Fort Calhoun Station Final Status Survey Final Report Phase 1
Request for Additional Information and Observations

The purpose of the Phase 1 Final Status Survey Final Report (FSSFR) is to provide a summary of the survey results and overall conclusions which demonstrate that those portions of the Fort Calhoun Station (FCS) site covered by the Phase 1 FSSFR meet the release criterion in 10 CFR 20.1402. The final status survey (FSS) results are to demonstrate that any residual radioactivity results in a total effective dose equivalent to an average member of the critical group that does not exceed 25 mrem/year, that the residual radioactivity has been reduced to levels that are as low as is reasonably achievable, and that that release criterion was translated into site-specific derived concentration guideline levels (DCGLs) for assessment and summary.

The FSSFR is to document that the FSS activities were performed consistent with the approved "Fort Calhoun Station Decommissioning Project License Termination Plan" (LTP) and the guidance in NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM); and NUREG-1757, Volume 2, Revision 2, "Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria." Furthermore, detailed information on the FSS measurements and sampling is necessary to ensure the survey requirements of 10 CFR 20.1501 (a) and (b) 10 CFR 50.82(a)(9)(ii)(D)) are met.

To support the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of Phase 1 of the FCS FSS Plan, please provide the additional information requested below.

RAI-01-01

Comment:

Instrument sensitivity and laboratory sample analysis should be capable of measuring residual radioactivity less than the DCGLs. The FSSFR and Survey Unit Release Reports (SURRs) should explicitly state the instrument and sample analysis minimum detectable concentrations (MDC) determined for the survey unit. Where *a posteriori* MDCs for instruments are used, include the variables, and show the calculations of the MDCs.

Basis:

Surveys shall be conducted to evaluate concentrations or quantities of residual radioactivity and the potential radiological hazards of radiation levels and residual radioactivity detected (10 CFR 20.1501(a)(2)). MARSSIM, Section 6.5.3, states "The instrument must be able to detect the type of radiation of interest, and the measurement should be capable of measuring levels that are less than the DCGL." MARSSIM, Section 4.7.1, "Selection of Instruments" recommends an MDC at 10-50% of the DCGL. Furthermore, for Class 1 survey units, the scan MDC should be less than the DCGL – Elevated Measurements Comparison ($DCGL_{EMC}$).

Section 5.4.2.1 of the FCS LTP, "Instrument Selection" indicated for direct measurements and sample analysis that MDC values be less than 50% of the Operational DCGL (OpDCGL) and scan MDCs be capable of detecting residual radioactivity at the Base Case DCGL (BcDCGL). Section 4.6 of the FSSFR, "Instrumentation" described the detector efficiencies, detector

sensitivities, instrument maintenance and control, and instrument calibration. The licensee referenced FC-19-006, "Ludlum Model 44-10 Detector Sensitivity," which provides the minimum detectable count rate (MDCR) values for the expected FCS soil mixtures based on detector background conditions, scan speed, soil depth (0.15 meters), soil density (1.6 g/cm^2), and detector distance to the surface. However, for the surveys conducted for Phase I open land areas (OLAs); the licensee used a Ludlum Model 44-20. For the random and judgmental sample results, those samples that were greater than the MDC were bolded in Table 7-2, "Summary of Gamma Spectroscopy Results and OpSOF Calculations for Samples Comprising the Statistical Sample Population," and Table 7-4, "Summary of Gamma Spectroscopy Results and OpSOF Calculations for Judgmental Samples" of the SURRs; however, an MDC for the sample analysis was not included.

The FCS LTP mentioned the use of an *In Situ* Object Counting System (ISOCS) detector as the instrument of choice to perform FSS in basement surfaces; however, there is no mention of its use for OLAs. Table 5-23 of the LTP, "Typical FSS instrument Detection Sensitivities" specifies a static MDC of "10% of the Operational DCGL (pCi/m^2)." The FSSFR provided limited information on the ISOCS used to obtain biased measurements to investigate selected areas identified during scanning with the Ludlum 44-20 in survey units 8103, 8109, and 8305. For survey units where in situ gamma spectroscopy was used, the SURRs indicated that the field of view (FOV) for the ISOCS unit was 1 m^2. A subset of the ISOCS locations, including the location with the maximum operational sum of fraction (OpSOF) were subsequently sampled. No additional information on the ISOCS sensitivity and calibrations were provided in the FSSFR or the SURRs.

