

**U. S. NUCLEAR REGULATORY COMMISSION
SAFETY EVALUATION REPORT ON**

**CENTRUS ENERGY CORP. REQUEST FOR REVIEW AND APPROVAL
OF AMERICAN CENTRIFUGE LEAD CASCADE FACILITY FINAL
STATUS SURVEY REPORT AND REQUEST FOR TERMINATION OF
DECOMMISSIONING FUNDING**

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Table of Contents

1.	INTRODUCTION.....	1
2.	BACKGROUND	2
2.1	History	2
2.1.1	Facility Licensing, Operation, and Decommissioning	2
2.1.2	Facility Operating History.....	4
2.1.3	Spills	5
3.	RADIOLOGICAL SURVEY RESULTS.....	6
4.	DOSE ASSESSMENT EVALUATION.....	6
4.1	Introduction.....	6
4.2	Exposure Scenario	7
4.3	Radionuclides of Concern.....	7
4.4	RESRAD-BUILD Analyses	8
4.5	Evaluation Of Area Factors and DCGL _{EMC} Values	10
4.6	Dose Assessment Findings	12
4.7	NRC Inspections of Decommissioning Activities	12
4.8	Environmental Protection Agency (EPA) Consultation	12
5.	ENVIRONMENTAL INFORMATION	12
6.	ALARA ANALYSIS	13
7.	FACILITY RADIATION SURVEYS.....	13
7.1	Release Criteria	13
7.2	Decommissioning Funding.....	13
8.	CONCLUSION	13

1. INTRODUCTION

This Safety Evaluation Report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's safety review and provides the basis for NRC's approval of Centrus Energy Corp.'s (Centrus) Final Status Survey (FSS) Report (FSSR), dated April 19, 2018 (NRC Agencywide Document Access and Management System [ADAMS] Accession No. ML18145A127), for the American Centrifuge Lead Cascade Facility (LCF) located near Piketon, Ohio.

It is noted that the NRC's review of the LCF FSSR is interrelated with its review of Centrus' LCF Decommissioning Plan (DP) dated January 5, 2018 (ADAMS Accession No. ML18025B285). Generally DPs are reviewed and approved prior to commencement of major decommissioning activities. However, since Centrus completed its major decommissioning activities in accordance with existing programs under its LCF License SNM-7003 (ADAMS Accession No. ML18192B477), prior to NRC's approval of its DP, Centrus was also able to complete its FSS and submit its FSSR prior to the NRC's approval of the DP. The NRC approved the LCF DP on August 7, 2018 (ADAMS Accession No. ML18192B590) as part of Amendment No. 14 of the LCF license SNM-7003.

This SER documents the NRC staff's review of the survey results, and assessment of the potential dose to future site users, as well as summarizes confirmatory survey results from surveys following all cleanup activities conducted at the LCF. It is also noted that the NRC's approval of the FSSR provides the basis for cancelling Centrus' LCF decommissioning fund, which Centrus had posted in the form of a surety bond.

Subpart E, "Radiological Criteria for License Termination," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation," establishes criteria for the release of sites for unrestricted use. Specifically, the residual radioactivity that is distinguishable from background radiation must result in a total effective dose equivalent to the average member of the critical group¹ of less than 0.25 millisieverts per year (mSv/y) (25 millirem per year (mrem/y)). In addition to meeting this limit, the residual radioactivity must be further reduced to levels that are as low as reasonably achievable (ALARA).

Calculations provided in the DP show that 50,000 disintegrations per minute per 100 square centimeters (dpm/100 cm²) is equivalent to the 0.25 mSv/y (25 mrem/y) dose requirement. However, the LCF license requirements are more restrictive, limiting total contamination levels for unrestricted release to 5,000 dpm/100 cm². NRC staff approved Centrus's use of 5,000 dpm/100 cm² value in the SER for the DP (ADAMS Accession No. ML18192B644) since it is consistent with LCF licensing requirements and satisfies the ALARA requirement in 10 CFR Part 20.

Centrus chose to calculate derived concentration guideline levels (DCGLs) to demonstrate compliance with the 10 CFR Part 20, Subpart E, dose-based criterion of 0.25 mSv/y (25 mrem/y). A DCGL is a radionuclide-specific surface residual radioactivity level that results in a dose of 0.25 mSv/y (25 mrem/y) to the average member of the critical group. The DCGL approach assumes that the entire LCF site is contaminated with uranium at the concentration that corresponds to a dose of 0.25 mSv/y (25 mrem/y). Because of the conservative

¹ The critical group is defined as the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

assumption that the entire site is at the calculated DCGL, this compliance approach provides the NRC staff with reasonable assurance that the exposure will not exceed the regulatory limit of 0.25 mSv/y (25 mrem/y).

