



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**

REGION IV  
1600 E. LAMAR BLVD.  
ARLINGTON, TX 76011-4511

February 03, 2015

Mr. John H. Ellis, President  
Sequoyah Fuels Corporation  
P.O. Box 610  
Gore, OK 74435

SUBJECT: NRC INSPECTION REPORT 040-08027/14-002

Dear Mr. Ellis:

This refers to the U.S. Nuclear Regulatory Commission (NRC) inspection conducted from November 13-20, 2014, at your Sequoyah Fuels Corporation site near Gore, Oklahoma. This inspection was an examination of activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. Within these areas, the inspection consisted of selected examination of procedures and representative records, observations of activities, and interviews with personnel.

The inspection included a review of the construction of your onsite disposal cell and a confirmatory survey of several excavated areas. The preliminary inspection findings were presented to you and your staff at the conclusion of the onsite inspection. The final inspection results were presented to your staff by telephone on January 21, 2015, after receipt of the NRC's confirmatory survey soil sample results on January 8, 2015. The enclosed report presents the results of this inspection. No violations were identified, and no response to this letter is required.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter, its enclosure, and your response, if you choose to provide one, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

Should you have any questions concerning this inspection, please contact Dr. Robert Evans, Senior Health Physicist, at 817-200-1234, or the undersigned at 817-200-1191.

Sincerely,

*/RA/*

Ray L. Kellar, P.E., Chief  
Repository and Spent Fuel Safety Branch  
Division of Nuclear Materials Safety

Docket No. 040-08027  
License No. SUB-1010

Enclosure:  
NRC Inspection Report 040-08027/14-002

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              M. Broderick

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U.S. NUCLEAR REGULATORY COMMISSION  
REGION IV

Docket: 040-08027

License: SUB-1010

Report: 040-08027/14-002

Licensee: Sequoyah Fuels Corporation

Location: P.O. Box 610, Gore, Oklahoma

Dates: November 13-20, 2014

Inspectors: Robert Evans, Ph.D., P.E., C.H.P., Senior Health Physicist  
Repository and Spent Fuel Safety Branch  
Division of Nuclear Materials Safety  
Region IV

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Approved by: Ray L. Kellar, P.E., Chief  
Repository and Spent Fuel Safety Branch  
Division of Nuclear Materials Safety  
Region IV

Attachment: Supplemental Inspection Information

Enclosure

## EXECUTIVE SUMMARY

### Sequoyah Fuels Corporation NRC Inspection Report 040-08027/14-002

This U.S. Nuclear Regulatory Commission (NRC) inspection was a routine, announced inspection of decommissioning activities being conducted at the Sequoyah Fuels Corporation site near Gore, Oklahoma. The inspectors concluded that Sequoyah Fuels Corporation (the licensee) was conducting decommissioning activities in accordance with regulatory and license requirements.

#### Onsite Construction

- The licensee was constructing the disposal cell in accordance with Reclamation Plan requirements. (Section 1.2)

#### Radiation Protection

- The licensee conducted its radiation protection program in accordance with the requirements of 10 CFR Part 20 and the license. (Section 2.2)

#### Closeout Inspection and Survey

- The inspectors reviewed the licensee's final status survey design and sample results for four general areas that were previously excavated. The four areas included the former Pond 1 spoils pile, north burial area, DUF<sub>4</sub> Building foundation, and the combined fluoride settling basins and fluoride clarifier. The licensee's records indicate that it designed and conducted its surveys in accordance with license requirements, and all sample results were less than the limits specified in the NRC-approved Reclamation Plan. (Section 3.2.a)
- The inspectors conducted confirmatory surveys of the four excavated areas. The surveys included measurement of ambient gamma radiation levels and collection of soil samples. All soil sample results were less than the limits specified in the Reclamation Plan. The confirmatory survey results indicate that the licensee had effectively remediated the four areas. (Section 3.2.b)

## Report Details

### Summary of Plant Status

License Condition 51 allows the licensee to conduct decommissioning in accordance with the Reclamation Plan dated July 2008, as amended. The licensee commenced with site decommissioning in April 2009. To decommission the site, the licensee planned to dismantle and remove systems and equipment, demolish structures, treat sludges and sediments, remediate contaminated soils, and treat wastewater. Most of the residual waste material will be placed in an onsite cell for permanent disposal.

The licensee is constructing the disposal cell in three phases. Since the previous inspection, conducted in April 2014 (ML14164A675), the licensee continued to remediate the site and continued to construct the onsite disposal cell. The licensee finished construction of the base of the Phase III portion of the disposal cell in July 2013. During the inspection, the licensee's contractor continued to place waste material into the Phase III portion of the cell for permanent disposal.

The licensee previously overfilled the Phase I and II areas of the disposal cell. The licensee was storing this excess material in the Phase I and II areas pending construction of the Phase III base. The licensee subsequently elected to increase the cell height by 25 feet, meaning that the overfill material could be disposed in the Phase I and II areas. However, not all material above a certain elevation was properly compacted for disposal, so the licensee had to remove and re-compact the material for permanent disposal. During the inspection, the licensee continued to remove this excess overfill material from the Phase I and II areas and re-compact the material into lifts in accordance with Reclamation Plan requirements. During 2015, the licensee plans to construct the compacted clay cover and synthetic liner on the northern end (Phase I and II areas) of the disposal cell.