The NRC staff was unable to verify whether instrumentation and laboratory analysis met the LTP criteria or the requirement for the MDC and the scan MDC to be less than the DCGL and $DCGL_{EMC}$, respectively.

Request:

(1) To facilitate validation that the instrument and method sensitivities are less than the appropriate DCGLs, provide the following:
   a) The instrument MDCs directly comparable to the DCGLs for survey instruments used in Phase I OLA final status surveys.
   b) The onsite and off-site laboratory sensitivities for each sample result in units directly comparable to the DCGLs.
   c) The ISOCS measurement system MDC, including inputs used for its calculation.

(2) Section 4.6.2 of the FSSFR, "Detector Sensitivities" discussed the determination of the gamma scan MDCR referencing FC-19-006, "Ludlum Model 44-10 Detector Sensitivity." The detector used for scanning the survey units was the Ludlum Model 44-20. To evaluate the appropriateness of this procedure to the Ludlum 44-20, the NRC staff requests a copy of FC-19-006.

RAI-01-02 ISOCS Application in OLA Survey Units

Comment:

The FSSFR should explicitly state how ISOCS is being applied to open land area surveys.

Basis:

Surveys shall be conducted to evaluate concentrations or quantities of residual radioactivity and the potential radiological hazards of radiation levels and residual radioactivity detected in accordance with 10 CFR 20.1501(a)(2). According to MARSSIM Section 5.5.3, “Developing an Integrated Survey Strategy,” a combination of random sampling and judgmental scanning surveys are conducted for a Class 3 area. Judgmental sampling and surveys are conducted at areas with the highest potential for contamination based on professional judgment. Any measurement that is equal to or greater than an investigation level indicates an area of relatively high concentration and is investigated, regardless of the outcome of nonparametric statistical tests. This gives some level of confidence that no areas of elevated activity were missed by random measurements or that there were no errors in classification of the area.

According to the FSSFR, an ISOCS was used to obtain biased measurements to investigate selected areas identified during scanning with the Ludlum 44-20 in survey units 8103, 8109, and 8305. The FCS LTP mentioned the use of an ISOCS detector as the instrument of choice to perform FSS in basement surfaces; however, there is no mention of its use for OLAs. No additional information on the application of ISOCS in OLAs was included in the FSSFR other than its use for biased sampling and the identification of the FOV. NRC staff noted that there were corresponding soil samples for a subset of ISOCS measurements with elevated readings. While these measurements were isolated to judgmental measurements, from the information supplied, NRC staff was unclear how the data derived from the use of ISOCS was utilized.

Request:

Explain how the ISOCS protocol was applied in open land area FSSs and how these measurements were used in the final evaluation of the survey unit.

RAI-01-03 Reclassification of Survey Units

Comment:

A justification for maintaining a Class 3 classification, rather than reclassifying the survey units with one or more judgmental samples/measurements exceeding 50% of the OpDCGL, is needed.

Basis:

MARSSIM, Section 4.4, “Classify Areas by Contamination Potential,” defines a Class 3 area as any impacted areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_w$. Section 5.5.3.2, “Land

Area Surveys" states that investigation levels for Class 3 areas should be established to identify areas of elevated activity. Scanning survey locations exceeding investigation levels should be flagged for further investigation. These investigations serve as the basis for reclassifying all or part of a survey unit as Class 1 or Class 2.

Final classification of the survey unit was performed in conjunction with the preparation of the FSS sample plan taking into consideration legacy and continuing characterization data. Section 5.3 of the FSSFR, "Anomalous Data/Scan Results and Investigation," stated that no judgmental samples or measurements resulted in the remediation and/or reclassification of a survey unit, and statements within each survey unit report indicate no changes to survey unit classifications. The FCS LTP states, "If an individual survey measurement in a Class 3 survey unit exceeds 50 percent of the Operational DCGL, then the survey unit, or a portion of the survey unit, will be investigated. If the investigation confirms residual radioactivity in excess of 50 percent of the Operational DCGL, then the survey unit, or the impacted portion of the survey unit will be reclassified to a Class 1 or a Class 2 survey unit and the survey will be re-designed and re-performed as a Class 1 or Class 2 survey unit." The sum of fraction (SOF) values for several samples exceeded the 50% of the OpDCGL criteria, yet the survey unit classification remained a Class 3.