2. BACKGROUND

2.1 History

2.1.1 Facility Licensing, Operation, and Decommissioning

In the early 1980s, the U.S. Department of Energy (DOE) initiated its construction of the Gas Centrifuge Enrichment Plant (GCEP) at the Portsmouth Gaseous Diffusion Plant (PORTS GDP) site in Piketon, Ohio. After installing and operating several hundred centrifuges, the DOE terminated the GCEP project in 1985. Approximately 15 years later, United States Enrichment Corporation (USEC), Inc. decided to use and expand the existing GCEP facilities for deploying its own commercial centrifuge plant. In 2004, USEC, Inc. signed a lease agreement with DOE to use certain GCEP facilities for testing and eventual commercial production as part of its overall gas centrifuge uranium enrichment project.

The NRC issued Materials License No. SNM-7003 for the LCF to USEC, Inc. on February 24, 2004 (ADAMS Accession No. ML062630432). At that time, USEC, Inc., under contract with the DOE, dismantled and packaged for transport for offsite disposition, the DOE's contaminated and non-contaminated GCEP classified waste, consisting of centrifuges and equipment. After licensing by the NRC, USEC, Inc. began to install its own centrifuges in a portion of one of the two existing GCEP process buildings and began operating the LCF as a test facility in August of 2006. The LCF's purpose was to obtain "reliability, performance, cost, and other data" for use in the decision whether to construct and operate a commercial uranium enrichment plant, commonly referred to as the American Centrifuge Plant (ACP). To govern any future commercial operation of the ACP, the NRC issued Materials License No. SNM-2011 on April 13, 2007 (ADAMS Accession No. ML070400284). To date, no significant construction activities have occurred at the ACP. These NRC licenses were subsequently modified to reflect USEC, Inc.'s change of name to Centrus in 2014.

The LCF lies completely within the ACP site, occupying about 10 percent of the space reserved for the ACP. The ACP site, in turn, lies completely within DOE's controlled access area, where an adjoining uranium enrichment facility using a gaseous diffusion process previously operated for several decades. Currently, DOE is decommissioning this facility. The layout of the Piketon site with the existing ACP and LCF buildings (circled) is provided in the figure below.



Figure 1. Overflight photo of the Piketon site with the existing ACP and LCF buildings circled

On March 2, 2016, Centrus notified the NRC, in accordance with paragraph 70.38(d)(2) of 10 CFR, of its decision to permanently cease operation of the LCF and to terminate Materials License No. SNM-7003 following decontamination and decommissioning activities (ADAMS Accession No. ML16074A405).

On May 17, 2016, Centrus submitted a license amendment request to the NRC to downgrade licensed activities at the LCF to “limited operations” and to remove enrichment capabilities from the license (ADAMS Accession No. ML16162A194). The NRC approved the amendment on December 23, 2016 (ADAMS Accession No. ML16330A248).

After notifying the NRC of its intent to decommission the LCF, Centrus began to remove the process gas in the form of uranium hexafluoride (UF_6) and other materials and package all LCF classified equipment, including all LCF centrifuges and piping. Starting in June 2017, Centrus transferred the materials and equipment packages for offsite disposition. The equipment packages were shipped to the DOE's National Nevada Security Site (NNSS) for disposal, over a period of about six months. Soon after that, the NRC verified that all classified matter had been shipped offsite for appropriate disposition and withdrew Centrus' authorization to possess classified information or material/equipment at the LCF and ACP in Piketon, Ohio. Although the NRC had not yet approved the DP, under the authority of its LCF license, Centrus completed the majority of the physical activities necessary for decommissioning the LCF prior to June 2018.

On March 1, 2017, Centrus had submitted its DP for the LCF (ADAMS Accession No. ML17067A183). On October 11, 2017, the NRC provided Centrus with Requests for Supplemental Information (RSI) (ADAMS Accession No. ML17262A075) related to the DP submittal. On October 30, 2017, the NRC met with Centrus to discuss the RSI (ADAMS Accession No. ML17321A081). As a result of the RSI and subsequent meeting, by letter dated November 8, 2017 (ADAMS Accession No. ML17324A264), Centrus withdrew the DP

Amendment Application submitted on March 1, 2017. In the letter, Centrus committed to submit an updated DP reflecting the current decommissioning status and incorporating the information requested in the RSI. Centrus submitted the revised DP on January 5, 2018 (ADAMS Accession No. ML18025B285).

After completing its LCF decommissioning activities, Centrus conducted its FSS of the LCF. Centrus documented the results of the survey in its FSSR and submitted it by letter dated April 19, 2018 to the NRC for approval (ADAMS Accession No. ML18145A127). After Centrus submitted its FSSR, the NRC informed Centrus that it would not commence its review of the FSSR as the NRC had not approved the LCF DP and Centrus had not requested termination of the LCF license (ADAMS Accession No. ML18187A220). Since the NRC had not approved Centrus' DP, Centrus was unable to submit its request to terminate the LCF license. On August 7, 2018, the NRC approved the DP as well as the proposed DCGLs (ADAMS Accession No. ML18192B477). Two days later, on August 9, 2018, Centrus submitted its request to terminate its LCF license SNM-7003 (ADAMS Accession No. ML18249A298). After Centrus' August 9, 2018 request was added in ADAMS on September 6, 2018, the NRC began its acceptance review along with its review of the FSSR. However, before the NRC completed its acceptance review, on September 19, 2018, DOE's Office of Nuclear Energy (DOE-NE) staff informed NRC staff that DOE-NE was interested in having Centrus restart centrifuge enrichment operations at Piketon for the purpose of generating uranium enriched up to 20 percent by weight, also known as High Assay Low Enriched Uranium (HALEU). At that point, the NRC temporarily halted its review of Centrus' request to terminate SNM-7003 along with its review of the FSSR. The NRC restarted its review of the FSSR, albeit at a slow pace, after DOE published a notice of intent to issue a sole-source contract with Centrus for the demonstration of HALEU production on January 8, 2019. According to the January 8th notice, DOE's HALEU Demonstration Program has two primary objectives:

- deployment of a 16 machine AC-100M HALEU cascade producing 19.75% U-235 enriched product by October 2020; and
- demonstration of the capability to produce HALEU with existing U.S.-origin enrichment technology, and provide DOE with a small quantity of HALEU beginning in 2020 for use in its research and development activities and other programmatic missions.

On May 31, 2019, DOE and Centrus signed the three-year sole-source contract. It was ratified on June 1, 2019. By letter dated June 18, 2019, Centrus requested the NRC to approve its FSSR thereby authorizing a full refund of its decommissioning fund for the LCF (ADAMS Accession No. ML19172A105). By letter dated June 27, 2019 (ADAMS Accession No. ML19186A272), Centrus requested to withdraw its LCF license termination request submitted on August 9, 2018. In accordance with this arrangement Centrus will continue to maintain its NRC license for programmatic purposes and will contain a license condition stating that no licensed material shall be received into the LCF without prior NRC approval.

2.1.2 Facility Operating History

The staff has reviewed the information in the "Facility Operating History" Section of the DP according to NUREG-1757, Volume 1, "Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees," Section 16.2. This information was used to assist the NRC staff in evaluating Centrus' determination of the radiological status of the facility.

During LCF's operation as a test and demonstration facility, the cascade operated on "recycle," where the enriched product stream was recombined with the depleted stream prior to being re-fed to the cascade. As a result, very little waste was produced during operations. Only small volume samples of UF₆ (<10 grams [g]) were removed from the process for laboratory analysis.

Table 1.2-2 of the License Application for the LCF provides the Authorized Uses of NRC-Regulated Materials (ADAMS Accession No. ML17107A403). Prior to December 23, 2016, the facility was licensed to enrich uranium up to 10 weight percent U-235. On December 23, 2016, Amendment 9 of the NRC Materials License SNM-7003 authorized the removal of enrichment of uranium from Table 1.2-2 of the License Application (ADAMS Accession No. ML16330A248). At the time of granting of the amendment, the equipment needed to enrich uranium was either de-inventoried of gaseous UF₆ and/or was removed from the operating portions of the LCF such that conducting any enrichment of UF₆ was not physically possible.

During operations, the licensed material was primarily used in a section of one of the two existing centrifuge process buildings (X-3001 Process Building, Train 3) intended for centrifuge machine demonstration and testing. As needed, used centrifuge machines containing small quantities of uranium were transferred to the X-7726 Centrifuge Training and Test Facility, located adjacent to X-3001, for rebuild and then transferred back to Train 3 for operation via the X-7727H Transfer Corridor.

The total amount of licensed material that was received by the LCF over the course of its operation was approximately 318 kilograms (kg) of UF₆ at natural assay (approximately 0.711 weight percent U-235). The amount of licensed material that was present in the LCF never exceeded 205 kg of UF₆. Uranium compounds encountered at the LCF were primarily within the highly soluble (Class "D") uranium compounds; namely UF₆ and uranyl fluoride (UO₂F₂). Additionally, there were instrument calibration and check sources as addressed in Section XV.a of the DP.

Prior to the initial issuance of the NRC Materials License SNM-7003 in February 2004, the processing of uranium occurred intermittently within these buildings/facilities under a DOE approved Safety Basis. Additionally, there was some PORTS GDP waste stored in certain areas of the buildings/facilities. Therefore, there was a potential for DOE legacy contaminants in the form of uranium and its decay products in areas where the DOE machines were operated and handled and where DOE waste was stored. In addition to uranium and its decay products, very small quantities of technetium could also have been present as a result of storage of DOE waste from the PORTS GDP in various empty areas of the buildings that housed the LCF. Centrus' FSS and NRC's confirmatory radiological surveys of these areas in the form of gross alpha and gross beta and gamma measurements did not find any contamination levels exceeding the DCGLs. The lower than the DCGL gross alpha measurements not only indicates acceptably low levels of uranium but also acceptably low levels of any other alpha radiation emitting contaminants that may have been present in DOE's legacy waste such as Neptunium-237.