Other work completed by the licensee in recent months included remediation of the storm water capture area, DUF<sub>4</sub> (depleted uranium tetrafluoride) Building foundation, Pond 1 spoils pile, north burial pit (formerly known as solid waste burial area No. 2), northeastern area (formerly a burial and burn site), fluoride clarifier basin, north/south fluoride settling basins, and clarifier basin No. 4. During the inspection, the licensee was demolishing the two cell rooms in the former main processing building. The remaining site structures within the radiologically restricted area included the northeastern corner of the main process building, water treatment facility, oil storage building, and laundry building.

Since the previous inspection, the licensee shipped the former DUF<sub>4</sub> autoclaves to another NRC licensee. The licensee cleaned, radiologically surveyed, and released the autoclaves from the restricted area prior to shipment. The licensee continued to store equipment previously salvaged from the former DUF<sub>4</sub> Building in the main process building. The licensee plans to transfer this salvaged material to the same NRC licensee in the near future. Further, the licensee continued to store DUF<sub>4</sub> and natural uranium in 77 drums. The drums were being stored in two metal shipping containers in the southeastern corner of the site. The licensee plans to ship this material for reuse or disposal at some point in the future.

The licensee still possessed approximately 11,000 tons of bagged raffinate sludge, material previously removed from the four clarifier basins. The licensee also possessed 851 bags of sediments removed from the emergency basin, north ditch, and sanitary lagoon. The licensee continued to store the bagged sludge and sediment material for possible transfer to an out-of-

state uranium mill for use as alternate feed material. However, if the licensee is unable to transfer the material to the mill, the license allows the licensee to dispose of this material in the onsite disposal cell.

## **1 Onsite Construction (88001)**

### **1.1 Inspection Scope**

The inspectors reviewed the licensee's decommissioning activities to determine if these activities were being conducted in accordance with Reclamation Plan requirements.

### **1.2 Observations and Findings**

License Condition 51 allows the licensee to conduct site decommissioning in accordance with the NRC-approved Reclamation Plan. The technical specifications, an attachment to the Reclamation Plan, provide the detailed requirements for construction of the disposal cell. The inspectors conducted tours of the construction area to observe work in progress. The licensee was conducting work in all three phases of the disposal cell. The inspectors compared the work in progress to the construction requirements specified in technical specifications. The inspectors also reviewed construction-related records and discussed these records with the licensee's staff. In summary, the inspectors concluded that the licensee was conducting construction activities in accordance with Reclamation Plan requirements.

The licensee had temporarily staged waste material in the Phase I and II areas above the 580-foot elevation. The licensee subsequently approved an increase in cell height, from the 590 to 615-foot elevation, through its performance-based license. Because the material in storage above the 580-foot elevation had not been compacted in accordance with technical specification requirements, the licensee had to remove and re-compact this material for permanent disposal in the Phase I and II areas. During the inspection, the licensee was compacting the material in 2-foot lifts with six compression roller passes in accordance with technical specification requirements. The inspectors noted that the Phase I and II areas had been compacted up to the 586-foot elevation during the site tour.

The licensee was adding material to the Phase III area, up to the height of the storm water retention embankment at the 590-foot elevation. The licensee recently placed material remediated from the storm water capture and Pond 1 spoils pile areas into the Phase III portion of the cell. A portion of the perimeter access road in the western area had to be removed as part of the clean-up efforts. The licensee also constructed an earthen berm on the western edge of the cell, to stabilize the edge of the Phase II cell area. This slope will eventually become part of the toe of the disposal cell cover. In addition, non-impacted storm water drainage in the western areas was being routed to the storm water reservoir. The licensee occasionally released water from the storm water reservoir in accordance with its State of Oklahoma discharge permit.

As noted earlier, the licensee completed remediation of the former storm water capture area. This area was the former settling basin located adjacent to the Pond 1 spoils area and emergency basin. Some of the sediment was relocated into the Phase II area for drying, and the remainder was mixed with fly ash for solidification and transferred to the Phase III area for disposal. The licensee also remediated the remainder of the Pond 1

spoils pile area. This effort required the licensee to relocate the restricted area boundary to allow the licensee to remediate the toe of the Pond 1 spoils pile.

The licensee also remediated the remainder of the north burial pit (formerly known as solid waste burial area No. 2). This effort required removal of the Phase I drainage collection sumps. As discussed below, the licensee rerouted the leak and leachate drainage from the Phase I cell to the Phase II collection sumps. Piles of concrete and excess soil located in this northern area were used as backfill in the north burial pit. (The NRC conducted a limited confirmatory survey of this material during the April 2014 inspection.) The northeastern corner of the property, a former burial and burn site, was also remediated. This excavated material was disposed in the Phase III portion of the cell. During the inspection, one small pocket of contaminated soil still required remediation in the northern area, pending relocation of several electrical power poles.