Request:

Explain why the following survey units, with judgmental samples having an SOF of greater than 50% of the OpDCGL were not reclassified.

- SU 8103 - two judgmental samples (8103X-3-FJ-GGDX-018 and 8103X-3-FJ-GGDX-031) with an SOF greater than 0.5.
- SU 8109 - three judgmental samples (8109X-3-FJ-GGDX-021, 8109X-3-FJ-GGDX-032, and 8109X-3-FJ-GGDX-040) with an SOF greater than 0.5.
- SU 8305 - two judgmental samples (8305X-3-FJ-GGDX-017 and 8305X-3-FJ-GGDX-037) with an SOF greater than 0.5.

RAI-01-04 Maximum SOF for Random and Judgmental Sample/Measurement

Comment:

The maximum SOF for survey units 8103 and 8109 throughout the SURRs are inconsistent.

Basis:

In the SURR for Survey Unit 8103, the executive summary states that the maximum SOF for random and judgmental samples was equal to 0.4305. The maximum SOF in Table 7-4 is listed as 0.8461. Similarly for Survey Unit 8109, the maximum SOF in the SURR executive summary is identified as 0.4195 while the value listed in Table 7-4 is 0.819. Clarification is needed to demonstrate compliance with 10 CFR 20.1501(a)(2) on the adequacy of surveys for residual radioactivity.

Request:

Explain the inconsistency in the maximum SOF for judgmental sample/measurements between the values identified in the executive summary and Table 7-4 for Survey Units 8103 and 8109.

RAI-01-05 C-14 Analysis

Comment:

The licensee does not discuss how C-14 is accounted for in judgmental measurements taken with ISOCS.

Basis:

To validate the adequacy of methods used to demonstrate, with reasonable assurance, compliance with unrestricted release criteria (10 CFR 20.1402), the site must have provisions for determining contributions from all radionuclides of concern, including hard to detects (HTDs), in the final dose calculations. Furthermore, detailed information on the FSS measurements and sampling is necessary to ensure the survey (10 CFR 20.1501 (a) and (b)) and LTP (10 CFR 50.82(a)(9)(ii)(D)) requirements are met.

Section 5.2.6.2 of the LTP, “Surrogate Radionuclides,” stated that C-14 is assessed by direct measurement by an off-site laboratory as opposed to the use of surrogate ratios. This eliminated the uncertainty associated with the C-14 mixture fraction. For a few survey units (8103, 8109, 8305), Table 5-5 of the SURR, “Synopsis of the Survey Design,” indicated a design criterion to submit 100% of the samples for HTD radionuclide of concern analysis; however, there was not a corresponding C-14 analysis for all ISOCS locations. An ISOCS measurement would not detect C-14, yet a zero value was recorded for measurements where no subsequent laboratory analysis was completed.

Request:

a) Clarify for which samples (random, systematic, judgment, or all) the 100% analysis criterion for HTDs applies.
b) Explain how C-14 was accounted for in conditions where ISOCS measurements were taken without a corresponding soil sampling.
c) Justify the use of a zero value for C-14 in the calculation of the judgmental sample SOF values, as shown in Table 7-4, when no C-14 analysis was done, and no surrogate ratio was used.

RAI-01-06 Relative Shift

Comment:

The relative shift derived in Equation 5-1 of the SURRs, “Relative Shift,” does not equate to the relative shift calculated from data in Table 3-1 of the SURRs, which contains statistical quantities for Cs-137 and Co-60 from characterization surveys. Additionally, there appears to be

a discrepancy in the stated source of characterization data used as the basis for the relative shift in several SURRs.

