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SUPPLEMENT ANALYSIS FOR HIGHLY ENRICHED URANIUM BLEND DOWN TO HIGH-ASSAY LOW-ENRICHED URANIUM AT THE SAVANNAH RIVER SITE

April 2025

Prepared by the U.S. Department of Energy
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Acronyms and Abbreviations

ASNF	aluminum spent nuclear fuel
BWXT	BWX Technologies
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
FGR	Federal Guidance Report
FONSI	Finding of No Significant Impact
FR	Federal Register
ft	feet
GHG	greenhouse gas
HALEU	High-Assay Low-Enriched Uranium
HEU	highly enriched uranium
HLW	high-level waste
LCF	latent cancer fatality
LEU	low enriched uranium
LLW	low-level radioactive waste
LR	Liqui-Rad
MAR	material at risk
MEI	maximally exposed individual
mrem	millirem
MT	metric ton
MT/yr	metric tons per year
MTHM	metric tons of heavy metal
NASNF	non-aluminum spent nuclear fuel
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
PM	particulate matter
ppm	parts per million
rem	roentgen equivalent man
ROD	Record of Decision
ROI	region of influence
SA	Supplement Analysis
SAR	Safety Analysis Report
SNF	spent nuclear fuel
SRS	Savannah River Site
TVA	Tennessee Valley Authority
U-234	uranium-234

Acronyms and Abbreviations Continued

U-235	uranium-235
U-236	uranium-236
U-238	uranium-238
UNH	uranyl nitrate hexahydrate
U.S.	United States

1 Introduction

High-Assay Low-Enriched Uranium (HALEU) fuels are being developed to support the replacement of highly enriched uranium (HEU) fuels used in High-Performance Research Reactors as well as advanced nuclear power reactor designs. The projected demand for HALEU far exceeds the current supply and studies are underway to assess various options to partially mitigate the potential short supply. The H-Canyon facility at the Savannah River Site (SRS) near Aiken, South Carolina, produced 4.95 percent low enriched uranium (LEU) from spent nuclear fuel (SNF) for the Tennessee Valley Authority's (TVA) commercial power reactor market for several decades; however, the facility blend down capability has been shut down since the last shipment to TVA in 2011. The capability to produce LEU at the H-Canyon A Line facilities (also referred to as H-Canyon outside facilities) can be readily transitioned to blend down the current inventory of HEU solutions to HALEU, which could help bridge the gap until other commercial initiatives can meet HALEU production needs.

The United States (U.S.) Department of Energy (DOE) recently prepared a *Final Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU)* (DOE/EIS-0559, the “HALEU EIS”) (DOE, 2024). The HALEU EIS evaluates the potential environmental impacts from activities associated with DOE’s Proposed Action, which is to acquire, through procurement from commercial sources, HALEU enriched to at least 19.75 and less than 20 weight percent uranium-235 (U-235) over a 10-year period of performance, and to facilitate the establishment of commercial HALEU fuel production. DOE’s objective is to establish a temporary domestic demand for HALEU to support the availability of HALEU for civilian domestic commercial use and demonstration projects by engaging with industry and other stakeholders to enter into partnership and incentivize the establishment of a domestic HALEU fuel cycle. Section 1.0.5.1, “DOE HALEU Supply,” of the HALEU EIS states the potential near-term supply of HALEU from processing DOE materials at DOE facilities could include HALEU produced from blending down existing HEU uranyl nitrate solution in storage at H-Canyon at SRS. These DOE activities could supply a limited amount of HALEU, considerably less than the 290 metric tons (MT) identified as part of the Proposed Action in the HALEU EIS. DOE inventories could provide some HALEU for advanced reactor developers, but this would not stimulate commercial development of a domestic HALEU production capability nor meet all near-term HALEU needs. Therefore, DOE blend down of HEU to HALEU was not analyzed in detail in the HALEU EIS.

The DOE regulations for compliance with NEPA state that "DOE shall prepare a supplemental [environmental impact statement (EIS)] if there are substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns" (10 CFR § 1021.314(a)). 10 CFR § 1021.314(c), directs that, “[w]hen it is unclear whether or not an EIS supplement is required, DOE shall prepare a Supplement Analysis” to assist in making that determination. This Supplement Analysis (SA) summarizes relevant NEPA reviews and evaluates the potential environmental effects of blending down HEU to HALEU at H-Area at SRS and transporting the HALEU to commercial facilities. This SA will assist DOE in determining if a Supplemental EIS or a new EIS is required.

1.1 Spent Nuclear Fuel Processing in H-Canyon

As described in the *Future of H-Canyon Operations and Management Options for Spent Nuclear Fuel and Nuclear Material at the Savannah River Site, Analysis of Alternatives* (DOE, 2019), H-Canyon was constructed during the early 1950s and became operational in 1955 as a back-up capability to F-Canyon, which was an almost identical facility constructed simultaneously with H-Canyon. F-Canyon has been deactivated, and H-Canyon is currently the only operating production-scale, nuclear chemical separation facility in the United States. When originally constructed, the mission for both F- and H-Canyons was to dissolve aluminum spent nuclear fuel (ASNF) and targets to separate plutonium-239 for nuclear weapons applications. Subsequently, the Plutonium Uranium Extraction process within H-Canyon was modified to more effectively recover U-235, essentially separating the plutonium and uranium missions between F-Canyon and H-Canyon, respectively. Since that time, the H-Canyon mission has changed multiple times, driving modifications to process equipment, chemistry, and capabilities. While the original dissolution system included only the capability to process ASNF and targets using nitric acid, the versatility of H-Canyon allowed introduction of an electrolytic dissolver, such that stainless steel and zircaloy-clad SNF (non-aluminum spent nuclear fuel [NASNF]) could also be processed.