At the time of the inspection, the licensee had remediated both clarifier basins 1 and 4, but more remediation was necessary in these areas of the site. Clarifier basins 2 and 3 remained in service and were being used for storage and processing of potentially contaminated water. Processed discharge from the clarifier basins was directed to the storm water reservoir for eventual discharge to the environment in accordance with State permit requirements.

The licensee also remediated the fluoride clarifier, north fluoride settling basin, south fluoride settling basin, and fluoride sludge burial area. These areas were located on the southern edge of the restricted area, and the excavated material was moved to the Phase III portion of the disposal cell. One small area near the north fluoride settling basin, adjacent to an electrical power pole, still required remediation. In addition, the licensee finished the reclamation of the former DUF<sub>4</sub> Building footprint. The excavated soil was moved to the Phase III cell for disposal. The licensee was also demolishing the two cell rooms located within the former main process building. This material was being placed in the Phase III portion of the cell. Further, the licensee planned to place contaminated soil situated on the eastern side of the site into the disposal cell in the near future.

The licensee conducted some remediation work within Pond 2, the large pond located west of the main plant site, but this work was placed on hold pending completion of the remediation of clarifier basin Nos. 1 and 4. Subsurface contamination from the area of the clarifier basin may be leaching into Pond 2, and the licensee concluded that remediation of the clarifier basin area was necessary before it could finish reclamation of Pond 2.

As part of cell construction, the licensee installed leak detection and leachate collection piping in all three phases of the disposal cell. The licensee originally intended to build six collection sumps, one leak detection collection sump and one leachate collection sump for each phase of the disposal cell. The Phase I sumps were located north of the disposal cell, and the Phase II and III sumps were located west of the disposal cell. The licensee has since elected to discontinue using three sets of sumps, and instead, the licensee rerouted all drainage to the Phase II sump area. At the time of the inspection, the total drainage was estimated to be about 900 gallons per day, including 500 gallons per day from the Phase II area of the disposal cell. The collected water was being transferred to the clarifier ponds for temporary storage and processing.

The licensee plans to eventually install a collection tank in the Phase II sump area to supplement the collection of cell drainage. In the long term, the licensee plans to consolidate the three sets of sumps into one central location. The inspectors reviewed the licensee's technical reasons for relocating the sump drainage lines and concluded that the licensee could make these changes under its performance-based license.

The licensee continues to store approximately 11,000 tons of bagged raffinate sludge material at the former yellowcake storage pad. The licensee was considering its options for disposal of this material. The Reclamation Plan allows the licensee to dispose of this material in the disposal cell. The licensee has been pursuing other disposal options, without success. During the onsite inspection, the licensee's engineering contractor was reviewing cell design to determine the best area within the cell for placement of the material, in case the licensee elects to dispose of the sludge and sediment material into the disposal cell.

The Reclamation Plan provides general guidance for the disposal of the raffinate sludge material in the disposal cell. These instructions include construction of upper and lower liners around the material, and placement of the material at the bottom of the disposal cell. If the licensee elects to dispose of the raffinate sludge and pond sediment material in the disposal cell, some other material already placed in the Phase III portion of the cell might have to be excavated to accommodate the disposal of the bagged material. The inspectors understood that the licensee would have to review the proposed changes to the disposal cell in accordance with its performance-based license. As noted earlier, the licensee plans to make a final decision about the disposal of the raffinate sludge and pond sediment material in 2015. The inspectors will review the licensee's efforts in this program area during a future inspection.

The licensee recently received from its contract engineers a summary report for three potential rock sources (one NRC-approved and two new sources) to be used for cell riprap and cell apron. Before starting the bidding process, the licensee must determine the final dimensions of the disposal cell including cell height, since the final dimensions will impact the quantity and size of rock needed. Currently, the proposed rock sizes are 1.5-inches for the filter rock, 5-inches for the mulch (top and side slopes) and 9-inches for the apron. Using its performance-based license process, the licensee plans select the type of rock and quarry that will provide the rock. The inspectors will continue to review the licensee's efforts in this program area during future inspections.

License Condition 54 allows the licensee to make changes to the Reclamation Plan under certain circumstances. The NRC staff reviewed two recent changes to the Reclamation Plan. The first change, designated as CL011, revised Section 4.2 of the Cell Construction Plan to modify the collection system discharge pathways. As noted earlier, the licensee elected to modify the discharge piping from the three sets of leak detection and leachate collection systems. The discharge lines were combined and discharged to a common area. This change was reviewed to accommodate field conditions during construction. Final drawings should provide the final, as-built configuration of the piping. The NRC inspectors observed the current piping configurations during site tours.

The second change, designated as CL012, involved a revision to technical specifications related to the licensee's soil borrow area. Prior to the change, the licensee was limited to one specific borrow area per technical specification requirements. The purpose of the

change was to establish the technical criteria for borrow area materials, an action which would allow the licensee to expand the number of locations where it could obtain soil. As long as the soil met the technical criteria established in technical specifications, it could be used in the construction of the disposal cell. The inspectors reviewed this proposed change and concluded that the licensee could expand the number of borrow areas, as long as the soil continued to meet the criteria established in technical specifications.