Basis:

MARSSIM Sections 5.5.2.3 describes the process for determining the number of measurements (N) required for the statistical test to demonstrated compliance with the Sign Test. The number depends on the Type I and Type II decision error rates, the relative shift, the potential for small areas of elevated activity, and the selection and classification of survey units. The input used to calculate the relative shift came from surface soil sample characterization data according to the SURRs.

Most of the individual SURRs, apart from Survey Units 8101 and 8102, state that survey unit specific characterization data is used to derive the relative shift. In the case of Survey Units 8101 and 8102, the data used to calculation the relative shift was Survey Area 8100. Equation 5-1 for all survey units (apart from 8106) are identical. The given relative shift does not match the relative shifts calculated by NRC staff with the licensee provided statistical quantities from Table 3-1 of the SURRs, which shows survey unit specific statistical quantities. Survey unit characterization data is not available in the LTP to verify the statistical quantities presented by the licensee in the SURRs.

Additionally, Table 3-2 "Off-site Analysis for Characterization Samples in 8103" indicates that the table includes off-site analysis for Survey Unit 8103; however, the sample numbers indicate the results are from the 8100 Survey Area. This same discrepancy occurs in Survey Units 8104 and 8105.

Request:

a) Clarify which survey unit specific or survey area characterization data was used to obtain relative shift for each survey unit.
b) Furnish a summary of survey unit specific characterization data used to obtain statistical quantities in Table 3-1.
c) Explain the source of the lower bound of the gray region (LBGR) and the standard deviation used as input to Equation 5-1 of the SURRs.

RAI-01-07 Scan Action Levels

Comment:

The SURR should include a description of the derivation of scan action levels (cpm) and how licensee delineates when judgmental samples are collected and analyzed following scan alarms.

Basis:

Surveys shall be conducted to evaluate concentrations or quantities of residual radioactivity and the potential radiological hazards of radiation levels and residual radioactivity detected

(10 CFR 20.1501(a)(2)). MARSSIM Section 5.5.2.6, “Determining Investigation Levels,” discusses the importance and methodology for establishing investigation levels for FSS.

Table 7-1, “Synopsis of Scan Results,” provides action levels by scan area. It is unclear how these action levels were determined. The table also indicated there were scan alarms at locations where no judgmental sample was taken.

Request:

a) Explain how the scan action levels (cpm) were derived.
b) Explain why some areas had scan alarms but no judgmental samples were taken

RAI-01-08 Scan Area Locations

Comment:

There is apparent inconsistency in how the scan areas and random sample locations are represented in Table 7-1, “Synopsis of Scan Results” and Figure 16-1 (scan and/or sample location map) of each SURR. NRC staff were unable to verify the location of random samples and scan locations in some instances.

Basis:

Surveys shall be conducted to evaluate concentrations or quantities of residual radioactivity and the potential radiological hazards of radiation levels and residual radioactivity detected (10 CFR 20.1501(a)(2)). According to MARSSIM Section 5.5.3, “Developing an Integrated Survey Strategy,” a combination of random sampling and judgmental scanning surveys are conducted for a Class 3 area. Judgmental sampling and scanning surveys are performed at areas with the highest potential for contamination based on professional judgment. NUREG-1757 Vol. 2, Rev. 2, Section 4.5, “Final Status Survey Report,” outlines information to be submitted in an FSSR including a map or drawing of the survey unit showing the random locations and areas scanned for Class 3 survey units.

Specific issues with the FCS SURRs:

Survey Unit 8101 – Table 7-1 provides an overview of the scan results for all 1 m^2 scan areas around each random sample location and the gamma walkovers (GWs). GW scan areas are shown in Figure 16-1; however, scan areas around random measurements are missing in most cases.

Survey Unit 8102 – Table 7-1 contains an overview of scan results for all 1 m^2 scan areas around each random sample location and the GWs. GW scan areas are shown in Figure 16-1; however, scan areas around random measurements are missing in most cases.

Survey Unit 8103 – Table 7-1 lists only the GW scans without including results for scan areas around random sample locations. Figure 16-1 appears to include scan areas surrounding random sample locations; however, there are two random sampling locations to the north of the

survey unit along the tree line without a scan area encompassing them. The scanned area appears to be displaced from these sampling locations. The map does not include the GW scan locations.