2.1.3 Spills

As discussed in the DP, spills did occur inside the facilities while under DOE regulation and were remediated to less than the surface contamination values in Appendix D of 10 CFR Part 835 prior to the NRC assuming regulatory control of the LCF. The licensee's corrective action program further confirms that there were no documented spills or uncontrolled

releases of radioactive material to the environment during the life of the NRC Materials License. In the DP, the licensee did commit to investigating any survey locations exceeding 1,000 dpm/100 cm² fixed alpha from uranium. After reviewing the survey data, the licensee performed additional measurements if a sample location indicated greater than two times the detection limit for the survey instrument. These conditions were found to occur at two different locations; in both cases the measurements were found to be less than the LCF License Application limits for fixed and removable contamination provided in the DP.

3. RADIOLOGICAL SURVEY RESULTS

As part of the FSS, Centrus collected 1,576 direct measurement scans. No alpha or beta results exceeded the 5,000 dpm/100 cm² limit. Except for a few locations, all survey results were less than 1,000 dpm/100 cm² alpha and beta and removable samples collected were all less than 20 dpm/100 cm².

The Oak Ridge Institute of Science and Engineering (ORISE), under contract with the NRC, performed confirmatory surveys, including radiation scans and sampling during the period of May 21-25, 2018, to independently assess whether contaminated areas remain at the site (ADAMS Accession No. ML18233A343). Confirmatory survey activities included alpha-plus-beta radiation floor scans, beta radiation drain scans, alpha radiation scans and direct measurements, and smear sampling, as applicable, in the X-3001 Train 2 North Utility Bay, X-3001 Train 3 North Utility Bay, X-3001 Trains 2 and 3 North Utility Bay Drains, X-3001 Train 1 Mezzanine, X-3001 Train 3 Mezzanine, X-3001 Train 3, X-3001 Train 3 Centrifuge Drains, X-3001 Train 6, X-7726 Centrifuge Training and Testing Facility, X-7726 Second Floor Utility Room, X-3012 Hot Shop, and X-7725 Loading/Storage Area.

ORISE's survey results, combined with laboratory analytical results from the smear samples, did not identify anomalous results or other conditions that preclude the FSS data from demonstrating compliance with the release criteria.

4. DOSE ASSESSMENT EVALUATION

4.1 Introduction

The DP proposed the use of DCGLs for documenting the cleanup of the LCF. Centrus proposed the use of 5,000 dpm/100 cm² as the established cleanup level in order to satisfy its agreement with the DOE. The approved DP proposed the use of computer code RESRAD-BUILD, Version 3.5, and site-specific parameter values to calculate doses corresponding to the previously established release criteria. Area factors, related to the two areas with relatively low levels of contamination, were then calculated and used to develop DCGL_{EMC} values. The resulting DCGL_{EMC} values were compared to the 5,000 dpm/100 cm² value to determine whether the proposed cleanup level is acceptable.

Centrus used the following modeling assumptions related to the site as input to its RESRAD-BUILD evaluation:

- The site will continue to be utilized as an industrial facility following decommissioning and termination of its NRC license; therefore a full-time industrial worker occupying the site is considered to be the most reasonably foreseeable exposure scenario;

- The occupancy time for the full-time industrial worker is assumed to be an 8 hour work day, 5 days per week, and 50 weeks per year (i.e., 2000 hours per year);
- The exposure area is based on the size of the Train 2 Utility Bay, the section of the X-3001 building expected to have the greatest potential for exposure;
- Contamination is assumed to be uniformly distributed throughout the site;
- The solubility of the uranium compounds in any residual contamination are categorized as Class D (the most likely chemical form being UO_2F_2); and
- Based on process knowledge at the site, the residual uranium contamination is assumed to exist in a ratio of 0.72 U-235, equivalent to naturally occurring uranium.

This section summarizes Centrus's dose analysis approach, which was previously reviewed during the NRC staff's review of the DP and found acceptable, and the NRC staff's review and findings following completion of decommissioning activities.

4.2 Exposure Scenario

The licensee considered an industrial worker scenario to be the most reasonably foreseeable exposure scenario for the site. The industrial worker was assumed to work an 8 hour work day, 5 days per week, and 50 weeks per year (i.e., 2000 hours per year). Based on the conditions of the site and reasonably foreseeable future uses for this site, NRC staff agree with the use of this scenario.

4.3 Radionuclides of Concern

While operating the LCF, Centrus evaluated various models and configurations of centrifuges associated with processes used to enrich uranium. The closed recycling process involved recombining the enriched UF_6 stream at the top end of the cascade with the depleted stream at the bottom of the cascade, essentially reforming near-natural uranium that would be placed back into the cascade. As part of these operations LCF was licensed to enrich uranium up to 10 weight percent U-235.

The arrangement between Centrus and the DOE required the facility be returned to DOE in a condition that meets the NRC's radiological criteria for unrestricted use. In general this means that Centrus would clean up the site to meet the 0.25 mSv/y (25 mrem/y) requirements discussed in 10 CFR 20.1402, "Radiological criteria for unrestricted use." This corresponds to a DCGL_W of 50,000 dpm/100 cm^2 for the facility. However, LCF license requirements are more restrictive, limiting the total contamination levels for unrestricted release to 5,000 dpm/100 cm^2 . The corresponding uranium concentrations, which were used in the RESRAD-BUILD analyses, are shown in Table 1.