However, the inspectors noted that the licensee made two additional technical changes when the licensee's Plant Review Committee approved CL012 without sufficient explanation for the reasons for these two changes. The first change involved the materials specifications (how much material must pass through a #200 sieve) and the second change involved the thickness of the side slopes. The inspectors discussed these two technical changes with the licensee, in part, to understand how they impacted radon attenuation. The licensee agreed to revise CL012 to provide additional justifications for these two technical changes. The licensee subsequently submitted the annual performance-based license report for 2014 to the NRC by letter dated January 13, 2015 (ML15023A455). The licensee included a summary of Change CL012 with the annual report (ML15023A478). The inspectors will review the licensee's revised CL012 during a future inspection.

During site tours, the inspectors observed the status of temporary erosion control efforts. The licensee used felt and soil on the Phase I and II side slopes and straw mats on the Phase III slopes. The inspectors noted that the straw mats appeared to be more effective than the felt and vegetative covers. Regardless, these various covers were only temporary, and the licensee planned to remove the covers prior to construction of the final cell cover.

### 1.3 Conclusions

The licensee was constructing the disposal cell in accordance with Reclamation Plan requirements.

## **2 Radiation Protection (83822)**

### 2.1 Inspection Scope

The inspectors examined the licensee's radiation protection program for compliance with license and 10 CFR Part 20 requirements.

### 2.2 Observations and Findings

During an NRC inspection conducted in April 2013 (ML13184A136), the inspectors concluded that the licensee had failed to maintain documentation demonstrating that only properly calibrated and maintained radiological survey meters were being used during decommissioning. In response, the licensee and its instrument calibration contractor implemented various corrective actions as described in the licensee's letter dated July 31, 2013 (ML13221A179). During this inspection, the inspectors reviewed the licensee's program for maintenance and calibration of radiation survey instruments to ensure compliance with license requirements and approved procedures.

License application Section 3.3.3 requires that radiation survey instrumentation be calibrated at least every 6 months. The inspectors reviewed the licensee's database of on-site survey instruments and confirmed that the database reflected calibrations on 6-month intervals. The inspectors also validated current calibration of selected instruments in the field and correlated field location with the location listed in the database.

Calibration is accomplished using recognized and licensed commercial suppliers of calibration services combined with calibrations conducted at the parent company, General Atomics, a facility licensed by the State of California for calibration services, License Number 0145-37, Amendment 187, Item 24. The inspectors noted improvements in the licensee's documentation, consistent with commitments made by the licensee in its July 2013 letter to the NRC. The inspectors noted that the calibration records received two formal reviews, one by the contractor after completion of the instrument calibration and the second by a licensee representative when the instrument is returned to the licensee. The inspectors noted that instruments with capability to measure alpha, beta, and gamma radiation were available.

The inspectors conducted site tours, in part, to observe the licensee's storage of radioactive material and to conduct radiological surveys within the radiologically restricted area. In particular, the inspectors reviewed the status of 77 drums of source material being stored on-site. The inspectors noted that the drums of source material were in storage at the former yellowcake storage pad. Licensee records indicated that 58 drums of natural uranium were stored in a cargo trailer. The inspectors visually confirmed the presence of drums in the cargo trailer. Radiation readings taken with a micro-Roentgen instrument calibrated to radium-226 (Ludlum Model 19, Serial Number 015540, calibration due date of 07/22/15) indicated radiation levels of approximately 1.5 millirems per hour general area with a peak reading of 1.8 millirems per hour at a distance of approximately 12 inches (30 centimeters) from the side of the cargo trailer. Survey records obtained from the licensee's radiological control technicians confirmed the presence of these drums (Radiological Exposure Rate Survey Form dated 10/21/2014, Monthly Survey). In addition to the cargo trailer, the inspectors noted the presence of DUF<sub>4</sub> material staged for shipment in a Sealand container located adjacent to the cargo trailer. The inspectors observed 19 drums in this container.

The inspectors noted a reduction in the total number of drums in storage, as compared to previous inspection observations. In particular, the inspectors noted that three drums were no longer listed in the licensee's inventory. The inspectors discussed this discrepancy with licensee staff. The licensee responded that Drum 22 was a consolidation of Drums 7 and 8 with some additional material added to the drum. The third missing drum, Drum 11, was emptied. The licensee's records reflect a transfer of 817 pounds of material from this drum to another NRC licensee (International Isotopes), and the remainder of the drum contents (539 pounds) was transferred to Drum 21. In summary, the licensee's records accurately reflected the number of drums in storage in the cargo trailer and Sealand container.

## 2.3 Conclusions

The licensee conducted its radiation protection program in accordance with the requirements of 10 CFR Part 20 and the license.

### **3 83890 Closeout Inspection and Survey**

#### **3.1 Inspection Scope**

The purpose of this portion of the inspection was to ensure that the licensee was conducting radiological surveys during decommissioning in accordance with license requirements.

