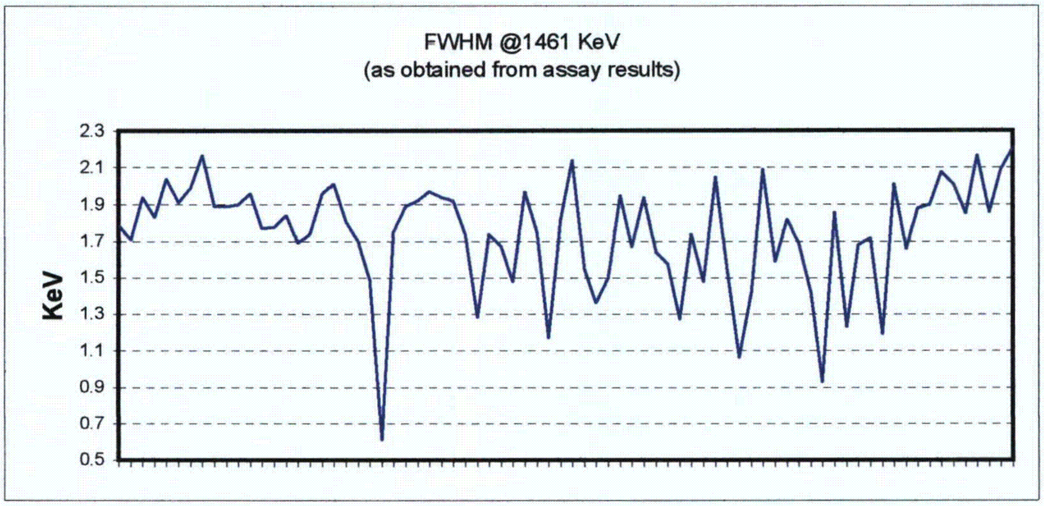
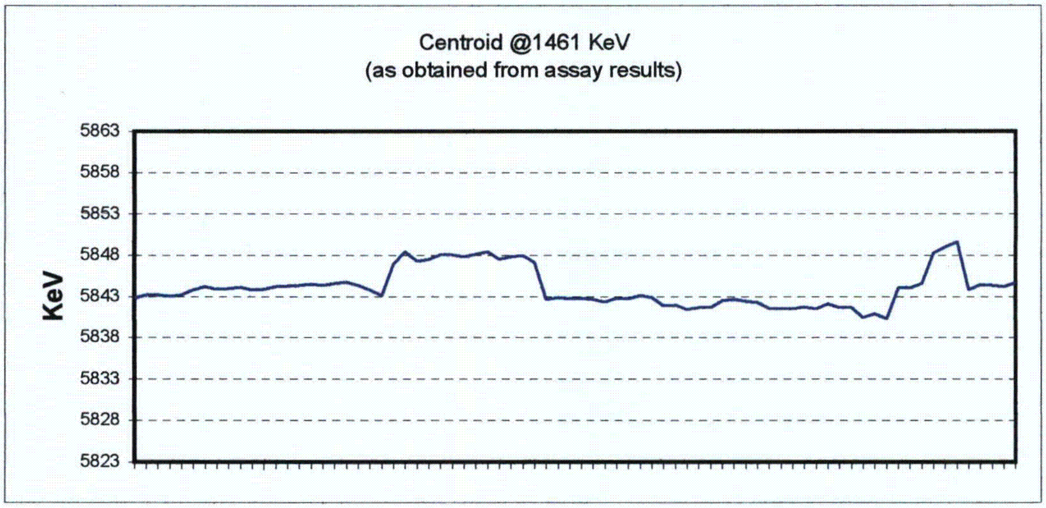
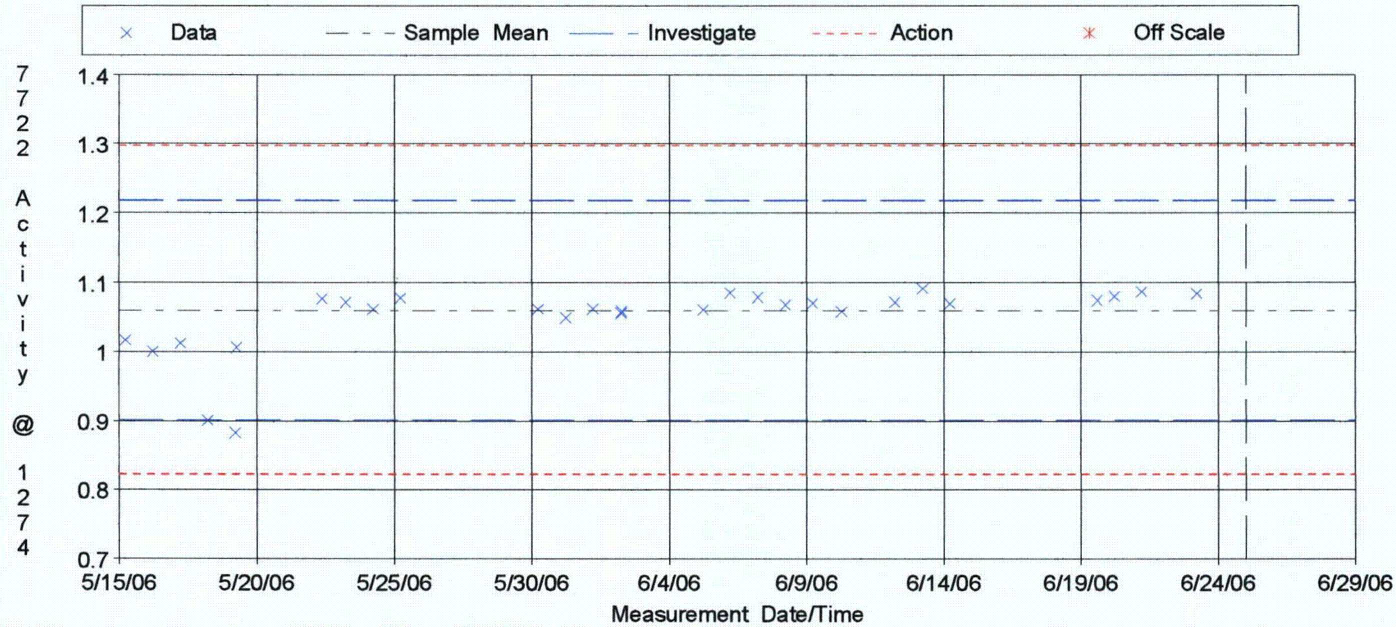
Parameter Description : 6279 Activity @ 1274 keV (uCi)
Selection Dates : 5/15/06 12:00:00 AM - 6/25/06 12:00:00 AM
Sample Mean +/- Std Dev : 1.023 +/- 0.056

