

**U.S. NUCLEAR REGULATORY COMMISSION SAFETY
EVALUATION REPORT FOR THE HIGH ASSAY LOW
ENRICHED URANIUM DEMONSTRATION PROGRAM
AT CENTRUS ENERGY CORP./AMERICAN
CENTRIFUGE OPERATING, LLC's AMERICAN
CENTRIFUGE PLANT IN PIKETON, OHIO**

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EXECUTIVE SUMMARY

American Centrifuge Operating, LLC (ACO), a wholly owned indirect subsidiary of Centrus Energy Corp. (Centrus), possesses two gas centrifuge enrichment facility licenses from the U.S. Nuclear Regulatory Commission (NRC). One license (SNM-7003), initially issued in 2004, is for the demonstration facility known as the American Centrifuge Lead Cascade Facility (LCF) located on a U.S. Department of Energy (DOE) reservation in Piketon, Ohio, which, until December 2016, authorized uranium enrichment in up to 240 operating centrifuges in existing buildings leased by ACO from the DOE. The purpose of the LCF, which operated from 2006 to 2016 and was decommissioned in 2018, was to demonstrate centrifuge cascade operation and obtain performance data. No product was withdrawn from the cascade for commercial purposes. ACO's second license (SNM-2011), issued in 2007 under 10 CFR Parts 30, 40 and 70 for a period of 30 years, is for the commercial production facility known as the American Centrifuge Plant (ACP). The NRC's safety and safeguards review for the commercial ACP is documented in NUREG-1851, which was issued in September 2006. These NRC licenses were subsequently modified in 2014 to reflect USEC Inc.'s change of name to Centrus. The LCF lies completely within the commercial ACP site, occupying about 10 percent of the space reserved for the commercial ACP. The commercial ACP site, in turn, lies completely within the southwest quadrant of the DOE's reservation, where an adjoining uranium enrichment facility using a gaseous diffusion process previously operated for several decades. Currently, DOE is decommissioning this facility.

On May 31, 2019, ACO signed a three-year letter contract with the DOE to deploy a cascade of 16 operating uranium enrichment centrifuges to demonstrate production of high-assay, low-enriched uranium (HALEU) fuel up to an enrichment of 19.75 percent uranium-235 (U-235). The contract terms were finalized on October 31, 2019. The contract states the ACP HALEU Demonstration Program has two primary objectives:

- (1) Deploy a 16-machine cascade producing 19.75 percent U-235 enriched HALEU product; and
- (2) Demonstrate the capability to produce HALEU with existing U.S.-origin enrichment technology and produce for DOE, by the end of the 3-year contract period, between 200 and 600 kilograms of HALEU in the form of uranium hexafluoride (UF₆) for future use in DOE's research and development activities and other programmatic missions.

Subsequent to signing the contract, ACO modified and updated the existing commercial ACP License Application (LA) and supporting documents and provided new supporting documents, where needed, to incorporate the HALEU Demonstration Program in the existing commercial ACP LA documents and prepared them for submittal to the NRC for their review and approval. Between December 2019 and June 2020, ACO provided the NRC a revised LA (RLA) and supporting documents to operate the HALEU cascade under the ACP license until its 3-year contract period with DOE ends on May 31, 2022. At the end of the contract period, the amendment being issued by this licensing action will expire. At that time, ACO will have the option of turning the facility back to DOE, unless it has its ACP license amended by the NRC and its lease agreement for the Piketon facility amended by DOE for a period beyond May 31, 2022.

In reviewing the submitted RLA and supporting documents, the staff focused on the new information in the form of changes and updates made to the previously approved LA and

supporting documents and new supporting documents. For the evaluation of areas with new or revised guidance or regulation, the staff also reviewed the descriptions and commitments for the commercial ACP, as approved in NUREG-1851, that are contained in the submitted RLA and supporting documents, to ensure continued demonstration of compliance with the appropriate requirements and consistency with the guidance used to conduct this review.

NRC staff conducted its safety review of the RLA and supporting documents in accordance with NUREG-1520 Revision 2, "Standard Review Plan for Fuel Cycle Facilities License Applications." For the staff's review of the safeguards section of the RLA and supporting documents, the staff used NUREG/CR-5734, "Recommendations to the NRC on Acceptable Standard Format and Content for the Fundamental Nuclear Material Control (FNMC) Plan Required for Low-Enriched Uranium Enrichment Facilities." For its review of the physical protection of special nuclear material (SNM), the staff used Regulatory Guide 5.59, "Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate to Low Strategic Significance."

The staff also reviewed ACO's Quality Assurance Program Description. ACO also submitted supplemental information updating the Environmental Report for the ACP. This information was used to prepare an Environmental Assessment for the HALEU Demonstration Program that was issued on June 4, 2021.

Although ACO can receive, store, assemble, and install the HALEU cascade equipment under its existing approved LCF programs, ACO may not begin enrichment operations until after the Commission verifies through inspection that the HALEU cascade has been installed in accordance with the requirements of the license (see 10 CFR 70.32(k)).

A summary of NRC's review and findings in each of the review areas is provided below:

General Information

ACO provided an adequate description of the HALEU cascade and processes so that the staff has an overall understanding of the relationships of the facility features as well as the function of each feature. Financial qualifications were properly explained and outlined in the application. The updated description of the site continues to include important information about regional hydrology, geology, meteorology, the nearby population, and potential effects of natural phenomena at the facility.

Organization and Administration

ACO adequately updated the description of the responsibilities and associated resources for the design, construction, and operation of the facility and its plans for safely and securely managing the HALEU Demonstration Program. The plans and commitments described in the application provide reasonable assurance that an acceptable organization, administrative policies, and sufficient competent resources have been established or committed for safe and secure operation of the HALEU cascade.

"Integrated Safety Analysis" (ISA) and ISA Summary

ACO adequately updated information about the site, processes, hazards, and types of accident sequences for the HALEU Demonstration Program. The updated information addressed

credible events, their potential radiological and chemical consequences, and their likelihoods. The ISA Summary and onsite review demonstrated that the performance requirements in Section 70.61 (b), (c) and (d) are met. ACO also provided adequate information about items relied on for safety (IROFS). License Condition 18 will be maintained to ensure that IROFS boundaries will be defined using ACO's IROFS boundary definition procedure.

Radiation Protection

ACO provided sufficient information to evaluate the Radiation Protection Program for the HALEU Demonstration Program. The application adequately describes the updates to: (a) the implementation program; (b) the program for ensuring that worker and public doses are as low as reasonably achievable (ALARA); (c) the qualification requirements; (d) the commitment to use written radiation protection procedures including radiation work permits; (e) the necessary training for all personnel who have access to radiologically restricted areas; (f) the ventilation and respiratory protection program; and the radiation survey and monitoring program. These aspects of the HALEU Demonstration Program demonstrate a comprehensive radiation protection program that is adequate to protect workers and members of the public who may be potentially exposed to radiation. This program is supported by the ISA, which identifies the events that could result in radiation exposures and commits to appropriate mitigations.

The labeling and posting special authorizations, as approved in NUREG-1851, continue to be applicable for the HALEU amendment. The alternate container labeling is authorized for UF₆ feed, product, and depleted uranium cylinders, and labeling bulk storage areas in lieu of individual container labeling within the radiologically restricted areas at the ACP. The ACO is also approved for an alternative method for controlling access to high radiation areas using radiation work permits and appropriate monitoring.

Nuclear Criticality Safety

ACO provided adequate information to evaluate the updated Nuclear Criticality Safety (NCS) program for the HALEU Demonstration Program. ACO described an NCS program that adequately protects against criticality hazards and assures that all nuclear processes are subcritical under normal and credible abnormal conditions, with an approved margin of subcriticality for safety, consistent with regulatory requirements. ACO described an NCS program that will adequately implement and maintain a criticality accident alarm system consistent with regulatory requirements.

Chemical Process Safety

ACO adequately described and assessed the updated chemical accident sequences and consequences for the HALEU Demonstration Program that could result from the handling, storage, or processing of licensed materials and that could have potentially significant chemical consequences and effects. ACO performed hazard analyses that identified and evaluated chemical process hazards and potential accidents and established safety controls that meet the regulatory requirements.

Fire Safety

ACO committed to engineered and administrative controls to minimize the risk of fires and explosions that may be associated with the HALEU Demonstration Program. The IROFS and defense-in-depth protection discussed in ACO's ISA Summary, along with the safety basis

assumptions and planned programmatic commitments in the license application, meet associated regulatory requirements and provide reasonable assurance that operation of the HALEU cascade is protected against fire hazards.

Emergency Management

ACO did not modify the commercial ACP Emergency Plan (EP) for the 3-year HALEU Demonstration Program. Instead, in accordance with the regulations in 10 CFR 70.22(i), ACO provided an evaluation for the HALEU Demonstration Program showing that the maximum dose to a member of the public offsite due to an accidental release of radioactive materials would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium during operations until the expiration of the contract period ending on May 31, 2022. Based on that information, the NRC determined that ACO does not require an EP to operate the HALEU Demonstration Program cascade until ACO's 3-year contract with DOE expires on May 31, 2022. However, if ACO desires to expand the scope of operation of the HALEU Demonstration Program beyond the description in the RLA or extend operations beyond May 31, 2022, it will need to reassess the need for an EP.

Environmental Protection

ACO committed to adequate environmental protection measures for the HALEU Demonstration Program, including: (a) environmental and effluent monitoring; and (b) effluent controls to maintain public doses ALARA as part of the radiation protection program. ACO's proposed controls are adequate to protect the environment and the health and safety of the public and comply with the regulatory requirements.

Decommissioning

ACO did not modify the ACP conceptual decommissioning plan or the decommissioning funding plan for the 3-year HALEU Demonstration Program, as, per its Lease Agreement with ACO, the Department of Energy has accepted all responsibility for decommissioning the facility after the end of the three-year contract period. However, if ACO desires to expand the scope of operation of the HALEU cascade beyond what is described in the RLA or extend operations beyond May 31, 2022, it will need to modify the terms of its Lease Agreement with DOE. The modified terms of the Lease Agreement will determine at that time whether a decommissioning plan or a decommissioning funding plan is needed.

Management Measures

ACO provided updated information in the RLA about management measures that will be applied to the 3-year HALEU Demonstration Program. The revised management measures discussion describes: (a) the overall configuration management program and policy; (b) the maintenance program; (c) training; and (d) the process for the development, approval, and implementation of procedures that are related to the operation and implementation of IROFS and for the management measures supporting the availability and reliability of those IROFS. ACO explained the audits and assessments program as well as incident investigations and records management system. ACO confirmed its commitment to establishing and documenting surveillances, tests, and inspections to provide reasonable assurance of satisfactory performance of the IROFS. The updated management measures are acceptable and meet the regulatory requirements in 10 CFR 70.62(d). ACO continues to request an exemption from the

reporting criteria for issuing a written follow-up report within 30 days of the initial event report. The staff continues to authorize this exemption.

Material Control and Accounting

ACO provided updated information describing the Fundamental Nuclear Material Control Plan (FNMCP) for the three-year HALEU Demonstration Program. The increase in the uranium enrichment levels from 10 wt.% for the commercial ACP up to but less than 20 wt.% for the HALEU Demonstration Program warrants an increase in the categorization of the facility from a Category 3 to a Category 2 (see definitions for special nuclear material of low and moderate strategic significance in 10 CFR Part 73). The FNMCP describes the programs to be used to control and account for SNM in the HALEU Demonstration Program. The program meets the applicable regulatory requirements in Part 74.

Physical Protection

ACO provided updated information on the policies, methods, and procedures to be implemented to protect SNM of moderate strategic significance used and possessed as part of the HALEU Demonstration Program. Previously, for the commercial ACP, this information was for protecting SNM of low strategic significance. The updated information is acceptable and meets the requirements in Part 73.

1 GENERAL INFORMATION

American Centrifuge Operating, LLC (ACO) is a wholly owned, indirect subsidiary of Centrus Energy Corp. (Centrus). It possesses two gas centrifuge enrichment facility licenses from the U.S. Nuclear Regulatory Commission (NRC). One license (SNM-7003), initially issued in 2004 is for the demonstration facility known as the American Centrifuge Lead Cascade Facility (LCF) located on a U.S. Department of Energy (DOE) reservation in Piketon, Ohio, which authorized up to 240 operating centrifuges. The NRC's license (NRC, 2004) and its associated Safety Evaluation Report (NRC, 2004a) for the initial approval of the LCF were issued in February 2004 and January 2004, respectively. The purpose of the LCF, which operated between 2006 and 2016 and was decommissioned in 2018, was to demonstrate centrifuge cascade operation and obtain performance data. No product was withdrawn from the cascade for commercial purposes. ACO's second license (SNM-2011) is for a proposed commercial production facility [that is yet to be built] known as the American Centrifuge Plant (ACP). The proposed commercial ACP would physically encompass the LCF within its footprint. The ACP license (SNM-2011) was initially issued in 2007 under 10 CFR Parts 30, 40 and 70 for a period of 30 years (NRC, 2007). As part of the initial licensing review, the NRC issued its Safety Evaluation Report (SER) for the commercial ACP in September 2006 (NRC, 2006). This SER pertains to an amendment request to the ACP license for the high-assay low-enriched uranium (HALEU) Demonstration Program submitted by ACO in portions between December 2019 and June 2020 (ACO, 2019a, ACO, 2020, ACO, 2020a, ACO, 2020b, and ACO, 2020c). The HALEU Demonstration Program involves operation of a 16-centrifuge cascade under SNM-2011 to demonstrate and produce a small quantity of HALEU in the form of UF₆ for the DOE in the buildings that formerly housed the LCF.

1.1 BACKGROUND

On May 31, 2019, ACO signed a three-year letter contract with the DOE to deploy a cascade of 16 operating uranium enrichment centrifuges to demonstrate production of HALEU fuel up to 19.75 percent U-235. The contract terms were finalized on October 31, 2019 (ACO, 2019). According to the contract, the HALEU Demonstration Program has two primary objectives:

- (1) Deploy a 16-machine cascade producing 19.75 percent U-235 enriched HALEU product; and
- (2) Demonstrate the capability to produce HALEU with existing U.S.-origin enrichment technology and produce for DOE, by the end of the 3-year contract period, between 200 and 600 kilograms of HALEU in the form of UF₆ for future use in DOE's research and development activities and other programmatic missions.

Subsequent to signing the contract, ACO updated and revised the commercial ACP License Application (LA) and supporting documents to incorporate the HALEU Demonstration Program and prepared them for submittal to the NRC for its review and approval. Between December 2019 and June 2020, ACO provided the NRC various submittals pertaining to the revised commercial ACP LA (RLA) and supporting documents to operate the HALEU cascade under the ACP license. These submittals were as follows:

- (1) Engineering Evaluation (EE) entitled NCS Code Validation of SCALE 6.2.3 and Cross Section Set v7-252 for k_{eff} Calculations (EE-3101-0013) submitted on December 5, 2019

(ACO, 2019a). The NRC staff's review of this EE is addressed in Chapter 5 and Appendix B of this SER.

- (2) Quality Assurance Program Description (QAPD) (ACO, 2020b), and Integrated Safety Analysis (ISA) Summary submitted on April 22, 2020 (ACO, 2020). The NRC staff's review of the RLA, QAPD, and ISA Summary is documented in Chapters 1 to 11 and Appendix A and B of this SER. ACO requested an approval of this submittal by June 2, 2021. Appendix A and B are non-publicly available and are marked Official Use Only – Security-Related Information.
- (3) Environmental Report (ER) and the Fundamental Nuclear Material Control Plan (FNMCP) submitted on May 7, 2020 (ACO, 2020a), as amended by letter dated June 17, 2020, (ACO, 2020b). The NRC staff's review of the ER is addressed in the environmental assessment (EA) (NRC, 2021) associated with this amendment. The NRC staff's review of the FNMCP is documented in Chapter 12 and Appendix C of this SER. ACO requested an approval of this submittal by June 2, 2021. Appendix C is non-publicly available and is marked Official Use Only – Security-Related Information.
- (4) Physical Security Plan (PSP) submitted on June 23, 2020 (ACO, 2020c), as supplemented by letter dated August 5, 2020 (ACO, 2020d). The NRC staff's review of the PSP is documented in Chapter 13 and Appendix D of this SER. ACO requested an approval of this submittal by June 2, 2021. Appendix D is non-publicly available and is marked Safeguards Information.

ACO also provided technical justifications for the proposed changes to the commercial ACP LA. According to ACO, the design capacity of the 16-centrifuge Demonstration Program facility will be 900 kilograms (Kg) uranium (U) of HALEU per year.

The RLA was developed using the original license application for the commercial ACP operation that was initially approved in 2007 (NRC, 2007). ACO modified the commercial ACP application and identified the changes for which it is seeking approval for the license amendment (modifications to the ACP LA were provided in redline/strikeout format). The NRC staff reviewed the proposed modifications to the ACP LA which are applicable to the HALEU Demonstration Program. The most significant changes in the RLA involved the increase in the operational enrichment limit from 10 wt.% U-235 to 25 wt.% U-235 necessary to operate the HALEU Cascade. The nuclear criticality safety (NCS) program was significantly modified due to changes in ACO's operations and increased enrichment, and the programs for physical protection of special nuclear material (SNM), and material control and accounting (MC&A) were significantly modified due to an increase in the significance of the security level of the facility from a Category 3 to a Category 2 facility. Operation of the relatively small capacity of the HALEU cascade (16 operating centrifuges compared to the approximately 11,500 centrifuges for the commercial ACP) will not require compliance with certain requirements that applied to the much larger proposed commercial facility. For example, ACO demonstrated to the NRC staff that according to the requirements of 10 CFR 70.22(i), an Emergency Plan is not required to operate the HALEU cascade for the duration of this license amendment, which ends with ACO's 3-year contract period with DOE. On May 25, 2021, ACO provided the NRC the entire RLA which is referenced in the ACP license SNM-2011 (ACO, 2021a) (ACO, 2021b) (ACO, 2021c).

Separate from this review, ACO received approvals from the NRC for the classified matter transportation security plan on October 20, 2020 (NRC, 2020), and for the classified matter

protection (CMP) plans to enable the re-establishment of ACO's possession facility clearance for its leased facility in Piketon, Ohio on October 30, 2020 (NRC, 2020a). After the NRC issued a facility clearance to ACO on October 30, 2020 to possess classified information, ACO began receiving, assembling, preparing and installing equipment for the HALEU cascade under its existing ACP and LCF licenses.

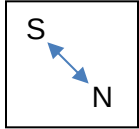
On February 6, 2020, ACO submitted its CMP plans for the Technology and Manufacturing Center (TMC) in Oak Ridge Tennessee (ACO, 2020e), where ACO manufactures centrifuge parts. The TMC CMP plans submission is separate from the CMP submittals for the facility in Piketon discussed above, and is not related to the amendment addressed in this SER. The NRC staff approved the TMC CMP plans and issued the amendment for the ACP license on March 25, 2021 (NRC, 2021a). This approval permitted the transfer of the TMC's Cognizant Security Agency (CSA) security regulatory oversight and its Authorizing Official (AO) responsibilities from the DOE to the NRC.

1.2 HISTORICAL PERSPECTIVE

In the early 1980s, the DOE initiated construction of the Gas Centrifuge Enrichment Plant (GCEP) at the Portsmouth Gaseous Diffusion Plant (PORTS) site in Piketon, Ohio. After installing and operating several hundred centrifuges, the DOE terminated the GCEP project in 1985. In 2004, USEC Inc. signed a Lease Agreement with DOE to use certain GCEP facilities for testing and for eventual commercial production. These activities were to be added to its overall gas centrifuge uranium enrichment project for the purpose of demonstrating the commercial viability of and for deploying new centrifuge enrichment technology.

The NRC issued Materials License No. SNM-7003 for the LCF to USEC Inc. on February 24, 2004 (NRC, 2004). The SER and Environmental Assessment (EA) associated with this licensing action was issued on January 28, 2004 (NRC, 2004b). 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, comprising of centrifuges and equipment. USEC Inc. installed centrifuges in a portion of one of the two existing GCEP process buildings, where USEC Inc. began operating the LCF as a test facility in August of 2006. The LCF test facility was licensed to obtain "reliability, performance, cost, and other data," to use in deciding whether to construct and operate a commercial uranium enrichment plant, referred to as the American Centrifuge Plant (ACP).

Separately, the NRC issued Materials License No. SNM-2011 on April 13, 2007 (NRC, 2007) to USEC Inc. for the proposed construction and commercial operation of a gas centrifuge facility known as the ACP. The NRC documented its safety and safeguards review of the ACP application in NUREG-1851, which was issued in September 2006 (NRC, 2006). The LCF lies completely within the ACP site, occupying about 10 percent of the space reserved for the ACP. The ACP site lies completely within the southwest quadrant of the DOE's reservation, where an adjoining uranium enrichment facility that used a gaseous diffusion process, was 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.



Overflight photo of the Piketon site with the existing ACP and LCF buildings (circled)

1.3 FACILITY AND PROCESS OVERVIEW

1.3.1 Purpose of The Review

The NRC staff reviewed and approved USEC Inc.'s Facility and Process Overview for the commercial ACP as documented in NUREG-1851, which was issued in September 2006 (NRC, 2006). The purpose of NRC's review of ACO's facility and process overview contained in the RLA is to evaluate whether ACO adequately described the HALEU Demonstration Program equipment, processes and facilities that will be used to protect health and minimize danger to life or property in the RLA documents. The areas of review in Chapter 1 of the RLA included; (1) general information, (2) plant and process description (overview), (3) site boundary and plant layout, (4) primary facilities description, (5) secondary facility description, (6) process description (detailed), (7) hazardous material storage, (8) phased modular expansion plan, (9) material of construction, (10) use of lubricants, (11) Chapter 1 Figures, and (12) Chapter 1 Tables.

1.3.2 Regulatory Requirements

The regulations in 10 CFR 70.22 "Contents of Applications," specifically in 10 CFR 70.22(a), establish requirements for the contents of the application.

1.3.3 Regulatory Guidance and Acceptance Criteria

The guidance and acceptance criteria used to review the facility and process description are contained in the Standard Review Plan for Fuel Cycle Facilities License Applications NUREG-1520, Rev.2 (SRP) (NRC, 2015). Section 1.1.3 of the SRP identifies the areas of review as; (1) Facility Layout Description, (2) Process Overview, (3) Site Overview, and (4) Descriptive

Summary of Licensed Material. The acceptance criteria applicable to the RLA Sections 1.1, 1.2 and 1.3 are contained in Section 1.1.4.3 of the SRP (NRC, 2015).

1.3.4 Staff Review and Analysis

1.3.4.1 General Information

In the RLA Section 1.0 General Information, ACO added information relevant to the HALEU Demonstration Program to the existing information applicable to the ACP. According to the RLA Section 1.0, the United States Enrichment Corporation (USEC)) leases portions of the Portsmouth Gaseous Diffusion Plant (GDP) reservation from the DOE through the non-public Lease Agreement between the DOE and USEC for the GCEP (GCEP Lease Agreement). Centrus subleased space for the LCF and the ACP from the USEC. Centrus, with approval of the DOE, assigned the sublease for the space for the ACP to ACO. ACO and its agents will conduct activities within the leased facilities and control access and egress, as stated in the RLA.

ACO modified the general information to reflect changes in contractual arrangements. ACO clarified that the HALEU Demonstration will not require new facilities for feed, withdrawal, sampling, and blending/transfer operations.

The NRC staff reviewed the changes to the general information section of the RLA. The staff determined that the original text subject to the changes described above adequately and sufficiently describe the licensee and the requested licensing action, and therefore, comply with 10 CFR 70.22(a) and are consistent with the guidance in Section 1.1.4.3 of the SRP (NRC, 2015).

1.3.4.2 Plant and Process Description

In the RLA Section 1.1 Plant and Process Description, in addition to editorial/administrative/nomenclature changes, ACO made substantial plant and process changes. For example, the changes reflect the fact that the HALEU cascade will enrich this material to an enrichment less than 20.0 wt.% U-235 in its product stream and will deplete the feed to a target tails stream enrichment of approximately equal to or less than 1.0 wt.% U-235, instead of the ACP which would enrich material to less than 10.0 wt.% U-235. The NRC staff reviewed the changes to the plant and process description section of the RLA and determined the changes comply with 10 CFR 70.22(a) and are consistent with the guidance in Section 1.1.4.3 of the SRP (NRC, 2015) and are therefore acceptable.

1.3.4.3 Site Boundary and Plant Layout

ACO did not make changes to the commercial ACP LA Sections 1.1.1 Site Boundary and 1.1.2 Plant Layout, where the physical location of the facility, the layout of the buildings, and the controlled access area within the site boundary is described. However, ACO did update figures, which are non-public, to include the HALEU cascade. The NRC staff continues to find this section consistent with the SRP Section 1.1.4.3, and therefore, is acceptable. The NRC staff's review of the non-publicly available figures is provided in Section 1.3.4.12 of this SER.

1.3.4.4 Primary Facilities Description

In the RLA Section 1.1.3 Primary Facilities Description, ACO retained the brief descriptions of the primary facilities associated with the ACP that involves up to about 11,500 operating centrifuges. These include the X-2232C Interconnecting Process Piping (IPP), X-3001 Process Building, X-3002 Process Building, X-3012 Process Support Building, X-3344 Customer Services Building, X-3346 Feed and Withdrawal Building, and X-3346A Feed and Product Shipping and Receiving Building. Other buildings and areas that provide direct support functions to the enrichment process are the X-7725 Recycle/Assembly Building, X-7726 Centrifuge Training and Test Facility, X-7727H Interplant Transfer Corridor, X-745G-2 Cylinder Storage Yard, X-745H (future) Cylinder Storage Yard, and X-7746S, X-7746W Cylinder Storage Yards and Intraplant Roadways and their descriptions are unchanged.

In the RLA Section 1.1.3, ACO described the first phase of enrichment production, the deployment of a cascade with 16 operating centrifuges and 2 spare centrifuges, which will demonstrate the feasibility of producing HALEU in the form of UF₆. The primary ACP building/facilities directly involved in the HALEU Demonstration Program are the X-3001 Process Building, X-3012 Process Support Building, X-7725 Recycle/Assembly Building, X-7726 Centrifuge Training and Test Facility, and X-7727H Interplant Transfer Corridor. Enclosure 3 of the RLA includes non-public drawings of the building layouts. ACO updated the Controlled Access Area (CAA) for the HALEU Demonstration Program in one of the drawings. No other substantive changes were made to Section 1.1.3 of the RLA.

In the RLA Section 1.1.3, ACO states its long-term goal is the resumption of commercial enrichment production consistent with market demand. The ACP design is modular, with the basic building block of enrichment capacity being a cascade of centrifuges. Modular deployment of additional cascades would accommodate market demand on a scalable, economical gradation. In the RLA Section 1.1.3, ACO states that the Fire Safety Program will be implemented to support the modular deployment, such that the fire protection systems/services are in place when needed.

The NRC staff reviewed the changes to the primary facility descriptions and determined them to be clear and sufficiently detailed, and therefore, in compliance with 10 CFR 70.22(a) and consistent with the guidance in SRP Section 1.1.4.3.

1.3.4.5 Secondary Facility Description

In the RLA Section 1.1.4 Secondary Facility Description, ACO describes secondary facilities, including the X-6000 Cooling Tower Pump House, Air Plant, Air Plant Support Systems; X-6002 Boiler System; X-6002A Oil Storage Facility, X-7721 Maintenance, Stores and Training Building, X-7725A Waste Accountability Facility, and X-7745R Recycle/Assembly Storage area. These facilities are depicted in the non-public drawings in Enclosure 3 of the RLA. ACO deleted the X-112 Data Processing Building and the X-1020 Emergency Operations Center from the commercial ACP LA since these two facilities will not be needed for the HALEU Demonstration.

The HALEU Demonstration cascade utilizes a centrifuge design similar to that used for the Lead Cascade. The equipment necessary to perform the HALEU enrichment process is located in the X-3001 Process Building and consists of the product and tails withdrawal system, uranium hexafluoride (UF₆) cylinders, centrifuges, and supporting units. The product and tails withdrawal systems use three cold boxes. Sodium fluoride (NaF) traps are used for additional withdrawal capacity during dumping. A 30B UF₆ cylinder is used for the feed material. Centrifuges and

supporting units are placed in the Train 3 area of the X-3001 Process Building. No other substantive changes were made to Section 1.1.4 of the RLA. The NRC staff reviewed the changes to the secondary facility descriptions and determined them to be clear and sufficiently detailed and therefore, in compliance with 10 CFR 70.22(a) and consistent with the guidance in SRP Section 1.1.4.3.

1.3.4.6 Process Description

In the RLA Section 1.1.5 Process Description, ACO addresses (1) centrifuge program history; (2) separation fundamentals; (3) centrifuge fundamentals; (4) enrichment process theory; (5) total process configuration; (6) enrichment process support systems; (7) centrifuge assembly and movement systems; and (8) plant support systems.

In the RLA Section 1.1.5.1 Centrifuge Program History, and in the rest of the Application, ACO made editorial changes by describing various structures as “facilities” or “buildings.” Whereas, previously these were exclusively described as “facilities.”

In the RLA Section 1.1.5.2, Separation Fundamentals, ACO notes that the HALEU Demonstration will increase the enrichment from a feed enrichment of up to 5.0 wt.% U-235 up to a target product enrichment of 19.75 wt.%. However, in its request to amend License SNM-2011, ACO proposed an increase in enrichment from 10 wt.% to 25 wt.%, as indicated in Table 1.2-2 Demonstration Program Possession Limits for NRC Regulated Materials and Substances of the RLA. ACO explained that authorization for the increased product enrichment is to account for in-process fluctuations that may result in small amounts of uranium with U-235 enrichments between 20 and 25 wt.%.

In the RLA Section 1.1.5.3 Centrifuge Fundamentals and in the remainder of the Application, ACO made one global editorial change, replacing the word “machine” with “centrifuge.”

In the RLA Section 1.1.5.4 Enrichment Process Theory, ACO did not make any changes.

In the RLA Section 1.1.5.5 Total Process Configuration, in addition to editorial/administrative changes, ACO notes that the centrifuges could be used with either Molecular Pumps or Diffusion Pumps.

In the RLA Section 1.1.5.6 Enrichment Process Support Systems, in addition to editorial/administrative changes, ACO notes that per 10 CFR 70.24, a Criticality Accident Alarm System (CAAS) is required in each area where threshold quantities (e.g., more than 700 grams of U-235) of special nuclear material are handled, used, or stored. Additionally, ACO notes that the CAAS coverage areas are identified on plant drawings, and controls are established to preclude special nuclear material from areas where coverage is not provided. The need for and use of CAAS is addressed in Chapter 5 of this SER.

In the RLA Section 1.1.5.7 Centrifuge Assembly and Movement Systems, in addition to editorial/administrative changes, ACO added the word “Cart” to the “Centrifuge Transporter” and clarified that it includes a tugger vehicle and can accommodate a maximum of two centrifuges. In addition, ACO clarified that it would not be using a separate trailer intra plant tow tractor with a capacity of up to ten centrifuges for the HALEU Demonstration Program.

The NRC staff reviewed the changes to the process descriptions and determined them to be clear and sufficiently detailed and therefore, in compliance with 10 CFR 70.22(a) and consistent with the guidance in SRP Section 1.1.4.3.

1.3.4.7 Hazardous Material Storage

In the RLA Section 1.1.6 Hazardous Material Storage, ACO only made editorial/administrative changes. The NRC staff continues to find this section to be consistent with the SRP Section 1.1.4.3 and therefore acceptable.

1.3.4.8 Roadways

In the RLA Section 1.1.7 Roadways, ACO only made editorial/administrative changes. The NRC staff continues to find this section to be consistent with the SRP Section 1.1.4.3 and therefore acceptable.

1.3.4.9 Phased Modular Expansion Plan

In the RLA Section 1.1.8 Phased Modular Expansion Plan for the American Centrifuge Plant, ACO deleted the reference to transitioning from the LCF to the ACP commercial plant and replaced it with a description of the HALEU Demonstration Program.