#### **3.2 Observations and Findings**

##### **a. Review of Final Status Survey Results**

License Condition 51 stipulates that site decommissioning be conducted in accordance with the guidance provided in the Reclamation Plan dated January 2008, as amended. At the time of the inspection, the licensee had excavated several former disposal areas. These disposal areas included the Pond 1 spoils pile area, northern burial area, fluoride clarifier, and fluoride settling basins. The northern burial area included the former interim storage cell, cylinder laydown yard, DUF<sub>4</sub> Building foundation, and various disposal and burn pits. Before the licensee could backfill these areas, the licensee had to verify that the ground surfaces met certain radiological characteristics.

The NRC-approved Reclamation Plan provides two sets of survey requirements, depending on the radionuclides of concern in that area. In certain areas, the radionuclides of concern include thorium-230, radium-226, and natural uranium. These areas include the clarifier basins, Pond 2, and Pond 1 spoils pile area. For the remainder of the site, the radionuclide of concern is natural uranium.

Section 3.2.3 of the Reclamation Plan specifies that the licensee will conduct final status surveys based on the radionuclides of concern for that area. The Reclamation Plan stipulates that the former Pond 1 spoils pile area, an area with radium and thorium contamination, will be surveyed in accordance with the requirements specified in 10 CFR Part 40, Appendix A, Criterion 6. The licensee is required to survey the natural uranium contaminated areas using the guidance provided in NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)."

To verify if an area was adequately remediated, the licensee collected soil samples and measured ambient gamma radiation levels. The licensee conducted these scan surveys to identify areas of elevated radioactivity. Normally, gamma scans were conducted in areas with uranium contamination only. In accordance with the Reclamation Plan, gamma scans may be used to support surveys in areas with thorium and radium contamination. Because thorium-230 is not easily detected in the environment using gamma scan surveys, soil sampling is the primary method for ensuring compliance with the cleanup criteria in the Pond 1 spoils pile area.

Section 3.2.2 of the Reclamation Plan provides the cleanup criteria for radionuclides in soil. If the soil sample results are less than the cleanup levels, then the licensee has effectively remediated the areas. If the sample results are above the cleanup levels, the licensee is required to conduct additional reclamation work in that area. The soil cleanup levels provided in the Reclamation Plan are presented in Table 1:

**Table 1: Cleanup Levels (picocuries per gram)\***

Depth of Sample (in centimeters)	Natural Uranium (total uranium)	Thorium-230	Radium-226
First 15 cm below surface	100 pCi/g	≤ 14 pCi/g	≤ 5 pCi/g
Greater than 15 cm below surface	100 pCi/g	≤ 43 pCi/g	≤ 15 pCi/g

\*According to Section 3.2.2 of the Reclamation Plan, the cleanup levels will be applied without subtracting background levels

In addition to soil sampling, the licensee conducted scan surveys. For these types of surveys, the licensee established an action level of three times background. This action level represents the differentiation between background levels and contaminated material. Prior to conducting the walk-over scan survey of an excavated area, the licensee conducted survey measurements in a background area. The licensee then compared the measurements in the excavated area to the background measurements. Any area that exhibited elevated contamination was flagged for further investigation or additional remediation. As noted above, the licensee was required to conduct scan surveys in areas with natural uranium contamination; the licensee had the option of conducting scan surveys in areas classified with thorium and radium contamination.

The licensee conducted surveys of the various remediated areas to demonstrate that the residual radioactivity in each survey unit satisfied the applicable release criteria. Detail guidance for conducting final status surveys was provided in Attachment B, "Final Status Survey," of the Reclamation Plan. Additional details are provided in site procedure AI-33, "Final Status Survey, Class 1 Soils." The inspectors reviewed the licensee's final status survey design and survey results for the four excavated areas, in part, to ensure that the licensee had remediated and surveyed the areas in accordance with Reclamation Plan requirements.

The Pond 1 spoils pile area was approximately 6,070 square meters (m<sup>2</sup>) in size. In this area, the radionuclides of concern included thorium-230, radium-226, and natural (total) uranium; therefore, the licensee conducted a radiological survey in accordance with the instructions provided in 10 CFR Part 40, Appendix A, Criterion 6. The licensee established 100 m<sup>2</sup> survey grids and collected soil samples from each grid for comparison to the cleanup levels provided in the Reclamation Plan. The licensee was not required to conduct a scan survey of the Pond 1 spoils pile area.

However, the licensee conducted gamma scan surveys and collected soil samples in narrow strips of land adjacent to the Pond 1 spoils pile area. In these two areas, the licensee established 250 m<sup>2</sup> survey grids, as allowed by the Reclamation Plan. One of two areas was located between the Pond 1 spoils pile area and the western edge of the disposal cell. After completion of the scan survey and soil sampling in this narrow strip of land, the licensee elected to construct a berm in this area. This berm was constructed as a safety precaution, to help prevent the potential for slumping of the western edge of the disposal cell.