NOL-04-01
ISOCS DETECTOR 6279

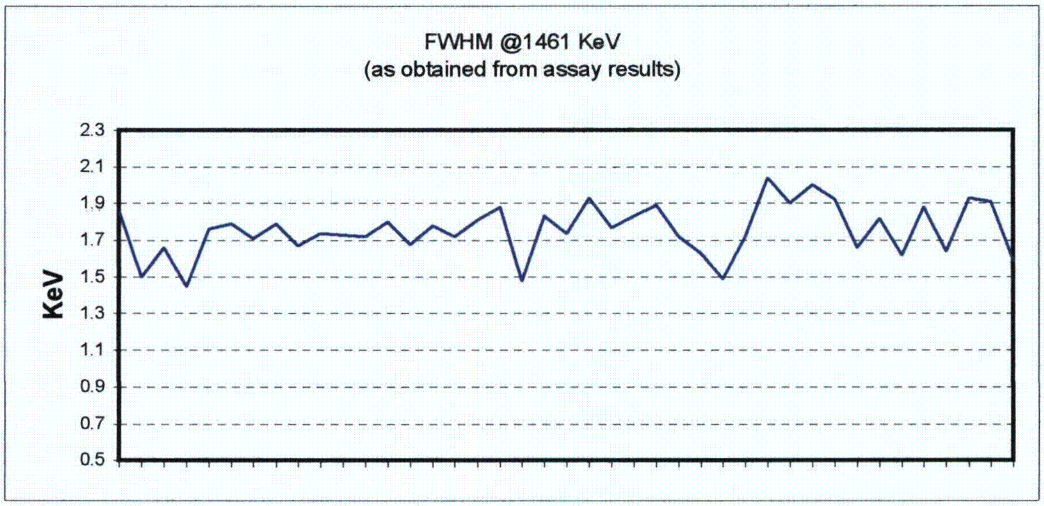


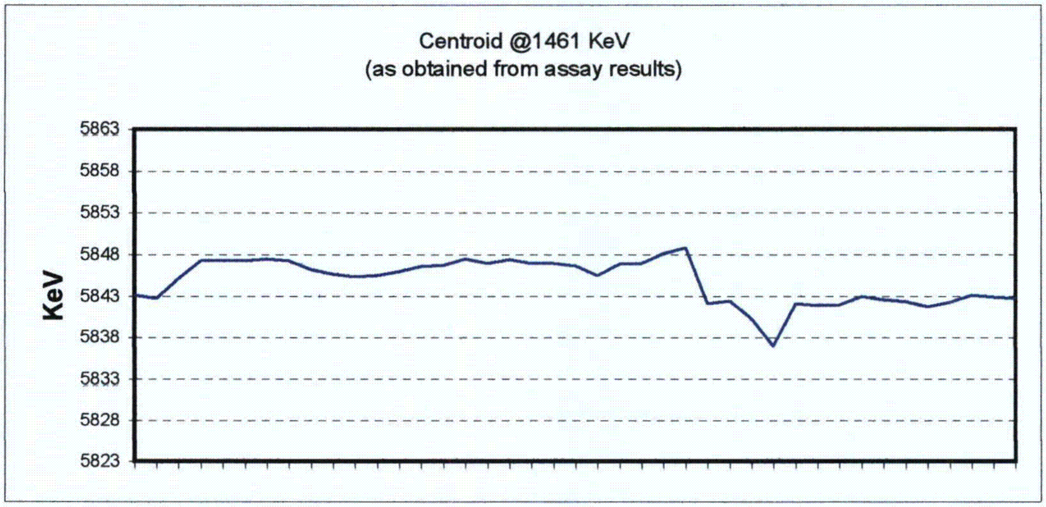


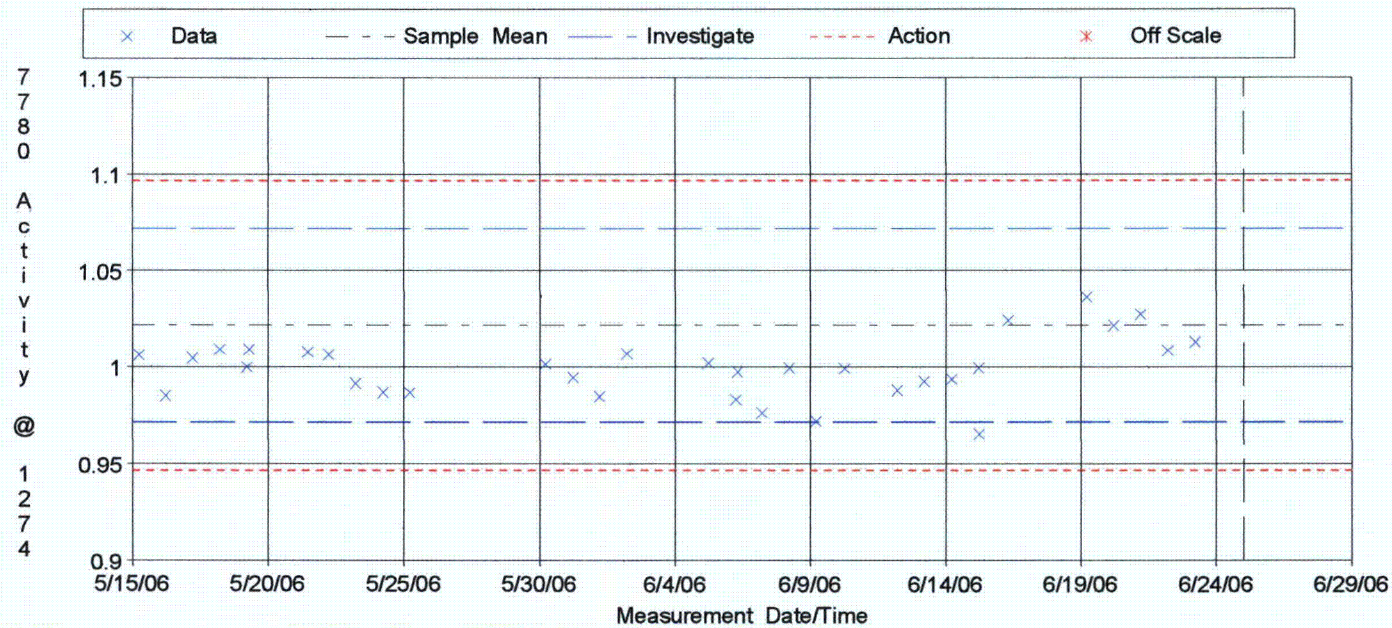


QA Filename	:	S:\3BrownRover (7722)\Archived QC Files\7722.QAF
Parameter Description	:	7722 Activity @ 1274 keV (uCi)
Selection Dates	:	5/15/06 12:00:00 AM - 6/25/06 12:00:00 AM
Sample Mean +/- Std Dev	:	1.060 +/- 0.079

