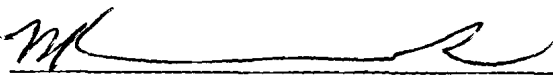
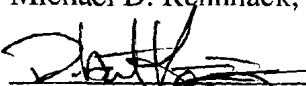


**YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT**

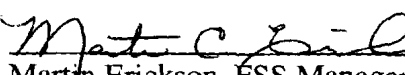
REPORT NO.: YNPS-FSS-OOL-16-00

Prepared by: 
Michael D. Rennhack, FSS Radiological Engineer

Date: 9-13-06

Reviewed by: 
Robert Tozzie, FSS Radiological Engineer

Date: 9/13/06

Approved by: 
Martin Erickson, FSS Manager

Date: 9/13/06

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- Appendix C – ALARA Evaluations, OOL-16

List of Attachments

- Attachment A – Maps and Posting Plots
- Attachment B – Data Quality Assessment Plots and Curves
- Attachment C – Instrument QC Records
- Attachment D – ORTEC Direct Measurement Data

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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 _o	Null Hypothesis
HSA	Historical Site Assessment
HTD	Hard-to-Detect
ISOCS	<i>In-situ</i> 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 OOL-16 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

Survey Unit OOL-16 consists of a single unit, OOL-16-01, known as the Furlon House Lot, approximately 2,342.4 m² of surface area. Survey Unit OOL-16-01 is entirely bounded by non-impacted YAEC-owned property. The only subsurface structure that traverses or connects within OOL-16-01 is the sanitary sewer system that services the Furlon House. Survey Unit OOL-16-01 contains soil that was excavated during the construction activities of the YNPS site. Because site excavated soils were deposited, low levels of radioactivity may minimally impact this area. OOL-16-01 was never part of the RCA, did not contain any radioactive systems and no decommissioning activities were performed in this area; therefore it meets the criteria for a Class 3 survey unit.

1.2 Dates(s) of Survey

Table 1 Date of Surveys

Survey Unit	Survey Start Date	Survey End Date	DQA Date
OOL-16-01	7/13/2006	7/25/2006	7/27/2006

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, hand-held survey instrument scans were performed over 80 m² 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_0) (that the Survey Unit exceeds the release criteria) is rejected.

1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, OOL-16 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

Survey Area OOL-16 consists of a single unit, OOL-16-01, known as the Furlon House Lot, approximately 2,342.4 m² of surface area. Survey Unit OOL-16-01 is entirely bounded by non-impacted YAEC-owned property. The only subsurface structure that traverses or connects within OOL-16-01 is the sanitary sewer system that services the Furlon House.

3.2 History of Survey Area

Survey Unit OOL-16-01 contains soil that was excavated during the construction activities of the YNPS site. Because site excavated soils were deposited, low levels of radioactivity may minimally impact this area. OOL-16-01 was never part of the RCA, did not contain any radioactive systems and no decommissioning activities were performed in this area, however some roll off containers were staged in this area.

3.3 Division of Survey Area into Survey Units

OOL-16 has a single Survey Unit, OOL-16-01 which is a Class 3 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

The final status survey of OOL-16-01 was performed between the dates of 7-13-06 and 7-25-06.

4.1.2 Radionuclide Selection and Basis

During the initial DQO process, Cs-137 was identified as the radiological nuclide of concern. Characterization survey data indicated no other LTP-specified radionuclides warrant consideration in the OOL-16 Survey Area, however, the soil samples for this Survey Area were evaluated for all LTP listed nuclides.

4.1.3 Scoping & Characterization

The characterization data in the HSA was not sufficient to support FSS planning. Two characterization soil samples were collected from this Survey Unit. The results were consistent with historical use information in that no plant-related radionuclide was identified in either sample. Survey Unit OOL-18-01, the Monroe Hill Lot, was utilized in the same manner as OOL-16-01, as a staging area for shipments. 13 additional characterization samples were collected from OOL-18-01 to support this FSS. All FSS soil samples collected in OOL-16 were analyzed for the LTP-listed gamma-emitting radionuclides, and 5% of the FSS soil samples were sent to an independent laboratory for complete analyses (HTD nuclides and TRUs).

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 OOL-16 is identified as a Class 3 Area.

4.3 Remedial Actions and Further Investigations

No remedial actions or investigations were performed.

4.4 Unique Features of Survey Area

Survey Area OOL-16 has no unique features; it is an open land area containing soils.