In the RLA Section 1.1.8.1 High Assay Low Enriched Uranium Demonstration, ACO states that the HALEU Demonstration cascade utilizes a centrifuge design similar to that used for the LCF. The equipment necessary to perform the enrichment process is in the X-3001 Process Building and consists of a product and tails withdrawal system, UF₆ cylinders, centrifuges, and supporting systems. The product and tails withdrawal systems use three cold boxes. The NaF traps provide additional withdrawal capacity during dumping. A 30B UF₆ cylinder is used to feed UF₆ to the HALEU cascade. Centrifuge and supporting units are placed in the Train 3 area of the X-3001 building. A more detailed process description is provided in Addendum 1 of the Integrated Safety Analysis for the American Centrifuge Plant - HALEU Demonstration.

In the RLA Section 1.1.8.1, High Assay Low Enriched Uranium Demonstration, ACO states that DOE amended Appendix 1 of the Lease Agreement between DOE and United States Enrichment Corporation for the Gas Centrifuge Enrichment Plant by renewing and extending the term of the lease through May 31, 2022. Additionally, in Section 1.1.8.1, ACO states that at the conclusion of the three-year HALEU Demonstration Program (Phase 1), the facilities will either be returned to the DOE in accordance with the requirements of the GCEP Lease Agreement or the parties will amend the GCEP Lease Agreement to allow the performance of other work on the leased premises.

The RLA Section 1.1.8.2 High Assay Low Enriched Uranium Demonstration Continuation, ACO states that the second phase of deployment would continue operation of the 16-centrifuge HALEU cascade for up to 10 years beyond the expiration of the current lease agreement with DOE.

In the RLA Section 1.1.8.4 Expanded Low Enriched Uranium and High Assay Low Enriched Uranium Production, ACO also discussed a potential future phase involving the addition of one or more 120-centrifuge HALEU cascades and/or LEU cascades and associated Feed and Withdrawal stations in a modular fashion all within the X-3001 building. In this potential phase, the HALEU cascades could be fed directly from associated LEU cascades or directly with LEU

cylinders. However, the NRC staff notes that ACO has not identified plans to initiate this expansion.

1.3.4.10 Material of Construction

In the RLA Section 1.1.9 Material of Construction, ACO did not make changes. The NRC staff continues to find this section in compliance with 10 CFR 70.22(a), consistent with the SRP Section 1.1.4.3, and therefore acceptable.

1.3.4.11 Use of Lubricants

In the RLA Section 1.1.10 Use of Lubricants, ACO did not make any changes. The NRC staff continues to find this section in compliance with 10 CFR 70.22(a), consistent with the SRP Section 1.1.4.3, and therefore acceptable.

1.3.4.12 Chapter 1 Figures

The figures in Chapter 1 of the RLA contain sensitive Export Controlled Information (ECI) as well as non-sensitive information. The sensitive figures are in Appendix B to the RLA. Revised Figure 1.1-1 (ECI) contains the outline of the Controlled Access Area for the ACP. Revised Figure 1.1-2 (ECI) in Appendix B identifies existing primary and secondary ACP facilities as well as the proposed, but not yet built, primary and secondary facilities. The non-sensitive Figures 1.1-12 and 1.1-16 illustrate the process flow schematics and show the use of diffusion pumps for the ACP centrifuges. However, ACO noted that the ACP centrifuges for the HALEU Demonstration may also use molecular pumps. The NRC staff reviewed the changes and determined that the modifications are in compliance with 10 CFR 70.22(a), consistent with the SRP acceptance criteria provided in SRP Section 1.2.2, and therefore acceptable.

Sensitive (ECI) RLA Figures 1.1-3, 1.1-4, 1.1-5a, 1.1-5b, 1.1-5c, 1.1-5d, 1.1-5e, 1.1-6, 1.1-7, 1.1-8, 1.1-9, 1.1-10, and 1.1-14, which provide drawings of equipment and process flow layouts, were not modified from the ACP LA (NRC, 2006). Sensitive (ECI) RLA Figures 1.1-11, 1.1-13, and 1.1-15, containing process flow schematics, were not substantially modified. Based on a review of the modifications, the NRC staff determined that they continue to satisfy the SRP acceptance criteria in Section 1.2.2 and are, therefore, acceptable. Accordingly, the NRC staff continues to find this section in compliance with 10 CFR 70.22(a), consistent with the SRP Section 1.1.4.3, and therefore acceptable.

1.3.4.13 Chapter 1 Tables

LA Table 1.1-1 entitled American Centrifuge Plant Major Facilities, provides a list of major ACP facilities and their corresponding functions. In addition to identifying editorial/administrative changes, ACO removed references to buildings that would not be utilized for the HALEU Demonstration Program. Specifically, ACO removed reference to the X-112 Data Processing Building, which provided secure housing for the data systems and necessary personnel, the X-1020 Emergency Operations Center, which served as a central location to coordinate any emergencies that occur on the DOE reservation, and the X-3000 Office Building, which housed personnel necessary for plant administration, from the listing. The NRC finds the removal of these three major facilities acceptable because they are not needed for HALEU Demonstration Program. For these reasons, the NRC staff finds the revised Table 1.1-1 to be consistent with the SRP acceptance criteria contained in SRP Section 1.1.4.3, and therefore acceptable.

1.3.5 Evaluation Findings

The staff has reviewed ACO's updated description of the facility and process overview according to Section 1.1 of the Standard Review Plan. Chapter 1 of the application summarizes the updated facility information contained in the ISA Summary and its addendum and includes descriptions of the overall facility layout on scaled drawings. The summary also describes the relationship of specific facility features to the major processes that will be ongoing at the facility. The major chemical and mechanical processes involving licensed material are described in summary form, based in part on information presented in the ISA Summary. This description includes: (a) reference to the building locations of major process components; (b) brief descriptions of the process steps; and (c) the chemical forms of licensable material in process. ACO has cross-referenced its general description with the more detailed descriptions elsewhere in the application.

The staff finds ACO has adequately described: (1) the facility and processes so that the staff has an overall understanding of the relationships of the facility features; and (2) the function of each feature. The staff concludes that ACO has met the regulatory requirements in 10 CFR 70.22(a) and acceptance criteria applicable to this section.

1.4 INSTITUTIONAL INFORMATION

1.4.1 Purpose of Review

The purpose of NRC's review of ACO's institutional information is to evaluate whether the changes and updates to the information in the previously approved commercial ACP LA (NRC, 2007) continue to adequately identify the licensee and describe the proposed activity. The areas of review included: (1) corporate identity; (2) site location; (3) other reservation activities; (4) foreign ownership control and influence; (5) financial analysis; (6) special exemptions or special authorizations; (7) security of classified information; (8) physical security; (9) transportation security; (10) applicable codes and standards; and (11) license application regulatory guidance documents.

1.4.2 Regulatory Requirements

The regulations in 10 CFR 70.22 require each application for a license to include: (a) information on the corporation applying for a license; (b) the location of the principal office; (c) the names and citizenship of the principal officers; (d) information concerning ownership and control; (e) the proposed site activities; (f) financial qualifications; and (g) the name, amount, and specifications of the licensed material to be used. The regulations in 10 CFR 70.23(a)(5) require that the applicant appears to be financially qualified to engage in the proposed activities in accordance with the regulations. The regulations in 10 CFR 70.40 place restrictions on the ownership of Centrus and ACO. The regulations in 10 CFR Part 95 contain provisions for obtaining a facility security clearance. The regulations in 10 CFR 140.13b require applicants for uranium enrichment facilities to provide and maintain liability insurance.

1.4.3 Regulatory Guidance and Acceptance Criteria

The acceptance criteria applicable to the NRC staff's review of the institutional information section of the application are contained in Section 1.2.4.3 of NUREG-1520 (NRC, 2015).

1.4.4 Staff Review and Analysis

1.4.4.1 Corporate Identity

In the RLA Section 1.2.1 Corporate Identity, ACO states that Centrus is a supplier of various components of nuclear fuel to utilities and advanced engineering, design, and manufacturing services to government and private sector customers. USEC Inc., the predecessor to Centrus, was organized in 1998 under Delaware law in connection with the privatization of the USEC. Centrus' direct and indirect subsidiaries are also registered companies in the State of Delaware. The address of the principal office of Centrus (formerly USEC Inc.) was modified from 6903 Rockledge Drive, Bethesda, MD 20817 to 6901 Rockledge Drive, Bethesda, MD 20817. Centrus is listed on the NYSE American under the symbol LEU. The principal officers were updated to Daniel B. Poneman, President and Chief Executive Officer, and Larry B. Cutlip, Sr. Vice President, Field Operations.

In September 2008, USEC Inc., the predecessor to Centrus, formed five wholly owned subsidiaries in the State of Delaware to carry out future commercial activities related to the American Centrifuge program. These subsidiaries were intended to own the ACP and equipment, provide operations and maintenance services, manufacture centrifuge machines and conduct ongoing centrifuge research and development. These subsidiaries are American Centrifuge Holdings, LLC (ACH), a direct subsidiary to Centrus, and ACO; American Centrifuge Technology, LLC (ACT); American Centrifuge Manufacturing, LLC (ACM); and American Centrifuge Enrichment, LLC (ACE). ACO is the Licensee and operating organization for the ACP. ACO will operate the HALEU Demonstration Program under the NRC ACP license. ACO's principal officers, all citizens of the United States, are the same as Centrus' principal officers. The workers necessary to operate the centrifuge facilities in Piketon, Ohio, will be employed by ACO or its qualified contractors.

Centrus does not plan for near term deployment of a commercial scale uranium enrichment facility. As a result, Centrus consolidated the ACP operations at its Piketon, Ohio facility. Centrus has consolidated its technical, engineering, and manufacturing activities at the TMC in Oak Ridge, Tennessee.

The mailing address for ACO at the ACP is:

American Centrifuge Operating, LLC
American Centrifuge Plant
P. O. Box 628
Piketon, Ohio 45661-0628

1.4.4.2 Site Location

The site location continues to be on DOE-owned land in rural Pike County, a sparsely populated area in south-central Ohio. Specifically, the ACP is located on the DOE reservation in the former GCEP facilities. The buildings/facilities and grounds are leased by Centrus from the DOE. ACO in turn subleases the buildings and grounds from Centrus.

1.4.4.3 Other Reservation Activities

In the RLA Section 1.2.1.2 Other Reservation Activities, ACO removed its reference to operating the gaseous diffusion plant (GDP) on the DOE reservation because the Part 76 license was

terminated by the NRC in October 2011. The NRC staff confirmed that the USEC had complied with all applicable NRC requirements and DOE accepted the return of the leased facilities (NRC, 2015a). ACO updated the commercial ACP LA to include: (1) DOE's ongoing decommissioning activities for the GDP on the reservation, which are led by Fluor-BWXT Portsmouth, LLC, and (2) the conversion of depleted UF₆ (DUF₆) to a stable oxide being undertaken by Mid-America Conversion Services, LLC. ACO also removed the reference to the Ohio National Guard's use of an area on the reservation because the Guard is no longer present on the Reservation. ACO also added that Pixelle Specialty Solutions, formerly Glatfelter Specialty Papers, operates a lumberyard on the north edge of the DOE reservation. This facility is a sorting and transfer area for commercial and paper grade lumber.

1.4.4.4 Foreign Ownership, Control, or Influence (FOCI)

10 CFR 95.17 states, in part, that prior to granting a facility clearance the NRC must determine that a facility is not under foreign ownership, control, or influence to such a degree that granting the facility clearance would be inconsistent with the national interest. Prior to issuing the facility clearance for the Piketon facility on October 30, 2020, the NRC conducted a FOCI review of ACO and its parent company Centrus. On August 14, 2020, as documented in a non-public letter from the NRC to ACO, the NRC staff determined that ACO's FOCI will not pose an undue risk to national security.

1.5 FINANCIAL ANALYSIS

1.5.1 Purpose of the Review

The NRC staff's review of ACO's financial analysis and liability insurance evaluates whether the RLA adequately describes the changes and updates made to the financial information approved by the NRC staff for the ACP LA (NRC, 2007).

1.5.2 Financial Qualification and Liability Insurance Requirements

The regulations in 10 CFR 70.23(a)(5) require that, when determined necessary, the NRC must determine whether the applicant appears financially qualified to engage in the proposed activities. The regulations in 10 CFR 70.22(n) and 10 CFR 140.13b establish requirements for liability insurance for uranium enrichment facilities.

1.5.3 Financial Qualification and Liability Insurance Guidance

The guidance and acceptance criteria used to review ACO's financial qualification and liability insurance for uranium enrichment facility are contained in Section 1.2.4 of the SRP (NRC, 2015).

1.5.3.1 Financial Qualifications

In Section 1.2.2 Financial Qualification of the RLA, ACO states that under the HALEU Demonstration Contract (ACO, 2019), DOE agreed to reimburse ACO for 80 percent of its costs incurred in performing the contract. ACO has committed to assuming 20 percent of the projected costs, and any expenses incurred above that amount. The total cost of the three-year HALEU Demonstration Program is \$115 million, with the DOE assuming responsibility for \$92 million in costs.

Costs under the HALEU Contract include *program costs*, including direct labor and materials and associated indirect costs that are classified as *Cost of Sales*, and an allocation of corporate costs supporting the program that are classified as *Selling, General, and Administrative Expenses*. Services to be provided during the 3-year contract include, constructing and assembling centrifuges and related infrastructure in a cascade formation. If the estimates of remaining program costs for this integrated construction-type contract exceed estimates of total revenue to be earned, a provision in the HALEU Contract provides for the remaining loss on the contract to be recorded to *Cost of Sales*, in the period the loss is determined. ACO's corporate costs supporting the program are to be recognized as expenses incurred over the duration of the contract term. The accrued loss on the contract will be adjusted over the remaining contract term, based on actual results and remaining program cost projections.

The NRC staff reviewed Section 1.2.2 Financial Qualification in ACO's RLA. In addition, the NRC staff reviewed the 3-year HALEU Demonstration contract between ACO and DOE (ACO, 2021), and the Centrus Annual Report on Form 10-K filing, dated April 14, 2020, for the fiscal year ended December 31, 2019. See ACO's Website: <https://investors.centrusenergy.com/financial-information/sec-filings>. Based on ACO's financial submittals, the staff concludes that ACO has sufficient cash on hand to fund operations of the HALEU Demonstration for the 3-year contract period. Accordingly, staff finds that ACO appears financially qualified to operate the HALEU Demonstration Project in accordance with the RLA.

The ACP license includes License Condition 15, which the NRC imposed when approving the initial license for the ACP to ensure that USEC would be financially qualified to construct and operate the proposed commercial facility (NRC, 2006). ACO has requested relief from the following requirement in License Condition 15 for operation of the HALEU Demonstration:

Operation of the ACP shall not commence until ACO has in place either: (1) long term contracts lasting five years or more that provide sufficient funding for the estimated cost of operating the facility for the five year period; (2) documentation of the availability of one or more alternative sources of funds that provide sufficient funding for the estimated cost of operating the facility for five years; or (3) some combination of (1) and (2).

Based on the NRC staff's determination that Centrus has sufficient cash on hand to cover its share of the costs of construction and operation of the HALEU Demonstration, License Condition 15 is modified as follows:

Operation of the ACP, with the exception of operation of the HALEU demonstration cascade until expiration of DOE's HALEU Demonstration contract on May 31, 2022, shall not commence until the Licensee has in place either: (1) long term contracts lasting five years or more that provide sufficient funding for the estimated cost of operating the facility for the five year period; (2) documentation of the availability of one or more alternative sources of funds that provide sufficient funding for the estimated cost of operating the facility for five years; or (3) some combination of (1) and (2).

1.5.3.2 Liability Insurance

In evaluating USEC's application for the ACP, the staff found USEC Inc. in compliance with the liability insurance requirements in 10 CFR 140.13b based on the determination that DOE would provide indemnity for the ACP, as it had done for the Portsmouth and Paducah GDPs, unless liability insurance became commercially available at commercially reasonable rates

(NRC, 2006). In order to confirm DOE's indemnification of the ACP or proof of liability insurance, the staff-imposed LC 14 of SNM-2011 which states:

American Centrifuge Operating, LLC (ACO) shall provide to the Commission, at least 120 days prior to the planned date for obtaining licensed material, documentation of any liability insurance required to be obtained by ACO under its lease with the U.S. Department of Energy (DOE) for the ACP by that time or, alternatively, the status of ACO's efforts to obtain any such liability insurance. During the time that ACO is engaged in efforts to obtain liability insurance, ACO shall provide the Commission with status reports regarding those efforts. The status reports shall be submitted at a frequency of at least once every six months following issuance of a license. ACO shall notify the Commission within 30 days upon receiving notification of denial or approval of commercial liability insurance for the ACP. If commercial liability insurance is required to be obtained under its lease with DOE, within 60 days of receiving notification of approval of commercial liability insurance, ACO shall provide proof of liability insurance coverage and a justification, for Commission review and approval, if ACO is proposing to provide less than \$300 million of liability insurance coverage.

In the RLA Section 1.2.2 Financial Qualifications, ACO states that DOE amended the GCEP Lease Agreement to provide that any liabilities of the Corporation (ACO) arising from or incident to the performance of work under the Demonstration Contract with the DOE shall be governed solely by such contract. Both the GCEP Lease (ACO, 2019c) and the HALEU Demonstration Contract (ACO, 2021) state that DOE will indemnify ACO for liability claims arising out of any occurrence within the United States, causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of chemical compounds containing source or SNM arising out of activities under the lease. Based on a review of the indemnity provisions of those documents, the Staff has determined that ACO will continue to comply with the liability requirements in 10 CFR 140.13b for the duration of the contract.

ACO seeks modification of License Condition 14 to permit ACO to accept licensed material to operate the HALEU demonstration without first providing documentation of any liability insurance required to be obtained by ACO under its lease with the DOE for the ACP or alternatively, the status of ACO's efforts to obtain any such liability insurance. Given the fact that DOE will provide indemnification during the 3-year contract period for the HALEU Demonstration, the staff has determined that additional documentation of DOE indemnification is not necessary before ACO obtains licensed material for the HALEU Demonstration. Accordingly, License Condition 14 is modified to read:

American Centrifuge Operating, LLC (ACO) shall provide to the Commission, at least 120 days prior to the planned date for obtaining licensed material, other than material for the HALEU Demonstration Program, documentation of any liability insurance required to be obtained by ACO under its lease with the U.S. Department of Energy (DOE) for the ACP by that time or, alternatively, the status of ACO's efforts to obtain any such liability insurance. During the time that ACO is engaged in efforts to obtain liability insurance, ACO shall provide the Commission with status reports regarding those efforts. The status reports shall be submitted at a frequency of at least once every six months following issuance of a license. ACO shall notify the Commission within 30 days upon receiving notification of denial or approval of commercial liability insurance for the ACP. If commercial liability insurance is required to be obtained under its lease with DOE,

within 60 days of receiving notification of approval of commercial liability insurance, ACO shall provide proof of liability insurance coverage and a justification, for Commission review and approval, if ACO is proposing to provide less than \$300 million of liability insurance coverage.

1.5.4 Evaluation Findings

The staff reviewed the financial qualifications and liability coverage information provided in the RLA and finds it is consistent with the guidance in Section 1.2.4 of the SRP (NRC, 2015). The NRC staff finds ACO's financial qualifications and liability coverage meet the requirements of 10 CFR 70.22(a)(8) and 70.23(a)(5). The NRC concludes that ACO is financially qualified to construct and operate the ACP HALEU 16-centrifuge cascade for the duration of its three-year contract with DOE. Additionally, the NRC staff confirmed that during the operation of the HALEU Demonstration, in accordance with the GCEP Lease and the three-year HALEU Contract, ACO will be indemnified by DOE. Therefore, the NRC finds that ACO has satisfied the liability insurance requirements of 10 CFR 140.13b and 140.14(a)(3).

1.6 TYPE, QUANTITY, AND FORM OF LICENSED MATERIAL

In Section 1.2.3 of the RLA, ACO refers to Tables 1.2-1 and 1.2-2 (non-public) which contain the type, quantity (possession limits), and form of NRC-regulated special nuclear, source, and by-product material for the ACP Commercial Plant and the HALEU Demonstration Program. Table 1.2-1 is unchanged. Table 1.2-2 is entirely new and was reviewed by the staff for completeness. The NRC staff finds Table 1.2-2 provides a description of the licensed material to be used in the 3-year HALEU Demonstration Program (Phase 1) that is reasonable and meets the requirements of 10 CFR 70.22(a), and is consistent with the guidance in SRP Section 1.1.4.3.

1.6.1 Authorized Uses

The specific authorized uses for each class of NRC-regulated material for the ACP Commercial Plant and the HALEU Demonstration Program are shown in Tables 1.2.3 and 1.2-4 of the RLA. Table 1.2.3 was not changed, while Table 1.2.4 is entirely new. Table 1.2.4 describes authorized uses of uranium (non-fissile), source material, SNM, by-product material (Elements 3-89 and 91), Elements 93, and 95-100, and Tc-99. The NRC staff finds the information in Table 1.2-4 to be accurate and complete for the 3-year HALEU Demonstration Program (Phase 1) and in compliance with 10 CFR 70.22(a) and consistent with the guidance in SRP Section 1.1.4.3.

1.7 SECURITY OF CLASSIFIED INFORMATION

On March 31, 2020, ACO submitted its Security Plan for the Protection of Classified Matter at the American Centrifuge Plant (ACO, 2020f), separately from license amendment request. The NRC approved the Security Plan on October 30, 2020 (NRC, 2020a) and issued a facility clearance to ACO, which authorized possession of classified matter at the Piketon facility.

Independent of this amendment, on March 10, 2020, ACO submitted its modified Transportation Security Plan (TSP) for classified matter shipments in support of the HALEU Demonstration Program (ACO, 2020h). The NRC approved the TSP and amended SNM-2011 on October 20, 2020 (NRC, 2020).

1.8 APPLICABLE CODES AND STANDARDS AND GUIDANCE DOCUMENTS

The purpose of NRC's review of ACO's license application codes and standards and guidance documents is to evaluate whether the RLA adequately describes the changes and updates to the codes and standards and guidance documents that were part of NRC's approval of the commercial ACP LA (NRC, 2007).

1.8.1 Applicable Codes and Standards

In Section 1.4 of the RLA, ACO provides a list of industry codes and standards applicable to the ACP. In Section 1.4 of the RLA, ACO states that the current design of the ACP does not include any items relied on for safety (IROFS) that use software, firmware, microcode, Programmable Logic Controllers, and/or any digital device, including hardware devices that implement data communication protocols. ACO removed the commitment which stated that "Should this design change, ACO will obtain prior NRC approval for the applicable guidance and standards." The NRC staff finds the removal of the commitment acceptable because ACO is required to seek prior NRC approval of changes determined to be significant under 10 CFR 70.72, and 10 CFR 70.72(f) requires that documentation for all changes be maintained onsite for the NRC to inspect.

ACO moved all previously listed guidance documents in Section 1.4.7 and Section 1.4.9 of the commercial ACP LA to a newly added Section 1.5 of the RLA. These include seven Regulatory Guides, six NUREG documents, three NUREG/BR documents, four NUREG/CR documents, one NRC Information Notice, one Federal Guidance Report (FGR), one Recommended Practice document, and one International Atomic Energy Agency (IAEA) document.

1.8.1.1 American National Standards Institute/American Nuclear Society

In Section 1.4.1 of the RLA, ACO updated and/or modified its commitments to the following standards as follows:

- ANSI/ANS-8.1-1998, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactor," was updated to the 2014 version;
- ANSI/ANS-8.19-1996, "Administrative Practices for Nuclear Criticality Safety," was updated to the 2014 version;
- The text associated with ACO's commitment to ANSI/ANS-8.3-1997, "Criticality Accident Alarm System," was modified; and
- ANSI/ANS-8.23-1997, "Nuclear Criticality Accident Emergency Planning and Response," was updated to the 2007 version, with the text associated with ACO's commitment to this standard also modified.

In Section 1.4.1 of the RLA, ACO added:

- ANSI/ANS-8.24-2017, "Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations."

These updates and/or changes are discussed in Chapter 5 of this SER.

1.8.1.2 American National Standards Institute

In Section 1.4.2 of the RLA, ACO updated and modified its commitments to the following standard as follows:

- ANSI N14.1-2001, *Nuclear Materials - Uranium Hexafluoride - Packaging for Transport* was updated to the 2012 version and its text associated with the commitment to the standard was modified.

The update and changes are discussed in Chapter 3 of this SER.

1.8.1.3 American National Standards Institute/American Society of Mechanical Engineers

In Section 1.4.3 of the RLA, ACO modified its commitments to the following standards as follows:

- The commitments associated with ANSI/ ASME NQA-1-1994, "Quality Assurance Requirements for Nuclear Facility Applications," were modified.

The application of NQA-1-1994 is discussed in Chapter 11 of this SER.

1.8.1.4 American Society of Mechanical Engineers

In Section 1.4.4 of the LA RLA, ACO updated:

- ASME B31.3-2004, "Process Piping" to the more recent 2018 standard.

1.8.1.5 American Society for Testing and Materials

In Section 1.4.5 of the RLA, ACO updated its commitments to the following standards as follows:

- ASTM C787-2003, "Standard Specification for Uranium Hexafluoride for Enrichment," was updated to the 2015 version;
- ASTM C996-2004, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5 % ²³⁵U," was updated to the 2015 version; and
- ASTM C1052-2001, "Standard Practice for Bulk Sampling of Liquid Uranium Hexafluoride," was updated to the 2014 version.

These updates are discussed in Appendix C of this SER.

1.8.1.6 National Fire Protection Association

In Section 1.4.6 of the RLA, ACO updated and/or modified its commitments to the following standards as follows:

- NFPA 10-2002, “Standard for Portable Fire Extinguishers,” was updated to the 2019 version;
- NFPA 13-2002, “Standard for the Installation of Sprinkler Systems,” was updated to the 2019 version and its text associated with ACO’s commitment to the standard was modified;
- NFPA 15-2001, “Standard for Water Spray Fixed Systems for Fire Protection,” was updated to the 2017 version;
- NFPA 25-2004, “Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems” was updated to the 2002 version;
- NFPA 30-2003, “Flammable and Combustible Liquids Code,” was updated to the 2018 version;
- NFPA 51B-2003, “Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,” was updated to the 2019 version;
- NFPA 55-2005, “Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks,” was updated to the 2020 version;
- NFPA 101-2003, “Life Safety Code,” was updated to the 2018 version;
- NFPA 232-2000, “Standard for the Protection of Records,” was deleted;
- NFPA 241-2000, “Standard Safeguarding Construction, Alteration, and Demolition Operations,” was updated to the 2019 version; and
- NFPA 801-2003, “Standard for Fire Protection for Facilities Handling Radioactive Materials,” was updated to the 2020 version.

These updates and/or commitment modifications are discussed in Chapter 7 of this SER.

1.8.1.7 Institute of Electrical and Electronics Engineers

In Section 1.4.8 of the RLA, ACO updated and/or modified its commitments to the following standards as follows:

- ANSI/IEEE 336-1985, “ANSI/IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities,” was updated to the 2010 version; and
- IEEE 7-4.3.2-1993, “Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations,” was updated to the 2003 version.

1.8.1.8 Other Various Codes and Standards

In Section 1.4.9 of the RLA, ACO updated its commitment to the following standard as follows:

- ANSI/ISA 67.04.01-2000, “Setpoints for Nuclear Safety-Related Instrumentation,” was updated to the 2018 version.

This update is discussed in Chapter 3/Appendix A of this SER.

1.8.2 License Application Regulatory Guidance Documents

In Section 1.5 of the RLA, ACO provides a list of regulatory guidance documents applicable to the ACP.

In Section 1.5.1 of the RLA, ACO clarified its commitment to Regulatory Guide 3.67, Revision 0, “Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities,” stating that this RG does not apply under the HALEU Demonstration Program. This clarification is discussed in Chapter 8 of this SER.

In Section 1.5.1 of the RLA, ACO replaced Regulatory Guide 5.15, Revision 1, “Tamper-Indicating Seals for the Protection and Control of Special Nuclear Material,” with Regulatory Guide 5.80, Revision 0, “Pressure-Sensitive and Tamper-Indicating Device Seals for Material Control and Accounting of Special Nuclear Material.” This is discussed in Appendix C of this SER.

In Section 1.5.1 of the RLA, ACO updated NUREG-1520, “Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility,” from the March 2002 version to Revision 2 published in June 2015. The NRC staff finds this acceptable as Revision 2 is the latest version of NUREG-1520.

1.9 EVALUATION FINDINGS

The staff reviewed the institutional information for the RLA, according to Section 1.2 of the Standard Review Plan. ACO has adequately described and documented changes to the corporate identity, structure, and financial information, and is in compliance with those parts of 10 CFR 70.22 related to institutional information. The staff reviewed updated information related to ACO’s financial qualifications. This information meets the requirements of 10 CFR 70.23(a)(5). The staff reviewed the information provided by ACO on DOE indemnification for liability and determined that the requirements of 10 CFR 140.13b have been satisfied. In addition, in accordance with 10 CFR 70.22(a)(2) and (4), ACO has adequately described the changes to the types, forms, and quantities and proposed purpose and authorized uses of licensed materials to be permitted at the facility.

As discussed above, the staff determined that ACO’s FOCI will not pose an undue risk to national security. As discussed above the staff had previously reviewed and approved ACO’s transportation security plan and classified matter protection plans.

The staff reviewed the updated list of codes and standards and regulatory guides. The adequacy of the changes and updates made by ACO to these are discussed in the various chapters of this SER.

1.10 SITE DESCRIPTION

1.10.1 Purpose of the Review

The purpose of NRC's review of ACO's site description is to evaluate whether the RLA adequately described the changes and updates to the site description, made after the NRC approved the commercial ACP LA (NRC, 2007). The areas of review include: (1) geography, (2) demographics, (3) meteorology, (4) surface hydrology, (5) subsurface hydrology, and (6) geology and seismology. The NRC staff only reviewed the significant (non-editorial) changes and updates made by ACO to these areas of review.

1.10.2 Regulatory Requirements

The regulations in 10 CFR 70.22, and 10 CFR 70.65(b)(1) require each application to include a general description of the site, with emphasis on those factors that could affect safety (i.e., nearby facilities, meteorology, and seismology).

1.10.3 Regulatory Guidance and Acceptance Criteria

The regulatory guidance applicable to this section are contained in Chapter 1 of NUREG-1520 (NRC, 2015). The acceptance criteria are contained in Section 1.3.4.3 of NUREG-1520 (NRC, 2015).

1.10.4 Staff Review and Analysis

This Section of the SER documents the NRC staff's review and analysis of ACO's significant (non-editorial/administrative changes, such as spelling and nomenclature) changes and updates made to Section 1.3 Site Description, which addresses the HALEU Demonstration Program. Some changes are also addressed in the Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the ACP HALEU Demonstration (NRC, 2021).

1.10.4.1 Geography

In the RLA Section 1.3.1 Geography, ACO appropriately updated the primary roadways near the DOE reservation. ACO has also appropriately updated the identification of the non-commercial airports as: the Pike County Airport located approximately 11 miles north-northeast of the DOE reservation; the Greater Portsmouth Regional Airport, located approximately 15 miles southeast of the DOE reservation; and the Chillicothe-Ross County Airport located approximately 35 miles north-northeast of the DOE reservation. ACO has also appropriately updated the identification of the commercial airports as: John Glenn Columbus International Airport in Columbus, Ohio, approximately 75 miles north; Rickenbacker Airport near Columbus, Ohio approximately 60 miles away; the Tri-State Airport in Huntington, West Virginia approximately 65 miles southeast; and the Cincinnati/Northern Kentucky International Airport, approximately 100 miles west. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.2 Demographics

In the introduction section of the RLA Section 1.3.2 Demographics, ACO did not modify any text.

