Safety Evaluation Report
Nuclear Fuel Services, Inc. North Site
Final Status Survey Report
Subsurface Soil Characterization and Final Status Survey Project,
Survey Units 2, 8, 9, 19, and 20

1. Introduction

By letter dated May 24, 2010, Nuclear Fuel Services, Inc, (NFS) submitted the Final Status Survey (FSS) Report for Survey Units 2, 8, 9, 19, and 20 of the subsurface soil characterization and FSS Project of the NFS North Site Area. NFS requested confirmation that these survey units are suitable for unrestricted release in accordance with 10 CFR Part 20, Subpart E.

2. Background

The NFS North Site Decommissioning Plan (DP) was approved in Amendment 27 to Materials License SNM-124, dated June 19, 2001, and supplemented by information provided to satisfy Safety Condition S-47. One product of the DP was a FSS, to be performed after an area has been fully characterized and remediation has been completed.

The FSS design is an iterative process that requires appropriate site classification based on the potential radionuclide concentration levels relative to the derived concentration guideline levels (DCGLs), and incorporates a process to ensure the quality of the data obtained. In Amendment 69 to Materials License SNM-124, dated February 15, 2006, the U.S. Nuclear Regulatory Commission (NRC) approved a revised method to derive subsurface (greater than 15 cm below the ground surface) soil DCGLs and a method to perform subsurface FSSs. These DCGLs were derived to demonstrate compliance with the 25 mrem/year dose criterion for unrestricted release of the area in accordance with Title 10 of the Code of Federal Regulation (10 CFR) Part 20, Subpart E.

In the approval of Amendment 69, the NRC Staff (Staff) concluded that the subsurface FSS Plan, as described in the revised Appendix B to Chapter 5 of the DP (dated December 14, 2005) was adequate to perform FSS for subsurface soils in the North Site area for demonstrating compliance with the radiological criteria for license termination.

The Staff reviewed the FSS Report for survey units 2, 8, 9, 19, and 20, submitted May 24, 2010, by NFS. Direct comparison of a single survey unit, out of many units that cover the North Site Area, to the unrestricted use criteria of Subpart E is generally inappropriate.

The Staff had correspondence and discussions with the licensee to clearly understand and document the FSS:

- Original survey unit final status survey reports (Ref. 1)
- RAIs (Ref. 2)
- NFS response (Ref. 3)
- NRC/NFS teleconference on March 31, 2011
- NRC evaluation (Ref. 4)
- NFS supplemental information (Ref. 5)
- NFS response (Ref. 6)
- NRC/NFS conference call July 20, 2012, to discuss NRC evaluation (Ref. 7)

- NRC/NFS meeting September 11, 2012 (Ref. 8)
- NFS supplemental information (Ref. 9)
- NRC/NFS conference call December 6, 2012 for clarifications (Ref. 10)
- NRC clarification regarding information needed, dated January 11, 2013 (Ref. 11)
- NRC/NFS conference call February 15, 2013, for clarifications (Ref. 12)
- NFS supplemental information (Ref. 13)

3. Scope of the Staff Evaluation

While the focus of Amendment 69 was the methods for performing the subsurface FSS, the NFS DP provides plans for both surface soil and subsurface soil FSSs. The licensee's FSS Plan is provided in the North Site DP, Revision 3, which was submitted to the Staff May 2, 2006, and approved by letter from NRC dated May 18, 2006. The surface soils FSS Plan is documented in Chapter 5 of the DP; the subsurface FSS Plan is documented in Appendix B. While the original FSS Report for Survey Units 2, 8, 9, 19, and 20 (from 2010) did not address surface soil FSSs, the revision to the FSS Report (Enclosure 3 to March 25, 2013, NFS letter) includes an Addendum that addresses surface soils for Survey Unit 2. However, NFS initially was addressing surface soils separately (see NFS submittal dated August 16, 2011) and the Staff is completing the review of the surface soils FSSs separately. Therefore, this Staff evaluation addresses only the subsurface soils FSSs. If evaluation of contamination of other media is needed prior to partial site release, that must be done separately.