The licensee collected 77 soil samples in the Pond 1 spoils pile area and adjacent strips of land including eight duplicate and eight replicate samples. The samples were analyzed by an offsite laboratory. Because the excavated Pond 1 spoils pile area will be backfilled, the subsurface cleanup levels are the limits that apply in this situation. The

highest natural (total) uranium sample result was 92 picocuries per gram (pCi/g) with a cleanup level of 100 pCi/g. The highest radium-226 sample result was 1.27 pCi/g with a cleanup level of 15 pCi/g. Finally, the highest thorium-230 sample result was 38.7 pCi/g with a cleanup level of 43 pCi/g. All sample results were less than the respective cleanup limits.

As noted earlier, the licensee conducted walk-over survey scans of the narrow strip of land located to the east of the Pond 1 spoils pile area, the area that was partially covered by the newly constructed berm. The licensee's documentation indicates that the ambient gamma radiation levels were within the action level (three times background). The inspectors were unable to conduct a confirmatory survey of the area underneath the newly constructed berm; therefore, the inspectors had to rely on the licensee's survey results to demonstrate compliance with the cleanup levels.

The inspectors also reviewed the licensee's survey results for the fluoride clarifier, fluoride settling basins, and adjacent areas in the southern portion of the restricted area. This area was approximately 11,900 m<sup>2</sup> in size. The licensee's survey included gamma scans and soil sampling for natural (total) uranium concentrations. None of the licensee's scan survey results exceeded the action level (three times background), although elevated measurements were identified in the northeastern corner of the surveyed area. These elevated scan survey results were most likely the result of radiation emanating from the bagged raffinate sludge material located on the yellowcake storage pad.

The licensee established a 250 m<sup>2</sup> survey grid in this area. The licensee collected 68 soil samples from this area, including seven duplicate and seven replicate samples. The highest soil sample result for natural (total) uranium was 12.9 pCi/g. In summary, all soil sample results were below the cleanup level of 100 pCi/g.

Finally, the inspectors reviewed the licensee's survey results for the northern portion of the restricted area. This area included the former interim storage cell, cylinder laydown yard, DUF<sub>4</sub> Building foundation, and various disposal and burn pits. The surveyed area totaled 19,760 m<sup>2</sup> in size. Because the radionuclide of concern was natural uranium, the licensee conducted gamma scans and collected soil samples, using a 250 m<sup>2</sup> grid, from this area. The scan results were below the action level (three times background). The licensee collected 104 soil samples from this area, including 10 duplicate and 10 replicate samples for analysis of natural (total) uranium content. The highest sample result was 42.7 pCi/g with a cleanup level of 100 pCi/g. In summary, all sample results were less than the cleanup level.

The inspectors conducted a review of the licensee's survey design to ensure that the licensee collected a sufficient number of samples. Using MARSSIM guidance, for areas with natural uranium contamination only, the licensee calculated that each 2,000 m<sup>2</sup> survey unit should have at least eight sample locations—one sample for every 250 m<sup>2</sup> of surface area. Further, the licensee collected one sample from every 100 m<sup>2</sup> grid in the area with radium/thorium contamination. In addition, the licensee is required to collect duplicate/split and replicate samples for quality assurance/quality control requirements. In summary, the inspectors concluded that the licensee collected a sufficient number of samples to comply with Reclamation Plan and procedure requirements.

Table 3-1 of the Reclamation Plan provides the NRC-approved cleanup levels for the ground surface and backfill material. In accordance with the Reclamation Plan, the natural uranium concentrations in the soil and backfill material must be less than or equal to 100 picocuries per gram (pCi/g), with background included. If the soil exceeds this cleanup level, then it must be placed into the disposal cell. The inspectors reviewed the licensee's soil sample results for backfill material that were available during the inspection. All samples were less than the cleanup level (100 pCi/g). The licensee plans to submit the final status survey results to the NRC at a later date, after the site has been remediated.

b. Confirmatory Survey

The inspectors conducted confirmatory surveys of the Pond 1 spoils pile area, northern burial area, fluoride clarifier, and fluoride settling basins. The purpose of the surveys was to confirm the effectiveness and accuracy of the licensee's final status survey relative to whether the areas meet the acceptance criteria established in the Reclamation Plan. The confirmatory surveys included measurement of ambient gamma exposure rates and collection of soil samples.

The inspectors conducted the gamma scans using a Ludlum Model 19 microRoentgen survey meter calibrated to radium-226 (NRC No. 015540, calibration due date of 07/22/15) and a Ludlum Model 12 count rate meter with 2-inch by 2-inch sodium iodide probe (NRC No. 20888G, calibration due date of 07/30/15). Prior to conducting the gamma scans, the inspectors measured ambient background levels to establish action levels for each survey meter. The background measurements were recorded outside of the restricted area in the yard adjacent to the administrative building. Because the licensee's action level for gamma radiation exposure rates was three times the background level, for consistency, the NRC inspectors' action levels were also set at three times the measured background levels.