1.10.4.3 Area Population

In the RLA Section 1.3.2.1 Area Population, ACO appropriately updated: the DOE reservation population from 2842 in October 2010 to 2336 in January 2020; the Piketon Ohio population from 1907 in 2000 to 2181 in 2010; and the Waverly Ohio population from 4433 in 2000 to 4408 in 2010. ACO also appropriately updated the populations for other population centers in Ohio that are further away from the site including Chillicothe, Portsmouth, and Jackson. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.3.1 Significant Transient and Special Populations

In the introduction section of the RLA Section 1.3.2.2 Significant Transient and Special Populations, ACO appropriately did not modify any text.

1.10.4.3.2 Schools

In the RLA Section 1.3.2.2.1 Schools, ACO appropriately updated the number of students and teachers to January 2020 levels in schools located within a 5-mile radius of the DOE reservation including: Piketon High School and Junior High School; Zahn's Corner Middle School, which had been relocated to Piketon High School and Jasper Elementary for the 2019-2020 school year; and Jasper Elementary School. The reason for relocating Zahn's Corner Middle Schools was due to possible elevated levels of radioactive contamination. This situation is addressed in NRC staff's EA and FONSI for this RLA (NRC, 2021). ACO also appropriately updated the student numbers for the Pike County Career and Technology Center, the Pike County Community Action Committee, and Miracle City Academy. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.3.3 Hospitals and Nursing Homes

In the RLA Section 1.3.2.2.2 Hospitals and Nursing Homes, ACO appropriately updated the number of staff at the closest hospital to the site, the Adena Pike Medical Center located about 7.5 miles north of the ACP. ACO identified a new urgent care center in Waverly operated by Southern Ohio Medical Center Family Health Center. ACO updated the names of two health centers located in Piketon. Piketon also has two licensed nursing homes, the Piketon Nursing Center and the Pavilion at Piketon (formerly known as Pleasant Hill Manor). Additionally, ACO identified a name change for a home for people with intellectual and developmental disabilities in Wakefield from Friends of Good Shepard Manor to Scioto Trails Group Home with 32 beds and 100 staff. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.3.4 Recreational Areas and Recreational Events

In the RLA Section 1.3.2.2.3 Recreational Areas and Recreational Events, ACO deleted 10 non-electric campsites for primitive overnight camping. However, ACO added Rock Water Campground, which is a private, secured campground with 68 campsites within 5 miles west of the site. The site is approximately 20 acres that includes a 12-acre lake for swimming and fishing. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.3.5 Uses of Nearby Lands and Waters

In the RLA Section 1.3.2.3 Uses of Nearby Lands and Waters, ACO identified a new farm supply store and distribution center, and a plastic recycling and processing center located in an industrial park south of Waverly. The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.4 Meteorology

In the introduction section of the RLA Section 1.3.3 Meteorology, ACO did not modify any text.

In the RLA Section 1.3.3.1 that addresses regional climatology, ACO updated the average temperatures based on more recent (2019) weather data.

In the RLA Section 1.3.3.2 that addresses the on-site meteorological measurements program utilizing a 60-m meteorological tower on the DOE reservation, ACO did not modify any text.

In the RLA Section 1.3.3.3 that addresses local meteorology, ACO added average wind speed data and the minimum and maximum hourly temperatures recorded by the meteorological tower. The number of tornadoes since 1950 in Pike county was updated from three to eleven. However, the average number of days experiencing severe storms between 1990 and 2019 with winds exceeding 58 mph remained the same at three.

The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.5 Surface Hydrology

In the RLA Section 1.3.4.1 that addresses the Scioto River Basin in which the DOE reservation is located, ACO added the average annual mean flow range for the Scioto River as 1,364 cubic feet per second (cfs) in 1954 to 8,178 cfs in 1996. ACO changed the nominal elevation of the DOE reservation above the normal stage of the Scioto River from 113 to 130 ft.

In the RLA Section 1.3.4.2 Flood History, ACO updated the period over which the average annual discharge at the Higby station on the Scioto River, 13 miles north of the DOE reservation, was calculated from 1930-2001 to 1930-2018. The discharge rate of 4,721 cfs remained the same.

The data provided in Section 1.3.4.3 Probable Maximum Flood, remained the same.

In the RLA Section 1.3.4.4 Potential Seismically Induced Dam Failures, ACO modified the height of the DOE reservation above the normal Scioto River level from 113 feet to 130 feet,

which is well above the 41.3 ft wave height in the event of a flood combined with a domino-type failure of dams upstream of the Scioto River.

The data provided in the RLA Section 1.3.4.5 Channel Diversion and Ice Formation on the Scioto River, remained the same.

In the RLA Section 1.3.4.6 Low Water Considerations, ACO updated the period over which the minimum river flow at the Higby station on the Scioto river was calculated from 1930-2001 to 1930-2019. The minimum flow of 244 cfs on October 23, 1930 was not changed. Additionally, ACO deleted the sentence that reported that the consecutive seven-day minimum discharge of 255 cfs occurred during October 19-25, 1930. The NRC staff finds this deletion acceptable because reporting the minimum flow for a single day provides an adequate information on the flow rate variations in the Scioto River near the DOE Reservation.

In the RLA Section 1.3.4.7 Dilution of Effluents, ACO deleted three sentences which stated that: (1) the USEC is responsible for 11 National Pollutant Discharge Elimination System (NPDES) outfalls at the DOE reservation; (2) DOE and the USEC NPDES outfalls remained in compliance with contaminant concentration discharge limits in 2002; and (3) a further description of Surface Water contaminants is located in the Environmental Report. In the RLA Section 1.3.4.7, ACO added new text indicating that in support of ACP operations, the GDP NPDES permits have been modified to transfer ownership of certain discharge points. ACO now has two outfalls that discharge directly to surface water and one outfall that discharges to the Flour BWXT Portsmouth (FBP) X-6619 Sewage Treatment Plant before leaving site through FBP Outfall 003 to the Scioto River. The Tower Water Cooling system discharges its blowdown to GDP Recirculating Cooling Water system under a service agreement, which in turn discharges its blowdown directly to the Scioto River via an underground pipeline (NPDES Outfall 004). FBP has eight outfalls and nine internal outfalls. MCS has one outfall and one internal outfall. In 2017, the overall Licensee's NPDES compliance rate was 100 percent and the overall FBP's NPDES compliance rate was 99 percent. The changes to the NPDES permits are addressed in the EA for this amendment.

The NRC staff finds these updates and modifications to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.6 Subsurface Hydrology

In the introduction of the RLA Section 1.3.5 Subsurface Hydrology, ACO did not make any changes to the text. In Sections 1.3.5.1 Regional and Area Characteristics, 1.3.5.1.1, Aquifers, 1.3.5.1.2 Regional Groundwater Use, 1.3.5.1.3 Flow in the Regional Aquifers, 1.3.5.2 Site Characteristics, 1.3.5.2.1 Aquifers Beneath the Site, 1.3.5.2.2 Aquifer Properties, and 1.3.5.2.3 Groundwater Flow, ACO did not modify any data.

1.10.4.7 Geology and Seismology

In the introduction of the RLA Section 1.3.6 Geology and Seismology, ACO did not make changes to the text. In the RLA Sections 1.3.6.1 Regional and Site Physiography, 1.3.6.2 Site Geology, 1.3.6.3 Site Structural Setting, and 1.3.6.4 Engineering Geology, ACO did not modify data. In Section 1.3.6.5, ACO added two small recent seismic events. On December 21, 2014, a magnitude 2.0 event occurred in Union Township of Pike County, approximately four miles southeast of the DOE reservation. On March 20, 2019, a magnitude 2.1 event occurred in Minford, Scioto County, approximately 12 miles southeast of the DOE reservation. In the RLA

Sections 1.3.6.6 Surface Faulting, and 1.3.6.7 Liquefaction Potential, ACO did not modify any data.

The NRC staff finds these updates to be reasonable and consistent with the guidance in SRP Section 1.1.4.3.

1.10.4.8 Natural phenomena hazards

The evaluations of the baseline design criteria, building structures, and internal equipment for Natural Phenomena Hazards (NPH) are discussed in Section 3.4.5 of this SER and Appendix A of this SER.

1.10.5 Evaluation Findings

The staff has reviewed ACO's updated site description information for the HALEU Demonstration Program as part of the RLA according to Section 1.3 of the Standard Review Plan. On the basis of the review, the NRC staff determined that ACO has adequately described and documented changes to (1) the site geography, including its location relative to prominent natural and manmade features such as rivers, airports, population centers, schools, and commercial facilities, (2) population information using the most current available census data, and (3) meteorology, hydrology, and geology and seismology for the HALEU Demonstration Program site, in compliance with the requirements in 10 CFR 70.22 and 10 CFR 70.65. The review verified that the site description is consistent with the information used as a basis for the Environmental Report and ISA Summary.

1.11 REFERENCES

(ACO, 2021) American Centrifuge Operating, LLC, "DOE's HALEU Demonstration Contract Number 89303519CNE000005, awarded May 31, 2019 and definitized on October 31, 2019," ACO 21-0022, ADAMS Accession Number ML21127A153, April 27, 2021.

(ACO, 2021a) American Centrifuge Operating, LLC, "Revision for American Centrifuge Operating, LLC's License Application and Supporting Documents," ACO 21-0027, ADAMS Accession Numbers ML21148A261, ML21152A164, ML21153A417, and ML21152A073, May 25, 2021.

(ACO, 2021b) American Centrifuge Operating, LLC, "Revision for American Centrifuge Operating, LLC's License Application and Supporting Documents," ACO 21-0030, ADAMS Accession Number ML21148A148, May 25, 2021.

(ACO, 2021c) American Centrifuge Operating, LLC, "Revision for American Centrifuge Operating, LLC's License Application and Supporting Documents," ACO 21-0031, ADAMS Accession Number ML21148A147, May 25, 2021.

(ACO, 2019) American Centrifuge Operating, LLC, "DOE's HALEU Demonstration Contract Number 89303519CNE000005 Awarded May 31, 2019 and Definitized on October 31, 2019," ADAMS Accession Number ML21127A153, April 27, 2021.

(ACO, 2019a) American Centrifuge Operating, LLC, "Submittal of Nuclear Criticality Safety Code Validation for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML19352G024, December 5, 2019.

(ACO, 2019c) American Centrifuge Operating, LLC, "Withdrawal of Request to Terminate the American Centrifuge Lead Cascade NRC Materials License," ACO 19-0008 ADAMS Accession Number ML19186A272 June 27, 2019 (Public); Enclosure 1 entitled "Amendment to Appendix 1 Lease Agreement Between the U.S. Department of Energy and United States Enrichment Corporation for the Gas Centrifuge Enrichment Plant," ADAMS Accession Number ML21109A010 (non-public), June 27, 2019.

(ACO, 2020) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML20125A103 (ML20125A126 - Package), April 22, 2020.

(ACO, 2020a) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0013, ADAMS Accession Number ML20139A100, May 7, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC, "Resubmittal of Enclosure to License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0025, ADAMS Accession Number ML20174A144, June 17, 2020.

(ACO, 2020c) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0021, ADAMS Accession Number ML20314A098, June 23, 2020.

(ACO, 2020d) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0029, ADAMS Accession Number ML20314A099, August 5, 2020.

(ACO, 2020e) American Centrifuge Operating, LLC, "Security Facility Approval for Classified Work: Review of Security Program and Applicable Security Plans for American Centrifuge Operating, LLC's Technology and Manufacturing Center in Oak Ridge, Tennessee" ACO 20-0004, ADAMS Accession Number ML20050F863, February 6, 2020.

(ACO, 2020f) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's Security Plan(s)" ACO 20-0009, ADAMS Accession Number ML20136A471, March 31, 2020.

(ACO, 2020h) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's Transportation Security Plan," ACO 20-0008, ADAMS Accession Number ML20108F542, March 10, 2020.

(NRC, 2004) U.S. Nuclear Regulatory Commission, "License for the American Centrifuge Lead Cascade Facility," ADAMS Accession Number ML062630432, February 24, 2004.

(NRC, 2004a) U.S. Nuclear Regulatory Commission, "Final Safety Evaluation Report of the USEC Inc. American Centrifuge Lead Cascade Facility at Piketon, Ohio," ADAMS Accession Number ML040280554, January 2004.

(NRC, 2004b) U.S. Nuclear Regulatory Commission, "Final Safety Evaluation Report, Finding of No Significant Impact, and Environmental Assessment for the Lead Cascade Facility," ADAMS Accession Number ML040280479, January 28, 2004.

(NRC, 2006) U.S. Nuclear Regulatory Commission, NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2007) U.S. Nuclear Regulatory Commission, "License for the USEC Inc. American Centrifuge Plant," ADAMS Accession Number ML070400284, April 2007.

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2, ADAMS Accession Number ML15176A258, September 30, 2015.

(NRC, 2015a) U.S. Nuclear Regulatory Commission, "U. S. Nuclear Regulatory Commission Final Report to Congress on Health, Safety, and Environmental Conditions at the Gaseous Diffusion Plants Located Near Paducah, Kentucky, and Portsmouth, Ohio, October 1, 2013, to February 2, 2015," Enclosure ADAMS Accession Number ML15289A308

(NRC, 2020) U.S. Nuclear Regulatory Commission, "Approval of American Centrifuge Operating Request to Amend its Transportation Security Plan for the Protection of Classified Matter," ADAMS Accession Number ML20255A012, October 20, 2020.

(NRC, 2020a) U.S. Nuclear Regulatory Commission, "Approval of American Centrifuge Operating's License Amendment Request to Enable the Re-Establishment of its Possessing Facility Clearance for its Leased Facility in Piketon, Ohio," ADAMS Accession Number ML20272A174, October 30, 2020.

(NRC, 2021) U.S. Nuclear Regulatory Commission, "Environmental Assessment and Finding Of No Significant Impact for the American Centrifuge Plant HALEU Demonstration Program License Amendment," ADAMS Accession Number ML21085A705, June 2021.

(NRC, 2021a) U.S. Nuclear Regulatory Commission, "Approval of American Centrifuge Operating's License Amendment Request for the Classified Matter Protection Plan for American Centrifuge Operating's Technology and Manufacturing Center in Oak Ridge Tennessee," ADAMS Accession Number ML21067A085, March 25, 2021.

2 ORGANIZATION AND ADMINISTRATION

2.1 PURPOSE OF REVIEW

The purpose of the review of ACO's organization and administration is to ensure that the proposed changes to management hierarchy and policies will provide reasonable assurance that ACO plans, implements, and controls site activities in a manner that ensures the safety of workers, the public, and the environment. The review also ensures the applicant has identified and provided adequate descriptions of the proposed modifications to the qualifications for key management positions.

The NRC staff initially reviewed and approved the Organization and Administration chapter for the ACP commercial plant in 2006, as documented in its Safety Evaluation Report (NRC, 2006). As part of this review, the NRC staff focused on ACO's proposed changes made to Chapter 2.

2.1.1 Regulatory Requirements

The regulations at 10 CFR 70.22 and 70.23 contain requirements related to the establishment of a management system and administrative procedures for the effective implementation of health, safety, and environment (HS&E) functions. Effectively implementing these functions will better ensure adequate safety for workers and the public, and protection of the environment. Specifically, 10 CFR 70.22(a)(6) requires an applicant to include "The technical qualifications, including training and experience of the applicant and members of his staff to engage in the proposed activities in accordance with the regulations in this chapter."

2.1.2 Regulatory Guidance and Acceptance Criteria

There are no regulatory guides specific to the description of the organization and administration of fuel cycle facilities. The guidance applicable to the NRC staff's review of the organization and administration section of the RLA is contained in Section 2.4.3 of "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility," NUREG-1520, Rev. 2 (NRC, 2015). Section 2.3 of NUREG-1520, "Areas of Review," includes areas of review for both new facility applications and applications for modifications of existing facilities. Because the HALEU Demonstration involves modification to an existing license, the areas of review for existing facilities are applicable. Similarly, Section 2.4.3 of NUREG-1520, "Regulatory Acceptance Criteria," lists acceptance criteria for both new facilities and existing facilities. The regulatory acceptance criteria for existing facilities are applicable to the RLA (ACO, 2020).

2.2 STAFF REVIEW AND ANALYSIS

This Section of the SER documents the NRC staff's review and analysis of the significant changes and updates ACO made to Chapter 2 Organization and Administration for the HALEU Demonstration Program.

In the introduction of the RLA Section 2.0 Site Description, ACO added information on the programmatic implementation of ACO's operational policy with respect to environmental, health, nuclear safety, safeguards, security, and quality in order to guide the day-to-day business activities of and provide direction to ACP personnel. Specifically, ACO stated that contracted resources are utilized in these programmatic areas to provide day-to-day functional support, and

that arrangements, through reverse work authorizations, are in place to provide the support. The NRC staff finds the use of contracted resources in the aforementioned areas to be normal practice in other NRC-licensed facilities, and is therefore acceptable.

In the RLA Section 2.1.2.1.1 Nuclear Materials Control and Accountability (NMC&A) Manager, ACO deleted the phrase “[commercial operations only]” that had been appended to the title. The NRC staff finds this change to be acceptable because the NMC&A Manager should also be responsible for non-commercial operations. In this Section, ACO clarified that the NMC&A Manager has programmatic responsibility for the NMC&A program and that regulatory requirements are followed on a day-to-day basis. As discussed in Appendix C of this SER, the staff finds this clarification in accordance with the regulations in 10 CFR 74.33 and 10 CFR 74.43(b)(1).

In Section 2.1.2.2.1 Procurement Manager, ACO modified reportability of the Procurement Manager from the Director of Procurement and Contracts to the Director of Engineering, Procurement and Construction. The staff finds this acceptable as the title of the Director has been changed to remove Contracts but add Engineering and Construction.

In Section 2.1.2.2.2 Packaging, Transportation, and Materials Management Manager, ACO modified reportability of the Packaging, Transportation, and Materials Management Manager from the Director of Procurement and Contracts to the Director of Engineering, Procurement and Construction. The staff finds this acceptable as only the title of the Director has been changed to remove Contracts but add Engineering and Construction.

In Section 2.1.2.3 Operations Manager, ACO removed the requirement that the Operations Manager have six months of experience at a uranium processing plant. The staff finds this acceptable as the HALEU Demonstration Program does not involve operations with large quantities of hazardous materials, including, liquid UF₆ and large quantities of hazardous chemicals.

In Section 2.1.2.3.2 Process Area Managers [commercial operations only], ACO deleted the word “legacy” from the waste disposition related responsibilities of the Process Area Manager. The staff finds this acceptable because the areas to be used by the HALEU Demonstration Program had been cleaned as part of the decommissioning activities for the Lead Cascade Facility (LCF). The NRC staff independently confirmed this information through its inspection process (NRC, 2018).

In the RLA Section 2.1.2.3.5 Maintenance Work Center Supervisor, ACO deleted language that excepted or excused this supervisor from directing the performance of preventive, predictive, and corrective maintenance and providing support on centrifuge machines. In addition, ACO added that the Maintenance Work Center Supervisor is responsible for directing and providing support on programs, processes, and procedures that are within one’s personnel training limitations. The staff finds these changes acceptable because maintenance work on the centrifuges may be needed and the Maintenance Work Center Supervisor should not be directing or providing support beyond one’s training limitations.

In the RLA Section 2.1.2.4.2 Radiation Protection Manager/Supervisor, ACO deleted the requirement that the Radiation Protection Manager/Supervisor have six months of operational experience. In a response to a request for additional information (ACO, 2020b) Centrus restored the commitment and the staff finds this acceptable for the reasons discussed in Chapter 4 of this SER.

In the RLA Section 2.1.4 Director, Engineering, Procurement, and Construction, ACO removed the responsibility of managing the execution for the Balance of Plant (BOP) work which ACO self-performs for the deployment of the ACP for the Director, Engineering, Procurement, and Construction. The staff finds this change to be acceptable because the size of the BOP for the HALEU cascade is much smaller than that of the ACP's former commercial plant and there no longer is a need to manage work within the BOP.

In the RLA Section 2.1.6 Director, Engineering, ACO added the overall design authority for Piketon operations to the responsibilities of the Director, Engineering. The staff finds this acceptable.

In the RLA Section 2.1.7 Plant Shift Superintendent (PSS) (Contractor), ACO added language to the commercial ACP LA that stipulates that the PSS reports to the DOE reservation contractor management, rather than "contractor management." ACO also added that the PSS provides support through approved reverse-work authorizations with the DOE. The staff finds these changes to be acceptable because DOE's contractor managers have experience operating uranium enrichment facilities.

In the RLA Figure 2.1-1 American Centrifuge Organization Chart, ACO clarified that the General Manager of the ACP is also the HALEU Program Manager.

All other changes made in commercial ACP LA Chapter 2 were editorial/administrative in nature.

2.3 EVALUATION FINDINGS

The NRC staff has reviewed the changes to ACO's organization and administration for the HALEU Demonstration Program following the criteria in Section 2.4.3 of the Standard Review Plan. The NRC staff determined that the changes adequately describe and document the description of its organization and administration. In addition, the staff finds the changes are in compliance with the requirements in 10 CFR 70.22 and 70.23, specifically those pertaining to the establishment of a management system and administrative procedures for the effective implementation of health, safety, and environment (HS&E) functions.

2.4 REFERENCES

(ACO, 2020) American Centrifuge Operating, LLC. "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML20125A103 (ML20125A126 - Package), April 22, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC. "Response to Requests for Additional Information Related for American Centrifuge Operation LLC's License Amendment Request," ACO 20-0036, ADAMS Accession Number ML20301A436; ADAMS Package Number ML20301A440, October 14, 2020.

(NRC, 2006) U.S. Nuclear Regulatory Commission. "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," NUREG-1851, ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2015) U.S. Nuclear Regulatory Commission. NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2, ADAMS Accession Number ML15176A258, September 30, 2015.

(NRC, 2018) U.S. Nuclear Regulatory Commission. "NRC Inspection Report No. 07007003/2018001(DNMS) – American Centrifuge Operating, LLC, Lead Cascade Facility," ADAMS Accession Number ML18260A122, September 12, 2018.

3 ISA AND ISA SUMMARY

3.1 PURPOSE OF REVIEW

The NRC staff conducted this review to evaluate whether the Licensee, American Centrifuge Operating, LLC (ACO) complied with requirements for an ISA in the amendment request submitted by letter dated April 22, 2020 (ACO, 2020c) and supplemented by letter dated October 14, 2020 (ACO, 2020d). ACO describes its ISA program in Chapter 3 of the RLA (ACO, 2020a) which reflects changes to ACP operations, including the proposed HALEU processes. In addition to the RLA, ACO submitted the ISA Summary for the commercial ACP as well as an ISA Summary specifically for the HALEU Demonstration in Addendum 1 (ACO, 2020c). These ISA Summaries demonstrate ACO's implementation of the ISA program described in Chapter 3 of the RLA.

The purpose of this review is to determine whether ACO's ISA program continues to demonstrate compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 70, Subpart H, "Additional Requirements for Certain Licensees Authorized to Possess a Critical Mass of Special Nuclear Material" for operation of the proposed HALEU processes. The staff also evaluates whether the ISA Summaries continue to provide reasonable assurance that:

- 1) ACO conducted an ISA of appropriate detail for each applicable process, using methods and qualified staff adequate to achieve the requirements of 10 CFR 70.62, "Safety program and integrated safety analysis;"
- 2) ACO identified and evaluated in the ISA credible events involving process deviations or other events internal to the facility (e.g., explosions, spills, and fires) and credible external events (e.g., natural phenomena hazards (NPH)) that could result in facility-induced consequences to workers, the public, or the environment, that could exceed the performance requirements of 10 CFR 70.61, "Performance requirements;"
- 3) ACO has established an ISA team with qualifications and expertise in engineering and process operations; and
- 4) ACO appropriately designated IROFS, evaluated those IROFS for preventing or mitigating the applicable accident sequences and applied its management measures program to demonstrate compliance with the performance requirements of 10 CFR 70.61.

3.1.1 Regulatory Requirements

The staff evaluated ACO's ISA program as described in Chapter 3 of the RLA and the ISA Summaries for the commercial ACP and HALEU Demonstration Program, to determine whether ACO meets the following requirements:

- a) The regulations in 10 CFR 70.61(a) require that the ISA evaluate compliance with performance requirements. The performance requirements in 10 CFR 70.61(b) and (c) specify that: (1) the risk of each credible high-consequence event must be limited so that the likelihood of occurrence is highly unlikely, and (2) the risk of each credible intermediate-consequence event must be limited so that the likelihood of occurrence is unlikely, respectively. In addition, the performance requirements in 10 CFR 70.61(d) the

risk of criticality accidents must be limited by assuring that under normal and all credible abnormal conditions, all nuclear processes are subcritical including the use of an approved margin of subcriticality for safety, respectively.

- b) The regulatory requirements in 10 CFR 70.62(a)-(d) require that ACO (1) establish and maintain a safety program, including process safety information, (2) perform an ISA that demonstrates compliance with the performance requirements of 10 CFR 70.61 and (3) establish management measures. To comply with 10 CFR 70.62(c), ACO's ISA must identify radiological hazards, chemical hazards, facility hazards that could affect the safety of licensed materials and thus present an increased radiological risk. In addition, the ISA must identify potential accident sequences, the consequence and likelihood of occurrence of each potential accident sequence and each IROFS. Furthermore, the ISA team shall include at least one person who has experience and knowledge specific to each process being evaluated, and persons who have experience in nuclear criticality safety, radiation safety, fire safety, and chemical process safety. One member of the team must be knowledgeable in the specific integrated safety analysis methodology being used.
- c) The regulations in 10 CFR 70.64(a) specify the requirements for baseline design criteria, system design, and facility layout for new processes that require a license amendment under 10 CFR 70.72.
- d) The regulations in 10 CFR 70.65(b), "Additional content of application," require ACO to submit an ISA Summary with the current amendment that contains specific information to demonstrate compliance with 10 CFR 70.61.

3.1.2 Regulatory Guidance and Acceptance Criteria

For this review, the staff used the guidance in NUREG-1520, specifically the applicable acceptance criteria in Sections 3.4.3.1 and 3.4.3.2 (NRC, 2015). The acceptance criteria in Section 3.4.3.1 pertain to the performance of an ISA, while the criteria in Section 3.4.3.2 describe the content of an ISA Summary and its documentation.

3.2 STAFF REVIEW AND ANALYSIS

The NRC staff used the applicable acceptance criteria in NUREG 1520, Revision 2 to evaluate the current licensing basis documents, (i.e., RLA, ISA Summaries for the commercial ACP and HALEU Demonstration Program and license), the previous safety evaluation report (SER) and ACO's responses to the staff's requests for additional information (RAIs), dated October 14, 2020 (ACO, 2020d). The NRC staff also conducted an onsite review to confirm that ACO demonstrates compliance with its ISA Program, as described (NRC, 2020a). The following sections summarize the staff's review and analysis of ACO's safety program to include its ISA program and the ISA Summaries.

3.2.1 Process Safety Information

The staff reviewed the ISA and ISA Summaries and conducted onsite reviews to confirm that ACO provided written information on (1) the hazards of all materials used or produced in the processes, (2) the technology of the processes, and (3) the equipment used in the processes. This information includes updates to the codes and standards to which ACO commits to support implementation of its ISA program. In Section 1.4 of the RLA (ACO, 2020a), ACO discusses updates to its commitments regarding the following codes and standards:

1. ANSI N 13.6-1999, Practice/or Occupational Radiation Exposure Records Systems;
2. ANSI N14.1-2012, Nuclear Materials - Uranium Hexafluoride - Packaging for Transport; and
3. ANSI/ISA 67.04.01-2000, Setpoints for Nuclear Safety-Related Instrumentation.

The staff reviewed these updates to the extent that their reference in the ISA Summaries may affect the relevant detail of process safety information.

The NRC staff finds ACO's process safety information is consistent with the types of process safety information ACO commits to maintain, as described in Section 3.1.1, "Process Safety Information" of the RLA (ACO, 2020a). Additionally, process safety will be evaluated in an operational readiness review conducted before the introduction of UF₆ under the existing License Condition 11 which states:

Introduction of UF₆ into any module of the ACP shall not occur until the Commission completes an operational readiness and management measures verification review to verify that management measures that ensure compliance with the performance requirements of 10 CFR Section 70.61 have been implemented and confirms that the facility has been constructed and will be operated safely and in accordance with the requirements of the license. ACO shall provide the Commission with 120 days advance notice of its plan to introduce UF₆ in any module of the ACP (NRC, 2021).

In order to ensure that the readiness review and verification is performed before UF₆ is introduced into the HALEU Demonstration cascade, License Condition 11 is modified as follows:

Introduction of UF₆ into any module of the ACP, including the HALEU Demonstration cascade, shall not occur until the Commission completes an operational readiness and management measures verification review to verify that management measures that ensure compliance with the performance requirements of 10 CFR Section 70.61 have been implemented and confirms that the facility has been constructed and will be operated safely and in accordance with the requirements of the license. The licensee shall provide the Commission with 120 days advance notice of its plan to introduce UF₆ in any module of the ACP, including the HALEU Demonstration cascade.

Therefore, based on the commitment in Section 3.1.1 of the RLA and License Condition 11, the NRC staff finds that ACO has met the acceptance criteria for providing written safety information as outlined in Section 3.4.3.1 of NUREG-1520 (NRC, 2015).

3.2.2 Integrated Safety Analysis

Section 3.0 of the RLA, “Integrated Safety Analysis and Integrated Safety Analysis Summary,” describes ACO’s ISA program (ACO, 2020a). The staff reviewed the proposed changes in the RLA and identified changes to the description of the ISA program. The staff review of the ISA program focused on the proposed changes identified in the RLA, as well as confirming whether ACO demonstrates compliance with 10 CFR 70.61. The staff also reviewed NUREG-1851, “Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio” and the proposed changes to the ISA Summaries for the commercial ACP and the HALEU Demonstration Program (NRC, 2006). In Section 3.0 of the RLA, “Integrated Safety Analysis and Integrated Safety Analysis Summary,” ACO commits to conducting and maintaining an ISA of appropriate complexity for each process (ACO, 2020a). ACO’s ISA Summary demonstrates that the results of the ISA have been used to identify process hazards, credible accident scenarios, the consequences and likelihood of those scenarios, and the IROFS needed to meet the performance requirements of 10 CFR 70.61.

As described in Section 3.0 of the RLA, “Integrated Safety Analysis and Integrated Safety Analysis Summary,” ACO commits to using methods listed in NUREG-1513, “Integrated Safety Analysis Guidance Document,” to conduct the ISA (ACO, 2020a). In Section 3.1.2.3.2.8 of the RLA, ACO describes the use of a deterministic method to evaluate criticality events for the HALEU Demonstration. The staff determined that use of this method is acceptable. Chapter 5 of this SER includes a detailed discussion of the methodology and the staff’s associated findings.

ACO also commits to maintaining an accurate and up to date ISA using the configuration management process described in Section 11.1, “Configuration Management,” of the license application (ACO, 2020b). The RLA states that the Piketon Engineering Manager is responsible for administering the configuration management process to evaluate proposed changes to the facility or its processes. If the evaluation of a proposed change identifies new accident scenarios or increases in accident sequences or likelihoods, Section 11.1, “Configuration Management,” of the RLA states that ACO will use the configuration management process to evaluate changes to the associated IROFS and management measures. In addition to its configuration management process, ACO conducts operational assessments to ensure the operational assumptions as defined in the ISA Summaries are valid.

Section 3.1.2, “Integrated Safety Analysis,” of the RLA states that ISA team members are knowledgeable in ISA methods and in the operation, hazards, and safety design criteria of the process being analyzed (ACO, 2020h). Furthermore, Section 11.0, “Management Measures,” of the RLA describes how the ISA team will retain the expertise and qualifications to maintain the ISA (ACO, 2020b). The staff performed an onsite review to confirm that ACO conducts an ISA using acceptable methodologies. The details of the onsite review are discussed in Section 3.3.4 of this chapter. In addition to the onsite review, License Condition 11, as modified above, requires an operational readiness and management measures verification review before introduction of UF₆ in the HALEU Demonstration cascade.