4.5 ALARA Practices and Evaluations

An ALARA evaluation was developed for OOL-16-01 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 OOL-16 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 OOL-16 Design Parameters

Survey Unit	Design Parameter	Value	Basis
OOL-16-01	Survey Unit Area	2342 m ²	Class 3, Soil, no restrictions
	Number of Direct Measurements	15 (calculated) + 5 (added) Total: 20	α (Type I) = 0.05 β (Type II) = 0.05 σ : 0.0327 Relative Shift: 2 DCGLw: 3 LBGR: 2.9346
	Critical Value	14 for Sign test.	$(20/2) + (1.645/2) * \text{Square Root}(20)$
	Gridded Sample Area Size Factor	Class 3: N/A	No grid in Class 3 area
	Sample Grid Spacing:	No Grid	No grid in Class 3 area, random locations
	Direct Measurement Investigation Level	> 50% DCGLw	Class 3 Area: > 50% DCGLw
	Scanning Coverage Requirements	Judgmental	Class 3 Soil Area: Judgmental
	Scan Investigation Level	> Background	Class 3 Area: Detectable over background

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 OOL-16 Survey Area and throughout this report, the administrative acceptance criterion of 8.73 mRem/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, no biased, 1 recount, and 2 split samples were also collected.

The direct measurement sampling locations were selected with a random pattern and a random starting point. Sample measurement locations are provided in Attachment A.

5.2 Survey Implementation Activities

The Table below provides a summary of daily activities performed during the Final Status Survey of Survey Units in OOL-16.

Table 4 FSS Activity Summary for OOL-16 Survey Units

Survey Unit	Date	Activity
OOL-16-01	5-22-06	Performed walk-down of Survey Unit
	7-13-06	Established Isolation and Controls
	7-13-06	Performed Job Hazard Analysis
	7-13-06	Performed Unit Classification
	7-13-06	Performed Sample Quantity Calculations, established DQOs
	7-13-06	Generated FFS Sample Plans
	7-13-06 to 7-25-06	Initiated Scans, and Direct measurements.
	7-27-06	Performed DQA, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area OOL-16, the Survey Unit was placed into the program for periodic surveillance surveys on a quarterly basis in accordance with YNPS procedure DP-8860, "*Area Surveillance Following Final Status Survey.*" These surveys provide assurance that areas with successful FSS remain unchanged until license termination.

5.3.2 Resurveys

No resurvey was performed.

5.3.3 Investigations

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

5.4 Survey Results

Direct measurement surveys indicated that OOL-16-01 had no 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_0) (that the Survey Units exceeds the release criteria) is rejected.

Table 5 Direct Measurement Summary

Sample Description	Activity (SOF)
OOL-16-01-001-F	5.14E-02
OOL-16-01-002-F	6.74E-02
OOL-16-01-003-F	7.56E-02
OOL-16-01-004-F	5.84E-02
OOL-16-01-005-F	3.82E-02
OOL-16-01-006-F	3.67E-02
OOL-16-01-007-F	2.43E-02
OOL-16-01-008-F	3.07E-02
OOL-16-01-009-F	4.65E-02
OOL-16-01-010-F	2.81E-02
OOL-16-01-011-F	8.71E-02
OOL-16-01-012-F	1.67E-02
OOL-16-01-013-F	4.65E-02
OOL-16-01-014-F	4.01E-02
OOL-16-01-015-F	3.89E-02
OOL-16-01-016-F	1.15E-01
OOL-16-01-017-F	5.02E-02
OOL-16-01-018-F	4.17E-02
OOL-16-01-019-F	3.56E-02
OOL-16-01-020-F	5.02E-02

Maximum Sum of Fractions	1.15E-01
Standard Deviation	2.31E-02

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.

A data set review was performed on OOL-16-01. The data range was within three standard deviations and exhibited a normal variance about the arithmetic mean. The

frequency plot exhibited a Poisson distribution with the exception of one data point skewed slightly high; however this data point was a small fraction of the DCGLw and a review of the posting plot did not clearly reveal any systematic spatial trends. The quantile plot displayed some asymmetry in the lower quartile due to the number of lower values present. The power function, shown by the retrospective power curve, was adequate to pass the FSS of the Survey Unit and the retrospective standard deviation was approximately equal the prospective standard deviation. The data set verified the assumptions of the statistical test.

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*".

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 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 performed in accordance with DP-8540, "*Operation and Source Checks of Portable Friskers*." Instrument response checks were performed prior to and after use for the E-600 w/SPA-3. All instrumentation involved with the FSS of OOL-16 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 OOL-16.

7.0 CONCLUSION

The FSS of OOL-16 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_0) is rejected.

OOL-16 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, OOL-16 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.

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