NOL-04-01
ISOCS DETECTOR 7722

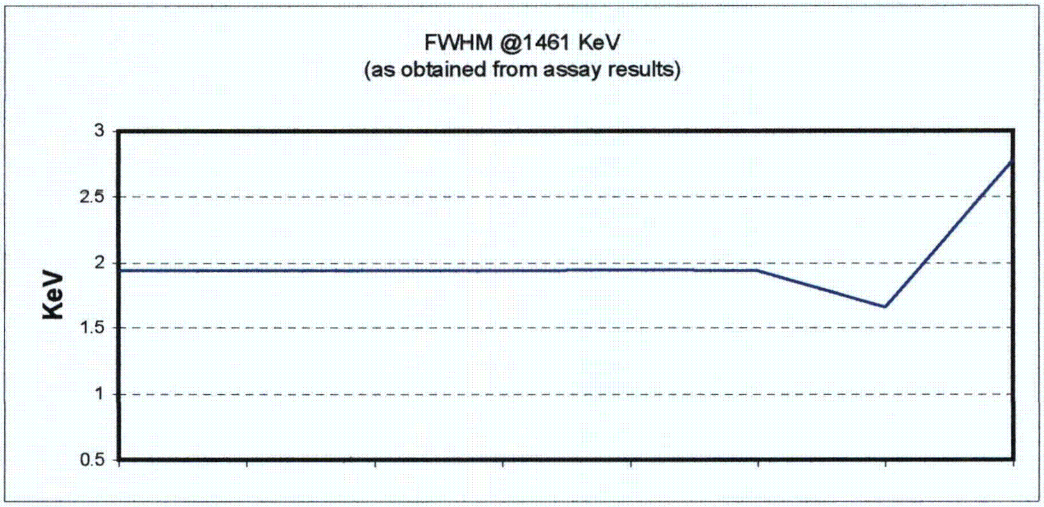


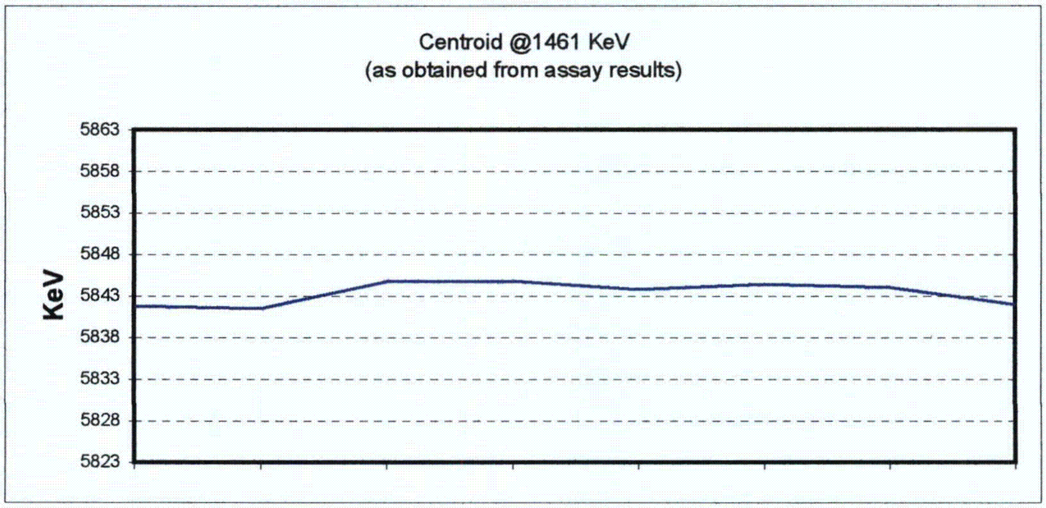


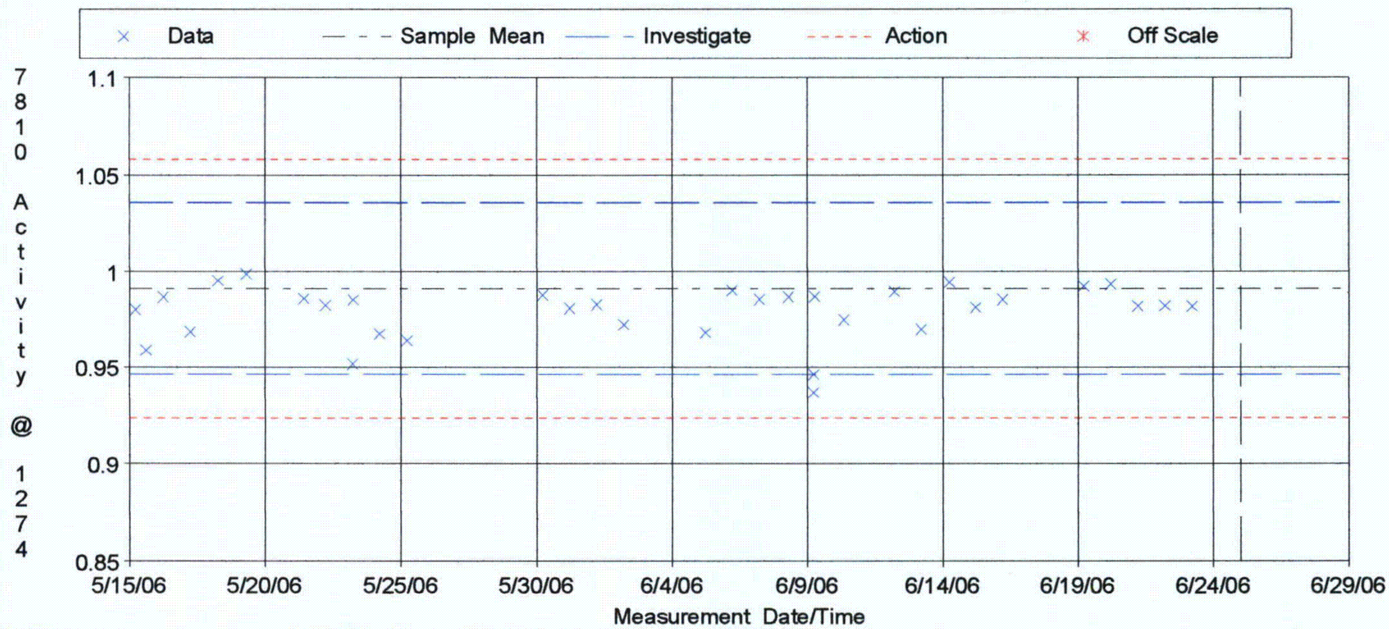


QA Filename : S:\4GreenRover (7780)\Archived QC Files\7780.QAF
Parameter Description : 7780 Activity @ 1274 keV (uCi)
Selection Dates : 5/15/06 12:00:00 AM - 6/25/06 12:00:00 AM
Sample Mean +/- Std Dev : 1.022 +/- 0.025