Table 1. Natural uranium concentrations corresponding to 5,000 dpm/100 cm²

	Isotopic Ratio	Concentration (pCi/g)
U-234	0.4966	111846.8
U-235	0.0225	5067.6
U-238	0.4809	108310.8

4.4 RESRAD-BUILD Analyses

Centrus used a combination of site-specific and default RESRAD-BUILD parameter values to evaluate the doses associated with an industrial worker in the building. Considering an average work year of 2000 hours, the indoor time fraction was set to 0.23. Ingestion and inhalation dose conversion factors (DCFs) for U-234, U-235, and U-238 were also modified in a site-specific RESRAD-BUILD DCF library in consideration of the highly soluble (“Class D”) uranium compounds (e.g., UF₆ and UO₂F₂) associated with past activities performed in the building. Use of these site-specific values were reviewed and found acceptable during the NRC staff’s review and approval of the DP (ADAMS Accession No. ML18192B644).

The greatest exposure potential was associated with the X-3001 building so the RESRAD-BUILD model was conservatively developed to include a single room with an area of 676.4 m² and a ceiling height of 2.5 m. Centrus performed sensitivity analyses to evaluate the contributions from other parameters, including the removable fraction, the resuspension rate, and the indoor fraction on the DCGL_W. Results provided in the DP demonstrate that the only parameter that ultimately impacts the dose is the indoor fraction, which doubled the dose when increased from 0.23 or 2000 hours per year to 0.5 or 4380 hours per year. NRC staff agreed that it is unlikely that a single individual would spend half a year in the building. Evaluations using different DCGL_W values, which would be equivalent to different assays of uranium, were also found to have minimal impact on the dose. In all cases the maximum dose was calculated to occur at year zero which, for these analyses, corresponds to 2015.

During its review of the DP, NRC staff noted that some of the parameters Centrus used in its RESRAD-BUILD analysis were not the most conservative. The dose assessment provided in the DP considered a single square room with an area of 676 m² and a ceiling height of 2.5 m with a 531 m² circular area of contamination within the footprint of the square room. The RESRAD-BUILD analysis also centered the contaminant source in the corner of the room while placing the receptor in the middle of the room.

Following discussions with NRC staff, Centrus revised its analysis and submitted an updated RESRAD-BUILD analysis that considered contamination throughout the entire 676 m² room (ADAMS Accession No. ML18129A390). Figure 2 below provides a three dimensional diagram of the revised RESRAD-BUILD scenario evaluated by Centrus. Although this updated analysis was more conservative than the original submittal it still centered the contamination in the corner of the room and placed the receptor in the middle of the room.

Instead of issuing a second round of requests for additional information (RAIs), NRC staff performed an independent analysis to calculate doses associated with the more conservative exposure scenario. NRC staff modified the coordinates of the source to locate it on the floor in the center of the 26 m X 26 m room (X= 13, Y= 13, Z= 0). Using the guidance provided in

Section 2.3 of ANL/EAD/03-1, “User’s Manual for RESRAD-BUILD Version 3” (ANL, 2003), which indicates that the location of the calculated dose deposited within the receptor should be at the midpoint of the receptor, NRC staff also located the receptor in the center of the room, but 1 m above the floor (X= 13, Y= 13, Z= 1). Figure 3 provides a three dimensional diagram of the locations used in the NRC staff’s conservative RESRAD-BUILD analysis. It is important to note that the sizes of the circles identifying the contaminated areas in Figures 2 and 3 are not representative of the areas of contamination; the RESRAD-BUILD three dimensional diagrams are intended to demonstrate the location of the receptor and the center of the contaminated area. Using the U-234, U-235, and U-238 concentrations equivalent to the 5,000 dpm/100 cm² provided in Table 1 and these updates to the locations of both the contaminant and receptor NRC staff calculated a minimal increase in the dose from 0.0319 mSv/y (3.19 mrem/y) reported by Centrus to 0.0325 mSv/y (3.25 mrem/y).

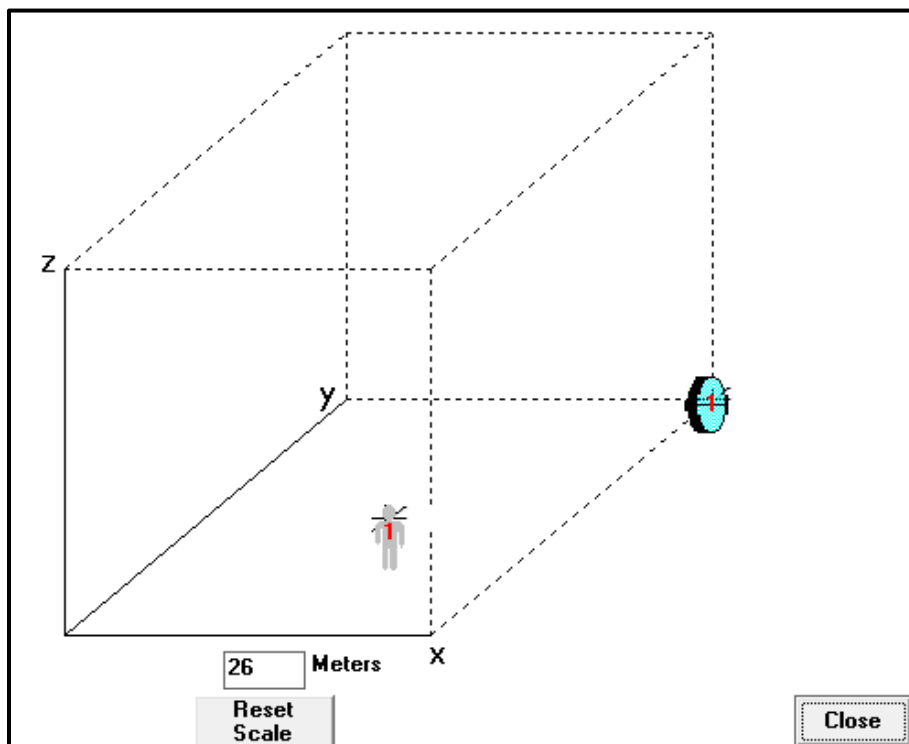


Figure 2. Diagram of the X-3001 room using the location parameters provided in the updated Centrus evaluation.

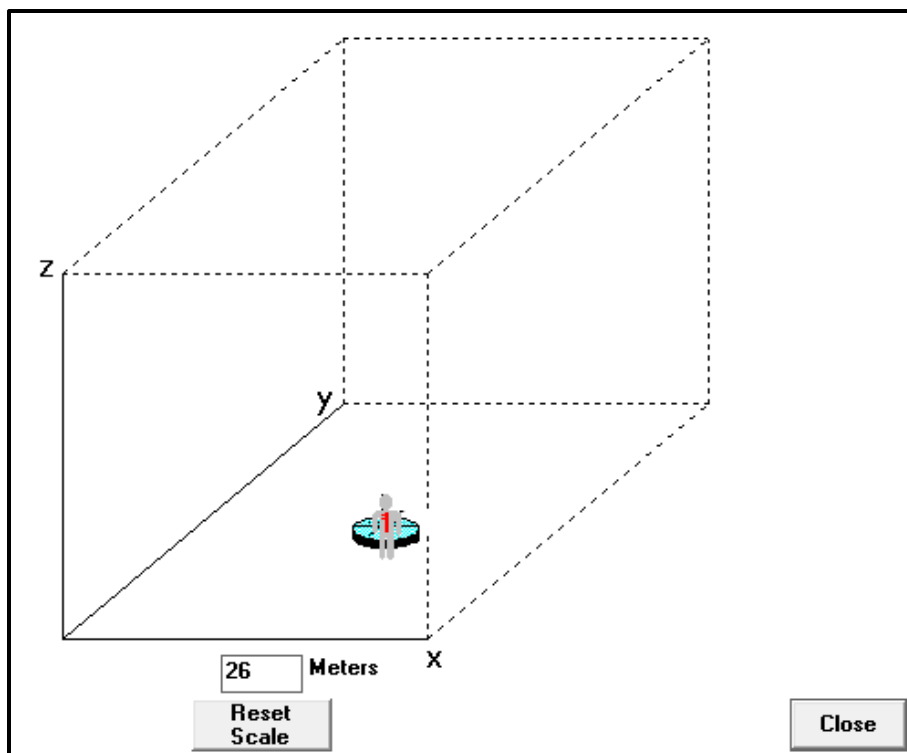


Figure 3. Diagram of the X-3001 room using the intended location parameters to describe the maximum dose received by individual located in the center of the room.

4.5 Evaluation Of Area Factors and $DCGL_{EMC}$ Values

Centrus demonstrated in the DP that 50,000 dpm/100 cm² is equivalent to the 0.25 mSv/y (25 mrem/y) dose requirement. However, the more restrictive licensing requirements for the LCF limits the total contamination levels for unrestricted release to 5,000 dpm/100 cm². Centrus proposes using the 5,000 dpm/100 cm² value since it is consistent with the LCF licensing requirements and satisfies the ALARA guidelines.

Centrus used the RESRAD-BUILD, Version 3.5, computer code with site-specific parameter values to demonstrate that the use of a $DCGL$ value of 5,000 dpm/100 cm² for the entire site is less than the site-specific $DCGL_{EMC}$ value for the known hot spots at the site. The $DCGL_{EMC}$ is calculated using the equation

$$DCGL_{EMC} = DCGL_W \times AF$$

The $DCGL_{EMC}$ was determined by first calculating an area factor (AF), which represents the magnitude by which the residual activity in a small area of elevated activity can exceed the $DCGL_W$ and still satisfy the 0.25 mSv/y (25 mrem/y) regulatory criterion. The AF was then multiplied by the $DCGL_W$, which is the $DCGL$ for the entire site, to calculate the $DCGL_{EMC}$.

Using Microsoft Excel, Centrus plotted area factors for specific areas based on doses calculated using RESRAD-BUILD to create a graphical representation. The corresponding equation of the curve was used to extrapolate the area factor for the hot spot area of concern (9.313 m²). The corresponding $DCGL_{EMC}$ for the 9.313 m² area was then calculated.

NRC staff had some initial concerns with this approach. NRC staff noted that the U-238 values from Table 5.7, “Illustrative Example of Indoor Area Dose Factors,” in NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” Revision 1, were used for deriving site-specific DCGLs. NRC staff also observed that the RESRAD-BUILD analyses for calculating the DCGL_W were based on a circular contaminated area of 531 m² and not the entire 676 m² area of the room.

Centrus submitted an updated version of the DCGL_{EMC} calculations that addressed the issues with uranium and included the entire room area in the DCGL_W calculation (ADAMS Accession No. ML18157A298). However, NRC staff noted that the curve and corresponding equation used to calculate the area factors considered a maximum total room area of 36 m² and that the area factors used to create the curve were based on comparing the dose from the smaller area to the dose corresponding to a 36 m² contaminated area. The dose associated with the entire 676 m² room area was not considered when calculating the area factor.

To evaluate Centrus’s approach for determining the area factor and corresponding DCGL_{EMC}, NRC staff used the data provided by Centrus to calculate a site-specific area factor using RESRAD-BUILD and the following equation:

$$AF = \frac{DCGL_{EMC}}{DCGL_W} = \frac{(25 \text{ mrem} / \text{Dose for } DCGL_{EMC})}{(25 \text{ mrem} / \text{Dose for } DCGL_W)} = \frac{DCGL_{EMC} \text{ Dose}}{DCGL_W \text{ Dose}}$$

where 0.25 mSv/y (25 mrem/y) is the dose required to meet the regulatory requirements for unrestricted use. NRC staff then used the area factor to calculate a DCGL_{EMC} value using a total room area of 36 m², which is the approach used by Centrus. NRC staff also calculated the area factor and corresponding DCGL_{EMC} values using a total room area of 676 m². Table 2 provides the data used by Centrus to calculate a DCGL_{EMC} based on a total area of 36 m². Table 3 contains the Centrus data used by NRC to calculate the DCGL_{EMC} for the same size hot spot in a 676 m² room. Footnote b to Table 3 notes that the NRC staff independently calculated a DCGL_{EMC} of 2.20E+06 dpm/100 cm².

Table 2. Evaluating Centrus’s DCGL_{EMC} calculation from the DP (DCGL_W area = 36 m²)

	Area (m ²)	Dose (mrem/y)	Area Factor	DCGL _{EMC} (dpm/100 cm ²)
DCGL _W	36	1.70E-01		
Hot Spot	9.316	4.41E-02	3.85	1.50E+05 ^a

^a Centrus, using the equation from the curve, calculated a DCGL_{EMC} of 151,555 dpm/100 cm²

Table 3. Using the DCGL_W dose at t=0 for an area of 676 m² to calculate the DCGL_{EMC}

	Area (m ²)	Dose (mrem/y)	Area Factor	DCGL _{EMC} (dpm/100 cm ²)
DCGL _W	676	3.19 ^b		
Hot Spot	9.316	4.41E-02	72.3	2.82E+06

^b The NRC staff calculated a dose of 3.25 mrem/y, which resulted in an area factor of 56.5 and a corresponding DCGL_{EMC} of 2.20E+06 dpm/100 cm²

As expected, the resulting area factor considering the entire 676 m² room area, 72.3, was larger than the area factor of 3.85 calculated using a DCGL_W based on an area of 36 m². However, both DCGL_{EMC} values are larger than the 5,000 dpm/100 cm² value being proposed for evaluating any remaining radioactive contamination in the area. Therefore, the NRC staff

concludes that the use of the 5,000 dpm/100 cm² DCGL as the basis for this site to be considered “clean” is conservative and acceptable.

4.6 Dose Assessment Findings

The NRC staff reviewed Centrus’s dose modeling approach for the LCF as part of the review of the DP using Section 5.2 of NUREG-1757, Volume 2, “Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria.” The staff concluded that the exposure scenario, building site conceptual model, and source term are appropriate for assessing risks to individuals associated with future uses of the site, and for demonstrating compliance with the decommissioning criterion of 0.25 mSv/y (25 mrem/y) contained in 10 CFR Part 20.

Using the same approach NRC staff reviewed the findings provided by Centrus in the FSSR (ADAMS Accession No. ML18145A131). Table XI-1 of the FSSR summarizes the RESRAD-BUILD results for various areas of the site over time following all decommissioning activities. NRC staff reviewed these results and confirmed that doses to an industrial worker were all less than 0.01 mSv/y (1 mrem/yr) and therefore meet the 0.25 mSv/y (25 mrem/y) dose limit for unrestricted use as required by 10 CFR 20.1402.