The inspectors conducted walk-over scan surveys of the four general areas. The inspectors measured the ambient gamma exposure rates using the Model 19 survey meter. With a background of 12-15 microRoentgens per hour ( $\mu\text{R/hr}$ ), the exposure rates in the Pond 1 spoils pile area ranged from 18-45  $\mu\text{R/hr}$ . The exposure rates in the north burial area ranged from 10-16  $\mu\text{R/hr}$ , while the exposure rates in the DUF<sub>4</sub> Building foundation area ranged from 13-15  $\mu\text{R/hr}$ . Finally, the exposure rates in the area of the fluoride clarifier and fluoride settling basins ranged from 15-35  $\mu\text{R/hr}$ .

The inspectors also surveyed the same areas with the Model 12 count rate meter. With a background of about 12,000 counts per minute (cpm), the count rates in the Pond 1 spoils pile area ranged from 18,000 to 60,000 cpm. One corner of the Pond 1 spoils pile area exceeded the action level of three times background. Further discussion of this area is provided below. The count rates in the north burial area ranged from 9,000-14,000 cpm, while the count rates in the DUF<sub>4</sub> Building foundation area ranged from 11,000-16,000 cpm. Finally, the count rates in the area of the former fluoride clarifier and fluoride settling basins ranged from 14,000-34,000 cpm.

As noted above, two areas approached or exceeded the action level of three times background. The first area was located in the southeastern corner of the Pond 1 spoils pile area. This general area was apparently impacted by radiation emanating from the bagged raffinate sludge material that was being stored on the adjacent yellowcake

storage pad. The Reclamation Plan identifies the Pond 1 spoils pile area as an area with thorium-230 contamination. Because thorium-230 is not easily detected in the environment using gamma scan surveys, soil sampling is the primary method for ensuring compliance with the cleanup criteria in the Pond 1 spoils pile area. The second area with elevated gamma radiation levels was the northeastern corner of the former north fluoride settling basin. These elevated ambient radiation levels were most likely due to the stored raffinate sludge material as well as unremediated soils located to the east of the former fluoride settling basins.

The inspectors collected 18 soil samples for comparison to the cleanup levels. Six samples were collected from the former Pond 1 spoils pile area, four samples were collected from the north burial area, two samples were collected from the DUF4 Building foundation area, four samples were collected from the north and south settling basins, and two samples were collected from the fluoride clarifier area. The inspectors submitted the soil samples to the NRC's contract laboratory, Oak Ridge Associated Universities in Oak Ridge, Tennessee.

The samples collected from the Pond 1 spoils pile area were analyzed by alpha and gamma spectroscopy for determination of thorium-230, radium-226, and total uranium concentrations. The remainder of the samples was analyzed by gamma spectroscopy for determination of total uranium concentrations. The licensee collected split samples and submitted the samples to its contract laboratory for radiochemical analysis. The NRC's sample results and the licensee's split sample results are presented in Tables 2-4 below in units of picocuries per gram (pCi/g):

**Table 2: Split Sample Results for Total Uranium Concentrations**

NRC Sample	Licensee Sample	Sample Location	NRC (pCi/g)	Licensee* (pCi/g)
NRC-1	HA-1806	Pond 1 spoils pile, north-central area	7.01 ± 0.51	5.12
NRC-2	HA-1807	Pond 1 spoils pile, northeastern edge	13.6 ± 1.00	10.6
NRC-3	HA-1808	Pond 1 spoils pile, central area	3.32 ± 0.27	3.40
NRC-4	HA-1809	Pond 1 spoils pile, western edge	7.50 ± 0.59	7.38
NRC-5	HA-1810	Pond 1 spoils pile, southeastern area	5.70 ± 0.42	4.64
NRC-6	HA-1811	Pond 1 spoils pile, southern edge	3.09 ± 0.25	2.10
NRC-7	HA-1812	North burial area, southeastern drainage ditch	3.00 ± 0.53	1.73
NRC-8	HA-1813	North burial area, northern culvert	17.26 ± 0.9	13.7
NRC-9	HA-1814	North burial area, northwest area	5.70 ± 0.70	3.14
NRC-10	HA-1815	North burial area, western edge	3.09 ± 0.58	1.93
NRC-11	HA-1816	DUF <sub>4</sub> Building foundation, northern edge	9.41 ± 0.72	8.67
NRC-12	HA-1817	DUF <sub>4</sub> Building foundation, eastern edge	2.84 ± 0.60	2.26
NRC-13	HA-1818	Area northeast of north fluoride settling basin	3.64 ± 0.66	2.59
NRC-14	HA-1819	Area southeast of south fluoride settling basin	4.97 ± 0.66	3.51
NRC-15	HA-1820	North fluoride settling basin, northeast corner	2.91 ± 0.54	2.16
NRC-16	HA-1821	South fluoride settling basin, northeast corner	2.92 ± 0.61	2.27
NRC-17	HA-1822	Fluoride clarifier, northeast corner	3.10 ± 0.58	2.09
NRC-18	HA-1823	Fluoride clarifier, southwest area	3.21 ± 0.64	1.91

\*Licensee's sample results were converted from units of micrograms per gram to units of pCi/g