Sections 1.1.2, “Plant Layout” and 11.1.2, “Design Requirements” of the RLA state that the design of the ACP complies with (1) the Baseline Design Criteria (BDC) specified in 10 CFR 70.64(a) and (2) the defense-in-depth requirements contained in 10 CFR 70.64(b) (ACO, 2020b). ACO’s compliance with 10 CFR 70.64 is also demonstrated in Chapter 2 of the ISA Summary for the commercial ACP and is discussed in Section 3.4.4, “ISA Summary,” below.

Based on the NRC staff's onsite review, License Condition 11, the findings in Chapter 5 of this SER, and a review of the RLA and the ISA Summaries, the staff finds that ACO has met the acceptance criteria for conducting and maintaining an ISA as outlined in Section 3.4.3.1 of NUREG-1520 (NRC, 2015).

3.2.3 Management Measures

Section 11.0 of the RLA, "Management Measures," describes ACO's program to maintain the availability and reliability of IROFS (ACO, 2020b). In Section 11.0, ACO commits to apply management measures to IROFS specified in the ISA for ensuring the reliability and availability of each IROFS. The staff's detailed review and analysis of Management Measures is in Chapter 11 of this SER.

Based on the review of the documentation mentioned above and the staff's findings in Chapter 11 of this SER, the staff finds that ACO has met the acceptance criteria for management measures as outlined in Sections 3.4.3.1 and 3.4.3.2 of NUREG-1520 (NRC, 2015).

3.2.4 ISA Summary

The NRC staff reviewed the ISA Summaries, including conducting onsite horizontal and vertical slice reviews of the ISA. The staff concluded that the ISA Summaries discuss the nine elements required by 10 CFR 70.65(b): (1) a description of the site; (2) a description of the facility; (3) a description of each process in sufficient detail to understand the theory of the process; (4) information that demonstrate ACO's compliance with the performance requirements of 10 CFR 70.61; (5) a description of the team, qualifications, and the methods used to perform the ISA; (6) a list briefly describing each IROFS; (7) a description of the proposed quantitative standard used to assess the consequences in 10 CFR 70.61 (b)(4) and (c)(4); (8) a descriptive list that identifies all sole IROFS; and (9) a description of the definitions of "unlikely," "highly unlikely," and "credible" as used in the ISA.

The NRC staff reviewed Section 2.6 of the ISA Summaries to determine whether ACO's methodology to address the baseline design criteria complies 10 CFR 70.64. Each criterion includes references to the RLA or ISA Summaries to address design basis events, safety parameter limits and the methods, standards and guidance applied to meet the criteria. The staff found that Section 2.6 adequately describes each criterion and the processes and programs that demonstrate compliance with the baseline design criteria.

The NRC staff evaluated how ACO implements its likelihood definitions for accidents, as unlikely, high unlikely, and not credible, as specified in its ISA methodology. The staff reviewed accident sequences associated with criticality, chemical, fire, and radiological safety. The staff found that for credible criticality, fire, and radiological accident sequences, ACO designated initiating event frequencies, failure frequencies, and consequences consistent with its ISA methodology. Initiating events included external events such as NPH. A detailed discussion of the staff's review of NPH can be found in Section 3.2.5 of this SER.

The staff reviewed a sample of IROFS to determine if the licensee's human factors practices, as incorporated into the licensee's safety program, are adequate to support the functionality of IROFS. The results of this review are referenced in Appendix A of this SER. The staff finds that the sample of IROFS demonstrated that the licensee's human factors practices are being sufficiently incorporated into the licensee's safety program and provide further indication that IROFS can perform their functions.

As part of its onsite horizontal and vertical slice reviews, the NRC staff assessed the following operations and analyses: feed operations, transportation operations of feed and tails cylinders, analysis of uranyl fluoride as a hazard, release rates of UF₆ in calculations for accident sequences HD3-2 and HD3-3, vacuum interfaces, and the accumulation of fissionable material (e.g., filter housing, ventilation ducts). The staff assessed engineering evaluations and screening criteria used to determine the elements of the ISA, including accident sequence consequences, likelihoods and IROFS. The staff also reviewed the nuclear criticality safety evaluations that incorporate the results of the engineering evaluations. The staff found that ACO's ISA program and methodology provides the mechanism for ACO to reasonably and systematically select and apply relevant facility processes, identify credible high and intermediate consequence accident sequences, determine accident sequence consequences and likelihoods, and apply appropriate IROFS and supporting management measures.

The acceptance criteria in Section 3.4.3.2 of NUREG-1520 (NRC, 2015) describe the contents of the ISA Summary as outlined in 10 CFR 70.65(b), which should demonstrate that the ISA Summary:

- Consistently identifies and evaluates credible events involving process deviations or other events internal to the facility (e.g., explosions, spills, and fires) and credible external events that could result in facility-induced consequences to workers, the public, or the environment, or could exceed the performance requirements of Section 70.61 and
- Documents IROFS designated to maintain compliance with Section 70.61 (NRC, 2015).

Based on the onsite review, the review of the documentation mentioned above, and ACO's response to the staff's RAI, the staff finds that ACO meets the acceptance criteria of Section 3.4.3.2 of NUREG-1520 (NRC, 2015). Therefore, the staff concludes that the updated ISA Summaries for the commercial ACP and the HALEU Demonstration Program show that ACO conservatively and consistently applied its ISA methodology to process safety areas.

3.2.5 Natural Phenomena Hazards

ACO addresses Natural Phenomena Hazards (NPH) for HALEU Demonstration Facility in Sections 1.3.3 through 1.3.6 of the RLA and Sections 6.1.1.7 and 7.3.7 of Addendum 1 of the ISA Summary. ACO considered NPH including extreme temperatures, lightning, snow, and ice with a focus on the most predominant NPH of seismic, flooding, and high wind events. The scope of the NRC staff's review focused on the changes associated with this amendment. Following NUREG-1520 (NRC, 2015) and Interim Staff Guidance FCSE-ISG-15 (NRC, 2015a), the NRC reviewed the evaluation methods, the applied codes and standards, and the incorporation of the NPH assessments into Addendum 1 of the ISA Summary including the identification of NPH accident sequences and NPH IROFS.

3.2.5.1 Baseline Design Criteria for Natural Phenomena Hazards

ACO describes the seismic design basis for the HALEU Demonstration Facility in Sections 1.3.6.5 and 3.4 of the RLA and Section 6.1.1.7 of Addendum 1 of the ISA Summary. The seismic design basis consists of a 1,000-year return period seismic event for the site. This correlates to a 0.15 gravity peak ground acceleration and a 0.29 gravity short period response spectral acceleration.

ACO describes the design basis flooding events in Section 1.3.4 of the RLA and Section 6.1.1.7 of Addendum 1 of the ISA Summary. For these events, ACO concludes that the facility is a dry site above the flood plain.

ACO describes the design basis events for high winds, tornados, and tornado generated missiles in Sections 6.1.1.7 and 7.3.7 of Addendum 1 of the ISA Summary. ACO evaluated the design of building structures for high wind events. For the tornado and tornado generated missile events, ACO evaluated the annual probability of tornado occurrence for the site and determined the events were highly unlikely.

ACO addresses other NPH events including extreme temperatures, lightning, snow, and ice in Section 1.3.3 of the RLA and Section 6.1.1.7 of Addendum 1 of the ISA Summary.

ACO has not changed the design basis of any NPH events as part of this amendment. The NRC staff previously reviewed and approved this design basis as documented in the ACP SER NUREG-1851 (ADAMS Accession Number ML062700087).

The NRC staff reviewed the changes associated with the amendment request and finds that the previously approved NPH design criteria continue to be applicable to the facility, as amended. Based on the review of this amendment and the applicability of the previously approved design criteria, the NRC staff finds that the design criteria for NPH are consistent with NUREG-1520 (NRC, 2015) and FCSE-ISG-15 (NRC, 2015a) and meet the requirements of 10 CFR 70.62(c)(iv) and 10 CFR 70.64(a)(2).

3.2.5.2 Evaluation of Building Structures

The building structures comprising the HALEU Demonstration Facility have been designed and evaluated for the design basis wind and seismic events. ACO discusses the design of the building structures in Sections 1.3 and 3.4 of the RLA with appropriate references to supporting design documents. The evaluation of the building structures is discussed further in Appendix A of this SER.

The NRC staff reviewed the methods and the applied codes and standards of the structural evaluations of the buildings and the incorporation of the evaluations into the ISA Summary. The NRC staff finds that the building structure evaluations described are consistent with the facility's baseline design criteria for NPH, NUREG-1520 (NRC, 2015), and FCSE-ISG-15 (NRC, 2015a) and meet the requirements of 10 CFR 70.62(c)(iv) and 10 CFR 70.64(a)(2).

3.2.5.3 Evaluation of Equipment

A variety of internal equipment at the HALEU Demonstration Facility have been structurally evaluated for the design basis seismic event. ACO discusses the design of these equipment supports in Section 3.4 of the RLA. The evaluation of the equipment supports is discussed further in Appendix A of this SER.

The NRC staff reviewed the methods and the applied codes and standards of the structural evaluations of the internal equipment and the incorporation of the evaluations into the ISA Summary. The NRC staff finds that the internal equipment evaluations described are consistent with the facility's baseline design criteria for NPH, NUREG-1520 (NRC, 2015), and FCSE-ISG-15 (NRC, 2015a) and meet the requirements of 10 CFR 70.62(c)(iv) and 10 CFR 70.64(a)(2).

3.3 EVALUATION FINDINGS

The NRC staff finds that ACO established an ISA program that will continue to be in compliance with 10 CFR Part 70, Subpart H. Furthermore, the staff finds that the ISA Summaries demonstrate compliance with the performance requirements of 10 CFR 70.61. Specifically, the staff has reasonable assurance that:

- 1) ACO has conducted an ISA of appropriate detail for each applicable process for the proposed operation of the HALEU Demonstration Program, using methods adequate to achieve the requirements of 10 CFR 70.62;
- 2) ACO has identified and evaluated in the ISA credible events involving process deviations or other events internal to the facility (e.g., explosions, spills, and fires) and credible external events that could result in facility-induced consequences to workers, the public, or the environment for the proposed operation of the HALEU Demonstration Program, that could exceed the performance requirements of 10 CFR 70.61;
- 3) ACO has established an ISA team, which is qualified and has expertise in engineering and process operations; and
- 4) ACO has designated IROFS, evaluated those IROFS for preventing or mitigating the applicable accident sequences, and applied its management measures program to demonstrate compliance with the performance requirements of 10 CFR 70.61.

3.4 REFERENCES

(ACO, 2020a) American Centrifuge Operating, LLC, "License Application for the American Centrifuge Plant Chapters 1 – 3," ADAMS Accession Number ML20125A108, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC, "License Application for the American Centrifuge Plant Chapters 4 - 11," ADAMS Accession Number ML20125A116, 2020.

(ACO, 2020c) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ADAMS Accession Numbers ML20125A117 (Part 1) (non-public) and ML20125A106 (Part 2) (non-public), April 22, 2020.

(ACO, 2020d) American Centrifuge Operating, LLC, "Enclosure 1 - Responses to NRC's Requests for Additional Information Related to the License Amendment Request for the High Assay Low Enriched Uranium Demonstration Program - License Application Chapters 4, 6, 7, and 11," ADAMS Accession Number ML20301A439, October 14, 2020.

(NRC, 2001) U.S. Nuclear Regulatory Commission. NUREG-1513, "Integrated Safety Analysis Guidance Document," ADAMS Accession Number ML011440260, May 2001.

(NRC, 2006) U.S. Nuclear Regulatory Commission. NUREG-1851 "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2015) U.S. Nuclear Regulatory Commission. NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications, Revision 2," ADAMS Accession Number. ML15176A258, September 30, 2015.

(NRC, 2015a) U.S. Nuclear Regulatory Commission. FCSE-ISG-15, "Natural Phenomena Hazards in Fuel Cycle Facilities," ADAMS Accession Number ML15121A044, June 26, 2015.

(NRC, 2021) U.S. Nuclear Regulatory Commission. "Materials License SNM-2011, Amendment 12 for American Centrifuge Operating, LLC," ADAMS Accession Number ML21067A090, March 25, 2021.

(NRC, 2020) U.S. Nuclear Regulatory Commission. "Request for Additional Information Regarding Centrus Energy Corp. American Centrifuge Operation American Centrifuge Plant High Assay Low Enriched Uranium Program Amendment," ADAMS Accession Number ML20245E173, September 1, 2020.

(NRC, 2020a) U.S. Nuclear Regulatory Commission. "Summary of Onsite Review of Centrus' HALEU Amendment Application's Nuclear Criticality Safety and Integrated Safety Analysis," ADAMS Accession Number ML20237F263, August 26, 2020.

4 RADIATION PROTECTION

4.1 PURPOSE OF REVIEW

The NRC staff conducted this review to evaluate whether ACO's proposed changes to the radiation protection (RP) program in the amendment application submitted by letter dated April 22, 2020 (ACO, 2020a). The NRC staff evaluated these proposed changes to determine whether the amended RP program continues to protect the health and safety of workers and the public.

4.1.1 Regulatory Requirements

Regulations applicable to establishment of an RP program are presented in 10 CFR Part 20, "Standards for Protection Against Radiation," and the overarching licensing requirements for a uranium enrichment facility are in 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

4.1.2 Regulatory Guidance and Acceptance Criteria

The guidance applicable to NRC's review of the RP program is contained in Chapter 4 of NUREG-1520, Revision 2, "Standard Review Plan for Fuel Cycle Facilities License Applications," (NRC, 2015). Chapter 4 of NUREG-1520, Revision 2, is applicable in its entirety. The acceptance criteria applicable to this review are contained in Sections 4.4.1.3, 4.4.2.3, 4.4.3.3, 4.4.4.3, 4.4.5.3, 4.4.6.3, 4.4.7.3, and 4.4.8.3.

4.2 STAFF REVIEW AND ANALYSIS

The staff reviewed the proposed changes using the acceptance criteria in NUREG-1520.

The HALEU Demonstration Program operates under the same principles as the ACP, with the primary difference being the level of enrichment, which does not substantially impact the radiation protection program requirements. The NRC staff reviewed the proposed changes to the RP program to support the HALEU process, which included clarification of text in several sections of the program and updated references to the ACP to include the HALEU Demonstration Program. The NRC staff's review is subdivided into sections based on the acceptance criteria in NUREG-1520.

4.2.1 Radiation Protection Program Implementation

ACO's commitments to the radiation protection program implementation were previously reviewed and approved by the NRC staff and are documented in NUREG-1851 (NRC, 2006); the commitments in this section, which contain editorial or administrative revisions from those previously approved by the NRC, continue to be applicable to the HALEU Demonstration Program. The NRC staff confirmed the commitments continue to comply with 10 CFR 20.1101 and the acceptance in NUREG-1520, Section 4.4.1, "Commitment to Radiation Protection Program Implementation." The staff confirmed that the ACO's commitments to the Radiation Protection Program Implementation maintain occupational and public doses below regulatory limits and ALARA, as approved in NUREG-1851. The ACO did not request modification of its commitments to implement the RP Program. The NRC staff finds the RP Program

Implementation is adequate to maintain the safe operation of the HALEU Demonstration Program.

4.2.2 ALARA Program

The NRC staff confirmed that the ACO's commitments to implement a comprehensive ALARA Program overseen by an ALARA committee, as approved in NUREG-1851, are applicable to the HALEU Demonstration Program. The ACO did not request any modification to their commitments for the ALARA Program, which the staff finds will provide for the safe operation of the HALEU Demonstration Program consistent with 10 CFR 20.1101 and the acceptance criteria in NUREG-1520, section 4.4.2, "Commitment to an ALARA Program."

4.2.3 Organization and Personnel Qualifications

The NRC staff confirmed that the ACO's commitments to maintain an organization with specific personnel qualifications, as approved in NUREG-1851, are applicable to the HALEU Demonstration Program. The ACO proposed one reduction to the qualifications for the Radiation Protection Manager/Supervisor in their initial submittal. The ACO's response to the NRC staff's Radiation Protection RAI-1 restored the commitment for the qualifications of the Radiation Protection Manager/Supervisor to include appropriate training and at least six months operational experience (ACO, 2020b). The NRC staff finds this commitment, in conjunction with the existing commitments to implement the Organization and Personnel Qualifications, adequately provide for safe operation of the HALEU Demonstration Program. As revised, ACO's commitments to maintain the Organization and Personnel Qualifications are adequate to comply with paragraph (a)(6) of 10 CFR 70.22, "Contents of applications," and the acceptance criteria in NUREG-1520, Section 4.4.3, "Organization and Personnel Qualifications."

4.2.4 Written Procedures

The ACO did not request any modification to their commitments to use written procedures for the RP program that were approved in NUREG-1851, which the NRC staff had found demonstrated compliance with 10 CFR 70.22(a)(8) and the acceptance criteria in NUREG-1520, Section 4.4.4, "Commitment to Written Procedures."

4.2.5 Radiation Safety Training

The NRC staff confirmed that the ACO's commitment to maintain appropriate radiation safety training, as approved in NUREG-1851, is applicable to the HALEU Demonstration Program. The ACO requested minor changes to the radiation safety training. Section 4.5.3, "Radiation Worker Training," was revised to authorize qualified radiation workers to receive additional training on specific tasks, in order to become qualified to serve as a health physics technician. The NRC staff reviewed the modification and determined it provides an adequate level of training commensurate with the task and is thus consistent with the acceptance criteria. The staff also reviewed the additional radiation training details described in Chapter 11.3.1.3, "Radiation Worker Training," which remains unchanged, as approved in NUREG-1851. These commitments in Chapter 4 and 11 provide for adequate training of the staff which supports the safe operation of the and comply with 10 CFR 19.12, "Instructions to workers," 10 CFR 20.2110, "Form of records," paragraph (a)(6) of 10 CFR 70.22, "Contents of applications," and the acceptance criteria in NUREG-1520, Section 4.4.5, "Radiation Safety Training."

4.2.6 Ventilation and Respiratory Protection Programs

The NRC staff confirmed that the ACO's ventilation and respiratory protection programs, as approved in NUREG-1851, are applicable to the HALEU Demonstration Program. The ACO provided two new clarifications in their ventilation commitments. First, ACO clarified that although the ventilation program has never been used as an IROFS, ventilation is used for defense in depth to limit exposures to uranium. Second, ACO improved the definition of gulpers, which are mobile high efficiency particulate air (HEPA) filters with a vacuum motor/fan that reduce local airborne contamination. These updates to the programs are consistent with acceptance criterion four, which provides for description of the criteria for the ventilation and containment systems. Aside from these clarifications, the ACO did not request any additional modification to the ventilation and respiratory protection programs. ACO's revisions to these commitments will continue to provide adequate safety for the HALEU Demonstration Program and compliance with 10 CFR Part 20, Subpart H, "Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas," and the acceptance criteria in NUREG-1520, Section 4.4.6, "Ventilation and Respiratory Protection Programs."

4.2.7 Radiation Surveys and Monitoring Programs

The NRC staff confirmed that the ACO's Radiation Surveys and Monitoring Programs, as approved in NUREG-1851, are applicable to the HALEU Demonstration Program. The ACO provided modifications to the external and internal monitoring programs. In Section 4.7.3, "External," the commitment to use either self-reading or alarm dosimeters in high or very-high radiation areas was removed and replaced with a commitment to use radiation survey instruments. The change is acceptable because the ACO maintains the commitment to monitor exposures with the survey equipment. Also, the staff finds that ACO's commitment to restrict access to High Radiation Areas by using radiation work permits, specific to the work conditions, provides adequate protection to workers. In Section 4.7.4, "Internal," the commitment to use fecal sampling and lung counting dosimetry is removed and is replaced by the commitment to conduct urinalysis. Consistent with Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program," a urinalysis bioassay is an acceptable *in vitro* method for determining internal radiological exposure consistent with the requirements in 10 CFR 20.1204, "Determination of internal exposure." In addition, ACO updated Section 4.7.4, "Internal," of the application in response to the NRC staff's HP-RAI-2 (ACO, 2020b). ACO verified its commitment to maintain a baseline level of monitoring for personnel, administrative exposure limits, personnel dosimetry, and dose records that are consistent with 10 CFR 20.1502, "Conditions requiring individual monitoring of external and internal occupational dose." The ACO's commitments to maintain the Radiation Surveys and Monitoring Programs demonstrate compliance with 10 CFR Part 20 Subpart C, "Occupational Dose Limits;" Subpart F, "Surveys and Monitoring;" Subpart G, "Control of Exposure From External Sources in Restricted Areas;" Subpart L, "Records;" Subpart M, "Reports;" and the acceptance criteria in NUREG-1520, section 4.4.7, "Radiation Surveys and Monitoring Programs."

4.2.8 Control of Radiological Risk Resulting from Accidents

The NRC staff confirmed that the ACO's Integrated Safety Analysis, as approved in NUREG-1851, is applicable to the HALEU Demonstration Program. The Addendum 1 to the ISA Summary in Appendix C, "Hazard Identification Tables," identifies the "internal uptake of radiological material through the respiratory pathway as a concern in nearly all events postulated" (ACO, 2020c). However, the NRC staff finds the majority of these potential exposures are of low consequence, primarily due to the limited quantity of UF₆ present in the

enrichment process. Several initiating events were identified and evaluated by the ACO in the Appendix C, "Hazard Identification Tables" that could result in significant releases of UF₆ (e.g., fire), and, appropriate IROFS are applied, as needed.

External exposure to the radioactivity associated with a release of uranium is considered a low consequence event. The UF₆ produces low level alpha activity that does not result in a significant external exposure. However, contamination can result in uptake of the material through inhalation or ingestion resulting in an internal exposure. The ACO identified the appropriate events which may result in low or intermediate consequence due to internal radiological exposure and intermediate to high consequence events for chemical exposure to uranium and hydrofluoric acid. These are identified in the Appendix C, "Hazard Evaluation Table" (ACO, 2020a) to the Addendum 1 of the ISA Summary for the HALEU Demonstration Program (ACO, 2020c). The ISA also identifies the appropriate items relied on for safety, (e.g., fire management, training, and emergency response) that prevent the initiating event or mitigate subsequent releases.

The NRC staff's analysis determined the ISA methodology was applied appropriately to identify and protect against the radiological events in the HALEU Demonstration Program. The NRC staff agrees with the ACO's determination of no credible high consequence radiological events outside of a criticality event. The NRC staff confirmed that the ACO's ISA and associated management measures identify the appropriate accident sequences and provide an adequate safety basis for the radiological program for the HALEU Demonstration Program. The NRC staff finds the commitments ACO makes to maintain the Control of Radiological Risk Resulting from Accidents demonstrate compliance with 10 CFR 70.22(i)(1); 10 CFR Part 70 Subpart H, "Additional Requirements for Certain Licensees Authorized To Possess a Critical Mass of Special Nuclear Material;" 10 CFR 20.1101, "Radiation protection programs;" 10 CFR 20.1406, "Minimization of Contamination;" and the acceptance criteria in NUREG-1520, section 4.4.8.3, "Control of Radiological Risk Resulting from Accidents."

4.2.9 Additional Program Commitments

The NRC staff confirmed that ACO's additional program commitments, as approved in NUREG-1851, are applicable to the HALEU Demonstration Program. The ACO did not request modifications to its commitments, and for this reason the NRC staff finds the commitments are adequate for the safe operation of the HALEU Demonstration Program. The ACO did state that the posting and labeling exemptions from container labeling requirements of 10 CFR 20.1904, approved in NUREG-1851, continue to be applicable. The NRC staff finds this acceptable because the use of UF₆ feed, product, and depleted uranium cylinders are readily identifiable within the reservation boundary and do not require individual labeling for recognition. In addition, the staff find that ACO's commitment to area posting in lieu of individual container labeling is more practicable and provides the intended notifications within the restricted area. ACO provided the appropriate additional program commitments for compliance with 10 CFR Part 20, Subpart L, "Records;" 10 CFR Part 20, Subpart M, "Reports;" 10 CFR 20.1906, "Procedures for receiving and opening packages;" 10 CFR 20.2006, "Transfer for disposal and manifests;" 10 CFR 20.1904 "Labeling containers;" 10 CFR 70.74, "Additional reporting requirements;" 10 CFR Part 71, "Packaging and Transportation of Radioactive Material;" 49 CFR, "Transportation" and Section 4.4.9.3 Acceptance Criteria; and the acceptance criteria in NUREG-1520, Section 4.4.9, "Additional Program Commitments."

4.3 EVALUATION FINDINGS

The RP Program for the HALEU Demonstration Program is consistent with RP program previously approved for the ACP. The staff finds the proposed changes are acceptable because they: (1) do not impact the radiation protection program substantively; (2) continue to demonstrate compliance with the NRC's regulations and; (3) are consistent with guidance. The HALEU Demonstration Program operates under the same principles as the ACP, the primary difference being the higher level of enrichment, which the staff finds does not substantially impact the radiation protection program. Therefore, the staff finds the RP program approved for the ACP is also acceptable for the safe operations of HALEU. The staff also finds ACO appropriately identified credible accident sequences and developed appropriate measures to mitigate the credible accidents in the ISA, which further supports the acceptability of the RP program.

The Licensee has committed to an acceptable radiation protection program that includes the following:

- an effective documented program to ensure that occupational radiological exposures are ALARA,
- an organization with adequate qualification requirements for the radiation protection personnel,
- approved written radiation protection procedures and RWPs for radiation protection activities,
- radiation protection training for all personnel who have access to restricted areas
- a program to control airborne concentrations of radioactive material with engineering controls and respiratory protection,
- a radiation survey and monitoring program that includes requirements for controlling radiological contamination within the facility and monitoring external and internal radiation exposures, and
- other programs to maintain records; report to the NRC in accordance with 10 CFR Part 20 and 10 CFR Part 70; and appropriately respond to, investigate, and prevent incidents and accidents involving radiological exposures or uncontrolled releases of radioactive material.

The NRC staff concludes that the Licensee's radiation protection program is adequate and meets the requirements of 10 CFR Part 19, 10 CFR Part 20, 10 CFR Part 70, and 10 CFR Part 71. Conformance to the license application and license conditions will ensure safe operations.

In addition, the Licensee has accurately evaluated, in the ISA summary, those accident sequences with intermediate or high radiological consequences. The Licensee has also identified controls and management measures that reduce the likelihood or consequences of accident sequences and meet the performance criteria of 10 CFR 70.61.

4.4 REFERENCES

(ACO, 2020a) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0010, ADAMS Accession Number ML20125A103; ADAMS Package Number ML20125A126, April 22, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC, "Response to Requests for Additional Information Related for American Centrifuge Operation LLC's License Amendment Request," ACO 20-0036, ADAMS Accession Number ML20301A436; ADAMS Package Number ML20301A440, October 14, 2020.

(ACO, 2020c) American Centrifuge Operating, LLC, "Proposed Changes for Additional Information Related for American Centrifuge Operating, LLC's License Amendment Request," ACO 20-0039, ADAMS Accession Number ML20301A264 (non-public), October 19, 2020.

(NRC, 2006) U.S. Nuclear Regulatory Commission, "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," NUREG-1851, ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2015) U.S. Nuclear Regulatory Commission. NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2, ADAMS Accession Number ML15176A258, September 30, 2015.

5 CRITICALITY SAFETY

5.1 PURPOSE OF REVIEW

Chapter 5.0 of the commercial ACP LA, originally approved by the NRC in 2006 (NRC, 2006), contains ACO's programmatic commitments for the management of its nuclear criticality safety (NCS) program. The license amendment request for the HALEU Demonstration Program included administrative changes, clarifications, and several proposed technical changes to Chapter 5.0 of the commercial ACP LA. The licensee provided a technical justification for each proposed technical change.

The staff reviewed ACO's nuclear criticality safety validation report (ACO, 2019) and license amendment request to amend Materials License SNM-2011 (ACO, 2020) to determine whether the proposed changes are consistent with the requirements of 10 CFR Part 70. By letter dated September 11, 2020, the staff issued a request for additional information (NRC, 2020) to obtain the necessary information to facilitate the staff's technical review of the amendment request. The licensee subsequently responded to the staff's request in a letter dated October 14, 2020 (ACO, 2020a).

5.1.1 Regulatory Requirements

The staff conducted its review of ACO's request to ensure that the proposed changes are consistent with the requirements of 10 CFR Part 70, including:

- Section 70.24, "Criticality accident requirements;"
- Section 70.50, "Reporting requirements;"
- Section 70.52 "Reports of accidental criticality;"
- Section 70.61, "Performance requirements;"
- Section 70.62, "Safety program and integrated safety analysis;"
- Section 70.64, "Requirements for new facilities or new processes at existing facilities;" and
- Appendix A to Part 70, "Reportable Safety Events."

5.1.2 Regulatory Guidance and Acceptance Criteria

The staff's review was performed in accordance with NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," (NRC, 2015) and NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," (NRC, 2001).

5.2 STAFF REVIEW AND ANALYSIS

The staff noted that the majority of ACO's NCS Program was previously evaluated by NRC staff for the ACP and documented in NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio" (NRC, 2006). However, ACO's request involves new activities involving the production of HALEU, a new deterministic approach for evaluating criticality accident sequences in the production of HALEU, and other factors that necessitate the review of certain aspects of ACO's methodologies and technical practices beyond the scope of the changes to the commercial ACP LA, Chapter 5.0. For these reasons, ACO's request necessitated a review of ACO's proposed minimum margin of subcriticality for safety (MMS). Therefore, the staff's review consisted of the following:

- changes to Chapter 5.0 of the commercial ACP LA;
- the evaluation of criticality accident sequences for the HALEU Demonstration, including NCS-related changes and the associated impacts to the integrated safety analysis (ISA) and the ISA Summary;
- ACO's commitments and technical practices with respect to the double contingency principle (DCP) and compliance with the performance requirements of 10 CFR 70.61, including the review of nuclear criticality safety evaluations (NCSEs) and other technical documents; and
- ACO's criticality code validation report and proposed MMS.

5.2.1 Changes to Chapter 5.0 of the Commercial ACP LA

The proposed changes to Chapter 5.0 of the commercial ACP LA included administrative changes, clarifications, and several proposed technical changes. ACO provided a technical justification for each proposed technical change.

Chapter 5.0, Nuclear Criticality Safety (Preface Section): The current Chapter 5.0 (preface section) of the approved commercial ACP LA states that ACO is authorized to possess large quantities of UF₆ at enrichments up to 10 wt.% U-235. Proposed changes to this section revise the activities and enrichments from the current limits of UF₆ up to 10 wt.% to the possession and enrichment of UF₆ up to 10 wt.% and 20 wt.% for the commercial ACO operations and HALEU Demonstration, respectively. An allowance up to 25 wt.% to accommodate potential fluctuations within the HALEU Demonstration cascade is also specified by the changes. The staff finds the proposed changes to the preface section of Chapter 5.0 of the commercial ACP LA are administrative changes to align the RLA with the new activities requested as part of the amendment request to produce HALEU. For these reasons, the staff determined the changes were acceptable.

Proposed changes to the preface section of Chapter 5.0 of the commercial ACP LA also revise a statement related to the threshold at which a NCSE is required. The commercial ACP LA currently states that a threshold of ≥ 1 wt.% enrichment and ≥ 100 grams U-235 is used to determine whether a NCSE is required and justifies the use of the 100-gram portion of the threshold by stating that 100-grams is a factor of 10 below a minimum critical mass. The proposed revisions account for the higher enrichments associated with ACO's generation of HALEU, by stating in the RLA that the 100-gram threshold is a factor of 7 below a minimum critical mass. The staff reviewed the appropriate industry standards and technical references, including American National Standards Institute/American Nuclear Society (ANSI/ANS)-8.1, "Operations with Fissionable Materials Outside Reactors" (ANS, 2014), and LA-10860-MS, "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233" (LANL, 1986), to assess whether the proposed changes were technically sound.

