November 15, 2010

Mr. Mark P. Elliott, Director
Quality, Safety and Safeguards
Nuclear Fuel Services, Inc.
P.O. Box 337, MS 123
Erwin, TN 37650

SUBJECT: NUCLEAR FUEL SERVICES, INC., REQUEST FOR ADDITIONAL INFORMATION CONCERNING FINAL STATUS SURVEY FOR SURVEY UNITS 2, 8, 9, 19, AND 20 (TAC NO. L32997)

Dear Mr. Elliott:

This letter is in response to your letters dated May 24 and August 12, 2010, which submitted a final status survey report for Survey Units 2, 8, 9, 19, and 20 in the North Site. Our review has identified that additional information is needed before your request can be approved.

The additional information specified in the enclosure should be provided to us within 30 days from the date of this letter. Please reference TAC No. L32997 in your response.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390 of the U.S. Nuclear Regulatory Commission's (NRC) "Rules of Practice," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room and the Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

If you have any questions concerning this letter, please contact me at (301) 492-3123 or via e-mail to Kevin.Ramsey@nrc.gov.

Sincerely,

/RA/

Kevin M. Ramsey, Project Manager
Fuel Manufacturing Branch
Fuel Facility Licensing Directorate
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 70-143
License No.: SNM-124

Enclosure: Request for Additional Information

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Request for Additional Information
Regarding Final Status Survey Report
for Survey Units 2, 8, 9, 19, and 20 of the North Site

1. Relationships between Radionuclides for Surrogate Ratios

Request:
Provide justification/demonstration that sufficient relationships exist between radionuclides. Without significant relationships between the radionuclides, mean ratios and confidence intervals on the mean ratios may not be meaningful, and use of surrogate ratios may be inappropriate.

Basis:
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 Decommissioning Plan (DP) (Chapter 5, Appendix B, Section 2.5), Nuclear Fuel Services (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 Final Status Survey Report (FSSR) discusses the surrogate ratios. However, there is no discussion of whether consistent or conservative relationships exist between the radionuclides. The U.S. Nuclear Regulatory Commission's (NRC) staff reviewed the data and analyses presented regarding surrogates and have concerns about the adequacy of these relationships, based on the following.

First, in using a ratio to represent the relationship between two radionuclide concentrations, there is an implicit assumption of a linear relationship. A common approach to evaluate a potential relationship is to perform an ordinary least squares linear regression. There are a number of assumptions that must be met for the use of linear regression, especially for testing whether the slope coefficient is different from zero and for determining confidence intervals. These assumptions include (among others), (i) the response variable is linearly related to the explanatory variable, (ii) the variance of the residuals is constant, and (iii) the residuals are normally distributed (Helsel and Hirsch, 2002, Section 9.1.1 and Section 9). NFS has not provided any demonstration that these assumptions have been met or any indication that other methods are being used and the appropriate assumptions are met for use of such other methods.

Second, in some cases, it appears that a regression analysis would result in no significant relationship (based on no significant difference between the slope of the correlation line and a slope of zero). For example, the NRC staff performed a linear regression analysis for Tc-99 relative to U-235 for Survey Unit (SU) 9. Of the 21 possible pairs of Tc-99 and U-235 concentrations (from Table 4-5 of the FSSR), only 10 values were positive; these positive values were used. The NRC staff would typically consider a p-value of less than 0.05 to be significant. The regression analysis had a result of a p-value of 0.29 for the slope (i.e., testing whether the slope differs from a zero slope). This result indicates that the slope of the regression line is not statistically different from a zero slope. This indicates an insignificant linear relationship.

The staff also performed linear regression analyses for Pu-241 to Am-241 for all five SUs. Of the five SUs: in two cases the slope coefficient was not significantly different from zero; in one case the slope appeared significantly different from zero, but that result appears strongly dependent on a single pair of data, which indicates an inadequate basis for a linear relationship; and in all cases most of the concentrations are below the analytical laboratory reporting limits (as provided in Table 2-1 of the FSSR), and ratios based on these very low concentrations may not be representative for higher concentrations that might be closer to derived concentration guideline limits. The staff could provide other examples of the lack of significant linear relationships between radionuclides. NFS has not provided any analysis of the relationship between the radionuclide concentrations.