NOL-04-01
ISOCS DETECTOR 7780

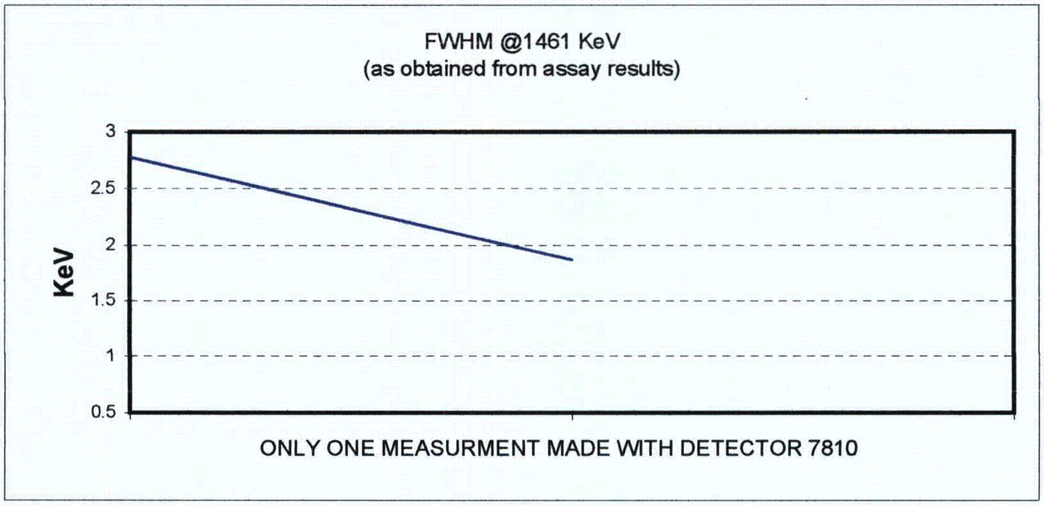


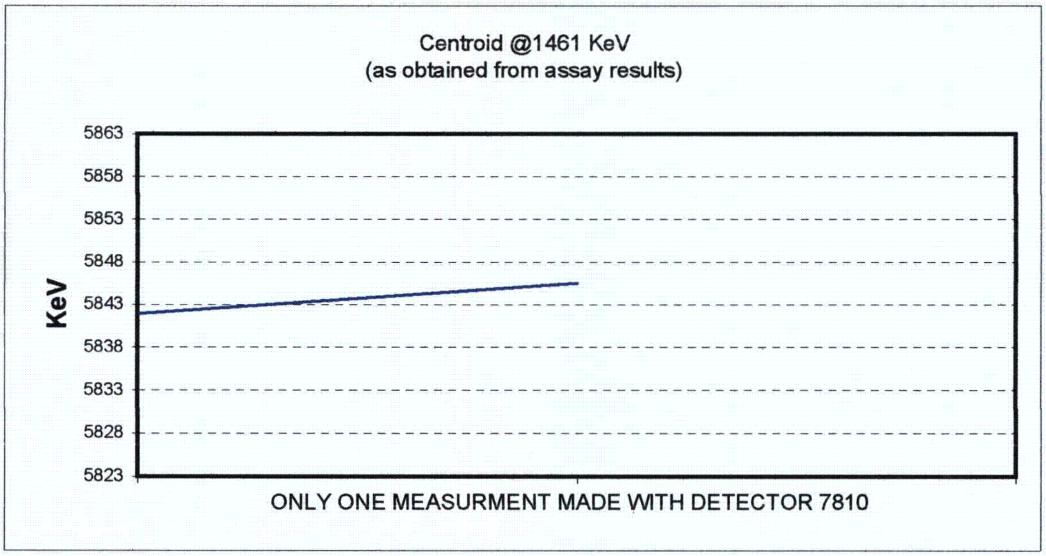




QA Filename : S:\5YellowRover (7810)\Archived QC Files\7810.QAF
Parameter Description : 7810 Activity @ 1274 keV (uCi)
Selection Dates : 5/15/06 12:00:00 AM - 6/25/06 12:00:00 AM
Sample Mean +/- Std Dev : 0.991 +/- 0.022

NOL-04-01
ISOCS DETECTOR 7810





Daily Survey Journal

Survey Area Unit No.: NOL-04-01		Survey Date: 5-17-06	
Survey Plan #: YNPS-FSSP-NOL04-01-00			
Supervisor: E. NEEL	Crew: J. SPRUCINSKI, M. SWEET, S. PENNOCK, M. MAXWELL, D. WALKER, S. ERICKSON, M. MISKEMAN (ISOCS)		
Instruments:			
Model:	ISOCS (BLUE)	ISOCS (BROWN)	
Serial #:	6279	~~7605~~ 5-17-06 7722	
Cal. Due.	03/07	04/07	
Pre-op source ✓:	Sat. ☑	Sat. ☑	
Post-op source ✓:	Sat. ☑ Date:	Sat. ☑ Date:	Sat. ☐ Date:

TIME	NOTES FOR SURVEY DATE
0700	CONDUCTED DAILY SAFETY BRIEFING TOWARD YNPS-FSSP-NOL04-01-00
0820	STAKE OUT OF ISOCS SCAN AND SOIL SAMPLE LOCATIONS BEGAN.
0835	ISOCS SCANS BEGAN WITH BROWN AND BLUE ROVERS
1000	ISOCS LOCATIONS #133 #117 #101 MOVED TOWARD THE
	SOUTHEAST TO STAY WITHIN SURVEY UNIT BOUNDARY.
1540	SOIL SAMPLING BEGAN IAW DP 8120 AND YNPS-BS-NOL04-01-00
1630	SOIL SAMPLING HALTED FOR THE DAY.
1645	TURNOVER FOR ISOCS GIVEN IN THE FIELD. PAPERWORK
	PASSED ON TO NIGHTSHIFT

Completed by [signature] Date 5-17-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

Page 1 of 1

Survey Area Unit No.: NOL-04-01		Survey Date: 5.18.06	
Survey Plan #: YNPS-FSSP-NOL04-01-00			
Supervisor: E. NOEL	Crew: S. ERICKSON, M. MAXWELL, M SWEET, D. WALKER, R. GRIPPEN		
Instruments:			
Model:	1506CS (BROWN)	1506CS (GREEN)	
Serial #:	7722	7780	
Cal. Due.	04/07	04/07	
Pre-op source ✓:	Sat.☑	Sat.☑	
Post-op source ✓:	Sat.☑ Date:	Sat.☑ Date:	Sat.☐ Date:

TIME	NOTES FOR SURVEY DATE
0700	DAILY SAFETY MEETING; FSSP-NOL04-01-00 BRIEFED
0815	BROWN AND GREEN ROVERS IN PLACE AND SCAN MEASUREMENTS
	BEGAN.
0820	D. WALKER AND R. GRIPPEN ATTEMPTING TO PERFORM LEVEL
	ONE SCAN INVESTIGATION OF ELEVATED 1506S MEASUREMENT
	AREAS.
0840	LEVEL ONE INVESTIGATIONS ARE BEING HALTED DUE TO ELEVATED
	BKGD LEVELS, 30-60 Kcpm. WE'LL WAIT UNTIL TEMP. SHIELDING
	CAN BE PUT IN PLACE.
0920	D. WALKER AND R. GRIPPEN ARE RESUMING SOIL SAMPLING PER DP-8120
1130	ADDED SHOTS #171 & #172 TO COMPLETE 100% COVERAGE.
1135	SHOT #171 ACCIDENTALLY SHOT AS #170. THIS WILL CAUSE
	A DUPLICATE RESULT AND NEEDS TO BE CORRECTED ON DOCUMENTATION.
1645	TURNED OVER TO NIGHTSHIFT - 5 SHOTS REMAINING W/1506S.
1650	ALL SAMPLES FROM SURVEY UNIT HAVE BEEN COLLECTED
	AND RECEIVED AT SPT.

Completed by [signature] Date 5-18-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

CONTROL POINT

PORTABLE INSTRUMENT ACCOUNTABILITY FORM

Instrument 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
E-600 # 02488 SPA-3 # 2055	✓	✓	✓	N0L-04-01	5/22/06 0646	Gagnon	5/22/06 1615	✓
E600 # 5156 SPA-3 # 07005	✓	✓	✓	Remed	5/22/06 / 0652	Pentecl C	5/22/06 / 1530	✓
E-600 # 2620 SPA-3 # 726557	✓	✓	✓	Remed.	5-22-06 0650	Meyers	5-22-06 0750	✓
~~E600 02619 SPA-3 2056~~	~~✓~~	~~✓~~	~~✓~~	~~FSS~~	~~5-22-06 0730~~	~~Sharon E~~	~~5-22-06 0750~~	
E600 # 5140 SPA-3 61035	✓	✓	✓	FSS	5-22-06 0750	Sharon E	5-22-06 0930	✓
~~E600 ... SPA-3 ...~~								
E 600 # 2620 SPA3 # 726557	✓	✓	✓	FSS	5-22-06 0830	E. Noel	5/22/06 1620	✓
E600 5140 SPA3 61035	✓	✓	✓	FSS	5-22-06 1300	Sharon E	5/22/06 1500	✓

RP Supervisor Review ______________ (1)

(1) If any post-use source check failures occur, ensure that the condition is documented by a Condition Report.

DPF-8504.1
Rev. 17

PORTABLE/GAMMA FRIS_ _ SOURCE CHECK FORM

E-600	SPA-3	61635	277	195710.4	293565.6
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
5-9-06	0550	SAT	N/A	5040	247000	241960	ws	5-9-06	1640	SAT	N/A	4990	249000	244010	ws
5-11-06	0810	SAT	N/A	4150	247000	242850	ws	5-11-06	1700	SAT	N/A	4690	248000	243310	ws
5-15-06	0540	SAT	N/A	4260	248000	243740	ws	5-15-6	1300	SAT	NA	5270	250 000	244730	gjc
5-15-6	13:00	SAT	NA	5270	250 000	244730	gjc	5-15-06	1640	SAT	N/A	5010	249000	243990	ws
5-16-06	0540	SAT	N/A	5000	247000	242000	ws	5-16-6	1700	SAT	NA	5400	250 000	244600	gjc
5-17-06	0540	SAT	N/A	5550	248000	242450	ws	5-17-06	1705	SAT	N/A	6060	246000	239940	ws
5-18-06	0545	SAT	N/A	4600	248000	243400	ws	5-18-6	15:20	SAT	NA	5680	247000	241320	gjc
5-19-06	0550	SAT	N/A	5750	246000	240250	ws	5-19-6	14:00	SAT	NA	5460	225000	219540	gjc
5-22-6	0725	SAT	NA	4680	248 000	243320	gjc	5-22-06	1210	SAT	N/A	4890	248000	243110	ws
5-22-06	1210	SAT	N/A	4890	248000	243110	ws	5-22-6	1520	SAT	NA	5790	247000	241210	gjc
5-23-06	0550	SAT	N/A	5380	246000	240620	ws								
5-24-06	0540	SAT	N/A	5330	244000	238670	ws	5-24-6	1655	SAT	NA	4930	244000	239070	gjc
5-25-06	0540	SAT	N/A	5440	244000	238560	ws	5-25-06	1507	SAT	N/A	6210	247000	240790	ws
5-30-06	0540	SAT	N/A	5000	247000	242000	ws	5-30-6	1605	SAT	NA	4730	238000	233270	gjc
5-31-06	0545	SAT	N/A	4950	245000	240050	ws	5-31-6	1635	SAT	NA	5200	243000	237800	gjc

RP Supervisor Review: Barbara Erickson [1]

[1] If any post-use source check failures occur, ensure that the condition is documented by a Condition Report.

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Rev. 17

Daily Survey Journal

Survey Area Unit No.: NOL 04-01		Survey Date: 5-22-06	
Survey Plan #: YNPS-FSSP-~~DOL~~ (EW 5-22-06) NOL-04-01-00			
Supervisor: E. NEEL	Crew: S. ERICKSON, M. MAXWELL, D. WALKER,		
Instruments:			
Model:	E600 / SPA3	ISOCS (YELLOW) ~~E600 / SPA3~~	~~E600 / SPA3~~ ISOCS YELLOW EW 5-22-06
Serial #:	5140 / 61035	7810	
Cal. Due.	10.7.06 / 10.6.06	5/07	
Pre-op source ✓:	Sat. ☑ VNS. EFF. 239	Sat. ☑	SAT ☑
Post-op source ✓:	Sat. ☐ Date:	Sat. ☐ Date:	Sat. ☐ Date:

TIME	NOTES FOR SURVEY DATE
0700	CONDUCTED DAILY SAFETY BREIFING TOWARD YNPS-FSSP-NOL 04-01-00
0915	SET UP YELLOW ROVER ON NOL 04-01-112-F-G FOR RESHOOT
	OF A CORRUPTED INITIAL SCAN.
	WATER IN SURVEY UNIT REMAINS AN ISSUE. BRUCE JOJO HAS BEEN
	NOTIFIED AND WILL WORK WITH US.
1030	ATTEMPTED TO PERFORM SPA-3 INVESTIGATION SCANS IN AREAS IDENTIFIED
	AS HAVING INDICATIONS OF ELEVATED ACTIVITY BASED ON ISOCS RESULTS
	USING A STEEL PLATE SUSPENDED BY CRANE ADJACENT TO SCAN AREA.
	PROVED UNSUCCESSFUL AND ANOTHER METHOD WILL BE ATTEMPTED TO
	SHIELD SHINE FROM ISFSI.
1230	S. ERICKSON HAD CONSTRUCTION PARK AN INTERMODAL BETWEEN ISFSI AND
	SURVEY AREAS. THIS METHOD SEEMS TO BE WORKING MUCH BETTER.
1330	SCAN OF ISOCS # 111 AND 172 BKGRD - 16-22Kcpm NO INDICATIONS
	OF ELEVATED ACTIVITY FOUND IN FOV.S
	ALL SCANNING PERFORMED IAW FSSP-NOL-04-01-00 AT
	A SCAN RATE OF 5"-6"/SEC (<.18m/s)
1900	SCAN OF ISOCS # 114 BKGD - 16K-25Kcpm. NO INDICATIONS OF
	ELEVATED ACTIVITY

Completed by [signature] Date 5-22-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

Area/Unit # NOL 04-01 Page 2 of 2 Date: 5-22-06

TIME	NOTES FOR SURVEY DATE
1415	INVESTIGATIONS OF ISOCS # 115, 116, & 132.
	BKGD - 16K - 25K cpm NO INDICATIONS OF ELEVATED ACTIVITY
	FOUND.
1445	INVESTIGATION SCAN OF ISOCS # 160. BKGD 15K-19K cpm
	NO INDICATIONS OF ELEVATED ACTIVITY FOUND.
1500	INVESTIGATION SCAN OF ISOCS # 145. BKGD 14K - 20K cpm
	NO INDICATIONS OF ELEVATED ACTIVITY FOUND.

Completed by [signature] Date 5-22-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

Page 1 of _

Survey Area Unit No.: NOL-04-01		Survey Date: 6-1-06	
Survey Plan #: YNPS-FSSP-NOL 04-01-00			
Supervisor: E. NEEL	Crew: M. MAXWELL, M. SWEET		
Instruments:			
Model:	ISOCS (BLUE)		
Serial #:	6279		
Cal. Due.	3/07		
Pre-op source ✓:	Sat.☑	Sat.☐	
Post-op source ✓:	Sat.☐ Date:	Sat.☐ Date:	Sat.☐ Date:

TIME	NOTES FOR SURVEY DATE
0645	CONDUCTED DAILY SAFETY BRIEFING TOWARD FSS ACTIVITIES
	FOR TODAY
0945	CRANE AND CRANE OPERATOR IN PLACE. BEGINNING ISOCS
	INVESTIGATIONS OF ORIGINAL ISOCS MEASUREMENTS. LOCATIONS
	DETERMINED BY FSS ENG. TO BE #s 108, 111, 114, 115, 116,
	132, 145, 160, 172. AREAS WILL BE SPLIT INTO 4 QUADRANTS
	AND A 1 METER SHOT WITH 90° COLLIMATOR WILL BE TAKEN FOR
	A TIME TBD THE FSS ENG. STARTING WITH 2 MINUTES.
1004	FIRST SHOT # NOL-04-01-173-FG-I SET UP IN FIRST QUADRANT OF
	ORIGINAL SHOT # NOL-04-01-160-F-G FOR 2 MIN COUNT TIME.
1014	PER FSS ENG 3RD SHOT COUNT TIME CHANGED TO 3 MIN.
1019	PER FSS ENG 4TH SHOT COUNT TIME CHANGED TO 5 MIN
1028	PER FSS ENG 5TH SHOT COUNT TIME CHANGED TO 10 MIN
1040	PER FSS ENG 6TH SHOT COUNT TIME CHANGED BACK TO 5 MIN
1131	PER FSS ENG 12TH SHOT COUNT TIME CHANGED TO 10 MIN.
1302	PER FSS ENG 15TH SHOT COUNT TIME CHANGED TO 5 MIN
1430	PER FSS ENG. ONE ADDITIONAL SHOT PER INVESTIGATION AREA
	TO BE TAKEN DIRECTLY OVER ORIGINAL SHOT.

Completed by [signature] Date 6.1.06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

Area/Unit # NOL 04-01 Page 2 of 2 Date: 6-1-06

TIME	NOTES FOR SURVEY DATE
1630	TURNOVER PERFORMED WITH NIGHTSHIFT
	TO FINISH SHOTS IN NOL 04-01.
	SO FAR, 3 INVESTIGATION MEASUREMENTS
	HAVE BEEN POSITIVE FOR LISENCED MATERIAL
	IN INVESTIGATIONS OF 145-F-G, 115-F-G,
	AND 111-F-G. THESE AREAS ARE TO BE
	FOLLOWED UP WITH SPA-3 TOMORROW.

Completed by [signature] Date 6-1-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

Survey Area Unit No.: NOL.04.01		Survey Date: 6.2.06	
Survey Plan #: YNPS. FSSP-NOL 04.01.00			
Supervisor: E.NEEL	Crew: GRIPPEN, S. PENNOCK, M. MAXWELL		
Instruments:			
Model:	ISOCS (BLUE)	E.600 / SPA.3	E.600 / SPA.3
Serial #:	6279	2419 / 2056	5756 / 70052
Cal. Due.	3.07	9/13/06 / 9/8/06	9/7/06 / 9/6/06
Pre-op source ✓:	Sat.☑	Sat.☑	☑
Post-op source ✓:	Sat.☐ Date:	Sat.☐ Date:	Sat.☐ Date:

TIME	NOTES FOR SURVEY DATE
0630	CONDUCTED DAILY SAFETY BRIEFING TOWARD FSS ACTIVITIES.
0725	BEGINNING ISOCS INVESTIGATIONS WITH BLUE ROVER 90° COLLIMATOR
	AT 1 METER, COUNT TIME - 5 MIN.
0735	BEGINNING SPA 3 INVESTIGATIONS OF IDENTIFIED INVESTIGATION AREAS.
	INCLUDING ORIGINAL SHOTS (145-F-G AND 116-F-G) THAT WERE OVER
	OR NEAR UNITY PER FSS ENG. AND AREAS IDENTIFIED BY ISOCS INVESTI-
	GATIONS INCLUDING AREAS IN 115-F-G AND 111-F-G
0800	ISOCS INVESTIGATIONS COMPLETED
1100	Completed SPA-3 Scan of Sectors 111, 115,
	116, 132 & 145 No other Elevated Area
	Noted
1300	Removed 64 kcpm particle from ≈ 1"
	below Surface in Sector 145. NOL-04-01
	218-F-SC-I (before removal) was 43.2k thu
	NOL-04-01-219-F-SC-I (After removal) was
	21.8 kcpm
1410	NOL-04-01-220-F-G-I taken only 1 Co-60
	peak ID No other isotopes.