4. Subsurface Final Status Survey Results

4.1. Survey Unit Demarcation

4.1.1. Evaluation

The DP discusses survey unit demarcation in Section 2.7 of Chapter 5, Appendix B. NFS states that survey units are laterally demarcated using the same concepts and criteria described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Section 4.6 of the MARSSIM (NRC, 2000) discusses identifying survey units. MARSSIM indicates that a goal is to distribute survey data points relatively uniformly among areas of similar contamination potential. MARSSIM recommends that sites be divided into survey units that share a common history or other characteristics, or are naturally distinguishable from other portions of the site. MARSSIM also suggests a maximum area for a Class 1 land survey unit of 2000 m^2.

The Staff reviewed the licensee's demarcation of the survey units. Section 2.3 of the FSS Report describes the process NFS used to demarcate survey units; here, the licensee indicates that historical knowledge and the historical sampling data were considered in the demarcation. Sections 2.6 through 2.10 of the FSS Report describe the survey units, which description is summarized as follows:

- Survey Unit 2 was a Radiological Burial Grounds (RBG) area. No remediation activities were performed. Little potential for additional remediation, based on historical sampling results.

- Survey Unit 8 was a RBG area. No remediation activities were performed. Little potential for additional remediation, based on historical sampling results.

- Survey Unit 9 was a RBG area. Excavation was done as remediation activities. Little potential for additional remediation, based on historical sampling results.

- Survey Unit 19 was a former effluent ponds area, and includes a protected wetlands area that was not remediated. Remediation, in the form or excavation, was done on part of the survey unit. Little potential for additional remediation.

- Survey Unit 20 was an effluent ponds area. Excavation was done as remediation activities. Additional remediation, based on historical sampling results, may be necessary.

Based on the MARSSIM guidance, it initially appeared to Staff that Survey Unit 19 should be divided into multiple survey units, based on the following. Section 2.9 of the FSSR describes Survey Unit 19 as having areas that seem to Staff to have different histories and/or are naturally distinct: (i) elevated concentrations may still be present in the far northwest corner and in a small area to the west-northwest in the survey unit; (ii) the west half of Survey Unit 19 is an area that was part of the evaporation pond and was remediated (excavated); and (iii) the east half of Survey Unit 19 encompasses a small protected wetlands area, which was not remediated and for which historical data indicate no elevated radioactivity exists. To Staff, it initially appeared that these three areas would have different contamination potential, which is inconsistent with the MARSSIM concept that survey units should have a similar contamination potential.

The Staff requested additional information from NFS (in the RAI of November 15, 2010) on this issue of demarcation of Survey Unit 19. NFS provided a response (dated February 18, 2011). In the response, NFS states its beliefs that: (i) an areal size limitation for survey units is inappropriate for the subsurface characterization work; (ii) NFS was following its *Characterization Plan for Security Zone, Burial Ground and Pond Areas* (2007, provided as Enclosure 2 to October 8, 2012, NFS letter, package at ML122970097); (iii) the subsurface method provides economic incentives to not include small areas with elevated concentrations of radioactivity into a larger survey unit; and (iv) the data obtained in the FSS demonstrate that the demarcation was appropriate. This issue was also discussed in the meeting between Staff and NFS (and its contractor) staff. During the meeting (meeting summary documented in a September 25, 2012, e-mail, ADAMS ML12270A027), NFS stated (v) that the historical data showed similar concentrations and variance across the whole survey unit.

The Staff has reevaluated this concern. The Staff agrees with NFS' point (i) that an areal limitation is inappropriate. The Staff has not reviewed and approved the 2007 Characterization Plan. Thus, the fact that NFS followed that plan is not persuasive. Thus, the Staff disagrees with point (ii). The Staff believes that in some ways the subsurface method actually could provide incentives for NFS to make a survey unit overly large, because a single large survey unit may result in fewer borehole locations than a number of (two or more) smaller survey units. So Staff disagrees with point (iii). Points (iv) and (v) are both related to the data (current and historical, respectively) for the survey unit. The Staff reviewed the historical data and the current data for Survey Unit 19.

Based on both sets of data, the Staff agrees that the data indicate similar concentration levels across Survey Unit 19. For Survey Unit 19, none of the concentrations from the historical or current data were high enough to indicate any compliance problem (none exceeded the *surface*

DCGL, which is the most restrictive DCGL). The data indicate no locally elevated areas of activity and there are no apparent spatial trends in radioactivity concentrations across the survey unit. NFS stated in the 2011 response to RAIs that concentrations of radioactivity in all regions of Survey Unit 19 are comparable to concentrations expected in non-impacted soils. The Staff concludes that, while there are indications of radioactivity due to facility operations in a small number of samples (i.e., impacted by operations), overall the levels of radioactivity do not appear statistically different from non-impacted soils. For this Survey Unit 19, the sampling density was determined only by requirements for sampling to demonstrate compliance with the wide area average statistical test (i.e., for the wide-area DCGL, or $DCGL_W$). There were no indications (in the historical or current data sets) to cause higher sample density to evaluate potential elevated areas. Based on this review of the historical and current data, it appears reasonable to Staff to have considered the contamination potential similar across all of Survey Unit 19.

4.1.2. Findings

The Staff finds that the licensee adequately demarcated the survey units.

The Staff finds that the existing demarcation of Survey Unit 19 is adequate and meets the plan in the DP.

4.2. Size of Survey Units

4.2.1. Evaluation

Based on considerations in the review of the FSSs for Survey Units 1, 3, and 10 (NRC letter dated June 15, 2010), the Staff concluded that the limitation of survey unit size is not necessary for the subsurface methodology.

4.2.2. Findings

The Staff finds that the survey unit sizes are adequate.

4.3. Determination of Number of Coreholes for Survey Unit

4.3.1. Evaluation

An important issue for the survey design for the subsurface FSS is the number of coreholes (boreholes) for each survey unit. The FSS Plan in the DP (Section 3.2 of Appendix B to Chapter 5) specifies that sum-of-fraction (SOF) values (which are sums of ratios of concentration to DCGL for all radionuclides) would be used in determining the number of coreholes based on the statistical test of the $DCGL_W$. For SUs 2, 8, 9, 19, and 20, NFS used the SOF values to determine the corehole density based on the statistical test of the $DCGL_w$.

The FSS Plan in the DP (Section 3.3 of Appendix B to Chapter 5) specifies the process for adjusting, or considering adjustment of, the corehole density to account for potential elevated volumes. The process involves evaluating existing data and determining reasonable maximum and expected maximum concentrations (90th percentile and maximum). As described in the FSS Report, Section 2.6.2.2, if the 90^{th} percentile concentration exceeds the $DCGL_W$, or if the maximum concentration exceeds 4 times the $DCGL_W$, then it is necessary to adjust the corehole

density. To make the adjustment, the reasonable and expected maximum concentrations are used to determine critical volumes, using "volume factor curves" derived from the dose assessment methods and limiting doses. The smallest critical volume is then used as a basis for (potentially) adjusted corehole density. For Survey Units 2 and 19, the reasonable maximum concentrations and expected maximum concentrations did not exceed the DCGLs or four times the DCGLs, respectively, so no adjustment to corehole density was necessary. For Survey Units 8 and 9, the reasonable maximum (90^{th} percentile) concentrations were high enough that adjustments to corehole density were necessary. The adjustments were made, resulting in higher density corehole spacing for the FSS.

However, for Survey Unit 20, it appeared initially to the Staff that the corehole density may not have been properly adjusted for the reasonable maximum concentration. The original FSS Report (2010), in Section 2.10 (second full paragraph on page 2-47), indicates that the "reasonable maximum concentration" calculation results in a maximum corehole density of 5.0 m^2 (meaning a maximum of 5.0 m^2 area per corehole). This would have resulted in 220 coreholes in Survey Unit 20. However, this was not done. The FSS Report continued, and (on page 2-47, third full paragraph) described that instead a sampling density of 50 m^2 was used, which results in a total of 22 coreholes, which appeared to be one-tenth the number called for by the DP process. A reference to the Characterization Plan, Section 4.3, was given. However, neither Section 4.3 of the Characterization Plan nor Section 2.10 of the FSS Report provided a technical basis for the proposed sampling density. Neither section demonstrated how the proposed sampling density is consistent with the process in the DP, which is the approved methodology.

Staff discussed this concern with NFS in the December 6, 2012, conference call and subsequent interactions. NFS discovered an error in their historical dataset that had initially resulted in incorrect depths being assigned to certain data points, which resulted in it appearing that certain sample data were still relevant to conditions after excavation when in reality the samples were no longer relevant. NFS describes the historical dataset and correction of the incorrect data in the Attachment to the March 25, 2013 NFS letter. In discussing the correction, NFS referred, in part, to the NFS Grading Plan, which shows the proposed final contours of the North Site Area (see Enclosure 2 to March 25, 2013 NFS letter). NFS has revised the FSS Report and its Appendices (Enclosures 3–5 of March 25, 2013 NFS letter) to correct the historical dataset. The revision to the FSS Report also included revisions to the wording of Section 2.10. In the revised Section 2.10, NFS stated that the corehole density for Survey Unit 20 was based on professional judgment based on three considerations: (1) the spacing of 5 m^2 was determined to be no longer representative, because the sampling data upon which that spacing was based was not representative of post-remediation conditions; (2) a spacing of 278 m^2 is suggested based on neighboring Survey Unit 19, which shares similar historical properties; and (3) a spacing of 100 m^2 suggested by the MARSSIM document. NFS's judgment was that a spacing of 50 m^2 was appropriate, given all considerations. The Staff reevaluated the revised historical dataset, and agrees that the historical data used to determine the spacing of 5 m^2 is not representative of the post-remediation conditions, so staff agrees the spacing of 5 m^2 is not necessary. The Staff concludes that the choice to set spacing at an area of 50 m^2 is reasonable and acceptable.

NFS has also committed to performing a post-FSS verification of the necessary corehole density, based on the FSS data. These post-FSS verifications are described in Section 5.8 of the FSS Report and show that, based on the FSS data, the corehole density was sufficient.

4.3.2. Findings

The Staff finds that the determination of the number of coreholes is adequate for Survey Unit 20.

4.4. Surrogate Ratios from Characterization and from FSS Results

4.4.1. Evaluation

The FSS Plan for the North Site subsurface includes use of surrogate radionuclides to estimate concentrations of hard-to-detect radionuclides. For the North Site, the hard-to-detect radionuclides are Tc-99, Pu-238, Pu-239/240, Pu-241, Pu-242, Th-230, U-233/234, and U-238. Am-241, U-235, and Th-232 are the surrogate radionuclides, with Am-241 the surrogate for the plutonium isotopes; U-235 the surrogate for U-233/234, U-238, and Tc-99; and Th-232 the surrogate for Th-230. In 10% of the systematic FSS samples, the surrogates and the hard-to-detect radionuclides are measured, and ratios of the surrogate to each hard-to-detect radionuclide are determined. The ratios are used to estimate the concentrations of the hard-to-detect radionuclides for the other 90% of the samples for which only the surrogate concentrations are measured directly. The hard-to-detect radionuclides are also referred to as inferred radionuclides, because they are inferred or estimated from the surrogate radionuclide concentrations. In the FSS Report, the multiple radionuclide concentrations are accounted for by determining the sum of fractions (the fractions being the concentration of a radionuclide as a fraction of its DCGL).

The Staff reviewed the surrogate and hard-to-detect data and the ratios for the five survey units. The Staff identified a concern that the surrogate ratios developed may not be meaningful. The use of surrogate radionuclides to estimate concentrations of other radionuclides depends on the existence of a relationship between the surrogate radionuclide(s) and the radionuclides to be estimated. In the DP (Chapter 5, Appendix B, Section 2.5), NFS states:

> "Surrogate measurements will be used to quantify the radionuclides present at the north Site. These methods require establishing "consistent" or conservative relationships between two or more radionuclides at the site prior to (or in the process of) conducting the final status survey."

Section 4.7 (and part of Section 2.2) of the FSS Report discusses the surrogate ratios. However, there is no discussion of whether consistent or conservative relationships exist between the radionuclides. The Staff reviewed the data and analyses presented regarding surrogates and performed some independent evaluations of the potential relationship between surrogate and hard-to-detect radionuclides. The Staff determined that NFS had not demonstrated that sufficient relationships exist between radionuclides in order to use surrogates. The Staff requested additional information on this issue (November 15, 2010).

There has been substantial discussion of this surrogates issue between NRC and NFS. Most of the documents listed in Section 2.0 of this SER addressed the issue. Keys points are as follows. In the March 1, 2012, submittal regarding Survey Units 2, 8, 9, 19, and 20, NFS acknowledged the lack of a strong statistical correlation between the surrogate radionuclides and the inferred radionuclides. NFS also provided an additional analysis to demonstrate that the hard-to-detect radionuclides contribute an insignificant amount to the dose. NFS evaluated the mean concentration of the hard-to-detect radionuclides for all survey units measured up to the point of Survey Units 2, 8, 9, 19, and 20, and calculated the dose contribution from those

mean concentrations. The sum of all HTDs was a dose contribution of 1.4% of the DCGL sum of fractions, or 0.35 mrem/y. In the September 11, 2012 meeting with Staff, NFS stated that they preferred to continue the approach to surrogates that was approved in the DP. But NFS also committed to evaluate the contribution to dose of the mean HTD concentrations. NFS stated that for future survey unit FSS Reports, NFS would include two additional tables to evaluate the cumulative to date HTD data and the HTD data for the individual survey units. NFS stated that the tables would include the calculated Sum of Net Mean Dose Contribution.

The Staff evaluation of the NFS proposed revised approach is as follows. NFS had indicated, in the March 1, 2012, submittal, that the reason for the lack of a consistent relationship between the surrogate and HTD radionuclides is that the HTDs are present in such low concentrations that they are frequently reported with activities below the detection limit for the analyses. The Staff agrees with this and additionally notes that the uncertainty in the measured concentrations is very large and so there is substantial uncertainty in the calculated ratios of surrogate to HTD. The approach that NFS used to evaluate the contribution to dose of the HTDs has followed the NRC guidance in NUREG-1757, Vol. 2, Rev. 1, Section 3.3. The Staff agrees that, based on the data to date, the HTDs contribute very little to the overall dose. Based on the additional data, and on NFS's commitments for future FSS Reports, NFS will essentially be evaluating the data in two ways: (i) surrogate ratios will be determined and used to estimate concentrations of the inferred HTDs (as in the DP); and (ii) contributions to dose will be evaluated directly from the measured concentrations of the HTDs. For the present survey units, the Staff concludes that the data indicate that the dose contribution from the HTDs is insignificant. The Staff also concludes that the number of analyses for HTDs (i.e., 10% of all samples) is sufficient. The Staff further concludes that evaluating the data with the two methods will ensure that significant contributions to dose from the HTDs would be identified if they occur in future survey units.

Surrogate ratios based on historical characterization data are also used in the survey design, specifically as part of the potential adjustment of corehole density to satisfy criteria for local area DCGLs. NFS committed to compare surrogate ratios obtained from the FSS results to surrogate ratios determined based on the historical data to verify that the planning of the FSS was appropriate. NFS provides that comparison in Section 5.7 of the FSS Report. The comparison indicated that some of the surrogate ratios based on historical data were non-conservative when compared to ratios developed from the FSS data. NFS performed additional evaluations to verify that the FSS design were appropriate (i.e., not impacted by the non-conservative ratios). The Staff concludes that these additional evaluations are appropriate—and, therefore, that the use of surrogate ratios for the design of the FSSs were acceptable.

4.4.2. Findings

The Staff finds that overall, the approach to surrogates and results of the surrogate evaluations are acceptable for Survey Units 2, 8, 9, 19, and 20.

4.5. FSS Results and Demonstration of Compliance with DCGLs

4.5.1. Evaluation

NFS provides an analysis of the sample results for compliance with the subsurface DCGLs in Chapter 5 of the FSS Report. NFS calculated the SOF values for each sample in the survey units and provides a histogram summary of the SOF values in Section 5.1 of the FSS Report. If all individual samples from a survey unit have an SOF (relative to the surface DCGL) no greater than 1, then the survey unit passes without further statistical analyses. For this group of survey

units, NFS stated that for Survey Units 9 and 19 each sample SOF value is less than or equal to one. Thus, those two survey units pass (the null hypothesis that residual radioactivity in the survey unit exceeds the $DCGL_w$ is rejected) and no further compliance tests are necessary in this case. The Staff reviewed the analyses of individual sample SOFs, and agrees with the conclusion that the SOF values are no greater than 1 for Survey Units 9 and 19.

For the three other survey units, the additional statistical compliance metrics must be evaluated. The statistical compliance metrics are described in Section 5 of Appendix B of the DP (2006). Sections 5.2 through 5.6 of the FSS Report describe NFS' analyses of these compliance metrics. As described, the data show that all of the survey units pass the additional compliance tests. The Staff reviewed the analyses and agrees with the conclusion that Survey Units 2, 8, and 20 pass the statistical compliance tests.

4.5.2. Findings

The Staff finds that the results of the subsurface survey demonstrate that the subsurface residual radioactivity in Survey Units 2, 8, 9, 19, and 20 are within the criteria.

4.6. Potential for Re-contamination and Disturbance

4.6.1. Evaluation

NFS is not requesting a partial site release of Survey Units 2, 8, 9, 19, and 20 at this time; instead, the licensee is requesting "confirmation that these survey units will be suitable for unrestricted release in accordance with Title 10, Code of Federal Regulations (CFR), Part 20, Subpart E" (Ref. 1). Decommissioning and sampling activities continue in other parts of the North Site area, giving rise to a potential for Survey Units 2, 8, 9, 19, and 20 to be re-contaminated. In their DP, the licensee discusses how re-contamination of decommissioned areas is prevented. When partial site release is requested, the potential for re-contamination or other disturbance of the survey unit areas must be considered.

5. Conclusion

The Staff's review of the FSS Report and NFS's responses to RAIs determined that the original FSS for Survey Unit 2 was performed inconsistent with the FSS Plans in the DP. Specifically, the original FSS did not address surface soils. NFS submitted the surface soils FSS Report for Survey Unit 2 as an addendum to the Revised FSS Report for Survey Units 2, 8, 9, 19, and 20, but the Staff is completing review of the surface soils FSS as a separate action. Therefore, the Staff does not confirm at this time that Survey Unit 2 would be suitable for unrestricted release. Before such confirmation can be approved by the Staff, Staff must complete review of the surface FSS of Survey Unit 2.

For the *subsurface* soils, the Staff finds that the FSSs for Survey Units 2, 8, 9, 19, and 20 were performed in a manner that is consistent with the subsurface FSS Plan in the DP.

6. Recommendations

The Staff approves confirming that the *surface and subsurface* soils of Survey Units 8, 9, 19, and 20 will be suitable for unrestricted release, subject to the caveats described in Sections 2.4 and 2.5. For Survey Unit 2, the Staff approves confirming that the *subsurface* soils will be suitable for unrestricted release, subject to the same caveats.

7. References

1. Letter dated May 24, 2010 (package ML101580442)
2. Letter dated November 15, 2010 (ML103090139)
3. Letter dated February 18, 2011 (ML110560250)
4. E-mail dated May 5, 2011 (ML12151A130)
5. Letter dated June 30, 2011 (ML11188A038)
6. Letter dated March 1, 2012 (ML12066A070)
7. Conference call summary dated July 20, 2012 (ML12223A165)
8. Meeting summary e-mail dated September 25, 2012 (ML12270A027)
9. Letter dated October 8, 2012 (package ML122970097)
10. Conference call summary dated January 7, 2013 (ML13007A086)
11. E-mail dated January 11, 2013 (ML13016A046)
12. Conference call summary dated February 15, 2013 (ML13064A199)
13. Letter dated March 25, 2013 (package ML130990501)

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