**Table 3: Split Sample Results for Radium-226 Concentrations**

NRC Sample	Licensee Sample	Sample Location	NRC pCi/g	Licensee pCi/g
NRC-1	HA-1806	Pond 1 spoils pile, north-central area	1.05 ± 0.06	0.42 ± 0.15
NRC-2	HA-1807	Pond 1 spoils pile, northeastern edge	1.30 ± 0.07	0.85 ± 0.19
NRC-3	HA-1808	Pond 1 spoils pile, central area	1.14 ± 0.06	0.58 ± 0.17
NRC-4	HA-1809	Pond 1 spoils pile, western edge	1.07 ± 0.07	1.13 ± 0.24
NRC-5	HA-1810	Pond 1 spoils pile, southeastern area	1.21 ± 0.06	0.44 ± 0.14
NRC-6	HA-1811	Pond 1 spoils pile, southern edge	1.13 ± 0.07	0.70 ± 0.16

**Table 4: Split Sample Results for Thorium-230 Concentrations**

NRC Sample	Licensee Sample	Sample Location	NRC pCi/g	Licensee pCi/g
NRC-1	HA-1806	Pond 1 spoils pile, north-central area	1.28 ± 0.16	1.07 ± 0.29
NRC-2	HA-1807	Pond 1 spoils pile, northeastern edge	17.2 ± 1.80	27.1 ± 1.03
NRC-3	HA-1808	Pond 1 spoils pile, central area	3.99 ± 0.42	4.43 ± 0.52
NRC-4	HA-1809	Pond 1 spoils pile, western edge	17.0 ± 1.70	14.1 ± 0.85
NRC-5	HA-1810	Pond 1 spoils pile, southeastern area	3.06 ± 0.33	1.30 ± 0.30
NRC-6	HA-1811	Pond 1 spoils pile, southern edge	1.76 ± 0.20	1.23 ± 0.21

The inspectors compared the total uranium, radium-226, and thorium-230 concentrations to the NRC-approved cleanup levels of 100 pCi/g for natural (total) uranium, 15 pCi/g for radium-226, and 43 pCi/g for thorium-230. All sample results were less than the respective cleanup levels.

Sample NRC-1, collected from the Pond 1 spoils pile area, was further analyzed by the licensee using the unity rule (Formula 4-3 from MARSSIM). According to Section 4.3.3 of MARSSIM, the unity rule is satisfied when the radionuclide mixture yields a combined fractional concentration limit that is less than or equal to 1.0. The licensee combined the

sample fractions (a summation of the radionuclide concentrations divided by the respective cleanup levels) for total uranium, radium-226, and thorium-230 at sample location NRC-1. The combined fractions totaled 0.8, a value below the unity limit of 1.0. Accordingly, this location could be free-released based on MARSSIM guidance.

The inspectors noted that the NRC's sample results were similar to the licensee's sample results suggesting good correlation between the two laboratories. Some variations in sample results can be explained by different laboratory sample protocols and possible inadequate mixing of split samples in the field. In summary, the confirmatory survey results suggest that the licensee had adequately remediated the Pond 1 spoils pile, north burial area, DUF<sub>4</sub> Building foundation, fluoride settling basins, and fluoride clarifier.

### 3.3 Conclusions

The inspectors reviewed the licensee's final status survey design and sample results for four general areas that were previously excavated. The four areas included the former Pond 1 spoils pile, north burial area, DUF<sub>4</sub> Building foundation, and the combined fluoride settling basins and fluoride clarifier. The licensee's records indicate that it designed and conducted its surveys in accordance with license requirements, and all sample results were less than the limits specified in the NRC-approved Reclamation Plan.

The inspectors conducted confirmatory surveys of the four excavated areas. The surveys included measurement of ambient gamma radiation levels and collection of soil samples. All soil sample results were less than the limits specified in the Reclamation Plan. The confirmatory survey results indicate that the licensee had effectively remediated the four areas.

## 4 **Exit Meeting**

The inspectors reviewed the preliminary inspection scope and findings during an exit meeting conducted at the conclusion of the onsite inspection on November 30, 2014. The final inspection findings were presented to the licensee's staff by telephone on January 21, 2015, after receipt of the confirmatory survey soil sample results. During the inspection, the licensee did not identify any information reviewed by the inspectors as proprietary.

## SUPPLEMENTAL INFORMATION

### PARTIAL LIST OF PERSONS CONTACTED

#### Sequoyah Fuels Corporation

J. Ellis, President  
R. Miller, Contractor, RMA  
S. Munson, Manager, Health, Safety and Environment  
B. Reid, Director, Decommissioning, RMA  
K. Schlag, Manager, Quality Assurance, RMA

### INSPECTION PROCEDURES USED

IP 88001	Onsite Construction
IP 83822	Radiation Protection
IP 83890	Closeout Inspection and Survey

### ITEMS OPENED, CLOSED, AND DISCUSSED

#### Opened

None

#### Closed

None

#### Discussed

None

### LIST OF ACRONYMS

ADAMS	Agencywide Documents Access and Management System
CFR	Code of Federal Regulations
cpm	counts per minute
DUF <sub>4</sub>	depleted uranium tetrafluoride
IP	Inspection Procedure
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
m <sup>2</sup>	square meters
μR/hr	microRoentgens per hour
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram