YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT

REPORT NO.: YNPS-FSS-OOL-18-00

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Section **Table of Contents** Page

1.0 EXECUTIVE SUMMARY 1

1.1 IDENTIFICATION OF SURVEY AREA AND UNIT 1
1.2 DATES OF SURVEYS 1
1.3 NUMBER AND TYPES OF MEASUREMENTS COLLECTED 1
1.4 SUMMARY OF SURVEY RESULTS 2
1.5 CONCLUSIONS 2

2.0 FSS PROGRAM OVERVIEW 2

2.1 SURVEY PLANNING 2
2.2 SURVEY DESIGN 2
2.3 SURVEY IMPLEMENTATION 3
2.4 SURVEY DATA ASSESSMENT 3
2.5 QUALITY ASSURANCE AND QUALITY CONTROL MEASURES 3

3.0 SURVEY AREA INFORMATION 4

3.1 SURVEY AREA DESCRIPTION 4
3.2 HISTORY OF SURVEY AREA 4
3.3 DIVISION OF SURVEY AREA INTO SURVEY UNITS 4

4.0 SURVEY UNIT INFORMATION 4

4.1 SUMMARY OF RADIOLOGICAL DATA SINCE HISTORICAL SITE ASSESSMENT (HSA) 4
4.1.1 Chronology and Description of Surveys Since HSA 4
4.1.2 Radionuclide Selection and Basis 5
4.1.3 Scoping & Characterization 5
4.2 BASIS FOR CLASSIFICATION 5
4.3 REMEDIAL ACTIONS AND FURTHER INVESTIGATIONS 5
4.4 UNIQUE FEATURES OF SURVEY AREA 5
4.5 ALARA PRACTICES AND EVALUATIONS 5

5.0 SURVEY UNIT FINAL STATUS SURVEY 5

5.1 SURVEY PLANNING 5
5.1.1 Final Status Survey Plan and Associated DQOs 5
5.1.2 Deviations from the FSS Plan as Written in the LTP 6
5.1.3 DCGL Selection and Use 6
5.1.4 Measurements 7
5.2 SURVEY IMPLEMENTATION ACTIVITIES 7
5.3 SURVEILLANCE SURVEYS 8
5.3.1 Periodic Surveillance Surveys 8
5.3.2 Resurveys 8
5.3.3 Investigations 8
5.4 SURVEY RESULTS 8
5.5 DATA QUALITY ASSESSMENT 9

6.0 QUALITY ASSURANCE AND QUALITY CONTROL 10

6.1 INSTRUMENT QC CHECKS 10
6.2 SPLIT SAMPLES AND RECOUNTS 10
6.3 SELF-ASSESSMENTS 10

7.0 CONCLUSION 10

Table List of Tables Page

TABLE 1 DATE OF SURVEYS AND DQOS 1
TABLE 2 DATES OF SURVEYS SINCE HSA 4
TABLE 3 SURVEY AREA OOL-18 DESIGN PARAMETERS 6
TABLE 4 SOIL DCGL VALUES 7
TABLE 5 FSS ACTIVITY SUMMARY FOR OOL-18 7
TABLE 6 SOIL SAMPLE SUMMARY 8

List of Appendices

Appendix A – YNPS-FSSP-OOL-18, *"Final Status Survey Planning Worksheets"*

Appendix B – YA-REPT-00-015-04, "*Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at Yankee Rowe"*

Appendix C – YA-REPT-00-003-05, "*Generic ALARA Review for Final Status Survey of Soil at YNPS*"

Appendix D – ALARA Evaluations, OOL-18

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

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

List of Abbreviations and Acronyms

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

1.0 EXECUTIVE SUMMARY

A Final Status Survey (FSS) was performed of Survey Area OOL-18 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 Unit

Survey Area OOL-18 consists of the surface area of an open lot comprised of packed soil and constitutes approximately 3,942 square meters. There are no sub-surface systems that traverse or connect within OOL-18. Only one survey unit, Survey Unit OOL-18-01, has been established for OOL-18. The land area is located in the non-RCA portion of the site and has been used for temporary storage of roll-off containers. Based upon the radiological condition of this survey area as a result of the decommissioning activities performed to date, Survey Area OOL-18-01 is designated a Class 2 Area.

A map of the Survey Area and Survey Unit in relation to the site is found in Attachment A.

1.2 Dates of Surveys

Table 1 Date of Surveys and DQOs

Survey Unit	Survey Start Date	Survey End Date	DQA Date
OOL-18-01	6/30/2006	6/30/2006	10/24/2006

1.3 Number and Types of Measurements Collected

A Final Status Survey Plan 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 statistical soil samples were taken in the Survey Area, providing data for the non-parametric testing of the Survey Area. In addition to the soil samples, 50% of the area was scanned with a SPA-3.

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. Soil sample surveys indicated that none of the systematic measurements exceeded the $DCGL_W$, depicted in Attachment B. A retrospective power curve was generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, OOL-18 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 per year, 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 per year 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 Area 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 Area, 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 Area must be identified, and the Survey Unit classified. Survey Unit 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 soil 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 soil 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-18 consists of a single Survey Unit, OOL-18-01. OOL-18-01 is a Class 2 Survey Unit consisting of an open land area situated adjacent to the Monroe hill road at the "hair-pin" turn. It comprises approximately 3,942 m2.

A map of the Survey Area is found in Attachment A.

3.2 History of Survey Area

Survey Area OOL-18 consists of the surface area of an open lot comprised of packed soil and constitutes approximately 3,942 square meters. Previous Historical Site Assessment data did not include this portion of the site, and it was not part of the original scope of impacted land areas. The decision was made to use the Monroe Hill Lot for temporary storage and staging of roll-offs containing plant-related low-level waste, creating an impacted area where one was not anticipated. There are no sub-surface systems that traverse or connect within OOL-18 and the area was never a part of the RCA. Based upon the contamination potential resulting from the storage of the roll-off containers, Survey Area OOL-18 is designated a Class 2 Area.

3.3 Division of Survey Area into Survey Units

Survey Area OOL-18 consists of a single Survey Unit, OOL-18-01.

A map of the Survey Area is found in Attachment A.

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 Table below provides a summary of surveys performed during the Final Status Survey of OOL-18.

Table 2 Dates of Surveys since HSA

Survey Unit	Survey Start Date	Survey End Date	Description
OOL-18-01	6/30/2006	6/30/2006	FSS Survey

4.1.2 Radionuclide Selection and Basis

Characterization sampling resulted in three positive measurements for Cs^{137} and all results <MDA for Co^{60}. All other plant-related radionuclides were <MDA. However, soil samples were evaluated for all LTP listed nuclides.

4.1.3 Scoping & Characterization

Characterization data for OOL-18-01 was collected on 6/5/06 in the form of surface soil samples. A total of 13 soil samples were taken, resulting in three positive measurements for Cs^{137} and all results <MDA for Co^{60}. All other plant-related radionuclides were <MDA.

4.2 Basis for Classification

Based upon the decommissioning activities performed to date, Survey Unit OOL-18-01 was identified as a Class 2 area.

4.3 Remedial Actions and Further Investigations

No remedial actions or investigations were required in Survey Area OOL-18.

4.4 Unique Features of Survey Area

Survey Unit OOL-18-01 was an open land survey area.

4.5 ALARA Practices and Evaluations

The generic ALARA evaluation for soils is documented in Appendix C, Technical Report YA-REPT-00-003-05, "Generic ALARA Review for Final Status Survey of Soil at YNPS". The report is augmented by individual evaluations which are found in Appendix D, which concludes that no further remediation of soil below the DCGL is warranted.

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-18 Survey Area 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 Plans. The FSS Plans 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 3 Survey Area OOL-18 Design Parameters

Survey Unit	Design Parameter	Value	Basis
OOL-18-01	Survey Unit Area	3942 m2	Class 2, Soil, > 2,000 m2, ≤ 10,000 m2
	Number of Direct Measurements	15 (calculated) + 5 (added) Total: 20	α (Type I) = 0.05 β (Type II) = 0.05 σ: 0.0349 Relative Shift: 2 DCGLw: 3 (Cs-137) LBGR: 2.93 (adjusted)
	Gridded Sample Area Size Factor	197.1m2	Area / Number of Samples (3942 m2/20)
	Sample Grid Spacing:	Triangular: 15.1m	Square Root (3942 m2/(0.866*20))
	Direct Measurement Investigation Level	> DCGLw	Class 2 Area: > DCGLw
	Scanning Coverage Requirements	394.2 m2	Class 2 Soil Area: 10-100% systematic & judgmental
	Scan Investigation Level	> Background Audible	Class 2 Area: > DCGLw or > MDC

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-18 Survey Area and throughout this report, the administrative acceptance criterion of 8.73 mRem per year has been set for Soil LTP-listed radionuclides.

Table 4 Soil DCGL Values

Nuclide	Soil 8.73 mr per year (pCi/g)	Nuclide	Soil 8.73 mr per year (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 statistical measurements. The quantity of statistical measurements collected for each unit is listed above in the table titled "Survey Area OOL-18 Design Parameters". Split samples and recounts are addressed under the quality control section 6.2. The OOL-18-01 soil 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.

Approximately 50% of OOL-18-01 was scanned with SPA-3 with no areas of elevated activity being identified.

5.2 Survey Implementation Activities

The Table below provides a summary of daily activities performed during the Final Status Survey of OOL-18.

Table 5 FSS Activity Summary for OOL-18

Survey Unit	Date	Activity
OOL-18-01	6/30/2006	Performed walk-down of Survey Unit
	6/21/2006	Established Isolation and Controls
	6/21/2006	Performed Job Hazard Analysis
	6/19/2006	Performed Unit Classification
	6/21/2006	Performed Sample Quantity Calculations, established DQOs
	6/27/2006	Generated FFS Sample Plans
	6/30/2006	Performed Scans, and Direct measurements.
	10/24/2006	Performed DQA, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area OOL-18, the Survey Area 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 resurveys were performed in OOL-18.

5.3.3 Investigations

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

5.4 Survey Results

Soil sample surveys indicated that OOL-18 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 Unit exceeds the release criteria) is rejected.

Table 6 Soil Sample Summary

Sample Description	SOF
OOL-18-01-001-F	0.02
OOL-18-01-002-F	0.03
OOL-18-01-003-F	0.11
OOL-18-01-004-F	0.02
OOL-18-01-005-F	0.10
OOL-18-01-006-F	0.03
OOL-18-01-007-F	0.05
OOL-18-01-008-F	0.06
OOL-18-01-009-F	0.04
OOL-18-01-010-F	0.04
OOL-18-01-011-F	0.04
OOL-18-01-012-F	0.03
OOL-18-01-013-F	0.03
OOL-18-01-014-F	0.03
OOL-18-01-015-F	0.03

Sample Description	SOF
OOL-18-01-016-F	0.06
OOL-18-01-017-F	0.04
OOL-18-01-018-F	0.04
OOL-18-01-019-F	0.12
OOL-18-01-020-F	0.09
Max	0.12
Average	0.05
Standard Deviation	0.03

SPA-3s were used for scan survey of OOL-18-01. No areas were identified for investigation (i.e. no audible indications above background were observed). No elevated areas, attributed to plant related activity, exist in OOL-18 (i.e. no audible indication above background) evidenced by SPA-3 scan.

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.

All fixed point sample concentrations were below the DCGLw and the sum-of-fractions for the samples were less than one. No elevated were identified in the Survey Unit. HTD sample results were <DCGLw. The data set was within approximately three standard deviations with normal dispersion about the arithmetic mean. The frequency plot is somewhat bimodal as witnessed in the scatter and quantile plot graphical representations. However, since the data set is a very small percent of unity and the retrospective sigma is approximately equal to the perspective sigma there is no reason to believe that biases have been introduced adversely affecting the verification of the statistical test assumptions. The data posting plot does not clearly reveal any systematic spatial trends. The survey maintained sufficient power to pass the unit and 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 preformed in accordance with DP-8540, "*Operation and Source Checks of Portable Friskers.*" Instrument response checks were performed prior to and after use for the E-600 w/SPA-3. All instrumentation involved with the FSS of OOL-18 satisfied the above criteria for the survey. QC records are found in Attachment C.

6.2 Split Samples and Recounts

Two split and two recount '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-18.

7.0 CONCLUSION

The FSS of OOL-18 has been performed in accordance with YNPS LTP and applicable FSS procedures. Evaluation of the soil sample data has shown none of the systematic soil samples 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.

OOL-18 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, OOL-18 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 per year, 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 per year limit will also be met.

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