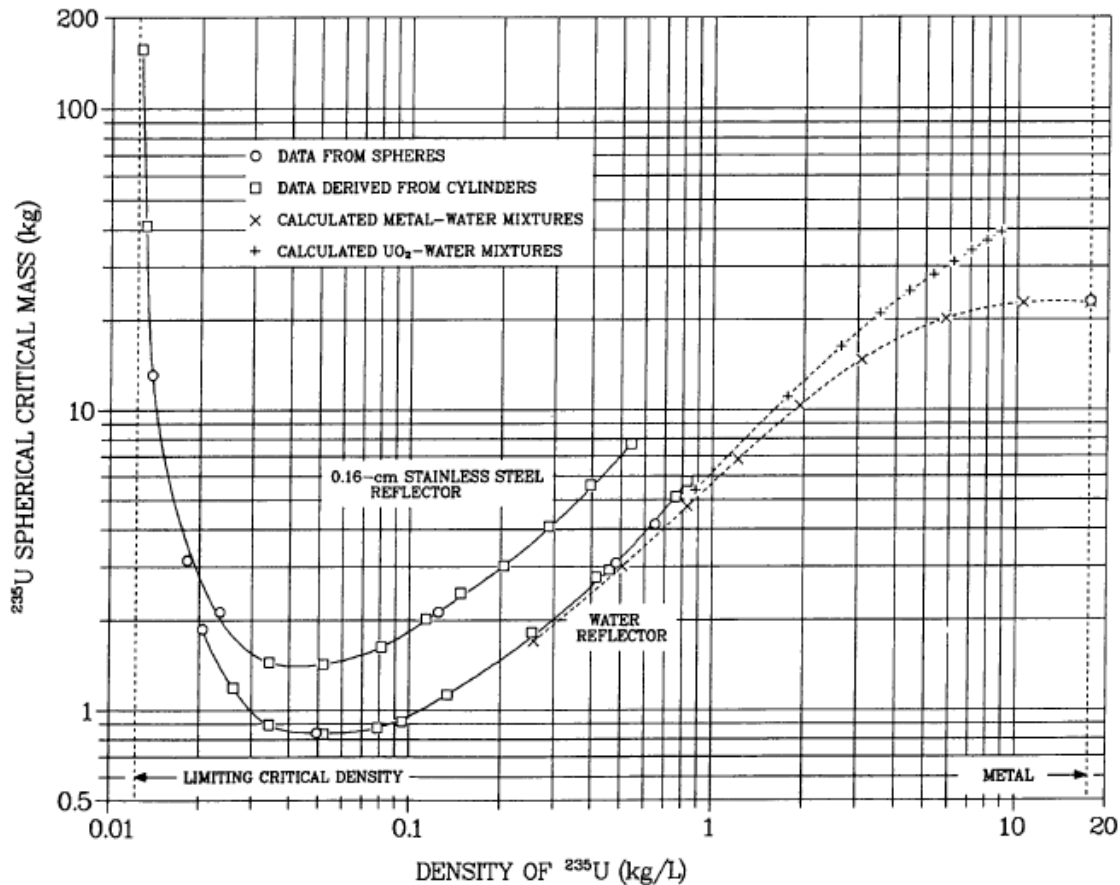


Figure 1 – Critical masses of homogeneous water-moderated U(93.2) spheres. (LA-10860-MS)

Based on a review of LA-10860-MS critical mass plots (Figure 1), the staff determined that the minimum critical mass for U-235 is approximately 764 grams. This value represents the absolute minimum mass required for criticality under the worst-case conditions for each NCS parameter (93.2 wt.% enrichment, spherical geometry, U-metal composition, optimum interstitial moderation, full light-water reflection, etc.). The staff also reviewed ANSI/ANS-8.1, which identified a minimum critical mass of approximately 760 grams for uranyl fluoride solutions. Given that these values represent the absolute minimum critical mass and that the normal and credible abnormal conditions associated with ACO operations are far less reactive (e.g., under-moderated ≤ 25 wt.% enrichment), the staff determined that the factor of 7 stated in the proposed change is technically conservative and consistent with reputable technical references and NRC-endorsed standards (ANSI/ANS-8.1), and is, therefore, acceptable.

The proposed changes replace many of the details regarding the identification of accident sequences and the development of the ISA with references to over-arching commitments and requirements, including a commitment to follow the double contingency principle (DCP) and the requirement to meet the performance requirements of 10 CFR 70.61. Because the over-arching commitments and requirements effectively bound ACO's strategy for identifying accident sequences and the development of the ISA, the staff determined that the changes are acceptable.

Section 5.1.2, Program Objectives: With respect to the objectives of the NCS Program, proposed changes to Section 5.1.2 of the commercial ACP LA add the objective to comply with the reporting requirements of Section 70.52 and Appendix A to 10 CFR Part 70.

The staff determined that the proposed changes to this section are consistent with the requirements of 10 CFR Part 70 and are, therefore, acceptable.

Section 5.2.1, NCS Responsibilities: Section 5.2.1 of the commercial ACP LA currently requires that qualified NCS engineers and senior NCS engineers review all work packages involving fissile material operations to ensure that the commitments made in the applicable NCSE are incorporated into work package instructions. The proposed changes revise the responsibility of qualified and senior NCS engineers, who will now review work packages involving fissile material operations only on an *as requested* basis.

In its request for additional information (NRC, 2020), the staff asked how the validity of safety bases would be ensured and maintained if the review of work packages by qualified NCS staff is performed only on an *as requested* basis. In its response (ACO 2020a), ACO stated that administrative controls for NCS are no longer incorporated into work packages, but now are incorporated into procedures subject to its Configuration Management (CM) program. Under ACO's CM program, new and revised procedures would be reviewed by the appropriate safety organization, including NCS staff, to ensure that NCS requirements are incorporated and to verify the proposed operation complies with NCS program requirements as detailed in the RLA. The staff finds the approach provides the staff with reasonable assurance that: (1) operations involving administrative NCS requirements as detailed in the RLA will be governed by approved procedures; (2) new and revised procedures will be reviewed by qualified NCS staff as appropriate; and (3) NCS program requirements as detailed in the RLA are met. The staff finds that the revised statement is consistent with NCS and CM program commitments, and is therefore, acceptable.

Section 5.2.2, NCS Staff Qualifications: Section 5.2.2 of the commercial ACP LA currently states that a minimum of one-year of experience at an enriched uranium processing facility is required for all qualified NCS engineers. Proposed changes to this section would revise this commitment to state that a minimum of one-year experience is required for all qualified NCS engineers at a facility that practiced NCS and processes uranium.

The staff determined that the proposed changes are more restrictive and conservative because the experience cannot be from a facility that merely processes enriched uranium, but from one that had and implemented an established NCS program. Many facilities exist in which enriched uranium is processed but does not pose a credible criticality concern (e.g., a facility authorized to possess/process less than a critical mass, or a facility authorized to possess/process more than a critical mass but in material forms or geometries such that criticality could not be achieved inadvertently, etc.). These types of facilities would not necessarily have an NCS program or otherwise practice NCS. Therefore, the previous statement in Section 5.2.2 is not fully aligned with the intent of the commitment to ensure that NCS engineers have experience practicing NCS. The staff determined that the revised statement is better aligned with the intent of the requirement in that it ensures NCS engineers have the desired type of NCS-related experience. Therefore, the staff determined that the proposed changes to this section are acceptable.

Section 5.3.4, Operations Surveillance and Assessment: Section 5.3.4 of the commercial ACP LA currently states that each fissile material operating area (FMO) is assessed annually by

NCS personnel via walk-throughs, with the annual walk-throughs distributed amongst the various FMOs such that NCS staff performs a walk-through on approximately a monthly basis. Proposed changes state that fissile material operating areas are assessed by NCS personnel through walk-throughs performed at least annually, removing the specification of how walk-throughs are distributed monthly. NUREG-1520, Section 5.4.3.1.6, states that ACO should commit to conducting audits of all operating SNM process areas such that all areas will be reviewed at some specified frequency. Section 5.4.3.1.6 further states that the specified frequency should consider the complexity and risk-significance of operations, as well as the degree of process monitoring and reliance on administrative controls. Given that the safety of ACO's operations is not heavily reliant on the use of administrative controls, the operations are subject to process monitoring for a number of variables (flow rate, etc.), and that the process equipment is designed to be passively safe, the staff determined that an annual frequency is acceptable without any specification as to how the various process areas are distributed over time. The staff, therefore, determined that the proposed change is acceptable.

Section 5.3.4 of the commercial ACP LA states that managers responsible for fissile material operations receive additional training on NCS and NCS deficiencies. Proposed changes to this section add new text to state that NCS non-compliances are evaluated by NCS staff to determine the impact on compliance with the DCP and Section 70.61 by reviewing the applicable NCSE and supporting documents against the "as found" conditions. Appendix A to 10 CFR Part 70 requires certain events to be reported to the NRC within one hour or twenty-four hours, depending on the circumstances of the event. Because the ISA methodology for criticality accident sequences in the HALEU Demonstration utilizes a deterministic approach (as opposed to the semi-quantitative approach used for all other ACO operations), the staff requested additional information (NRC, 2020) as to how NCS-related events would be evaluated against Appendix A criteria; specifically, Appendix A requirements (a)(4), (b)(1), and (b)(2). The staff also requested information as to how the use of "as found" conditions would impact such an evaluation or otherwise influence ACO's evaluation of an event. To highlight previous operating experience involving the use of "as-found" conditions in reportability determinations and evaluate how operating experience informs ACO's reportability determination process, the staff requested information as to how operating experience, such as that documented in NRC Information Notice (IN) 2007-13, "Use of As-Found Conditions to Evaluate Criticality-Related Process Upsets and Fuel Cycle Facilities" (NRC, 2007), is considered. As discussed in IN 2007-13, the validity of a safety limit must be established before (not after) an upset has occurred, and the inappropriate consideration of "as found" conditions may result in a failure to appropriately characterize an event and identify it as reportable.

In its response to the staff's request for additional information (ACO, 2020a), ACO acknowledged that the case documented in IN 2007-13 involved an inappropriate attempt to demonstrate compliance with the DCP via an "after the fact" evaluation of the "as found" conditions, and stated that such operating experience was used to establish ACO's expectations for how NCS-related events will be reported to the NRC. ACO revised Section 5.3.4 of the commercial ACP LA to state that the evaluation to determine the significance and reportability of events is based on whether the controls were lost or degraded, not whether the safety limits of the associated NCS parameters were actually exceeded. ACO stated that events are evaluated with consideration for lost or degraded controls, but are primarily focused on: (1) whether the remaining controls satisfy the DCP; (2) whether the remaining controls are adequate to ensure subcriticality as required by 10 CFR 70.61(d); (3) how likely subsequent concurrent changes in process conditions are; and (4) whether management measures are sufficient to ensure that remaining IROFS are available and reliable to perform their intended safety function. In its response, ACO also replaced the phrase "as found" conditions with a

reference to the availability and reliability of credited controls from the applicable NCSE. After consideration of ACO's response and its revision of the proposed change, the staff determined that ACO's proposed strategy for evaluating NCS-related events provides reasonable assurance that events will be reported consistent with the requirements of Appendix A to 10 CFR Part 70. The staff, therefore, determined that that proposed changes are acceptable.

Section 5.4.1, Adherence to ANSI/ANS Standards: Sections 5.4.1 and 1.4.1 of the commercial ACP LA were revised to update the American National Standards Institute/American Nuclear Society standards to which ACO commits. The commitments associated with ANSI/ANS-8.20-1991, "American National Standard for Nuclear Criticality Safety Training," and ANSI/ANS-8.21-1995, "Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors," were not changed. However, the commitments associated with the following standards were revised to update the referenced standard to the latest revision:

- ANSI/ANS-8.1-2014, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors"
The proposed change revises ACO's commitment to this standard from the 1998 to the 2014 version.
- ANSI/ANS-8.19-2014, "Administrative Practices for [NCS]"
The proposed change revises ACO's commitment to this standard from the 1996 to the 2014 version.
- ANSI/ANS-8.23-2007, "Nuclear Criticality Accident Emergency Planning and Response"
ACO currently commits to the provisions of the 1997 version of this standard. The proposed change revises ACO's commitment to this standard from the 1997 to the 2007 version.

The staff determined that the changes were consistent with NUREG-1520, Revision 2, Section 5.4.3.1.1, which states that licensees should generally commit to the most current revision of the standards as endorsed by NRC Regulatory Guide (RG) 3.71 (NRC, 2018). The staff, therefore, determined that the changes are acceptable.

The commitments associated with the following standards were revised to specify certain exceptions and clarifications:

- ANSI/ANS-8.3-1997, "Criticality Accident Alarm System,"
ACO commits to the provisions of this standard as modified by RG-3.71, Revision 3, with a clarification to Paragraphs 4.2.3 and 4.3.8. The proposed change revises the existing clarification to state more clearly that the CAAS provides audible alarms in all areas requiring CAAS coverage supplemented by visual alarms in high noise areas. The staff determined that the proposed change is consistent with the provisions of the standard and does not impact ACO's commitment. Therefore, the staff determined that the proposed change is acceptable.
- ANSI/ANS-8.23-2007, "Nuclear Criticality Accident Emergency Planning and Response,"
ACO currently commits to the provisions of the 1997 version of this standard. The proposed change revises ACO's commitment from the 1997 standard to the 2007 version, as modified by RG-3.71, Revision 3. The proposed change also adds a clarification to Paragraph 4.1(9), which currently requires the licensee's management to

ensure that accident dosimetry meeting ANSI N13.3-1969 (Reaffirmed 1981), “Dosimetry for Criticality Accidents” is provided. The proposed change clarifies that although accident dosimeters that at least meet the ANSI N13.3-1969 standard must be provided, other accident dosimeters that do not necessarily meet ANSI N13.3-1969 may also be used as an added measure. Because the clarification does not reduce the commitment to ANSI/ANS-8.3, the staff determined that the proposed change is consistent with ANSI/ANS-8.3 and is, therefore, acceptable.

ACO added a new commitment to the provisions of the following standard, as modified by RG-3.71:

- ANSI/ANS-8.24-2017, “Validation of Neutron Transport Methods for [NCS],”

Because ACO’s commitment to ANSI/ANS-8.24 is consistent with the NRC’s endorsement of the standard in RG-3.71, the staff determined that the change is acceptable.

In its request for additional information (NRC, 2020), the staff requested information as to whether ACO commits to other ANSI/ANS-8 standards endorsed by the NRC in RG-3.71, including:

- ANSI/ANS-8.7, “[NCS] in the Storage of Fissile Materials,”
- ANSI/ANS-8.14, “Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors,”
- ANSI/ANS-8.22, “[NCS] Based on Limiting and Controlling Moderators,” and
- ANSI/ANS-8.26, “Criticality Safety Engineer Training and Qualification Program.”

In its response to the staff’s request for additional information (ACO, 2020a), ACO stated that NCS limits are determined via calculations performed with a validated criticality code in lieu of using ANSI/ANS-8.7 and that soluble neutron absorbers are not used. Therefore, ACO does not commit to ANSI/ANS-8.7 or ANSI/ANS-8.14 as neither are applicable to ACO operations. With respect to ANSI/ANS-8.22, ACO stated that the centrifuge process equipment is comprised of closed systems that inherently minimize the introduction of moderation due to wet air in-leakage. The operation of the centrifuge process equipment would be impeded by the solid uranium-bearing compounds produced by the chemical reaction of UF_6 with moisture, and that for this reason the process equipment is inherently designed to minimize in-leakage. ACO stated that because moderation is controlled passively only, the ACO operations do not align with the full scope of the ANSI/ANS-8.22 standard as it largely focuses on active engineered and administrative moderation control. NUREG-1520, Section 5.4.3.1.1 states that licensees/applicants requesting to conduct activities to which an NRC-endorsed standard applies should generally commit to follow the requirements (i.e., “shall” statements) of the standard, subject to any exceptions and qualifications taken by the NRC, or should provide information to demonstrate that the standard (or parts thereof) is not applicable to the applicant’s activities or otherwise bound by other commitments. The staff determined that the argument provided by ACO reasonably demonstrates that ANSI/ANS-8.7, 8.14, and 8.22 do not directly apply to ACO’s operations and can reasonably be considered not applicable. Therefore, the staff determined that it is acceptable for ACO to not commit to these standards.

With respect to ANSI/ANS-8.26, ACO stated that Section 1.4.1 of the commercial ACP LA will be revised to include a commitment to ANSI/ANS-8.26, with an exception that the Director of Nuclear Safety can relax the qualification requirements for NCS Engineers and Senior NCS Engineers for personnel with a minimum experience of three years and five years, respectively. The staff determined that the addition of a commitment to ANSI/ANS-8.26 is consistent with NUREG-1520, Section 5.4.3.1.1, and RG-3.71, and that ACO's stated exception to allow the Director of Nuclear Safety to relax the qualification requirements for certain personnel based on his/her experience does not conflict with or dilute the intent of the standard as it can only be applied to experienced personnel. The staff, therefore, determined that the change is acceptable.

5.4.2, Nuclear Criticality Safety Evaluations: Section 5.4.2 of the commercial ACP LA currently requires prior NRC review and approval when the prevention of criticality relies on the natural and credible course of events as opposed to administrative or engineered controls. The proposed change would eliminate the requirement to obtain prior NRC review and approval for situations where the prevention of criticality relies on the natural and credible course of events.

The staff noted that the requirements of 10 CFR 70.61 involve the consideration of the natural and credible course of high and intermediate consequence events and, therefore, how the natural and credible course of criticality events are considered would be bound by ACO's methodology for performing and documenting an ISA. Additionally, the acceptance criteria for performing NCSEs provided in NUREG-1520, Section 5.4.3.1.7.2, do not necessitate the need for a licensee to commit to obtaining prior NRC approval for cases involving reliance on the natural and credible course of events. For these reasons, the staff determined that no further NRC review or approval beyond that described in NUREG-1851 and Chapter 3.0 of this report would be necessary to ensure that such factors are appropriately considered. Therefore, the staff considers the proposed change acceptable.

Section 5.4.2 of the commercial ACP LA currently states that new operations must comply with the DCP. Proposed changes to this section revise this statement to require that all fissile material operations comply with the DCP, not just new operations. For this change, the staff determined that the revised text is more conservative than the previous and is, therefore, acceptable.

The proposed changes to this section also include new added text to state that the use of NCS controls over the reliance on the natural and credible course of events is preferred. The staff determined that the proposed change is consistent with NUREG-1520, Section 5.4.3.1.7.3, which states that ACO should commit to "preference for designing explicit NCS controls over reliance on the natural and credible course of events" and is, therefore, acceptable.

5.4.2.1, Non-Fissile Material Operations: Section 5.4.2.1 of the commercial ACP LA currently allows the determination of whether an operation can be considered a "non-fissile material operation" to be made by personnel other than NCS staff. Proposed changes to this section revise this statement to require that NCS staff be responsible for making this determination. The staff determined that the revised text is more conservative than the previous and is, therefore, acceptable.

Section 5.4.2.1 of the commercial ACP LA states that controls are sometimes applied to a non-fissile material operation to ensure it does not inadvertently involve fissile material, and that the determination as to whether controls should be applied to a non-fissile material operation is made by the responsible line manager without involvement with NCS staff. Proposed changes

to this section revise this statement to require the determination be made by an NCS engineer in collaboration with the responsible line manager. The staff determined that the revised text is more conservative than the previous and is, therefore, acceptable.

5.4.3, Design Philosophy and Review: Section 5.4.3 of the commercial ACP LA contains a description of the hierarchy of NCS controls. Proposed changes to this section would revise this description to be stated more clearly and succinctly. The staff determined that the proposed change is consistent with NUREG-1520, Section 5.4.3.1.7.3, which states that licensees should commit to the following order of preference for NCS controls: (1) passive engineered; (2) active engineered; (3) enhanced administrative; and (4) simple administrative controls. Therefore, the staff determined that the proposed change is acceptable.

5.4.4, Criticality Accident Alarm System Coverage: Section 5.4.4 of the commercial ACP LA currently states that the CAAS utilizes neutron detection. The proposed change would state that the CAAS instead utilizes gamma detection. The requirements of 10 CFR 70.24 allow for either gamma or neutron detection. Therefore, the staff determined that the proposed change is consistent with 10 CFR 70.24 and is acceptable.

Section 5.4.4 of the commercial ACP LA currently states that the CAAS provides an audible evacuation alarm in the event of a criticality. Proposed changes to this section would revise this statement such that the CAAS provides both audible evacuation alarms, as well as visual alarms in high noise areas. ANSI/ANS-8.3, as endorsed by RG-3.71, Paragraph 4.2.3, states that in areas in which a CAAS is required, means shall be provided to detect a criticality accident and to signal that prompt action is required. Paragraph 4.3.8 states that the use of visual signals or other means of alarm should be considered for areas with very high audio background or mandatory hearing protection. The staff determined that the proposed change is consistent with ANSI/ANS-8.3, as endorsed by RG-3.71, and the requirements of 10 CFR 70.24. Therefore, the staff determined that the proposed change is acceptable.

Section 5.4.4 of the commercial ACP LA currently states that for each area requiring CAAS coverage, a monitoring system is installed that provides coverage by at least two independent detection units so that one unit may be temporarily taken out of service without affecting ongoing fissile material operations. Proposed changes to this section would revise this statement to require one detection unit, not two. In its request for additional information, the staff requested information as to how the proposed change is consistent with the requirements of 10 CFR 70.24, which requires coverage by two detectors. In its response, ACO stated that all areas requiring CAAS coverage have a monitoring system installed that provides coverage by at least one detection unit, but that a "detection unit" is comprised of a set of at least three detectors that may be co-located or distributed over the area. With this clarification, the staff determined that the proposed change is consistent with the Section 70.24 requirement to provide coverage by at least two detectors. Therefore, the staff determined that the proposed change is acceptable.

Section 5.4.4 of the commercial ACP LA currently states that facilities within 200 feet of a building/facility requiring CAAS coverage have evacuation horns installed inside and radiation warning lights installed on the exterior. Proposed changes to this section would revise this statement such that facilities within 125 feet of a fissile material operation area requiring CAAS coverage have these provisions. The staff estimated the potential difference between prompt doses associated with 200 feet versus 125 feet using NUREG/CR-6504, "An Updated Nuclear Criticality Slide Rule" (NRC, 1998). Because information for systems similar to ACO's operations were not provided, the staff performed its evaluation using the information provided

for a high-enriched uranyl nitrate system (to serve as an upper bound) and a low-enriched uranyl fluoride system (to serve as a lower bound) as these two systems provide a reasonable set of bounds for the 20 wt.% UF₆ and uranyl fluoride systems associated with ACO.

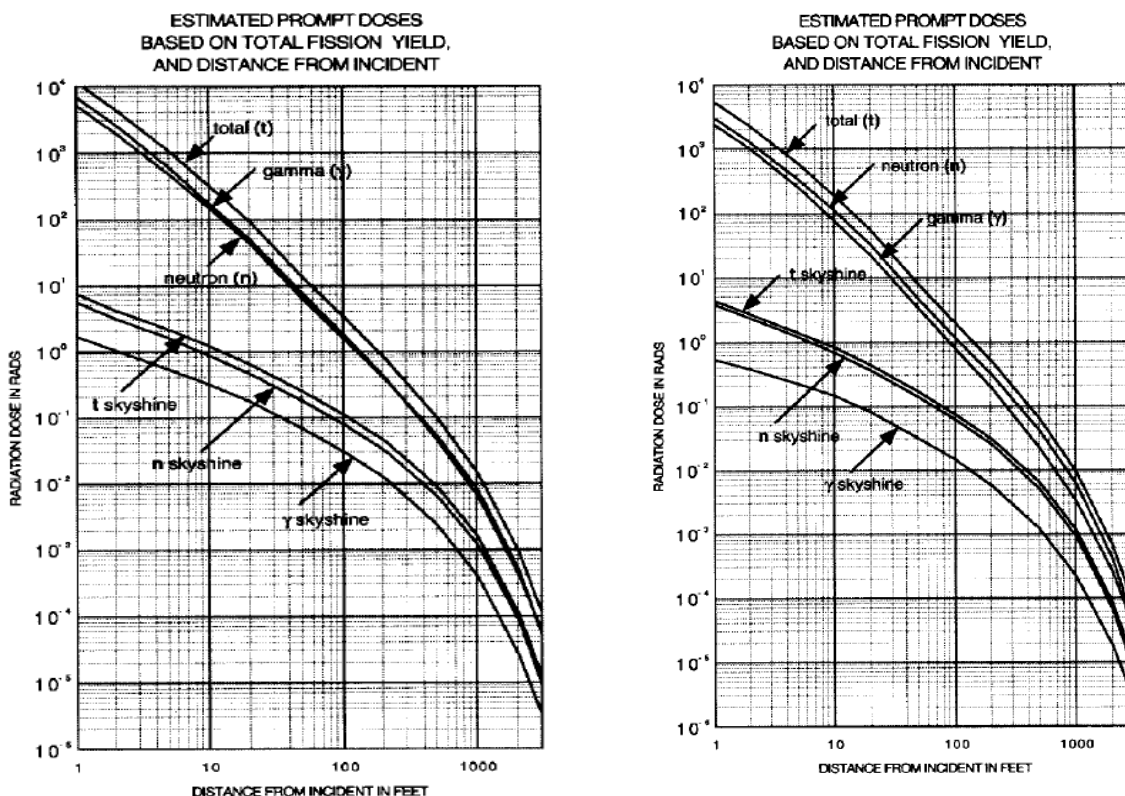


Figure 2: Estimated prompt dose for 93.2 wt.% uranyl nitrate (left) and 4.95 wt.% uranyl fluoride (right) 10¹⁷ fissions.

Composition	Initial Spike (No. of Fissions)	Estimated Total Dose @ 125' (rads)	Estimated Total Dose @ 200' (rads)
U(93.2)O ₂ (NO ₃) ₂ H/U-235 = 500	10 ¹⁷	0.5	0.4
U(4.95)O ₂ F ₂ H/U-235 = 410		0.4	0.35

Table 1 – The staff's estimated dose based on NUREG/CR-6504.

From review of Figure 2, as shown in Table 1, the staff noted that the dose from a system representative of ACO's operations (20 wt.% UF₆ or uranyl fluoride) would be somewhere between 0.5 and 0.4 rad at a distance of 125 feet. The values derived from NUREG/CR-6504 provide reasonable support to conclude that the dose at 125 feet (0.5 rad which is at most 10 rem¹) would be far less than the 100 rem and 25 rem total effective dose equivalent to the

¹ The exact conversion from rad to rem depends on the type of radiation and its energy. At 125 feet the prompt dose hazards from a criticality are gamma and neutron radiation. The worst-case conversion

worker described in 70.61(b) and (c) as high or intermediate consequence. Therefore, the staff determined that the proposed change is consistent with the requirements of 10 CFR Part 70 and is, therefore, acceptable.

5.4.4.1, Portable CAAS: Section 5.4.4.1 of the commercial ACP LA currently states that portable CAAS alarm annunciation is equipped with a telemetric link that transmits the location of the unit, if mobile, and allows the use of the plant public announcement (PA) system to warn personnel within 200 feet of the area of the portable unit to evacuate. Proposed changes to this section would replace the 200-foot distance with 125 feet. The staff determined that the proposed change administratively aligns the text with changes made to Section 5.4.4 of the commercial ACP LA and is, therefore, acceptable.

5.4.5.1, Application of Parameters: Section 5.4.5.1 of the commercial ACP LA describes the technical practices associated with the treatment of NCS parameters.

The staff noted that several acceptance criteria in Section 5.4.3.1.7.3 of NUREG-1520 for each individual NCS parameter are addressed by ACO's general commitment in Section 5.4.2 of the commercial ACP LA to comply with the double contingency principle (DCP) and the requirement of 10 CFR 70.61(d) to assure subcriticality under normal and all credible abnormal conditions. These acceptance criteria are further bound by general commitments added to the RLA in response to the staff's request for additional information. In its response, ACO provided the following general commitments in Section 5.4.2 of the RLA:

- Each parameter will be assumed to be at its optimal or most reactive credible value unless specified controls are implemented to limit the parameter to a particular range of values.
- When process variables can affect the normal or most reactive credible values of parameters, controls to maintain the variables are established, and the basis for the correlation between the process variable and associated controlled parameter is documented.
- When instrumentation is relied on for measuring a parameter credited for NCS, instrumentation subject to facility management measures is used.
- When measurement of a single parameter is used as the sole basis for double contingency, independent means of measurement are used.
- Safety limits on controlled parameters are established and/or implemented with sufficient margin to account for tolerances and uncertainties.

The addition of these general commitments on the treatment of NCS parameters provide bounding statements for many of the individual NCS parameters.

Mass: Proposed changes include a revision to ACO's definition for "safe mass" from a mass less than or equal to 43.5 wt.% of the minimum critical mass relative to a specific system, to the quantity of fissile material that is safely subcritical under the most reactive credible conditions, including allowance for over-batching. The staff determined that the revised text provides a level of conservatism that is at least consistent with, and in many cases more conservative than, the previous text as it is based on the most reactive credible conditions for each NCS parameter as opposed to a specific system (e.g., full light-water reflection vs 1 cm reflection) while

would be to assume all the radiation is neutron radiation with a conversion to rem of 1 rad to 20 rem. Therefore, the 0.5 rad would be at worst 10 rem.

maintaining an allowance for potential over-batching. Therefore, the staff determined that the proposed change is acceptable.

Enrichment: Proposed changes include the removal of text that states that reliable, real-time measurements that are both accurate and precise enough to use as an NCS control are difficult to obtain, and for this reason the maximum credible enrichment is assumed analytically for each operation. In its request for additional information (NRC, 2020), the staff requested information to justify the removal of this text; specifically, ACO's commitment to analytically assume the maximum credible enrichment for each operation. In its response (ACO, 2020a), ACO stated that the removal of this text is justified as its intent is bound by other statements in the RLA. Section 5.0 of the RLA states, "[t]he maximum acceptable enrichment is identified for each operation evaluated for [NCS]," and Section 5.4.5.1 states that the maximum acceptable enrichment will be established in each NCSE with consideration given to credible changes in process conditions. The staff determined that these statements, along with the overarching commitment to comply with the DCP and the requirement of 10 CFR 70.61(d) to assure subcriticality under normal and all credible abnormal conditions, provide adequate assurance that analytical assumptions regarding enrichment will appropriately and conservatively bound the credible range of physical enrichments involved in ACO's operations. Therefore, the staff determined that the proposed change is acceptable.

Moderation: Proposed changes add text to elaborate on the types of moderating materials (interstitial and interspersed) that can credibly be present at the ACO facility. The staff determined that the proposed change merely clarifies the types of moderators that may be present at the facility and does not add any new commitments or dilute any existing ones. Therefore, the staff determined that the proposed change is acceptable.

Concentration: Proposed changes remove ACO's commitment to require two independent samples that are also independently analyzed when relying on concentration as a means of control, remove the statement that no operations involving more than a "safe mass" exist at the ACO facility in which concentration is used as a means of control, and remove the statement that containers with concentration-controlled solutions are normally kept closed. In its response (ACO, 2020a) to the staff's request for additional information (NRC, 2020), ACO stated that concentration is not used as a controlled parameter in any current ACO operation, and that any future operations involving the use of concentration as a controlled parameter would be evaluated against 10 CFR 70.72 to determine whether a license amendment is required. Nevertheless, the staff determined that the general commitments added to Section 5.4.2 of the commercial ACP LA, along with the commitment to comply with the DCP and the requirement to assure subcriticality under normal and all credible abnormal conditions as required by 10 CFR 70.61(d), are sufficient to ensure that the use of concentration as a controlled parameter would be consistent with the acceptance criteria in Section 5.4.3.1.7.3 of NUREG-1520 and is, therefore, acceptable.

Other Changes to Chapter 5.0 of the Commercial ACP LA: The staff reviewed all other proposed changes to Chapter 5.0 of the commercial ACP LA and determined that they are either administrative in nature or otherwise did not negatively impact ACO's existing technical and programmatic commitments, are consistent with the requirements of 10 CFR Part 70, and are, therefore, acceptable.