4.7 NRC Inspections of Decommissioning Activities

NRC RIII conducted two inspections and issued two inspection reports during the decommissioning and FSSs at the LCF (ADAMS Accession Nos. ML18260A122 and ML18026A651). No violations were documented in the reports.

Separately, NRC Region II performed a security facility clearance closeout inspection between January 3 and 11, 2018, and confirmed the absence of classified information and material from the site.

4.8 Environmental Protection Agency (EPA) Consultation

On October 9, 2002, the NRC and the U.S. EPA entered into a Memorandum of Understanding (MOU) on “Consultation and Finality on Decommissioning and Decontamination of Contaminated Sites” (ADAMS Accession No. ML022830208). In accordance with the MOU, consultation with the EPA is not required for decommissioning sites that do not result in any radiological or non-radiological contamination of the environment or groundwater. Since the decommissioning of the LCF did not trigger this criterion of the MOU, the NRC did not consult with EPA for the present action.

5. ENVIRONMENTAL INFORMATION

The NRC staff prepared an Environmental Assessment (EA) (ADAMS Accession No. ML18204A294) for the DP in accordance with 10 CFR 51.30. Based on the review documented in the EA, the NRC staff determined that review and approval of the DP will not significantly affect the quality of the human environment. Therefore, a finding of no significant impact (FONSI) was appropriate. The draft EA was sent to the Ohio Department of Health for review and comment on June 12, 2018 (ADAMS Accession No. ML18130A472). The Ohio Department of Health responded on July 6, 2018, that it had no comments on the draft EA (ADAMS

Accession No. ML18193A742). The final EA and FONSI for the DP were published in the *Federal Register* on August 1, 2018 (83 FR 37530).

6. ALARA ANALYSIS

The NRC's regulations at 10 CFR 20.1402 provide, among other things, that before a site may be considered acceptable for unrestricted use, the residual radioactivity must be reduced to levels that are ALARA. The staff utilized the guidance in NUREG-1757, Volume 1, specifically Section 6 and Appendix N, to assess whether Centrus had met this regulatory requirement. This guidance indicates that the ALARA evaluation for compliance with decommissioning criteria should include quantitative analyses, when appropriate, and typical good practice efforts. Centrus has adopted a clean-up action level that is a factor of ten times below the release criteria in 10 CFR 20.1402, as determined by the DCGLs. Accordingly, Centrus has adequately demonstrated that it meets the ALARA requirements.

7. FACILITY RADIATION SURVEYS

7.1 Release Criteria

As discussed above, Centrus has chosen to decommission the facility to meet the release criteria of 10 CFR 20.1402 for unrestricted use. The staff has reviewed the information in the DP according to the requirements of 10 CFR 20.1402 and guidance contained in NUREG-1757, Volume 2, Section 4.1. The LCF is considered acceptable for unrestricted use under 10 CFR 20.1402 since the residual radioactivity that is distinguishable from background radiation to an average member of the critical group is less than 0.25 mSv/y (25 mrem/y). The guidance in NUREG-1757, Volume 2, Section 4.1, recommends that DCGLs be used to design the FSS and to demonstrate compliance with the radiological release criteria. Based on its review of the DP, the NRC staff had determined that Centrus had adequately summarized the DCGLs and area factors used for survey design and for demonstrating compliance with the radiological criteria for license termination.

7.2 Decommissioning Funding

The staff evaluated the licensee's DP and the FSSR and determined the facility meets the unrestricted release criteria of 10 CFR 20.1402. Therefore, the surety bond which Centrus provided to the NRC to cover the estimated cost to decommission the facility (ADAMS Accession No. ML13114A304) is being cancelled. As the NRC license will remain in place, the license is being amended by adding a license condition that the licensee cannot bring any radiological material onsite, including for test and calibration purposes, without prior NRC approval. Depending on the quantity and types of material, such an approval may require the licensee to reestablish decommissioning financial assurance prior to bringing radiological material onsite.

8. CONCLUSION

Centrus' FSS and the NRC's confirmatory surveys found that no measurements exceeded the DCGL_w for the site. Therefore, no statistical analysis was required to confirm that the LCF demonstrates compliance with the decommissioning radiological dose criterion of 0.25 mSv/y (25 mrem/y) contained in 10 CFR Part 20. Further, in compliance with the ALARA requirements

in 10 CFR 20.1402, Centrus set its DCGLw sufficiently lower than the level that could theoretically result in a dose equal to the 0.25 mSv/y (25 mrem/y) decommissioning dose criterion. In addition, to avoid any potential for inadvertent addition of radiological contamination in the LCF in the future, as a part of this amendment, the NRC is adding a license condition proposed by Centrus in its June 2019 request (ADAMS Accession No. ML19172A105) that prohibits introduction of radioactive material into the LCF without prior NRC approval. Therefore, the NRC staff concludes that the LCF has met the NRC's decommissioning requirements warranting a complete cancellation of the outstanding decommissioning fund for the LCF in the amount of \$15,980,000 which was approved and held by the NRC within the executed surety bond as previously provided by Centrus by letter dated April 15, 2013 (ADAMS Accession No. ML131140304).