Third, in many cases, a substantial number of the ratios calculated by NFS (provided in Tables 4-3 through 4-7 of the FSSR) are negative. In some cases, the calculated mean ratio is negative, and in at least one case (Tc-99 to U-235 for SU 19) the calculated 95^{th} percent upper confidence limit (UCL_{95}) is negative. Negative values of the ratios are not physically meaningful. The negative values arise in cases where radionuclide concentrations are extremely low. It appears to the NRC staff that, in some cases, the large number of measurements at very low concentrations results in high uncertainty in the individual ratio values and may be a partial cause of the lack of significant relationships.

The NRC staff concludes that NFS has not demonstrated that sufficient relationships exist between radionuclides. It appears to the NRC staff that NFS may have calculated mean and UCL_{95} surrogate ratios and used these ratios, without first verifying that relationships between radionuclides are consistent or conservative. Without significant relationships between the radionuclides, mean ratios and confidence intervals on the mean ratios may not be meaningful, and use of surrogate ratios may be inappropriate.

2. Methods for Calculating 95^{th} Percentile Upper Confidence Limit

Request:
Demonstrate that methods used to calculate the UCL_{95} surrogate ratios, and the assumptions required for those methods, are appropriate. Specifically, (i) justify the continued use of negative ratios to calculate the UCL_{95}, or remove negative ratios (actually, remove ratios based on negative concentrations); (ii) justify that the statistical methods used to calculate the UCL_{95} is appropriate; (iii) justify that basing ratios on the alpha-spectroscopy measurements of the surrogate radionuclides (Am-241, U-235, and Th-232) are appropriate; and (iv) ensure that meaningless ratio results are not created from missing concentration data. As appropriate, describe the methods used.

Basis:
As discussed in Request 1, NFS has included many negative ratios in its dataset used to calculate UCL_{95} surrogate ratios. These negative values have no physical meaning. The NRC staff evaluated the impact of negative values for some cases, by recalculating UCL_{95} values (using t-statistic method). In some cases, if only positive ratios are used, the UCL_{95} would be substantially higher. (The NRC staff acknowledges that in some cases the UCL_{95} may be lower; there may be counteracting effects of higher mean ratio but lower standard deviation when

negative values are removed.) Thus, the inclusion of negative ratios in the method used by NFS for calculating the UCL_{95} is non-conservative in some cases. NFS has not provided any justification that negative values of ratios should be used (or alternatively, how to deal with negative values) in determining a surrogate ratio to be used for estimating the difficult-to-measure (or hard-to-detect) radionuclides.

As mentioned above, it appears to the NRC staff that a one-sample z-statistic was used to determine the UCL_{95}. Use of a z-statistic makes use of some assumptions including, (i) the distribution of means is normally distributed and (ii) the variance of the population is known. The assumption of normality may be appropriate when the sample size is large, based on the Central Limit Theorem. With removal of the negative ratios, the number of ratio values can be fairly small, where the Central Limit Theorem may not apply. However, NFS has provided no information on applicability to the surrogate ratios data. To the NRC staff, the assumption that the variance is known seems inappropriate to the data obtained for surrogate ratios. In Sections 5.7.1 through 5.7.5 (Figures 5-60A, 5-61, 5-62, 5-63, and 5-64A) of the FSSR, NFS compares the statistics of the surrogate ratios obtained from the historical measurements (pre-final status survey [FSS]) to those of the FSSR measurements. Based on these comparisons, the sample standard deviations (which would be used as estimates of the population standard deviations) from the historical data are, in most cases, *substantially* different from those from the FSS data. The NRC staff concludes that it is inappropriate to assume the population variance of the ratios is known. If the assumption of normality is reasonable, a t-statistic could be appropriately used where the variances are not known. NFS's implementation of a z-statistic could be non-conservative in some cases (the z-statistic itself would provide a lower estimate of the UCL_{95} than would a t-statistic, but it also appears that NFS may have used the upper limit of a two-sided 95 percent confidence interval, which would overestimate the UCL_{95}). The NRC staff also concludes that it may be inappropriate to assume normality of the mean ratios, and this has not been addressed by NFS.

The ratios calculated by NFS are based on the alpha-spectroscopy (alpha-spec) measurement of the surrogate radionuclide. However, the UCL_{95} ratio is applied to the gamma-spectroscopy (gamma-spec) measurements of the surrogate radionuclides. The NRC staff would usually expect ratios to be developed using the same type of data to which it would be applied (i.e., in this case, based on the gamma-spec measurements since those are used to predict the hard-to-detect concentrations). It may be that the alpha-spec measurements are considered better measurements than the gamma-spec measurements, or perhaps the ratios developed using the alpha-spec measurements are considered more conservative. However, NFS has not justified why the alpha-spec measurements are used to calculate the ratios.

In addition, the NRC staff notes that in one case data appears to have been created (perhaps inadvertently) where a result was not available. Based on results in Table 4-4 of the FSSR, for SU 8, Sample 0203-E does not have a result for Tc-99 concentration. However, a result for the ratio Tc-99/U-235 is provided (the ratio provided is zero, which may result from the spreadsheet dividing a missing data point by a present data point) in the table, and appears to have been used in determining the UCL_{95}. This may not have a large impact on the UCL_{95} determination, but this error should be corrected.

The NRC staff concludes that the methods used by NFS to calculate the UCL_{95} are not clearly described in the FSSR or in the DP, and the methods have not been demonstrated to be appropriate.

3. Demarcation of Survey Unit 19

Request:
Separate SU 19 into multiple survey units or provide additional justification that the existing demarcation is appropriate.

Basis:
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* (emphasis added here by NRC staff). 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. Based on the MARSSIM guidance, it appears to NRC staff that SU 19 should be divided into multiple survey units, based on the following.

Section 2.9 of the FSSR describes the survey design for SU 19. SU 19 is described as having areas that seem to NRC 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 SU; (ii) the west half of SU 19 is an area that was part of the evaporation pond and was remediated (excavated); and (iii) the east half of SU 19 encompasses a small protected wetlands area, which was not remediated and for which historical data indicate no elevated radioactivity exists. To NRC staff, these three areas would have different contamination potential. In particular, it appears that the wetlands area may have very low contamination potential, while the remediated evaporation pond area and the small areas of potentially elevated concentrations would have more significant potential for contamination, based on the contamination previously in the area. The history of the wetlands area is different from the evaporation pond area that was excavated. If these areas are combined, in some sense the wetlands area, which is expected to not have any elevated contamination, would be diluting (in terms of contamination potential) the rest of the SU. In addition, SU 19 is larger than the recommended size for Class 1 SUs. To the NRC staff, this situation is inconsistent with the MARSSIM concept that survey units should have a similar contamination potential. NFS has not provided justification that these areas of SU 19 have similar contamination potential, such that they should all be combined in a single SU.

REFERENCE:
Helsel, D.R. and R.M. Hirsch, “Statistical Methods in Water Resources,” Chapter A3 of *Book 4, Hydrologic Analysis and Interpretation*, of Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Department of the Interior, U.S. Geological Survey, 2002, available at http://water.usgs.gov/pubs/twri/

U.S. Nuclear Regulatory Commission (NRC), *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Revision 1, NUREG-1575, Rev. 1, 2000.

COMMENT

The following comment may be helpful to consider for preparation of FSSRs for future survey units.

Section 4.2.1: On page 4-5, there are two statements that are unsupported by the evidence cited. First, NFS states that based on the summary statistics for the gamma-spectroscopy results, the residual radioactivity is comparable to that expected for non-impacted soils. That conclusion could potentially be made by comparison of the data with data from the reference area, but that was not done. Second, NFS states that various estimators of central tendency being nearly equivalent suggest that the data sets are approximately normally distributed. Equal central tendencies do not ensure a normal distribution. The NRC staff notes that the summary statistics include results of the Anderson-Darling normality test, and p-values are extremely small, indicating that the assumption of normality should be rejected. Similar, unsupported statements are made in other sections of the FSSR.