5.2.2 Evaluation of Criticality Events for the HALEU Demonstration

As part of ACO's amendment request, an Addendum 1 of the ISA Summary for the ACP was revised to provide information specific to the HALEU Demonstration (ACO, 2020c). Although ACO's request does not propose any significant changes to ACO's method for evaluating criticality events for commercial ACO operations, ACO has proposed the use of a deterministic method for evaluating criticality events for the HALEU Demonstration as discussed in Section 3.1.2.3.2.8 of the RLA.

ACO has proposed the use of a deterministic method to evaluate criticality events for the HALEU Demonstration, with compliance with the DCP being the foundation of the strategy. Section 3.1.2.3.2.8 of the RLA states that compliance with the DCP constitutes compliance with Section 70.61(b) and 10 CFR 70.61(d) provided the following additional conditions are also met:

- Controls are established on system parameters to preclude changes in process conditions, and these controls are designated as items relied on for safety (IROFS);
- The condition resulting from the failure of a leg of double contingency has been shown to be subcritical with an acceptable margin; and
- Controls are sufficiently reliable to ensure that each change in process conditions necessary for criticality is unlikely. Management measures are established to ensure that controls are available and reliable to perform their intended safety function.

Section 5.4.2 of the RLA requires that all operations involving fissile material comply with the DCP, which requires that at least two unlikely, independent, and concurrent changes in process conditions be required before a criticality accident is possible. Section 3.1.2.3.2.8 of the RLA provides additional details for the key terms as they appear in the DCP:

- Unlikely changes in process conditions are those that expected to occur rarely, or not at all, during the lifetime of the facility;
- Independent changes in process conditions are such that one contingency neither causes another contingency nor increases its likelihood of occurrence;
- Concurrent does not mean that the two changes in process conditions must occur simultaneously, but that the effect of the first contingency persists until the second contingency occurs; and
- Changes in process conditions do not imply that reliance on two different parameters is mandatory to satisfy the DCP. However, reliance on two different parameters is preferred over reliance on multiple controls on a single parameter.

The staff determined that ACO's proposed approach for evaluating criticality events for the HALEU Demonstration is consistent with Appendix A to Chapter 5.0 to NUREG-1520, which states that compliance with the DCP is sufficient to satisfy the requirements of Section 70.61 (b) and Section 70.61(d) provided certain additional criteria is met. The staff determined that the key terms appearing in the DCP (e.g., unlikely, independent, etc.), as well as the additional criteria that must be satisfied in order for compliance with the DCP to constitute compliance with Section 70.61(b) and 10 CFR 70.61(d), are consistent with Appendix A to Chapter 5.0 of NUREG-1520. Therefore, the staff determined that the proposed change is acceptable.

5.2.3 Minimum Margin of Subcriticality for Safety

The staff reviewed ACO's proposed minimum margin of subcriticality for safety (MMS) and determined that its MMS of 0.02 is acceptable for the purposes of performing NCS analyses

with the SCALE 6.2.3/KENO V.a, 252 group ENDF/B-VII package. The details of this review are provided separately in Appendix B of this SER.

5.2.3.1 License Condition – UF₆ Enrichment

In Section 1.2.4 of the RLA, ACO clarified that the commercial ACP operation (Phase 4) will enrich UF₆ up to 10 wt. percent U-235. In the RLA, ACO requested authorization for the HALEU Demonstration cascade to enrich UF₆ up to a target enrichment of 19.75 wt. % U-235, but less than 20 wt. % U-235. However, ACO requested that enrichment levels up to 25 wt. % U-235 be authorized for limited conditions within the cascade involving process fluctuations which can result in slightly higher levels of enrichment at various stages within the cascade. ACO proposed License Condition 26 to allow for the necessary operational flexibility:

ACO shall not enrich UF₆ in excess of 20.0 wt.% U-235 other than in the course of cascade performance adjustments, thus providing the operational flexibility to generate material to satisfactorily fulfill customer orders up to 20.0 wt.% U-235. ACP shall not input parameters to extract product material for the assay above 20.0 wt.% U-235 at any time.

The NRC staff acknowledges that certain operational flexibility may be necessary to account for process fluctuations within the HALEU cascade. As previously discussed in this chapter of this SER, Section 5.0 of the RLA states, “[t]he maximum acceptable enrichment is identified for each operation evaluated for [NCS],” and Section 5.4.5.1 of the RLA states that the maximum acceptable enrichment will be established in each NCSE with consideration given to credible changes in process conditions. The staff determined that these statements ensure that an appropriate, conservative enrichment that bounds all process fluctuations within the HALEU cascade will be assumed for the purposes of NCS analyses. The staff determined that these statements, along with the overarching commitment to comply with the double contingency principle and the requirement of 10 CFR 70.61(d) to assure subcriticality under normal and all credible abnormal conditions, provide adequate assurance that analytical assumptions regarding enrichment will appropriately and conservatively bound the credible range of physical enrichments involved in ACO’s operations. Consistent with the staff’s conclusions in this chapter of this SER, the staff determined that reasonable assurance of adequate protection has been provided for situations involving process fluctuations up to 25 wt. percent U-235. Therefore, the staff determined that the License Condition 26 is acceptable.

5.2.3.2 License Condition - Changes to the Criticality Code Validation Report

ACO proposed the following condition (SNM-2011 License Condition 27) regarding changes to the criticality code validation report:

Within 30 days of making any non-administrative changes to the validation report, the Licensee shall provide the Commission with a summary of changes and shall provide the revised validation report upon request. The Licensee shall not implement changes to reduce the margin of subcriticality for safety (i.e. factors or methods that would adversely affect the Upper Subcritical Limit) without prior NRC approval of the change.

Changes to the validation report can adversely impact the margin of subcriticality for safety approved by the NRC in accordance with 10 CFR 70.61(d). Under certain circumstances, such changes may not necessarily trigger the criteria in 70.72(c) to request prior approval from the NRC. License Condition 27 was proposed to prohibit changes to the validation report that

would reduce the margin of subcriticality below the minimum margin of subcriticality previously approved by the NRC without first seeking prior NRC approval. The NRC staff finds the proposed License Condition 27 acceptable because it ensures that ACO will use an approved margin of subcriticality for safety as required by 10 CFR 70.61(d), while providing ACO the flexibility to change their validation report.

5.3 EVALUATION FINDINGS

Based on the review discussed in this report, the staff finds that ACO's request provides reasonable assurance of subcriticality under all normal and credible abnormal conditions, provides reasonable assurance that the risk of criticality is limited such that its likelihood of occurrence is highly unlikely, and otherwise satisfies the requirements of 10 CFR Part 70.

5.4 REFERENCES

(ACO, 2019) American Centrifuge Operating, LLC, "Engineering Evaluation EE-3101-0013, *NCS Code Validation of SCALE 6.2.3 and Cross Section Set v7-252 for k_{eff} Calculations*," ACO 19-0030, ADAMS Accession Number ML19352G024 (ML19352G477 - Package), December 5, 2019.

(ACO, 2020) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML20125A103 (ML20125A126 - Package), April 22, 2020.

(ACO, 2020a) American Centrifuge Operating, LLC, "Responses to NRC's Requests for Additional Information Related to the License Amendment Request for the High Assay Low Enriched Uranium Demonstration Program – License Application Chapters 5 and 3," ACO 20-0036, ADAMS Accession Number ML20304A439 (non-public), October 14, 2020.

(ACO, 2020c) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ADAMS Accession Numbers ML20125A117 (Part 1) (non-public) and ML20125A106 (Part 2) (non-public), April 22, 2020.

(ANS, 2014) American Nuclear Society, "Nuclear Criticality Safety in Operations with Fissile Material Outside Reactors," 2014.

(LANL, 1986) Los Alamos National Laboratory, LA-10860 "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233," 1986.

(NRC, 1998) U.S. Nuclear Regulatory Commission, NUREG/CR-6504, "An Updated Nuclear Criticality Slide Rule," Volume 2, ADAMS Accession No. ML20236S695, April 1998.

(NRC, 2001) U.S. Nuclear Regulatory Commission, NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," Revision 0, ADAMS Accession No. ML050250061, January 2001.

(NRC, 2006) U.S. Nuclear Regulatory Commission, NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," ADAMS Accession No. ML062700087, September 30, 2006.

(NRC, 2007) U.S. Nuclear Regulatory Commission, Information Notice (IN) 2007-13, "Use of As-Found Conditions to Evaluate Criticality-Related Process Upsets and Fuel Cycle Facilities," 2007.

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications, Revision 2," ADAMS Accession Number ML15176A258, September 30, 2015.

(NRC, 2018) U.S. Nuclear Regulatory Commission, Regulatory Guide 3.71, Nuclear Criticality Safety Standards for Materials Outside Reactor Core, Revision 3" ADAMS Accession Number ML18169A258, October 2018.

(NRC, 2020) U.S. Nuclear Regulatory Commission, "Request for Additional Information Regarding Centrus Energy Corp. American Centrifuge Operating American Centrifuge Plant High Assay Low Enriched Uranium Program Amendment," ADAMS Accession Number ML20245E175, September 11, 2020.

6 CHEMICAL PROCESS SAFETY

6.1 PURPOSE OF REVIEW

The purpose of U.S. Nuclear Regulatory Commission's (NRC's) review of the Licensee's chemical process safety program is to evaluate whether the application provides reasonable assurance that American Centrifuge Operating, LLC (ACO) will adequately protect workers, the public, and the environment during normal operations and under potential accident conditions from chemical hazards under NRC's regulatory jurisdiction.

6.1.1 Regulatory Requirements

The regulatory bases for the staff's review of chemical process safety are the general requirements in 10 CFR 70.22, Contents of application and 10 CFR 70.65, Additional contents of an application. In addition, the staff's chemical process safety review determines if reasonable assurance of ACO compliance with requirements for approval of an application as stated in 10 CFR 70.23 and 70.66 has been demonstrated.

6.1.2 Regulatory Guidance and Acceptance Criteria

The guidance applicable to NRC's review of chemical process safety for the proposed facility is contained in Chapter 6 of "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility," NUREG-1520 Rev 2 (NRC, 2015). The specific acceptance criteria contained in Section 6.4.3 is applicable in its entirety to this chapter of the SER. The staff also used NUREG-1601, "Chemical Safety at Fuel Cycle Facilities (NRC, 1997) and NUREG-1513, "Integrated Safety Analysis Guidance Document" (NRC, 2001), as guidance documents for its review.

6.2 STAFF REVIEW AND ANALYSIS

6.2.1 Background

In 2006 (NRC, 2006), the NRC staff reviewed the chemical safety aspects of the license application (LA) and the Integrated Safety Analysis (ISA) Summary submitted by USEC Inc. for the American Centrifuge Plant (ACP). The staff evaluated the Process Description; Chemical Accident Sequences; Items Relied on for Safety (IROFS); Management Measures; Emergency Management; and Baseline Design Criteria (BDC).

The staff concluded that the Licensee's plan for managing chemical process safety and chemical process safety controls met the requirements of 10 CFR Part 70 and provided reasonable assurance that the public health and safety, and the environment would be protected (NRC, 2006).

The NRC issued a 30-year license for the ACP on April 13, 2007 (NRC, 2007).

6.2.2 Revised Application for HALEU Demonstration

ACO requested an ACP license amendment by letter dated April 20, 2020 (ACO, 2020a) and supplemented by letter dated October 14, 2020 (ACO, 2020b). ACO requested approval for operating a 16-centrifuge HALEU Demonstration Program cascade to produce HALEU according to the terms of a contract with DOE.

The HALEU Demonstration Program operations and chemical hazards of these operations are the same as those approved for the ACP in 2006. The most significant chemical hazard is uranium hexafluoride (UF₆), which is reactive with many materials (e.g., organic material, moisture). The reactions can be energetic and can produce toxic material (e.g., hydrogen fluoride (HF) is produced by the hydrolysis of UF₆ with atmospheric moisture). The UF₆ inventory for the HALEU Demonstration Program is much less than that authorized for ACP LEU operations, that the NRC previously reviewed and approved. In addition, the HALEU Demonstration Program will utilize cylinders that are smaller than those planned for the ACP LEU production operations. The HALEU Demonstration Program product cylinders (5B) and tails cylinders (12B) are smaller than the product cylinders (30B) for the commercial ACP operations.

The RLA proposes that the chemical safety program approved for the ACP will be used for the HALEU Demonstration Program. There are no new chemical safety hazards associated with the proposed HALEU Demonstration Program. The RLA clarified that Occupational Safety and Health Administration Process Safety Management threshold quantities were not used to limit the consideration of chemical hazards under NRC's regulatory jurisdiction. The staff agrees with this clarification.

6.2.3 HALEU Demonstration Chemical Safety Review

The staff reviewed the application for the HALEU Demonstration Program using the current review guidance as documented in NUREG-1520, Rev. 2 (NRC, 2015). The review areas are:

- Site, facility, and chemical process (NUREG-1520, section 6.4.3.1)
- Hazards and accident sequences (NUREG-1520, section 6.4.3.2)
- Accident likelihood and consequences (NUREG-1520, section 6.4.3.3)
- Items relied on for safety (NUREG-1520, section 6.4.3.4)
- Management measures (NUREG-1520, section 6.4.3.5)
- Requirements for new facilities (NUREG-1520, section 6.4.3.6)

6.2.4 HALEU Demonstration Program Process Description

The description of the uranium enrichment process with emphasis on the HALEU Demonstration Program is presented in Chapter 1 of the RLA and Chapter 3 of the ISA Summary Addendum for the HALEU Demonstration Program (ACO, 2020c). Chapter 1 of the RLA includes a description of the site and facilities along with a process description.

The chemical process for the HALEU Demonstration Program is the same as that reviewed and approved for the ACP with a few changes. First, the scale of operation is much smaller (much less inventory, much lower processing rate), the duration of operations is much shorter (months of operation rather than years) and there are no liquid UF₆ cylinder sampling operations for the HALEU Demonstration Program.

The staff finds that the process description and facility information is consistent with that previously reviewed and approved with limited changes to distinguish HALEU Demonstration Program operations from commercial ACP operations. The information includes a description of chemical hazards of both a toxic and reactive nature. The information meets the guidance in Section 6.4.3.1 of NUREG-1520 (NRC, 2015), and is therefore acceptable.

6.2.5 HALEU Demonstration Chemical Hazards

The NRC staff's review of HALEU Demonstration Program accident sequences involving chemical hazards and the associated accident sequence likelihoods and consequences, items relied on for safety (IROFS), and management measures is documented in Appendix A of this SER.

6.2.6 HALEU Demonstration Chemical Hazards and Accident Sequences

Chapter 6 of the ISA Summary Addendum for the HALEU Demonstration Program (ACO, 2020c) identifies accident sequences for HALEU Demonstration Program operations. The accident sequences involve potential errors or failures during the various phases of plant operation that could lead to the release of uranium. The analysis also considered accident sequences that are initiated by natural phenomena. Chemical hazards that have the potential to result in significant consequences are primarily those involving UF₆ releases.

Appendix B of the ISA Summary Addendum for the HALEU Demonstration Program (ACO, 2020c) presents a summary of the hazards identified using the ISA methodology. The Appendix shows consideration of both toxic and reactive chemical hazards.

The staff concluded that ACO has identified appropriate chemical accident sequences. This determination is based on the staff's review of the Licensee's hazards analysis methods and the staff's detailed review of selected chemical accident sequences. The information provided by the Licensee, as described above, is consistent with the acceptance criteria in Section 6.4.3.2 of NUREG-1520 (NRC, 2015) and is therefore acceptable. The staff discusses results of its review of the ISA methodology in Chapter 3 of this SER

6.2.7 HALEU Demonstration Chemical Accident Sequence Likelihood and Consequences

The analysis of accident sequences and consequences for the HALEU Demonstration is discussed in Chapter 6 of the ISA Summary Addendum for the HALEU Demonstration.

The major consequences identified in the ISA Summary involve larger releases of UF₆ (often multiple cylinders) following a fire.

The staff finds that the Licensee has used appropriate techniques in estimating the likelihood and consequences of chemical accident sequences and that the consequences have been conservatively estimated. The information provided by the Licensee, as described above, meets the guidance in Section 6.4.3.3 of NUREG-1520 (NRC, 2015), and is therefore acceptable.

The RLA and the ISA Summary Addendum for the HALEU Demonstration Program presents accident likelihood and consequence information consistent with the requirements of 10 CFR 70.62. The staff considers the information acceptable for use in the 10 CFR 70, subpart H licensing process.

6.2.8 HALEU Demonstration Chemical Safety-Related IROFS

Items Relied on for Safety (IROFS) are engineered or administrative controls identified by the Licensee. The IROFS are intended to provide assurance that the performance requirements of 70.61 will be met.

The controls (IROFS) applied to the HALEU Demonstration operations are identified and discussed in Chapter 7 of the ISA Summary Addendum for the HALEU Demonstration.

Based on the review of ISA Summary Addendum, the staff concludes that ACO has adequately identified chemical safety IROFS to prevent and/or mitigate the consequences of accident sequences involving chemical hazards under NRC's regulatory jurisdiction. The information meets the acceptance criteria in Section 6.4.3.4 of NUREG-1520 (NRC, 2015) and is therefore acceptable.

6.2.9 Management Measures

Management Measures are actions taken to provide assurance the IROFS will be available and reliable when they are required.

The management measures applied to the HALEU Demonstration chemical safety related IROFS are identified in Chapter 7 of the ISA Summary Addendum and are training, procedures and configuration management.

The review concluded that the description and discussion of management measures related to chemical safety meets the acceptance criteria in Section 6.4.3.5 of NUREG-1520 (NRC, 2015) and therefore is acceptable.

6.2.10 Baseline Design Criteria

Section 6.3 of the HALEU Demonstration Program application amendment discusses Requirements for New Buildings/Facilities or New Processes at Existing Facilities. The discussion is unchanged from the discussion in the application for the ACP facility.

The application for the HALEU Demonstration Program makes the same commitments that were previously found acceptable in NUREG-1851 (NRC, 2006). Therefore, the staff concludes that the information the Licensee provided for the HALEU Demonstration Program meets the acceptance criteria in Section 6.4.3.5 of NUREG-1520 (NRC, 2015) and is acceptable and meets the requirements of 10 CFR 70.64(a)(5).

6.3 EVALUATION FINDINGS

The staff evaluated the HALEU amendment application against the regulatory requirements for chemical safety using the applicable review guidance in NUREG-1520, Rev. 2 (NRC, 2015). The NRC staff finds that the Licensee has described the HALEU enrichment process, facilities, equipment, and operations. The staff also finds that the Licensee has identified and evaluated chemical accident sequences that are under NRC's regulatory authority. The Licensee has established safety controls (i.e., IROFS) providing reasonable assurance of meeting the performance requirements of 70.61 related to chemical safety. The Licensee has implemented

management measures to provide reasonable assurance that the controls will be maintained, available, and reliable to perform their safety-related functions when needed.

The staff's review of chemical accident sequence identification and analysis as well as the identification of chemical safety controls was coordinated with the staff's review of the ISA (Chapter 3 of this SER). The review of management measures intended to assure the availability and reliability of controls identified for chemical safety was coordinated with the staff review of management measures (Chapter 11 of this SER).

The staff also finds that the application complies with the requirements of Section 70.60 through 70.65 as they relate to chemical safety and meets the requirements of 70.66 as they relate to chemical safety.

6.4 REFERENCES

(ACO, 2020a) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML20125A116 (ML20125A126 - Package), April 22, 2020.

(ACO, 2010b) American Centrifuge Operating, LLC, "Enclosure 1 - Responses to NRC's Requests for Additional Information Related to the License Amendment Request for the High Assay Low Enriched Uranium Demonstration Program - License Application Chapters 4, 6, 7, and 11," ADAMS Accession Number ML20301A439, October 14, 2020.

(ACO, 2020c) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ADAMS Accession Numbers ML20125A117 (Part 1) (non-public) and ML20125A106 (Part 2), (non-public) April 22, 2020.

(NRC, 1997) U.S. Nuclear Regulatory Commission, NUREG-1601, "Chemical Process Safety at Fuel Cycle Facilities," ADAMS Accession Number ML20210J626, August 1997.

(NRC, 2001) U.S. Nuclear Regulatory Commission, NUREG-1513, "Integrated Safety Analysis Guidance Document," ADAMS Accession Number ML011440260, May 2001.

(NRC, 2006) U.S. Nuclear Regulatory Commission, "NUREG-1851 Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio," ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2007) U.S. Nuclear Regulatory Commission, Letter Janosko (NRC) to Toelle (USEC), "License for the USEC Inc. American Centrifuge Plant," April 13, 2007 (ADAMS Accession Number ML070400284).

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications, Revision 2," ADAMS Accession Number ML15176A258, September 30, 2015.

7 FIRE SAFETY

7.1 PURPOSE OF REVIEW

The purpose of the U.S. Nuclear Regulatory Commission's (NRC) review is to determine whether the changes in the fire protection program associated with the proposed license amendment will provide reasonable assurance of adequate protection against fires and explosions that could affect the safety of licensed materials and thus present an increased radiological or chemical risk.

7.1.1 Regulatory Requirements

The regulatory bases for the review are the general and additional contents of an application that address fire safety, as required by 10 CFR 70.22 and 70.65. In addition, the fire safety program must provide reasonable assurance of compliance with 10 CFR 70.61 and 70.62.

7.1.2 Regulatory Guidance and Acceptance Criteria

The acceptance criteria that the NRC staff uses for reviews of fire safety are outlined in Sections 7.4.3.1 through 7.4.3.5 of NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications" (NRC, 2015).

7.2 STAFF REVIEW AND ANALYSIS

The NRC staff reviewed the changes to Chapter 7 Fire Safety of the RLA and the Integrated Safety Analysis (ISA) Summary Addendum submitted by ACO for the HALEU Demonstration. The review also included changes to Chapters 3, and 11 of the RLA and Chapter 7 of the ISA Addendum. The amended chapters of the commercial ACP LA identified changes from the application for the ACP, which the NRC staff had reviewed and approved in 2006 as documented in the Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio in NUREG-1851 (NRC, 2006) as part of issuing the facility license SNM-2011.

7.2.1 Fire Safety

In Section 7.0 Fire Safety of the RLA, ACO states that the primary building/facilities directly involved in HALEU Demonstration are the X-3001 Process Building, X-3012 Process Support Building, X-7725 Recycle/Assembly Building, X-7726 Centrifuge Training and Test Facility, and X-7727H Interplant Transfer Corridor. ACO further states that some ACP buildings/facilities do not meet NFPA 801 and the applicable daughter standards, because ACP buildings/facilities were built or established under earlier versions or different codes and standards, which were applicable when constructed and installed. ACO deleted language regarding these buildings that duplicated the baseline configuration assessment described in Section 11.1 Configuration Management of the RLA.

7.2.2 Fire Safety Management Measures

The previous NRC staff review of ACO's management measures is documented in NUREG-1851 (NRC, 2006). The commitments in Section 7.1 of the RLA, which contain editorial or administrative revisions from those previously approved by the NRC, continue to be applicable in their entirety to the HALEU Demonstration Program. The management measures include fire safety organization; fire prevention; inspection, testing, and maintenance of fire protection systems; emergency response organization and training; and pre-fire plans. The pre-fire plans for the HALEU Demonstration Program include the areas of the facility which will be involved with that project. Pre-fire plans for buildings and areas outside of the HALEU Demonstration Program will be developed prior to deployment of operations involving licensed materials in those areas of the facility.

In Section 7.1 Fire Safety Management Measures of the RLA, ACO did not make any changes.

7.2.2.1 Fire Prevention

In Section 7.1.1 Fire Prevention, ACO updated its commitment to NFPA 30 Flammable and Combustible Liquids Code from the 2003 version to the 2018 version; NFPA 55 Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tank from the 2005 version to the 2020 version; and NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations from the 2000 version to the 2020 version. The NRC staff finds ACO's commitment to the latest versions of NFPA 30, NFPA 55, and NFPA 241 at the time of submittal of the RLA to be acceptable.

In Section 7.1.1 Fire Prevention, ACO moved designated smoking areas from inside the buildings/facilities to outside the buildings/facilities. The NRC staff finds this change acceptable.

7.2.2.2 Hot Work Permits

In Section 7.1.1.2 Hot Work Permits, ACO updated its commitment to NFPA 51B Standard for Fire Protection During Welding, Cutting, and Other Hot Work from its 2003 version to its 2019 version. The NRC staff finds ACO's commitment to the latest versions of NFPA 51B at the time of submittal of the RLA to be acceptable.

7.2.2.3 Inspection, Testing, and Maintenance

In Section 7.1.2 Inspection, Testing, and Maintenance, ACO changed its commitment to NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems to the 2002 version. ACO is correcting an incorrect citation to the 2004 version of the NFPA standard for water-based fire protection systems. Section 7.3.1 of the RLA contains a commitment to the current, 2017 version of NFPA 25 for all new water-based fire protection systems.

7.2.2.4 Pre-Fire Planning

In Section 7.1.4 PreFire Planning of the RLA, ACO clarified that the Pre-fire plans for the HALEU Demonstration include X-3001 Process Building; X-3012 Process Support Building; X- 7725 Recycle/Assembly Building; X-7726 Centrifuge Training and Test Facility; and X-7727H Interplant Transfer Corridor. ACO added that Pre-fire plans for other facilities will be developed

prior to deployment of operations involving licensed materials in those facilities. The NRC staff finds this clarification acceptable as the HALEU Demonstration operations will only be conducted within the five structures listed above.

In Table 7.1-1 Applicable National Fire Protection Association Codes and Standards of the RLA, ACO updated its commitment to NFPA 10 Standard for Portable Fire Extinguishers from its 2002 version to its 2018 version; NFPA 13 Standard for the Installation of Sprinkler Systems from its 2002 version to its 2019 version; NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection from its 2001 version to its 2017 version; NFPA 101 Life Safety Code from its 2003 version to its 2018 version; and NFPA 801 Standard for Fire Protection for Facilities Handling Radioactive Materials from its 2003 version to its 2020 version. The NRC staff finds ACO's commitment to the latest versions of NFPA 10, NFPA 13, NFPA 15, NFPA101 and NFPA 801 at the time of submittal of the RLA to be acceptable.

7.2.2.5 Fire safety management measures Evaluation Findings

The NRC staff confirmed that the management measures commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.1, "Fire Safety Management Measures," and continue to comply with the requirements of 10 CFR 70.22(a)(6), 70.22(a)(8), and 70.62(d).

7.2.3 Fire Hazard Analysis

The previous NRC staff review of the development of ACO's fire hazards analyses (FHAs) is documented in NUREG-1851 (NRC, 2006). The commitments in Section 7.2 of the RLA, which contain editorial or administrative revisions from those previously approved by the NRC, continue to be applicable in their entirety to the HALEU Demonstration Program. The FHAs are used as an input into the ISA process to determine credible fire accident scenarios, their associated consequences, and any items relied on for safety (IROFS) needed to mitigate the consequences. Periodic building surveys are performed to evaluate the fire hazards in that building. The survey results are used to update the FHAs and ISA as needed. ACO maintains the commitment to NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," (NFPA, 2020) for performing and maintaining FHAs.

In Section 7.2 Fire Hazard Analysis of the RLA, ACO described the fire hazards analyses (FHAs) applicable to HALEU Demonstration. According ACO FHAs for the HALEU Demonstration include those for X-3001, X-3012, X-7725, X-7726, and X-7727H.

7.2.3.1 Integrated Safety Analysis

In Section 7.2.2 Integrated Safety Analysis of the RLA, ACO clarified that an ISA of the design, construction, and operation of the "commercial" ACP was conducted in accordance with the guidance provided in NUREG-1513, "Integrated Safety Analysis Guidance Document," and the requirements of 10 CFR 70.62(c) and that an associated Addendum to the ISA Summary was also performed for the HALEU Demonstration applying the same guidance and process.

7.2.3.2 Fire Hazard analysis Evaluation Findings

The NRC staff confirmed that the FHA commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.2, "Fire Hazards Analysis," and continue to comply with the requirements of 10 CFR 70.61.

7.2.4 Building/Facility Design

The previous NRC staff review of the fire safety aspects of ACO's building/facility design is documented in NUREG-1851 (NRC, 2006). The commitments in Section 7.3 of the RLA, which contain editorial or administrative revisions from those previously approved by the NRC, continue to be applicable in their entirety to the HALEU Demonstration Program. Building construction, fire area determination, and system design and installation (e.g., electrical systems, life safety, ventilation, drainage, lightning protection, and fire protection systems) are in accordance with the applicable building and NFPA codes (see Section 1.4.6 and Table 7.1-1 of the RLA for a list of applicable codes).

In Section 7.3 Building/Facility Design of the RLA, ACO deleted the commitment to finish floor surfaces in the ACP buildings/facilities to support contamination control. The NRC staff finds this acceptable because finishing floor surfaces to support contamination control does not affect fire safety. ACO also deleted the commitment to maintain fire hydrants equipped with monitor nozzles in the Cylinder Storage Yards X-745G 2 and X-745H. The NRC staff finds this acceptable because the DOE reservation's fire department will provide the hoses and nozzles to respond to fires in the storage yard areas. ACO also deleted the commitment to maintain cylinder handling equipment with fire suppresser systems for UF₆ cylinders 2.5 tons or larger. The NRC staff finds this acceptable because the fire suppresser systems were designed for use in engine departments using fossil fuel engines; ACO however, will use only electrical-powered equipment to handle the UF₆ cylinders 2.5 tons or larger.

7.2.4.1 Fire Suppression Systems

In Section 7.3.1 Fire Suppression Systems of the RLA, ACO clarified that Fire Suppression is provided to support the HALEU Demonstration in X 3001, X-3012, X-7725, X-7726, and X-7727H and that Fire Suppression in other buildings/facilities (e.g., X-3002, X-3346, X-3346A) will be provided prior to deployment of operations involving licensed materials in those facilities.

7.2.4.2 Fire Alarms

In Section 7.3.2 Fire Alarms of the RLA, ACO clarified that Fire Alarms are received in the X-300 Plant Control Facility, instead of X-1020 Emergency Operations Center, which are no longer leased by ACO. ACO identified X-300 and X-1007 as the buildings/facilities where building evacuations will be initiated manually. The NRC staff finds this acceptable because buildings X-300 and X-1007 are appropriate for these purposes, and X-1020 is no longer under the control of ACO.

7.2.4.3 Building/Facility Design Evaluation Findings

The NRC staff confirmed that the facility design commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.3, "Facility Design," and continue to comply with the requirements of 10 CFR 70.22(a)(7) and 70.64(a)(3).

7.2.5 Process Fire Safety

The previous NRC staff review of ACO's process fire safety is documented in NUREG-1851 (NRC, 2006). The commitments in Section 7.4 of the RLA, which contain editorial or administrative revisions from those previously approved by the NRC, continue to be applicable to the HALEU Demonstration Program. The handling of combustible and flammable gases and the performance of hot work are in accordance with the applicable NFPA codes (see Section 1.4.6 and Table 7.1-1 of the RLA for a list of applicable codes). The NRC staff confirmed that the process fire safety commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.4, "Process Fire Safety," and continue to comply with the requirements of 10 CFR 70.22(a)(7), 70.62, and 70.64.

In Section 7.4 Process Fire Safety of the RLA, ACO clarified that the IROFS for the HALEU Demonstration are identified in Addendum 1 of the ISA Summary and that IROFS for the commercial ACP operation will be implemented prior to the deployment of operations involving the commercial ACP. No other substantial (non-editorial and non-administrative) changes were made in Section 7.4.

7.2.5.1 Items Relied on For Safety and Accident Sequences Related to Fire Safety

The previous NRC staff review of ACO's IROFS and accident sequences related to fire safety is documented in NUREG-1851 (NRC, 2006). As part of the ISA development for the HALEU Demonstration Program, the Licensee identified IROFS that ensure the performance requirements of 10 CFR 70.61 continue to be met. The IROFS related to fire safety were provided in "Addendum 1 of the ISA Summary for the American Centrifuge Plant - HALEU Demonstration" (ACO, 2020c). All other aspects of the fire protection system that are not indicated as IROFS provide defense-in-depth protection.

The existing fire safety IROFS were determined to be bounding for the HALEU Demonstration Program. One new administrative IROFS was added as discussed in Appendix A of this SER. Trained and qualified firefighting personnel are available twenty-four hours a day to respond to a fire.

The NRC staff reviewed the amended IROFS and accident sequences related to fire safety and find that they are aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.4.1, "Fire-Initiated Accident Sequences," and Section 7.4.3.4.2, "Items Relied on for Safety and the Associated Management Measures." The NRC staff concludes that the Licensee has reasonably determined the required fire protection features for preventing or mitigating fire accident scenarios that could lead to unacceptable performance, in accordance with the requirements in 10 CFR 70.61.

7.2.5.2 Process Fire Safety Evaluation Findings

The NRC staff confirmed that the process fire safety commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.3, "Facility Design," and continue to comply with the requirements of 10 CFR 70.22(a)(7) and 70.64(a)(3).

7.2.6 Fire Protection and Emergency Response

The previous NRC staff review of ACO's fire protection and emergency response is documented in NUREG-1851 (NRC, 2006). The commitments in Section 7.5 of the RLA continue to be applicable in their entirety to the HALEU Demonstration Program.

In Section 7.5.2 Alarm and Fixed Fire Suppression Systems, ACO clarified that the alarm and fixed fire suppression relied on for HALEU Demonstration is identified in Addendum 1 of the Integrated Safety Analysis – HALEU Demonstration.

During the HALEU Demonstration Program, fire alarms are received in the X-300 Plant Control Facility instead of X-1020 Emergency Operations Center. Instead of X-1020, ACO identified X-300 and X-1007 as the buildings/facilities where building evacuations will be initiated manually. The NRC staff finds this acceptable because buildings X-300 and X-1007 are appropriate for these purposes, and X-1020 is no longer under the control of ACO.

The X-300 and X-1007 are occupied, as necessary, to support prompt notification of emergency response personnel to investigate and respond to alarm conditions. In Section 11.3.1.11.1 of the RLA, ACO states that firefighter training programs meet the requirements for the state certification program and emergency medical response personnel meet the requirements for state certification as emergency medical technicians. The NRC staff confirmed that the fire protection and emergency response commitments in the RLA remain aligned with the acceptance criteria guidance in NUREG-1520 (NRC, 2015), Section 7.4.3.5, "Fire Protection and Emergency Response," and will continue to comply with the requirements of 10 CFR 70.22(a)(8).

In Section 7.5.4 Mobile and Portable Equipment, ACO updated its commitment to NFPA 10 Standard for Portable Fire Extinguishers from the 2002 version to the 2018 version. The NRC finds this acceptable as NFPA 10-2018 was the latest version at the time the RLA was developed.

The staff notes that the ACO application for the HALEU Demonstration Program states in Section 8.1 that Fluor BWXT Portsmouth, LLC (FBP) currently serves as the Decontamination and Decommissioning contractor for DOE and will provide emergency fire response capabilities at the entire DOE site, including for the HALEU Demonstration Program. The staff finds these emergency fire response capabilities acceptable.

7.3 EVALUATION FINDINGS

As discussed in the preceding evaluation, the NRC staff reviewed the information presented in the RLA, in the addendum to the ISA Summary, and in RAI responses. The NRC staff determined that ACO's fire protection program meets the acceptance criteria presented in NUREG-1520 (NRC, 2015) and is adequate to protect against fires and explosions that could affect the safety of licensed materials. Therefore, the staff concludes that ACO meets the requirements of 10 CFR 70.22, 10 CFR 70.61, 10 CFR 70.62, and 10 CFR 70.65.

7.4 REFERENCES

(ACO, 2020c) American Centrifuge Operating LLC. "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ADAMS Accession Numbers ML20125A117 (Part 1) (non-public) and ML20125A106 (Part 2) (non-public), April 22, 2020.

(NFPA, 2020) National Fire Protection Association, (NFPA). NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," 2020.

(NRC, 2006) U.S. Nuclear Regulatory Commission, NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio," ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2," ADAMS Accession Number. ML15176A258, September 30, 2015.

8 EMERGENCY MANAGEMENT

8.1 PURPOSE OF REVIEW

The purpose of the Nuclear Regulatory Commission's (NRC's) review is to determine whether ACO's RLA complies with the emergency management requirements in 10 CFR Part 70. An Emergency Plan was developed and approved for the ACP license. The Emergency Plan prepared for the ACP does not cover the HALEU Demonstration Program. As part of its application for the HALEU Demonstration Program, the Licensee submitted an evaluation supporting its position that an Emergency Plan was not required for the HALEU Demonstration Program (ACO, 2020b). This chapter discusses the staff's review of the ACO Evaluation submitted by the Licensee.

8.1.1 Regulatory Requirements

The regulation in 10 CFR 70.22(i) requires applications to contain either (i)(1) an emergency plan or (i)(2) an evaluation showing that the maximum dose to a member of the public offsite due to a release of radioactive materials would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium.

8.1.2 Regulatory Guidance and Acceptance Criteria

The guidance applicable to the NRC's review of the evaluation of maximum dose to a member of the offsite public is contained in Chapter 8 of "Standard Review Plan for Fuel Cycle Facilities License Applications," NUREG-1520, Revision 2 (NRC, 2015). The guidance for content of an evaluation when an emergency plan is not required is presented in Section 8.3.2. The regulatory acceptance criteria for the review of such an evaluation is contained in Section 8.4.3.2. The review guidance for such an evaluation is presented in Section 8.6.2.2.

8.2 STAFF REVIEW AND ANALYSIS

The proposed license amendment to construct and operate the HALEU Demonstration Program seeks authorization to produce HALEU up to but less than 20 wt. % U-235 from low enriched uranium (LEU) with a nominal enrichment of 5 wt. % U-235. The HALEU Demonstration would involve a 16-machine AC-100M HALEU cascade. The UF₆ handling, storage and enriching operations would occur primarily in the X-3001 process building. ACO submitted an evaluation of the need to submit an emergency plan. The ACO Evaluation states that the maximum dose to a member of the public offsite due to a release of radioactive materials or a criticality event would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium (ACO, 2020a).

The NRC staff's review focused on determining whether ACO provided information that demonstrates ACO's compliance with the criteria of 10 CFR 70.22(i)(1)(i). Section 2 of ACO's Evaluation provides a description of the HALEU Demonstration facility and the materials used in its construction. Section 3 of the ACO Evaluation provides site-specific information on the types of accidents evaluated and Section 5 of the Evaluation describes consequences.

The NRC staff reviewed the information ACO presented on the six topics identified in Section 8.4.3.2 of NUREG-1520: (1) the description of the facility; (2) the types of materials used; including both radioactive material and hazardous chemicals; (3) the types of accidents, (4) the

detection of accidents; (5) site-specific information used to support the evaluation; and (6) the evaluation of the consequences.

8.2.1 Description of the Facility and Materials Used

Section 2 of the ACO Evaluation contains the site and facility description, including a description of the site and the major facilities used for the HALEU Demonstration Program. The processing and storage of UF₆ for the HALEU Demonstration Program, which occurs primarily in the process area of the X-3001 building, is also described. The section also describes various support buildings and the potential hazards in these buildings.

The description of facility and materials used for the HALEU Demonstration Program meet the acceptance criteria identified in Section 8.4.3.2.1 of NUREG-1520, and therefore the staff finds it to be acceptable.

8.2.2 Types of Accidents

Section 3 of the ACO Evaluation (Types of Accidents) identifies and discusses a range of accidents considered in the Evaluation for the HALEU Demonstration Program. The Evaluation considers fire events, explosion events, loss of confinement events, external events, criticality events and natural phenomena events. The accidents with the potential for the greatest offsite consequences were evaluated in later sections of the report to determine if an Emergency Plan was required.

The ACO discussion of fire events that could occur within the process building presents a fire scenario that ACO identified as the bounding fire scenario involving UF₆.

The ACO Evaluation also considered fires that might originate outside the process building, but ACO concluded that these fires could not extend to the HALEU process area.

Based on its review of the ACO controls, the NRC staff concludes that an internally or externally initiated fire leading to a cylinder rupture is not credible.

The estimated consequences of potential UF₆ releases are discussed in Appendix E of this SER.

Section 3.6 of the ACO Evaluation discussed the potential for criticality events because the operations at the facility involve enriched material. The staff's review concluded that a criticality event is credible for the HALEU Demonstration Program because of the presence of enriched uranium, including material enriched to near 20 percent. The potential consequences of a criticality accident are reviewed in Appendix E of this SER.

The ACO Evaluation of the types of accidents that could occur for the HALEU Demonstration Program is consistent with the acceptance criteria identified in Section 8.4.3.2.2 of NUREG-1520. On this basis, the NRC staff concludes criticality and UF₆ release events are credible and would produce the greatest offsite consequences. The consequences of these events must be evaluated to determine whether an emergency plan will be required for the HALEU Demonstration Program.

8.2.3 Detection of Accidents

Section 4 of the ACO Evaluation (Detection of Accidents) discusses the detection of accidents associated with the proposed HALEU operation.

The detection of accidents that could occur at the HALEU Demonstration Program is discussed in the ACO Evaluation, consistent with the acceptance criteria in Section 8.4.3.2.3 of NUREG-1520. The staff finds the methods described for detecting accidents to be acceptable.

8.2.4 Evaluation of the Maximum Public Exposure

Section 5 of the ACO Evaluation (Evaluation of Maximum Public Exposure) (ACO, 2020b) discusses the public exposure from accidents. The accidents of concern involve UF₆ releases and an accidental criticality, both of which could result in a release of various radioactive isotopes to the public.

8.2.4.1 Evaluation of Consequences of Identified UF₆ Releases

The ACO Evaluation assessed the consequences of the credible accident scenario with a bounding UF₆ release. ACO's calculated dose at the site boundary for the bounding release was much less than 1 rem and the calculated soluble uranium intake was less than 2 mg.

The staff recognizes the uncertainty about the size of a UF₆ release from a credible fire scenario at the HALEU Demonstration Program. The staff estimates that a potential release would be similar to the ACO estimate.

The staff's independent analysis using NRC's RASCAL code demonstrated that a net release of 500 kg (e.g., a release of 1000 kg with a leak path factor of 0.5 or a release of 5000 kg with a leak path factor of 0.1) would result in soluble uranium intake of less than 2 mg to a receptor at 0.7 km. The staff finds potential doses from these postulated releases are on the order of 10 mrem or less, and well below the regulatory limit in 10 CFR 70.22(i)(2).

The staff reviewed the ACO Evaluation and concludes that the dose to an offsite individual, in the event of the bounding UF₆ release during HALEU Demonstration Program operations, will be less than 1 rem and that the intake of soluble uranium will be less than 2 mg. The NRC staff concludes that an emergency plan is not required for the bounding UF₆ release event associated with the HALEU Demonstration Program because the requirements of 10 CFR 70.22(i)(2) are met.

8.2.4.2 Evaluation of Consequences of Identified Criticality Event

The staff reviewed the basis for the criticality event identified by ACO as having the greatest consequence. This event results in a maximum of 1E18 fissions.

Based on ACO's operations, throughput, and associated nuclide and fissionable material compositions, the staff considers the most likely criticality event to involve a finite, moderated uranyl fluoride solution system. Table 3-17 of NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook" (NRC, 1998), provides an estimated total fission yield of 1E18 fissions for such a system (i.e., a solution system of less than 100 gallons). The staff, therefore, determined that ACO's bounding criticality event involving 1E18 fissions is consistent with Table 3-17 of NUREG/CR-6410 and is acceptable.

ACO estimated the dose to an individual at the fence line due to (1) direct radiation, (2) inhalation, (3) and submersion. The estimated dose was significantly less than 1 rem and the estimated soluble uranium intake as significantly less than 2 mg.

The staff reviewed the criticality dose calculations presented by ACO following a criticality event. The staff review used information NUREG/CR-6410 (NRC, 1998), inhalation dose conversion factors in FGR-11 (EPA, 1988) and submersion dose conversion factors in FG-12 (EPA, 1993).

The NRC staff finds ACO's estimate of the dose to an offsite individual due to the postulated criticality event involving $1\text{E}18$ fissions is acceptable.

8.3 EVALUATION FINDINGS

The NRC staff reviewed the ACO Evaluation (ACO 2020a) to confirm compliance with the requirements of 10 CFR 70.22(i)(1)(i). The staff finds that an emergency plan is not required for the HALEU Demonstration Program because the maximum dose to a member of the public offsite due to a release of radioactive materials would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium for credible accidents associated with the project and thus meets the requirements of 10 CFR 70.22(i)(1)(i).

The staff notes that the ACO application for the HALEU Demonstration Program states in Section 8.1 that Fluor BWXT Portsmouth, LLC (FBP) currently serves as the Decontamination and Decommissioning contractor for DOE and will provide emergency response capabilities at the entire DOE site, including for the HALEU Demonstration Program. The staff finds these added emergency response capabilities provides defense-in-depth in the operation of the HALEU Demonstration Program.

8.4 REFERENCES

(ACO, 2020a) DAC-3901-0005, Rev. 2, Evaluation of No Need for an Emergency Plan for the HALEU Demonstration, (ADAMS Accession Number ML20335A331) (non-public), October 29, 2020.

(ACO, 2020b) American Centrifuge Operating, "Enclosure 1 - Responses to NRC's Requests for Additional Information Related to the License Amendment Request for the High Assay Low Enriched Uranium Demonstration Program - License Application Chapters 4, 6, 7, and 11," ADAMS Accession Number ML20301A439, October 14, 2020.

(EPA, 1988) Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11, EPA-520/1-88-020, September 1988.

(EPA, 1993) External Exposure to Radionuclides in Air, Water and Soil, Federal Guidance Report No. 12, EPA-402-R-93-081, September 1993.

(NRC, 1998) NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," (ADAMS Accession Number ML072000468, March 31, 1998.

(NRC 2015) NUREG-1520, Rev. 2, "Standard Review Plan for Fuel Cycle Facilities License Applications," ADAMS Accession Number ML15176A258, September 30, 2015.

9 Environmental Protection

9.1 PURPOSE OF REVIEW

The purpose of the Nuclear Regulatory Commission's (NRC's) review is to determine whether ACO's proposed environmental protection measures addressed in Chapter 9 of ACO's revised license application (RLA) for the HALEU Demonstration are adequate to protect the environment, and the health and safety of the public as required by 10 CFR Parts 20, 51, and 70.

9.1.1 Regulatory Requirements

Regulations applicable to establishment of an Environmental Protection (EP) program are presented in 10 CFR Part 20, "Standards for Protection Against Radiation," 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," and the overarching licensing requirements for a uranium enrichment facility are in 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

9.1.2 Regulatory Guidance and Acceptance Criteria

The guidance applicable to the NRC's review of the environmental protection program description section of the RLA (ACO, 2020a) is contained in Chapter 9 of "Standard Review Plan for the Review of Fuel Cycle Facilities License Applications, Revision 2," NUREG-1520 (SRP) (NRC, 2015). The acceptance criteria applicable to this review are contained in Section 9.4.3.1 through 9.4.3.3. For this RLA, the NRC staff evaluated these proposed changes and suitability of the environmental protection program to protect the radiological health and safety of workers and the public for the updated facility.

9.2 STAFF REVIEW AND ANALYSIS

The NRC staff prepared and environmental impact statement (EIS) for the commercial ACP in 2006 (NRC, 2006). ACO submitted its updates to the environmental report for the commercial ACP by letter dated May 7, 2020 (ACO, 2020b). For this amendment the NRC staff focused its review on two primary areas of the RLA: (1) the proposed updates to commitments in the environmental report that support the HALEU Demonstration Program; and (2) the non-public updated Addendum to the ISA Summary.

9.2.1 Radiation Safety

9.2.1.1 ALARA Goals for Air and Liquid Effluent Controls

ACO proposes to continue using the as low as reasonably achievable (ALARA) goals of 10 mrem/year for gaseous and 0.05 mrem for liquid radiological effluents approved for the ACP (NRC, 2006). ACO proposed an ALARA goal of 5 percent of the 10 CFR 20.1101 constraint of 10 mrem/year for the maximally exposed member of the public for the HALEU Demonstration facility. For liquid effluents, ACO proposes a goal of 10 percent of the air effluent goal, or 0.05 mrem/year to the most exposed member of the public. These liquid effluent goals are much lower than the 100 mrem/year regulatory limit in 10 CFR 20.1301 and is, therefore, acceptable to the staff.

9.2.1.2 Air Effluent Controls to Maintain Public Doses ALARA

ACO proposes to continue using controls approved for the commercial ACP to reduce emissions of radioactivity to the atmosphere to maintain doses to the public ALARA. These controls include: (1) activated alumina traps to capture uranium hexafluoride in the purge vacuum and evacuation vacuum systems; (2) a continuous vent sampler that draws samples from the process vent using an isokinetic probe that maintains a real time indication of effluent levels; and (3) engineered local ventilation systems to capture residual uranium during maintenance activity around the centrifuges. Sources of airborne radionuclides at DOE-owned plants are also covered by an EPA Permit-By-Rule issued under 40 CFR Part 61, (NESHAP) Subpart H. This rule imposes a limit on airborne effluents of 10 mrem/year to the maximum exposed individual, which applies to the entire DOE reservation regardless of what entity “owns” any individual source within the reservation (ACO, 2020a).

The staff finds that (1) ACO's proposed controls for radiological effluents will ensure that radiation levels to the public from the HALEU Demonstration remain well below regulatory limits and the proposed ALARA air effluent goals, and that (2) ACO's approach to effluent controls is consistent with the guidance found in Section 9.4.3.2.1(2) of NUREG-1520 (NRC, 2015), and are, therefore, acceptable. For these reasons, the staff finds that ACO demonstrated that its program will reduce gaseous effluents from the HALEU Demonstration and provide adequate protection of the environment and of the health and safety of the public.

9.2.1.3 Liquid Effluent Controls to Maintain Public Doses ALARA

ACO proposes to continue using the controls approved for the commercial ACP to maintain potential doses from liquid effluents to the public at ALARA levels. The NRC staff reviewed the controls described in the RLA, for both X-6002 Recirculating Hot Water Plant and X-3001 process building. The X-6002, which provides heat to multiple buildings at the ACP, contains a particulate separator that removes suspended solids from the water used in the plant. Samples from the blowdown of the particulate separator are taken prior to its discharge to the DOE reservation sewage treatment plant. Outdoor cylinder storage pads were evaluated in the 2006 ACP EIS, however for the HALEU Demonstration, all liquid waste will be stored in the X-3001 building.

The staff finds that ACO's liquid effluent controls will continue to ensure that radiation levels will remain well below regulatory limits and ALARA liquid effluent goals, and that ACO's approach to liquid effluent controls is consistent with the guidance found in Section 9.4.3.2.1(2) of NUREG-1520 (NRC, 2015), thus, implementation of ACO's controls for the HALEU Demonstration are acceptable to the staff. Therefore, the staff finds that ACO has demonstrated that it will reduce liquid effluents to provide adequate protection of the environment and of the health and safety of the public.

9.2.2 Effluent Monitoring

9.2.2.1 Air Effluent Monitoring

ACO describes its environmental monitoring program for radiological and non-radiological releases in Section 9.2.2 of its RLA (ACP, 2020a), which supplements the same section of the ACP application submitted in 2004 (USEC, 2004a). ACO also discusses the environmental monitoring program and releases for the commercial ACP in the ER (ACO, 2020b). The NRC staff presented a detailed evaluation of ACO's program in Chapter 6 of the Final EIS for the ACP (NRC, 2006).

ACO would utilize the effluent monitoring program approved for the ACP (NRC, 2006a). The only change proposed in the RLA that could impact the effectiveness of the ACP's air effluent monitoring program, as applied to the HALEU Demonstration operations, is that the feed material could include UF₆ produced in former enrichment operations external to the ACP, instead of using natural uranium, for instance from the Portsmouth Gaseous Diffusion Plant. This new feed material would meet the American Standard for Testing and Materials (ASTM) UF₆ product standard. ASTM's product standard is used to determine conformance to UF₆ specifications in the Enrichment and Conversion Facilities. Using enriched feed for the HALEU Demonstration may result in higher concentrations of the U-235 isotope than the uranium isotopic concentrations evaluated for the ACP because enriched feed has an inherently higher concentration. Thus, this isotope produced by the HALEU Demonstration will occur in higher concentrations than in natural uranium. Because the monitors utilized for the ACP will detect the radionuclides at these higher concentrations, the monitoring program will continue to be effective in the event that feed material from former enrichment operations is used.

On the basis of the staff's review documented above, the staff finds that ACO's air effluent monitoring program would effectively monitor radioactivity in air effluents to confirm that the effluent concentrations are below the limits in 10 CFR Part 20, is consistent with the guidance in Section 9.4.3.2.2(1) of NUREG-1520 (NRC, 2015), and is, therefore, acceptable to the staff.

The HALEU Demonstration Program operates under the same principles as the ACP, the primary difference being a higher level of enrichment, which does not diminish the effectiveness of the environmental protection program. Therefore, the NRC staff finds the environmental protection program approved for the ACP is also acceptable for safe operations of HALEU. The staff discusses the credible accident sequences addressed by ACO in the ISA, in a later section in this chapter of this SER.

9.2.2.2 Safe Storage and Timely Disposition of Waste

On October 31, 2019, ACO signed a three-year contract and modified its lease with the DOE to operate this HALEU Demonstration Program. The tails material from HALEU will be stored onsite in 12-series cylinders. Currently, there are no plans for shipment of HALEU Demonstration Tails Material offsite during the 3-year contract period. The product material from the HALEU Demonstration Program will be stored onsite in 5-series cylinders. Currently, there are no plans for shipment of HALEU Demonstration Program product material offsite during the 3-year contract period. The staff's review determined the storage of source, enriched, and tails materials will be conducted safely over the duration of the 3-year contract period. The ISA determined potential criticality events at the storage pads are highly unlikely. The potential for chemical or radiological events due to a fire are mitigated by ACO's commitments to limit the amount of combustibles in the area. Additionally, the radiation

protection program addressed in Chapter 4 of this SER ensures that any direct exposure from these cylinders is within the limits prescribed in 10 CFR Part 20 and is As Low As Reasonably Achievable. Based on these considerations in the safety programs and ISA Summary, the NRC staff determined that storage of this material will be in accordance with 10 CFR 20.1101 and is consistent with the guidelines in NUREG 1520, Rev 2, Section 9.4.3.2.1, "Effluent Controls and Waste Minimization."

9.2.2.3 ISA Summary

The staff evaluated the ISA methodology and the ISA addendum for the HALEU Demonstration Program (ACO, 2020) in Chapter 3 of this SER. The staff finds:

- ACO has identified and evaluated in the ISA credible events involving process deviations or other events internal to the facility (e.g., explosions, spills, and fires) and credible external events that could result in facility-induced consequences to the environment, that could exceed the performance requirements of 10 CFR 70.61; and

ACO has designated items relied on for safety (IROFS), evaluated those IROFS for preventing or mitigating the applicable accident sequences that could result in release to the environment, and applied its management measures program to demonstrate compliance with the performance requirements of 10 CFR 70.61.

Chapter 11 of this SER contains the staff's evaluation of the management measures ACO has committed to implement to provide assurance that the IROFS will be available to perform their intended safety functions.

Under 10 CFR Part 70, Subpart H (sections 70.60 through 70.76), ACO must ensure, among other things, compliance with various performance requirements to reduce the risks of credible high-consequence events (i.e., accidents) and credible intermediate-consequence events. Paragraph 70.61(c)(3) of 10 CFR identifies the environmental performance requirements that ACO comply with. ACO must apply engineered or administrative and controls that demonstrate a credible intermediate-consequence event is unlikely to occur or that the consequence of such an event will not exceed a 24-hour averaged release of radioactive material beyond the restricted area in concentrations 5000 times the values in 10 CFR Part 20, Appendix B, Table 2.

To reduce the risks of accidents, ACO evaluated accident sequences and applied preventive and mitigative controls per the ISA methodology. ACO identified various sequences in the ISA Summary (ACO, 2020) for radiological and non-radiological accidents and demonstrated compliance with the performance requirements by designating IROFS to provide adequate protection of worker health and safety. Demonstration of compliance with the performance requirements includes the environmental performance requirements of 10 CFR 70.61 (c)(3).

ACO's approach to risk reduction is accomplished through a combination of preventive and mitigative controls, with the emphasis on preventive controls. A more complete discussion is found in Chapter 3, which addresses credible high- and intermediate-consequence accident sequences. It also addresses preventive and mitigative controls.

The staff finds that ACO's ISA and ISA Summary (ACO, 2020) complies with 10 CFR Part 70, is consistent with the guidance in Section 9.4.3.3 of NUREG-1520 (NRC, 2015), and is therefore, acceptable to the staff.

9.3 EVALUATION FINDINGS

ACO's NRC-approved environmental program is committed to implementing adequate environmental protection measures, including: (1) environmental and effluent monitoring and (2) effluent controls to maintain public doses ALARA. The environmental program is part of the radiation protection program for the proposed HALEU operation, which complies with the regulatory requirements imposed by the Commission in 10 CFR Parts 20, 51, and 70. The NRC staff determined that under 10 CFR 51.31, the preparation of an EIS is not required for the proposed action and that a Finding of No Significant Impact is appropriate under 10 CFR 51.32.

9.4 REFERENCES

(ACO, 2020) American Centrifuge Operating LLC, "License Amendment Request for American Centrifuge Operating, LLC' s License Application and Supporting Documents for the American Centrifuge Plant," ACO 19-0030, ADAMS Accession Number ML20125A103 (Adams Package Number ML20125A126), April 22, 2020.

(ACO, 2020a) American Centrifuge Operating LLC, "License Amendment Request for American Centrifuge Operating, LLC' s License Application and Supporting Documents for the American Centrifuge Plant," Part 2, ADAMS Accession Number ML20125A116, April 22, 2020.

(ACO, 2020b) American Centrifuge Operating "Environmental Report for the American Centrifuge Plant in Piketon, Ohio", ADAMS Accession Number ML20139A098 and ML20139A097, May 7, 2020.

(NRC, 2006) Nuclear Regulatory Commission "Environmental Impact Statement for the Proposed American Centrifuge Plant in Piketon, Ohio, Final Report, NUREG-1834, Vol. 1.," ADAMS Accession Number ML061250131, April 2006.

(NRC, 2006a) U.S. Nuclear Regulatory Commission, NUREG-1851, "Safety Evaluation Report for the American Centrifuge Plant in at Piketon, Ohio," ADAMS Accession Number ML062700087, September 30, 2006.

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2, ADAMS Accession Number ML15176A258, September 30, 2015.

(USEC, 2004a) USEC Inc., "Environmental Report for the American Centrifuge Plant in Piketon, Ohio, Revision 0," (NRC Docket Number 70-7004), ADAMS Accession Number ML043620221, August 31, 2004.

10 DECOMMISSIONING FINANCIAL ASSURANCE

10.1 PURPOSE OF REVIEW

The NRC staff reviewed and approved USEC's funding for the commercial ACP as documented in NUREG-1851, which was issued in September 2006 (NRC, 2006). Based on USEC's proposed phased approach in building and installing centrifuges and generating depleted uranium tails, the staff granted USEC an exemption from 10 CFR 40.36 and 10 CFR 70.25. The exemption allowed incremental funding for decommissioning based on the expected number of centrifuges to be built and installed and on the expected amount of depleted uranium tails to be generated annually in a forward-looking manner (NRC, 2006). Because operation of the proposed HALEU Demonstration could impact the cost of decommissioning, the staff considered whether the RLA required any changes to the decommissioning funding for the ACP.

10.1.1 Regulatory Requirements

Under 10 CFR 70.25(a)(1), each applicant for a specific license for a uranium enrichment facility must submit either a decommissioning funding plan as described in paragraph (e) of that section or submit a certification of financial assurance in the amount prescribed in paragraph (d) of that section. Under 10 CFR 70.25(e), the funding plan must include a cost estimate of all decommissioning activities and a financial instrument that satisfies the requirements in paragraph (f) of that section. 10 CFR 70.25(f)(5), in turn, provides that financial assurance for decommissioning funding may be provided when a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

10.2 STAFF REVIEW AND ANALYSIS

In the RLA Section 10.1.8.1, ACO stated that at the conclusion of the three-year HALEU Demonstration Program (Phase 1), the HALEU Demonstration Program facilities would either be returned to the DOE in accordance with the requirements of the GCEP Lease Agreement or the parties would amend the GCEP Lease Agreement to allow the performance of other work on the leased premises. The current GCEP Lease Agreement includes the following statements pertaining to decommissioning of the HALEU Demonstration Program:

- Any facilities or equipment constructed or installed by the Corporation (Licensee) under the Demonstration Contract with the Department shall be included in Exhibit B (of the GCEP Lease Agreement) as Leased Property and may be returned to the Department in an "as is" condition at the end of the lease term (May 31, 2022).
- The Department hereby assumes all liability for the decontamination and decommissioning of such facilities and equipment installed, and any work performed, under the Demonstration Contract with the Department including any materials or environmental hazards on the site.
- The parties agree that any work performed under the HALEU Demonstration Contract on the leased premises shall be considered a permitted use; any alternations or changes to the premises pursuant to the Demonstration Contract with the DOE shall be a permitted change to the premises; and any liabilities of the Corporation (Licensee) arising from or incident to the performance of work under the Demonstration Contract with the DOE

shall be governed solely by such contract and any financial protection afforded to the Corporation (Licensee) as a person indemnified under the Act.

ACO has stated that, at the conclusion of the HALEU Demonstration Program, if the facilities are not returned to the DOE in accordance with the requirements of the GCEP Lease Agreement ACO will request an amendment to allow continued operation of the HALEU cascade, following a phased implementation of expanded centrifuge enrichment cascades, as described in Section 1.1.8 of the RLA. ACO also stated that a revised decommissioning funding plan, including an updated decommissioning cost estimate, would be provided to the NRC as part of any amendment request to extend operations beyond May 31, 2022 to reflect any new decommissioning liabilities.

Based on the provisions in the GCEP Lease Agreement, the NRC staff finds that DOE's contractual commitment to assume all liability for the decontamination and decommissioning of the HALEU Demonstration Program facilities and equipment is sufficient to satisfy the decommissioning funding requirements in 10 CFR 70.25. Because this RLA authorizes operations during the term of that lease agreement, which expires May 31, 2022, a license amendment will be required for operations beyond that date, including an updated decommissioning funding plan.

10.3 EVALUATION FINDINGS

The NRC staff finds that, under the terms of the GCEP Lease Agreement which expires on May 31, 2022, ACO complies with the decommissioning funding requirements in 10 CFR 70.25.

Because ACO is not required to obtain liability insurance for the HALEU Demonstration, ACO requested modification of License Condition 16, which requires ACO to provide copies of proposed financial assurance instruments to the NRC for review at least 6 months prior to planned date for obtaining licensed material. License Condition 16 states:

ACO shall provide final copies of the proposed financial assurance instruments to NRC for review at least six months prior to the planned date for obtaining licensed material (except for the sealed source and byproduct material calibration sources described in LC 6), and provide to NRC final executed copies of the reviewed financial assurance instruments prior to the receipt of licensed material (except for the sealed source and byproduct material calibration sources described in LC 6). The amount of the financial assurance instrument shall be updated to current year dollars and include any applicable changes to the decommissioning cost estimate. The decommissioning cost estimate shall include an update to ACO's Analysis of Depleted Uranium Disposal Costs for the ACP. To develop this update, ACO shall coordinate with DOE to determine necessary changes to the DOE contractor's depleted uranium cost estimate utilized as input to the ACO specific analysis.