Survey Unit 8105 – Table 7-1 lists only the GW scans without including results for scan areas around random sample locations. Figure 16-1 show the judgmental sample locations but not the random sample locations. The scan locations appear to surround many of the judgmental samples.

Survey Unit 8110 – Table 16-1 does not show all scan areas listed in Table 7-1 and does not include locations of random samples.

Survey Unit 8202 – Scan Areas 1 through 21 are listed in Table 7-1, but figures of these individual scan areas are not included. Table 16-1 does not include scan areas 1 through 21 and it is unclear if random samples are included as they are not included in the table legend.

Survey Unit 8203 – Scan Areas 1 through 14 are listed in Table 7-1, but figures of these individual scan areas are not included. Table 16-1 only shows ten out of 14 random sample locations and does not show any scan areas associated with those.

Survey Unit 8307 – Scan Areas 1 through 14 are listed in Table 7-1, but figures of these individual scan areas are not included. Table 16-1 shows table of random sample locations but does not appear to show associated scan areas.

In general, the nomenclature for scan areas in Table 7-1 of the SURR for the survey units vary without explanation. For example, some survey units used a numerical value (e.g., 8104, 8106). Others use GW values, which appear to represent gamma walkover areas (e.g., 8103, 8105). Another set appear to contain both (e.g., 8101).

Request:

a) For each survey unit listed above, provide figure(s) displaying all scan areas and the location of random samples taken in each survey unit (i.e. Figure 16-1).
b) Clarify if 1 m^2 scans were taken around each random sample location in each survey unit. If not, explain these inconsistencies.
c) Clarify the various scan area designations listed in Table 7-1 of each survey unit and the meaning of each identifier (whether it refers to a gamma walkover scan area, a 1 m^2 scan area surrounding a random sample, or something else).

RAI-01-09 Background Measurements

Comment:

The background measurement procedure was inconsistent between open land area survey units.

Basis:

10 CFR 50.82 outlines requirements for termination of license, which includes the submittal of detailed plans for the final radiation survey. Section 5.2.4 of the LTP, “Reference Areas and Materials,” stated that backgrounds were established as the mean of five one-minute static measurements taken from various locations within the area being surveyed. For gamma detectors, background measurements were collected at a minimum of six inches above the ground. For most of the survey units, the SURRs stated that background measurements were taken at six inches from the soil. However, for Survey Units 8103 and 8106, the background measurements were taken two inches from the soil, which is inconsistent with the LTP.

Request:

- Justify the deviation in the background measurement procedure for Survey Units 8103 and 8106.

Observations for Future Submittals

(1) Section 5.7.2 of the LTP, “FSS Final Reports” commits to providing a summary of the applicable historical site assessment (HSA) information in FSS Final Reports. However, the information in the HSA is not correlated to a specific survey unit. Consider including the following information in the survey unit description, particularly for Class 1 and Class 2 units:

- Unique features (low spots, discolored area, etc.).
- Structures, system, and components currently or previously located in the area.
- Radiological operations conducted previously in the areas.
- Spill/leakage history in the area.

Alternatively, refer to the relevant portions of the historical site assessment for the specific survey unit. This information would assist reviewers in evaluating potential risk of residual radioactivity from various media.

(2) For each SURR, add information on whether excavation and/or backfill were conducted in the survey unit.

(3) Include a summary of continuing characterization conducted for the survey unit in the characterization discussion, or state that no continuing characterization occurred. Include a statement clarifying whether sampling was conducted for insignificant contributor verification during continuing characterization, radiological assessments, or other surveys.

(4) Explain the choice of areas selected for judgmental scanning (e.g., low lying areas, areas of spills/leaks, etc.) within each survey unit. For example, in SU 8109 grid sample 15 GPS scan area was selected as a biased location due to high foot traffic, darker soil, and the location being a low point in the area.

(5) To facilitate the review, separate the ISOCS judgmental measurements from the soil sample measurements in Table 7-4 for survey units where ISOCS was used.

Editorial Issue

(1) Survey units 8103 and 8106 did not have axis labels for the retrospective power curve. Given that the curves from the other ten survey units are labeled, it is assumed that the labels are the same for these survey units. Please confirm that this is the case.