Completed by [signature] Date 6.2.06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

DPF-8856.2
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Daily Survey Journal

Area/Unit # NOL-04-01 Page 2 of 2 Date: 6-2-06

TIME	NOTES FOR SURVEY DATE
1430	INVESTIGATION SOIL SAMPLE COLLECTED AT LOCATION
	WHERE HOT PARTICLE WAS LOCATED AND
	DESIGNATED NOL 04-01-025-F-I @ 1340 BY RLG
LATE ENTRY 6-17-06	INVESTIGATION FOLLOWUP ISOCS SCAN PERFORMED AT
	1410 AND ASSIGNED # NOL 04-01-220-F-G-I WILL
	BE CHANGED TO NOL 04-01-226-F-G-I DUE TO
	DUPLICATE # ASSIGNMENT

Completed by [signature] Date 6-2-06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

CONTROL POINT

PORTABLE INSTRUMENT ACCOUNTABILITY FORM

Instrument 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
E-600 # 02619 SPA-3 # 2056	✓	✓	✓	NOL-4	6/2/06 0655	Grip	06/02/06 1420	✓
E-600 # 5156 SPA-3 # 70052	✓	✓	✓	NOL-4	6/2/06 0655	Grip	6/02/06 1420	✓
E-600 # 02468 SPA-3 # 2055	✓	✓	✓	NOL-3	~~0645~~ 6-2-06	Marie	6-2-06 1300	✓
E-600 # 5140 SPA-3 # 61035	✓	✓	✓	Area 1	6-2-05 0650	Moyer	6-2-06 1300	✓
E600 # 2620 SPA3 # 726557	✓	✓	✓	~~YARD~~ SEPTIC LEACH FIELD	6-2-06 / 07:05	MAXWELL	06-02-06 0857	✓

RP Supervisor Review ~~[signature]~~ [1]

(1) If any post-use source check failures occur, ensure that the condition is documented by a Condition Report.

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Rev. 17

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PORTABLE/GAMMA F[illegible] [illegible] SOURCE CHECK FORM

E-600	SPA-3	2056	277	181748	272622
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
5-10-06	1125	SAT	N/A	5010	228000	222990	ws	5-10-06	1725	SAT	N/A	4550	229000	224450	ws
5-11-06	0600	SAT	N/A	5710	228000	222290	ws	5-11-06	1715	SAT	N/A	5880	228000	222120	ws
5-15-06	0920	SAT	N/A	4620	227000	222380	ws	5-15-06	1635	SAT	N/A	4440	228000	223560	ws
5-19-6	0630	SAT	NA	5480	226000	220520	cjc	5-19-6	1410	SAT	NA	5150	247000	241850	cjc
5-22-6	0730	SAT	NA	4110	226000	221890	cjc	—							*
5-23-06	0550	SAT	N/A	4560	225000	220440	ws	—							*
5-24-06	0540	SAT	N/A	4590	224000	219410	ws	5-24-06	1055	SAT	N/A	5100	226000	220900	ws
5-24-06	1055	SAT	N/A	5100	226000	220900	ws	5-24-6	1700	SAT	NA	5090	226000	220910	cjc
5-25-06	0840	SAT	N/A	3600	225000	219400	ws	—							*
5-30-06	0540	SAT	N/A	5370	226000	220630	ws	5-30-6	1700	SAT	NA	5400	225000	219600	cjc
5-31-06	0545	SAT	N/A	4520	225000	220480	ws	—							*
6-1-06	0550	SAT	N/A	5890	226000	220110	ws	6-1-6	1700	SAT	NA	5670	226000	220330	cjc
6-2-06	0540	SAT	N/A	5260	227000	221740	ws	6-2-6	14:30	SAT	NA	4950	227000	222050	cjc
6-7-06	0540	SAT	N/A	5990	226000	220010	ws	6-7-06	1515	SAT	N/A	4800	224000	219200	ws
6-8-06	0550	SAT	N/A	5210	225000	219790	ws	6-8-6	1630	SAT	NA	4120	224000	219880	cjc

RP Supervisor Review: Barbara Erickson [1]   * Not used

[1] If any post-use source check failures occur, ensure that the condition is documented by a Condition Report.

DPF-8504.5
Rev. 17

COPY

PORTABLE/GAMMA FRIS. & SOURCE CHECK FORM

E-600	SPA-3	70052	277	191000	287000
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
5-15-06	0540	SAT	N/A	5910	239000	233090	[illegible]	5-15-6	13:10	SAT	NA	5350	241000	235650	CJC
5-15-6	13:10	SAT	NA	5350	241000	235650	cjc								*
5-16-06	0545	SAT	N/A	5440	239000	233560	[illegible]								*
5-17-06	0540	SAT	N/A	4650	238000	233350	[illegible]								*
5-18-06	0545	SAT	N/A	4970	238000	233030	[illegible]	5-18-6	15:10	SAT	NA	5540	236000	230460	CJC
5-19-06	0545	SAT	N/A	4610	240000	235390	[illegible]								*
5-21-06	1240	SAT	N/A	5520	238000	232480	[illegible]								*
5-22-06	0745	SAT	N/A	4800	234000	229200	[illegible]	5-22-6	1540	SAT	NA	5200	239000	233800	CJC
5-23-06	0550	SAT	N/A	4730	237000	232270	[illegible]								*
5-24-06	0540	SAT	N/A	5240	238000	232760	[illegible]	5-24-6	1650	SAT	NA	5380	239000	233620	CJC
5-25-06	0540	SAT	N/A	4890	239000	234110	[illegible]	5-25-6	12:00	SAT	NA	6100	239000	232900	CJC
5-30-06	0540	SAT	N/A	5540	241000	235460	[illegible]	5-30-6	1600	SAT	NA	5200	243000	237800	CJC
5-31-06	0545	SAT	N/A	5160	238000	232840	[illegible]	5-31-6	1640	SAT	NA	4010	238000	233990	CJC
6-1-06	0550	SAT	N/A	5020	239000	233980	[illegible]	6-1-6	1630	SAT	NA	5010	236000	230990	CJC
6-2-06	0540	SAT	N/A	5150	238000	232850	[illegible]	6-2-6	1425	SAT	NA	5210	241000	235790	CJC

RP Supervisor Review: Barbara Erickson [(1)]

* NOT USED

(1) If any post-use source check failures occur, ensure that the condition is documented by a Condition Report.