Since DOE is accepting responsibility for decommissioning of all equipment and materials, the financial assurance instruments under License Condition 16 are not required for the HALEU Demonstration Program. However, this License Condition continues to be applicable to the commercial ACP. Accordingly, License Condition 16 is modified as follows:

ACO shall provide final copies of the proposed financial assurance instruments to NRC for review at least six months prior to the planned date for obtaining licensed material

(except for the sealed source and byproduct material calibration sources described in LC 6, and the HALEU demonstration cascade under the lease agreement with DOE ending May 31, 2022), and provide to NRC final executed copies of the reviewed financial assurance instruments prior to the receipt of licensed material (except for the sealed source and byproduct material calibration sources described in LC 6, and the HALEU demonstration cascade under the lease agreement with DOE ending May 31, 2022). The amount of the financial assurance instrument shall be updated to current year dollars and include any applicable changes to the decommissioning cost estimate. The decommissioning cost estimate shall include an update to ACO's Analysis of Depleted Uranium Disposal Costs for the ACP. To develop this update, ACO shall coordinate with DOE to determine necessary changes to the DOE contractor's depleted uranium cost estimate utilized as input to the ACO specific analysis.

10.4 REFERENCES

(NRC, 2006) U.S. Nuclear Regulatory Commission, Consolidated Decommissioning Guidance (Volumes 1 - 3) NUREG-1757, September 2006.

11 MANAGEMENT MEASURES

11.1 PURPOSE OF REVIEW

The purpose of the U.S. Nuclear Regulatory Commission's (NRC's) review of the Licensee's management measures is to evaluate whether the application provided information to ensure that the management measures applied to IROFS, as documented in the ISA Summary, provide adequate assurance that the IROFS will be available and reliable. If a graded approach is used, the review will also determine whether the management measures are applied to the IROFS in a manner commensurate with the IROFS' importance to safety.

Management measures shall be implemented to assure compliance with performance requirements and the degree to which they will be applied will be a function of the item's importance in terms of meeting performance requirements as evaluated in the Integrated Safety Analysis (ISA). Included in the 10 CFR Part 70 definition of management measures, including: (a) configuration management (CM); (b) maintenance; (c) training and qualifications; (d) procedures; (e) audits and assessments; (f) incident investigations; (g) records management; and (h) other quality assurance (QA) elements. This chapter addresses the revisions to the management measures in the RLA.

11.1.1 Regulatory Requirements

The requirements for fuel cycle facility management measures are specified in 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

1. 10 CFR 70.4 states that management measures include: (a) CM; maintenance; (b) training and qualifications; (c) procedures; audits and assessments; (d) incident investigations; (e) records management; and (f) other QA elements.
2. 10 CFR 70.62(d) requires an applicant to establish management measures, for application to engineered and administrative controls and control systems that are identified as IROFS, pursuant to 10 CFR 70.61(e), to ensure they are available and reliable.
3. 10 CFR 70.64(a)(1) states, in part, that appropriate records of IROFS must be maintained by the licensee throughout the life of the facility.
4. 10 CFR 70.22(a)(8) states requirements for license applications to address proposed procedures to protect health and minimize danger to life and property.
5. 10 CFR 70.72 requires a licensee to establish a CM program to evaluate, implement, and track changes to the facility; structures, systems and components (SSCs); processes; and activities of personnel.
6. 10 CFR 70.74(a) and (b) state requirements for incident investigation and reporting.

11.1.2 Regulatory Guidance and Acceptance Criteria

The guidance applicable to NRC's review of the changes to the management measures description section in the revised license application (RLA) for the HALEU Demonstration is

contained in Chapter 11 of "Standard Review Plan for Fuel Cycle Facilities License Applications," NUREG-1520, Revision 2 (NRC, 2015). The staff used the guidance in the standard review plan along with the applicable acceptance criteria contained in Section 11.4.3 to inform the review of the changes from the previously approved license application (LA) for the ACP.

11.2 STAFF REVIEW AND ANALYSIS

The NRC staff reviewed the changes from the previously approved LA for the commercial ACP and contained in the 2020 ACO RLA for the HALEU Demonstration Program (ACO, 2020), which includes the Quality Assurance Program Description (QAPD)(ACO, 2020b) document. The changes include, but are not limited to, minor changes made throughout the document to make the information consistent with current practice and align with other changes made in the commercial ACP LA; references made to Addendum 1 of the ISA Summary where necessary to differentiate the HALEU Demonstration Program from the commercial ACP; update program elements from the American Society of Mechanical Engineers (ASME) standard Nuclear Quality Assurance (NQA)-1, Quality Assurance Requirements for Nuclear Facility Applications, 1994 edition to the 2008 edition (ASME, 2008) with the NQA-1a-2009 Addenda (ASME, 2009); and changes made to single and dual records storage definition based upon verbatim usage from NQA-1-2008. The staff reviewed the commitments to management measures in the 2020 ACO RLA for the HALEU Demonstration Program. In general, the staff found that the commitments in the 2020 HALEU amendment were fundamentally the same as the commitments made in the 2006 commercial ACP application and approved by the staff. Therefore, the NRC staff focused its review on the specific changes and updates ACO made to the previously approved commercial ACP LA contained in each of the same management measures. Documentation of the NRC staff's review of the modified sections of the HALEU amendment is provided below.

In 2006, the staff reviewed the elements of management measures identified in regulation, and that were identified and discussed in the 2006 ACP application. The 2006 review examined the following areas:

- Configuration Management Program
- Maintenance
- Training and Qualifications
- Procedures
- Audits and Assessments
- Incident Investigation
- Records Management
- Other QA Elements

The staff found them to be acceptable. This approval was documented in the 2006 SER (ADAMS Accession Number ML062700087).

As part of its review of the HALEU amendment, the NRC requested additional information on September 11, 2020 (NRC, 2020a). On October 14, 2020, ACO provided the NRC its responses (ACO, 2020a) to the questions asked, and proposed changes to its application.

11.2.1 Configuration Management Program

ACO's CM function is described in Section 11.1 of the RLA (ACO, 2020) and the elements are discussed below.

11.2.1.1 CM Policy

ACO has defined the Configuration Management Policy for the ACP HALEU Demonstration and provided a program overview in Section 11.1.1 of the RLA. ACO made additions and clarifications to this section, including an addition to the goal of the CM program to ensure the ACO documentation matches the plant's operational configuration and clarifying the responsibilities of key managers. In addition, ACO added references as necessary for the HALEU Demonstration. The staff determined that these additions and clarifications did not reduce the effectiveness of the CM Policy. Accordingly, the NRC staff finds that ACO has provided an adequate description of the overall CM policy and functions, the changes are consistent with the guidance provided in Section 11.4.3.1 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.1.2 Design Requirements

ACO has defined the design requirements as part of configuration management in Section 11.1.2 of the RLA. ACO made clarifications to this section by including provisions for defense in depth practices and the preference for engineered controls over administrative controls as applied to design. In addition, ACO added references as necessary for the HALEU Demonstration. The staff determined that these additions and clarifications did not reduce the effectiveness of the CM design requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the design requirements, the changes are consistent with the guidance provided in Section 11.4.3.1 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.1.3 Document Control

ACO has defined document control as part of configuration management in Section 11.1.3 of the RLA. ACO made a clarification to this section regarding the applicability of commercial grade dedication requirements in engineering specification data sheets. In addition, ACO added a reference as necessary for the HALEU Demonstration. The staff determined that these additions and clarifications did not reduce the effectiveness of the CM document control requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of document control requirements, the changes are consistent with the guidance provided in Section 11.4.3.1 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.1.4 Change Control, Assessments, and Design Verification

ACO has defined change control, assessments, and design verification as a part of configuration management in Sections 11.1.4, 11.1.5, and 11.1.6 of the RLA, respectively. Except for an addition of a HALEU Demonstration reference in Section 11.1.4.1, the description in each section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the change control, assessments, and design verification requirements, is consistent with the guidance provided in Section 11.4.3.1 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.2 Maintenance

ACO has defined maintenance for IROFS in Section 11.2 of the RLA, which addresses: (a) personnel qualifications and training; (b) design/work control; (c) corrective and preventive maintenance; (d) surveillance and monitoring; (e) post-maintenance testing; (f) control of measuring and test equipment; and (g) equipment/work history. In the introductory maintenance organization and administration Section 11.2.1, ACO clarified the responsibilities of the Maintenance Work Center Supervisor to include centrifuge machines and that maintenance would be performed within the training limitations of the personnel performing the work, which is also discussed and evaluated in Chapter 2 of this SER. ACO also provided examples of maintenance activities performed. In addition, ACO added a reference as necessary for the HALEU Demonstration and removed references to Piketon when discussing organization personnel in Section 11.2.3 for Design/Work Control. The staff determined that these additions and clarifications did not reduce the effectiveness of the maintenance organization and administration, and design/work control requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the maintenance organization and administration, and design/work control requirements; the changes are consistent with the guidance provided in Section 11.4.3.2 of NUREG-1520, Revision 2; and is therefore acceptable.

11.2.2.1 Corrective Maintenance

ACO has defined corrective maintenance in Section 11.2.4 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the corrective maintenance requirements, is consistent with the guidance provided in Section 11.4.3.2 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.2.2 Preventive Maintenance

ACO has defined preventive maintenance in Section 11.2.5 of the RLA. Except for removal of the Piketon reference, as described in Section 11.2.2 above, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the preventive maintenance requirements, is consistent with the guidance provided in Section 11.4.3.2 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.2.3 Surveillance and Monitoring

ACO has defined surveillance and monitoring in Section 11.2.6 of the RLA. Except for an addition of a HALEU Demonstration reference, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the surveillance and monitoring requirements, is consistent with the guidance provided in Section 11.4.3.2 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.2.4 Functional Testing

ACO has defined functional testing in Section 11.2.7 of the RLA. Except for removal of the Piketon reference, as described in Section 11.2.2 above, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the

NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of functional testing, is consistent with the guidance provided in Section 11.4.3.2 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3 Training and Qualifications

ACO discusses training and qualification programs in Section 11.3 of the RLA and the elements are discussed below.

11.2.3.1 Organization and Management of the Training Function

ACO describes organization and management of the training function in Section 11.3.1 of the RLA. ACO made clarifications to this section, which include specifically describing indoctrination as a part of training and clarifying when Laboratory Technician Training is applicable. In addition, ACO added references as necessary for the HALEU Demonstration.

The Licensee also describes the various training areas in Sections 11.3.1.1 - 11.3.1.12 of the RLA. Clarifications were also made in these sections. For Emergency Preparedness and Emergency Management Training, Emergency Plan training was replaced with emergency response training because an Emergency Plan is not required for the HALEU Demonstration Program. For Operations Technician and Operations Shift Supervisor, it was clarified that alarm response operating procedures were to be trained on for these positions and the specific requirement to train on emergency operating procedures was removed from these sections because it is already covered by the required IROFS training in these same sections. For Nuclear Criticality Safety Engineer Training, the references to ANSI/ANS standards have been updated to the most recent versions endorsed by the NRC.

The staff finds that ACO has provided an adequate description of the organization and management of the training function. The changes included in the application and provided by ACO, as described above, are consistent with the guidance in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.2 Analysis and Identification of Functional Areas Requiring Training

ACO describes its analysis and identification of the functional areas requiring training in Section 11.3.2 of the RLA. Except for an addition of a HALEU Demonstration reference, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.3 Position Training Requirements

ACO describes the position training requirements in Section 11.3.3 of the RLA. Except for an addition of a HALEU Demonstration reference, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the position training requirements, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.4 Development of the Basis for Training, Including Objectives

ACO describes the development of the basis and objectives for training in Section 11.3.4 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.5 Organization of Instruction, Using Lesson Plans and Other Training Guides

ACO describes the organization of instruction in Section 11.3.5 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.6 Evaluation of Trainee Accomplishment

ACO describes the evaluation of trainee accomplishment in Section 11.3.6 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.7 Conduct of On-the-Job Training.

ACO describes the conduct of on-the-job training in Section 11.3.7 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.8 Evaluation of Training Effectiveness

ACO describes the evaluation of training effectiveness in Section 11.3.8 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.9 Personnel Qualification

ACO describes the personnel qualification requirements in Section 11.3.9 of the RLA. Except for an addition of a HALEU Demonstration reference, the description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.3.10 Provisions for Continuing Assurance

ACO describes the provisions for continuing assurance in Section 11.3.10 of the RLA. The description in this section remains the same as the description set forth in the commercial ACP LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description, is consistent with the guidance provided in Section 11.4.3.3 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.4 Procedure Development and Implementation

ACO describes procedure development and implementation requirements in Section 11.4 of the RLA. ACO made one addition to this section regarding procedures, specifically, elements of procedures for consideration during development. In addition, HALEU Demonstration references were added in this section as necessary. The staff found that these additions did not reduce the effectiveness of the procedure development and implementation requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the procedure development and implementation requirements, the changes are consistent with the guidance provided in Section 11.4.3.4 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.5 Audits and Assessments

ACO discusses audits and assessments in Section 11.5 of the RLA and each is discussed below.

11.2.5.1 Audits

ACO describes audit requirements in Section 11.5.1 of the RLA. ACO made one clarification to this section regarding auditor independence. In addition, the reference to American Society of Mechanical Engineers (ASME) standard NQA-1, "Quality Assurance Requirements for Nuclear Facility Applications" was updated to the 2008 edition (ASME, 2008), which has been endorsed by the NRC in Regulatory Guide (RG) 1.28, "Quality Assurance Program Criteria (Design and Construction)," Revision 4. The staff found that the clarification did not reduce the effectiveness of the audit requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the audit requirements, the changes are consistent with the guidance provided in Section 11.4.3.5 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.5.2 Assessments

ACO describes the assessments required of the organization in Section 11.5.2 of the RLA. Except for an addition of a HALEU Demonstration reference, the description in this section remains the same as the description set forth in the ACP commercial plant LA previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the assessment requirements, is consistent with the guidance provided in Section 11.4.3.5 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.6 Incident Investigations

ACO describes the incident investigation process for the identification, reporting, and investigation of abnormal events in Section 11.6 of the RLA. ACO made updates in this section to a position title and the reference to the location of classified matter communication requirements. In addition, ACO added references to the HALEU Demonstration as necessary

and deleted an example root cause methodology. The staff found that these changes did not reduce the effectiveness of the incident investigation process. Accordingly, the NRC staff finds that ACO has provided an adequate description of the incident investigation process, the changes are consistent with the guidance provided in Section 11.4.3.6 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.7 Records Management

ACO describes the records management program and requirements in Section 11.7 of the RLA. ACO made changes and additions to this section as described below.

The revised QAPD (ACO, 2020b) was added as a reference that describes records requirements for the facility. Retention requirements for lifetime records was added to Section 11.7.1.5, as well as which document specifies those for lifetime storage in Section 11.7.1.8. Requirements for lost or damaged records and the controls for single copy records were added to Section 11.7.1.7. Protection of records from dust or airborne particles was added for clarification of storage requirements in Section 11.7.1.8. In this same section, the requirements for single and dual permanent storage and temporary storage of records was modified to be consistent with the requirements in ASME NQA-1-2008, Requirement 17, for quality assurance records, which has been endorsed by the NRC in RG 1.28, Revision 4. In Section 11.7.2.2, the language for document approval and release was clarified such that the document control program verifies the requirements for documents and changes to documents required by the QAPD are verified adequate, and the organizations authorized to distribute controlled documents are also identified in plant procedures. Applicable references were also updated to the new location of requirements for classified and sensitive records and documents.

The staff finds that ACO has provided an adequate description of the records management and document control program. The changes included in the application and provided by ACO, as described above, are consistent with the guidance in Section 11.4.3.7 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8 Other Quality Assurance Elements

ACO describes in Section 11.8 of the RLA that it has developed QA principles that will apply to the design, fabrication, refurbishment, modification, testing, operation, and maintenance of the ACP in order to meet the requirements of 10 CFR 70.64(a)(1). These principles are described in the Licensee's revised QAPD (ACO, 2020b), which is part of the RLA.

11.2.8.1 Organization

ACO describes the organization requirements in Section 1.1 of the revised QAPD. In addition to minor editorial changes and clarifications made in this section, ACO clarified the responsibilities of the Maintenance Work Center Supervisor to include centrifuge machines and that maintenance would be performed within the training limitations of the personnel performing the work. This is the same change as described in Section 11.2.2 of this SER. The staff determined that these clarifications did not reduce the effectiveness of the organization requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the QA organization element, the changes are consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.2 QA Program

ACO describes overall QA program in Section 2.0 of the revised QAPD. In this section, ACO made minor editorial changes and clarifications and updated the references to ASME NQA-1 to NQA-1-2008 (ASME, 2008) with the NQA-1a-2009 addenda (ASME, 2009), which are endorsed by the NRC in RG 1.28, Revision 4. The staff determined that the changes did not reduce the effectiveness of the overall QA program requirements. Accordingly, the staff finds that the Licensee has provided an adequate description of the QA program element, the changes are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.3 Design Control

ACO describes the design control process requirements in Section 3.0 of the revised QAPD. In this section, ACO made minor editorial changes and clarifications and removed the requirement for timely review and approval of design requirement documents and timely performance of design verification. The timeliness of these two design control activities is not required by NRC regulations or discussed in NUREG-1520, Revision 2. The review and approval of design requirement documents are still required to be to the level of detail necessary to permit the design activity to be carried out correctly and design verification to be completed prior to relying upon the IROFS, or computer program to perform its function. In addition, ACO updated the references and applicable sections of ASME NQA-1 to NQA-1-2008 (ASME, 2008) with the NQA-1a-2009 addenda (ASME, 2009), which are endorsed by the NRC in RG 1.28, Revision 4. Consistent with these updates, SNM-2011 License Condition (LC) 19.a was modified accordingly.

The staff finds that the Licensee has provided an adequate description of the design control element. The changes included in the application and provided by ACO, as described above, are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.4 Procurement Document Control

ACO describes the procurement document requirements in Section 4.0 of the revised QAPD. Except for a minor editorial change, the description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the procurement document control element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.5 Instructions, Procedures, and Drawings

ACO describes the requirements for instructions, procedures, and drawings in Section 5.0 of the revised QAPD. Except for a minor clarification to the document types used when a detailed step-by-step procedure is not required, the description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the instructions, procedures, and drawings element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.6 Document Control

ACO describes the requirements for document control in Section 6.0 of the revised QAPD. The description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the document control element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.7 Control of Purchased Items and Services

ACO describes the requirements for the procurement of items and services in Section 7.0 of the revised QAPD. ACO made additions and clarifications to this section. The supplier selection section was clarified to include supplier evaluation in the title. For the acceptance of items and services, it was clarified that using the certificate of conformance method occurs during receipt inspection and when using post-installation testing, acceptance documentation is established with the supplier, not just acceptance criteria with the option to establish the criteria with or without the supplier. The commercial grade items section was clarified to include commercial grade services as well and included supporting language and clarifications in the section with the inclusion of commercial grade services.

The staff finds that the Licensee has provided an adequate description of the control of purchased items and services element. The changes included in the application and provided by ACO, as described above, are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.8 Identification and Control of Items

ACO describes the requirements for the identification and control of items to assure that only correct and accepted items are used or installed in Section 8.0 of the revised QAPD. Except for a minor editorial change, the description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the identification and control of items element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.9 Control of Special Processes

ACO describes the control of processes affecting quality of items and services, including the control of special processes, in Section 9.0 of the revised QAPD. The description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the control of special processes element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.10 Inspection

ACO describes the QA element of inspection that details how inspections are planned and performed in order to verify conformance of items to applicable requirements in Section 10.0 of the revised QAPD. ACO made clarifications and additions to this section. ACO clarified that the planning of inspection activities is included during operation; that when a sample is used to verify acceptability of a group of item, the sampling procedure is based on a standard method

that is approved by engineering rather than just identifying a sampling basis; and inspection records require at least a reference to information on action taken in connection with nonconformance. In addition, periodic inspections or surveillances of structures, systems, or components to assure their continued performance was added to the types of inspections performed. The staff determined that the changes did not reduce the effectiveness of the inspection requirements. Accordingly, the staff finds that the Licensee has provided an adequate description of the inspection element, the changes are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.11 Test Control

ACO describes the test control requirements in Section 11.0 of the revised QAPD. ACO made one addition in this section to include in test procedures or design requirement documents provisions for documenting and evaluating the test results for conformance with test requirements. ACO also made a clarification that computer program testing performed in accordance with the updated reference to ASME NQA-1-2008 (ASME, 2008) and NQA-1a-2009 addenda (ASME, 2009) as endorsed by the NRC in RG 1.28, Revision 4, is applicable only to IROFS.

The staff finds that the Licensee has provided an adequate description of the test control element. The changes included in the application and provided by ACO, as described above, are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.12 Control of Measuring and Test Equipment.

ACO describes the requirements for the control of measuring and test equipment (M&TE) in Section 12.0 of the revised QAPD. ACO made additions and clarifications to this section to provide more specific information and requirements. ACO added the requirement that M&TE will be calibrated against standards that provide a minimum accuracy ratio of 4:1, and if this minimum accuracy ratio cannot be provided, the basis of the specified calibration is documented and approved by engineering. ACO clarified the requirement for proper handling and storage to maintain accuracy by including the specified environment to handle and store the M&TE and adding the M&TE are calibrated in the specified environment. The staff determined that the changes did not reduce the effectiveness of the M&TE requirements. Accordingly, the staff finds that the Licensee has provided an adequate description of the M&TE element, the changes are consistent with the guidance in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.13 Handling, Storage, and Shipping

ACO describes the requirements for handling, storage, and shipping in Section 13.0 of the revised QAPD. Except for a minor editorial change, the description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the handling, storage, and shipping element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.14 Inspection, Test, and Operating Status

ACO describes the requirements for inspection, test, and operating status in Section 14.0 of the revised QAPD. The description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the inspection, test, and operating status element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.15 Control of Nonconforming Items

ACO describes the requirements for the control of nonconforming items in Section 15.0 of the revised QAPD. ACO made a clarification to this section that repaired and reworked items are re-examined in accordance with applicable procedures in addition to the original acceptance criteria. The staff determined that this change did not reduce the effectiveness of the control of nonconforming items. Accordingly, the NRC staff finds that ACO has provided an adequate description of the control of nonconforming items element, the changes are consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.16 Corrective Action

ACO describes the requirements for corrective actions in Section 16.0 of the revised QAPD. The description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the corrective action element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.17 QA Records

ACO describes the requirements for QA records in Section 17.0 of the revised QAPD. ACO made modifications to this section to add requirements for electronic records; add a requirement to establish procedures to ensure QA records are complete, legible, traceable, maintained, and retrievable; clarify the requirements that apply to all QA records including both lifetime and nonpermanent records; and clarify that nonpermanent records are retained per the Retention Schedule and in accordance with the records management process. In addition, ACO updated the references to ASME NQA-1 to NQA-1-2008, which is endorsed by the NRC in RG 1.28, Revision 4 (NRC, 2010). The staff determined that the changes made by ACO did not decrease the effectiveness of the QA records requirements. Accordingly, the NRC staff finds that ACO has provided an adequate description of the QA records element, the changes are consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.18 AUDITS

ACO describes the internal and external audit requirements in Section 18.0 of the revised QAPD. The description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the audit element, is consistent with the guidance provided in Section 11.4.3.8 of NUREG-1520, Revision 2, and is therefore acceptable.

11.2.8.19 QAPD Changes

ACO describes the change control provisions in Section 19.0 of the revised QAPD. Except for a minor reference update to the title of 10 CFR 70.72, the description in this section remains the same as the description set forth in the QAPD previously approved by the NRC. Accordingly, the NRC staff finds that ACO has provided an adequate description of the change control provisions and is therefore acceptable.

11.3 EVALUATION FINDINGS

The staff reviewed the changes ACO made to the management measures for the HALEU Demonstration Program, which includes CM, maintenance, training and qualifications, procedures, audits and assessments, incident investigations, records management, and other management measures identified in the revised QAPD, and finds that these management measures ACO will apply to IROFS are acceptable. These documents demonstrate ACO's compliance with the management measures requirements of 10 CFR 70.62(d) and contribute to reasonable assurance that (1) the Licensee is qualified by reason of training and experience to use the material for the purpose requested in accordance with the regulations in this chapter; (2) The Licensee's proposed equipment and facilities are adequate to protect health and minimize danger to life or property; and (3) The Licensee's proposed procedures to protect health and to minimize danger to life or property are adequate.

11.4 REFERENCES

(ACO, 2020) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0010, ADAMS Accession Number ML20125A103 (ADAMS Accession Package ML20125A126), April 22, 2020.

(ACO, 2020a) American Centrifuge Operating, LLC, "Responses to NRC's Requests for Additional Information Related to the License Amendment Request for the High Assay Low Enriched Uranium Demonstration Program – License Application Chapters 4, 6, 7, and 11," ACO 20-0036, ADAMS Accession Number ML20301A439, October 14, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC, "Quality Assurance Program Description for the American Centrifuge Plant, Piketon, Ohio," ACO 20-0010, ADAMS Accession Number ML20125A105, April 16, 2020.

(ASME, 2008) American Society of Mechanical Engineers, Nuclear Quality Assurance, "Quality Assurance Requirements for Nuclear Facility Applications," ASME NQA-1-2008.

(ASME, 2009) American Society of Mechanical Engineers, Nuclear Quality Assurance, "Quality Assurance Requirements for Nuclear Facility Applications," ASME NQA-1a-2009, Addenda to ASME NQA-1-2008, 2009.

(NRC, 2010) U.S. Nuclear Regulatory Commission, Regulatory Guide 1.28, "Quality Assurance Program Criteria (Design and Construction)," Revision 4, ADAMS Accession Number ML100160003, June 2010.

(NRC, 2015) U.S. Nuclear Regulatory Commission, NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications, Revision 2," ADAMS Accession Number ML15176A258, September 30, 2015.

12 FUNDAMENTAL NUCLEAR MATERIAL CONTROL PLAN

On May 7, 2020, ACO submitted a revision to its Fundamental Nuclear Material Control Plan (FNMCP) to support ACO's high assay low enriched uranium (HALEU) Demonstration Program (ACO, 2020). On June 23, 2020, the NRC informed ACO it was acceptable for review (NRC, 2020). During the review, the NRC staff identified additional information that was needed, and a request for additional information (RAI) was issued on September 11, 2020 (NRC, 2020a). ACO submitted its updated FNMCP on October 15, 2020 (ACO, 2020a). On November 3, 2020, NRC staff conducted a teleconference with ACO to request clarification on four of ACO's responses to the RAIs (NRC, 2020b). ACO provided its response to the NRC on January 14, 2021 (ACO, 2021). The details associated with NRC's review of the FNMCP are documented in Appendix C.

The NRC staff finds that the material control and accounting program, described in FNMCP (ACO, 2021) satisfies the applicable reporting requirements, performance objectives, and system capabilities specified in 10 CFR 74.11, 74.13, 74.15, 74.17, 74.19, 74.33, 74.41, 74.43, and 74.45. Therefore, the NRC staff finds that the ACO program implemented by the FNMCP is acceptable and provides reasonable assurance that the requirements for the material control and accounting of SNM of low and moderate strategic significance will be met.

12.1 REFERENCES

(ACO, 2020) "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0013, ADAMS Accession Number ML20139A100, May 7, 2020.

(ACO, 2020a) "Response to NRC Staff Comments for American Centrifuge Operating, LLC's Fundamental Nuclear Material Control Plan," ACO 20-0035, ADAMS Accession Number ML20300A480, October 15, 2020.

(ACO, 2021) "Supplemental Response to NRC Staff Comments for American Centrifuge Operating, LLC's Fundamental Nuclear Material Control Plan," ACO 21-0002, ADAMS Accession Number ML21036A188, January 14, 2021.

(NRC, 2020) Acceptance for Detailed Review of Centrus Energy Corp.'s License Amendment Application for its American Centrifuge Plant High Assay Low Enriched Uranium Program Submitted on April 22, 2020 and May 7, 2020," ADAMS Accession Number ML20162A261, June 23, 2020.

(NRC, 2020a) "Request for Additional Information Regarding Centrus Energy Corp. American Centrifuge Operating American Centrifuge Plant High Assay Low Enriched Uranium Program Amendment," ADAMS Accession Number ML20245E173, September 11, 2020.

(NRC, 2020b) "Summary of Conference Call Between NRC and Centrus/ACO to Discuss FNMCP RAI Responses," ADAMS Accession Number ML20321A147, November 11, 2020.

13 PHYSICAL SECURITY PLAN

On June 23, 2020, ACO submitted its Physical Security Plan (PSP) marked Safeguards Information (ACO, 2020). On July 21, 2020, the NRC informed ACO it was acceptable for review and requested that additional information also be included in the Plan (NRC, 2020). ACO submitted its updated Plan on August 5, 2020 (ACO, 2020a). Draft RAIs were issued on August 31, 2020 (NRC, 2020b). On October 7, 2020, NSIR and NMSS staff conducted a site visit to ACO's Technology and Manufacturing Center in Oak Ridge Tennessee to discuss draft PSP RAIs (NRC, 2020b). The NRC issued its RAIs on December 15, 2020 (NRC, 2020c). ACO provided its response to the NRC on December 29, 2020 (ACO, 2020b). On May 25, 2021, ACO submitted its final revision of the PSP (ACO, 2021). The NRC's review of ACO's PSP is documented in Appendix D. Appendix D contains Safeguards Information and is therefore not publicly available.

Given the higher enrichments of the HALEU Demonstration Project, the NRC staff determined that two license conditions were required for ACO to ensure adequate protection of public health and safety and comply with NRC Order EA-07-0140, dated July 7, 2007. These are:

License Condition 25: The Licensee will request prior NRC's approval before any liquid UF₆ operations commence at the ACP.

License Condition 28: The Licensee will establish, maintain, and implement a maintenance, testing and calibration program to ensure that security systems and equipment are tested for operability and performance at predetermined intervals, maintained in operable condition, and are capable of performing their intended functions.

The NRC staff finds that the physical security program, described in PSP dated May 2021, satisfies the performance objectives, systems capabilities, and reporting requirements specified in 10 CFR 70.22(k), 10 CFR 73.67, and 10 CFR 73.71, and in NRC-issued security orders. Therefore, the NRC staff finds that the ACO program implemented by PSP is acceptable and provides reasonable assurance that the requirements for the physical protection of SNM of moderate and low strategic significance will be met.

13.1 REFERENCES

(ACO, 2020) American Centrifuge Operating, LLC, "License Amendment Request for American Centrifuge Operating, LLC's License Application and Supporting Documents for the American Centrifuge Plant," ACO 20-0021, ADAMS Accession Number ML20314A098, June 23, 2020.

(ACO, 2020a) American Centrifuge Operating, LLC, "Supplement to American Centrifuge Operating, LLC Security Plan License Amendment Request," ACO 20-0029, ADAMS Accession Number ML20314A099, August 5, 2020.

(ACO, 2020b) American Centrifuge Operating, LLC, "Supplement to American Centrifuge Operating, LLC Security Plan License Amendment Request," ACO 20-0038, ADAMS Accession Number ML21036A190, December 29, 2020.

(ACO, 2021) American Centrifuge Operating, LLC, "Issuance of Final Revision for American Centrifuge Operating, LLC's License Application and Supporting Documents," ACO 21-0030, ADAMS Accession Number ML21148A148, May 25, 2021.

(NRC, 2020) "E-Mail from Y. Faraz of NRC Forwarding Acceptance Review Conference Call Summary to K. Wiehle of ACO," ADAMS Accession Number ML20288A248, July 21, 2020.

(NRC, 2020a) "E-Mail from Y. Faraz of NRC Forwarding Draft RAIs to K. Wiehle of ACO," ADAMS Accession Number ML20245E408, August 31, 2020.

(NRC, 2020b) "E-Mail from Y. Faraz of NRC Providing August 31, 2020 Site Visit Summary to D. Marcano of NRC," ADAMS Accession Number ML20283A343, October 8, 2020.

(NRC, 2020c) "Request for Additional Information Regarding Centrus Energy Corp. American Centrifuge Operating, LLC Physical Security Plan for the American Centrifuge Plant High Assay Low Enriched Uranium Program Amendment," ADAMS Accession Number ML20338A149, December 15, 2020.

14 LIST OF PREPARERS

The individuals and organizations listed below are the principal contributors to the preparation and review of this Safety Evaluation Report. U.S. Nuclear Regulatory Commission (NRC) staff directed the effort and contributed to the technical evaluations and review.

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