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COPY

Daily Survey Journal

Survey Area Unit No.: NOL-04-01 / NOL-05-01			Survey Date: 06/15/06
Survey Plan #: YNPS-FSSP-NOL-04-01-00 and YNPS-FSSP-NOL-05-01-00			
Supervisor: Neel / Sprucinski Crew: S. Pennock			
Instruments:			
Model:	ISOCS (Blue)	E-600 / SPA-3	
Serial #:	6279		
Cal. Due.	03/07		
Pre-op source ✓:	Sat. ☐	Sat. ☐	
Post-op source ✓:	Sat. ☐ Date:	Sat. ☐ Date:	Sat. ☐ Date:

TIME	NOTES FOR SURVEY DATE
0700	Conducted daily safety briefing and POD for FSS activities.
0815	Excavation of soil above geo-tech fabric in NOL-04-01 commenced IAW dig
	plan. No equipment available to load into so soil is being piled for now.
0930	For equipment accessibility the excavation hole near ISOCS shots 109 and 110
	is being backfilled with the stockpiled dirt temporarily.
1015	Blue rover is being set up in NOL-05-01 remediation area to obtain investigation
	scan of the area.
1145	Excavation of geo-tech fabric in NOL 04-01 complete. Stock pile of dirt remains
	in place until nightshift. Activities halted for now.

Completed by [signature] FSS Field Supervisor Date 06-15-2006

Reviewed by [signature] FSS Radiological Engineer Date 7/19/06

Daily Survey Journal

Page 1 of

Survey Area No.: NOL-04	Survey Area Name:	Survey Date: 6/15/06
Survey Unit No. and Name: NOL-04-01		

Supervisor: Dwayne Neel
Jack Sprucinski

Crew: Mike Maxwell
Mike Sweet
Steve Pennock

Instruments: ISOCS ISOCS ISOCS

CDD

Pre-op source Sat. ☒ Pre-op source Sat. ☒ Pre-op source Sat. ☒
Post-op source Sat. ☐ Date Post-op source Sat. ☐ Date Post-op source Sat. ☐ Date

TIME	NOTES FOR SURVEY DATE
1100	Area cleaned up and all marafie was removed from area
1230	Shot locations inputed with the gps pole and locations delivered to eng. To develop a sampling plan
1500	Have sample plan for NOL-04 area to be used 6/16/06

Completed by ______________________ Date 6/15/06
FSS Field Supervisor

Reviewed by ______________________ Date 7/19/06
FSS Radiological Engineer

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Daily Survey Journal

Survey Area Unit No.: NOL-04-01			Survey Date: 6/16/06
Survey Plan #: YNPS-FSSP-NOL-04-01			
Supervisor: Jack Sprucinski		Crew: Mike Sweet, Dennis Walker	
Instruments:			
Model:	ISOCS Blue	ISOCS	ISOCS
Serial #:	6279		
Cal. Due.	3/07		
Pre-op source [:	Sat. ☐	Sat. ☐	Sat. ☐
Post-op source [:	Sat. ☐ Date:	Sat. ☐ Date:	Sat. ☐ Date:

TIME	NOTES FOR SURVEY DATE
0715	Established the eight shot locations for the ISOCS after the removal of the landscape fabric. # NOL-04-01-218-F-G THROUGH NOL-04-01-225-F-G
0818	Initiated the final shots for the area
1050	Final shots completed for the remediation of NOL-04-01, Blue ISOCS moved to the NOL-09-02 area.
LATE ENTRY	
6-19-06	#NOL-04-01-219-F-G MIS LABELED AS NOL-04-01-214-F-G
	REQUEST FORM FILLED OUT TO CHANGE NAME

Completed by ______________________ Date ____________
FSS Field Supervisor

Reviewed by ______________________ Date ____________
FSS Radiological Engineer

Daily Survey Journal

Survey Area Unit No.: NOL-04-01			Survey Date: 06/19/06
Survey Plan #: YNPS-FSSP-OOL-04-01-00			
Supervisor: Dockins Crew: D. Payeur			
Instruments:			
Model:			
Serial #:			
Cal. Due.			
Pre-op source check :	Sat. ☐	Sat. ☐	Sat. ☐
Pre-op source check :	Sat. ☐ Date:	Sat. ☐ Date:	Sat. ☐ Date:

TIME	NOTES FOR SURVEY DATE
1930	Received instruction from D. Neel that sample number NOL-04-01-009-F
	needed to be re-sampled due to the geo-tech fabric removal in the survey unit.
2000	Conducted safety briefing and gave instruction for work activities to crew.
2100	Soil sample collected at 2040 by D.P. Sample given # NOL-04-01-026-F.

Completed by [signature] Date 06-19-2006
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

Daily Survey Journal

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Survey Area No.: NOL-04 &05	Survey Area Name:	Survey Date: 6/13/06
Survey Unit No. and Name: NOL - 04 & 05		

Supervisor: Dwayne Neel
Jack Sprucinski

Crew: Mike Maxwell
Mike Sweet
Steve Pennock
Sharon Erickson
Jimmy White

Instruments: ISOCS ISOCS ISOCS

CDD

Pre-op source Sat. ☒ Pre-op source Sat. ☒ Pre-op source Sat. ☒
Post-op source Sat. ☐ Date Post-op source Sat. ☐ Date Post-op source Sat. ☐ Date

TIME	NOTES FOR SURVEY DATE
0830	Notified Bruce Joejoe will need to pump out water from the tank basin before we start to remove the soil and maraphie. *
1300	Work in these areas will not be completed today due to the equipment needed being in use else where. Will continue on 6/14/06
LATE ENTRY 0800	* MARAPHIE (GEOTECH FABRIC) WAS IDENTIFIED AFTER SEVERAL
	RAIN EVENTS EXPOSED IT IN THE SOUTHERN SECTION OF THE SURVEY
	UNIT. FSS ENGENEERS DIRECTED THE REMOVAL OF SOILS ABOVE
	THE FABRIC.

Completed by [signature] Date 6/13/06
FSS Field Supervisor

Reviewed by [signature] Date 7/19/06
FSS Radiological Engineer

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