More recently, the mission for H-Canyon primarily focused on conventional processing or processing of ASNF and other nuclear materials of U.S. origin[1] that were subsequently blended down with natural uranium, to produce a low-enriched, uranyl nitrate liquid product (i.e., uranyl nitrate liquid that is 4.95 percent U-235). Figure 1-1 provides a simplified flowchart showing conventional processing with uranium recovery at H-Canyon. The steps in the conventional processing flowchart are described in the following paragraphs. This description is from Appendix A of the *Savannah River Site Spent Nuclear Fuel Management Environmental Impact Statement* (DOE, 2000a) (hereafter referred to as the SRS SNF EIS), modified to reflect recent conditions.

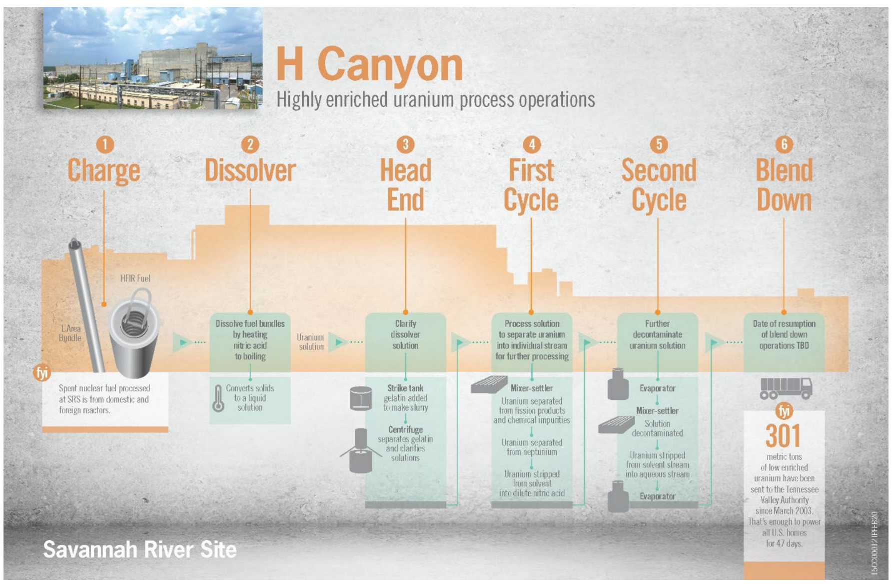


Figure 1-1. Flowchart for Conventional Processing of Spent Nuclear Fuel in H-Canyon

The start of Conventional Processing would begin with removing SNF from L-Basin and placing it in a cask for rail transport to H-Canyon. Inside the airlock doors to the hot canyon, the SNF was unloaded and placed in lag storage to await processing or fed into the top of a dissolver tank. The SNF was then dissolved in hot nitric acid, producing a solution of uranium, fission products, aluminum, and small amounts of transuranic materials, such as neptunium and plutonium.

Head-end processing used two clarification steps to remove undesirable contaminants that could impede the subsequent solvent extraction process. Gelatin was added to precipitate silica and other impurities. The clarified solution was adjusted with nitric acid and water in preparation for the first-cycle solvent extraction. The waste stream generated from the head-end process was chemically neutralized and sent

[1] This includes the Canadian HEU target residue material solutions, as described in the *Supplement Analysis for the Savannah River Site Spent Nuclear Fuel Management Environmental Impact Statement* (DOE, 2013) (DOE/EIS-0279-SA-01 and DOE/EIS-0218-SA-06).

to the storage tanks.

The first-cycle solvent extraction in the hot canyon removed the fission products and other impurities and then separated the uranium from the other actinides. If necessary, a second-cycle solvent extraction was used to further purify the uranium solution. The solvent was recovered for reuse, the acid solution containing the fission products was neutralized and transferred to the storage tanks, and the uranium in a uranyl nitrate solution was transferred to H-Area tanks to be blended down to about 5 percent U-235 (LEU). This LEU was transported to commercial fuel fabricators where it was converted to fuel for use in the TVA commercial nuclear power plants.[2]

1.2 HEU Blend Down

Blend down of the HEU would be performed at the A Line of H-Area. The A Line consists of a series of stainless-steel storage and loading tanks, pumps, piping, valves, associated instrumentation and other equipment by which uranyl nitrate solutions are transferred, mixed, and stored (Figure 1-2 and Figure 1-3). The A Line was previously modified to blend down HEU into LEU for use in commercial light water reactors. This modification followed the publication of the Finding of No Significant Impact (FONSI) for the *Environmental Assessment for the Construction and Operation of the Highly Enriched Uranium Blend-Down Facilities at the Savannah River Site* (DOE, 2000b)[3] (hereafter referred to as the HEU Facilities EA) published in November of 2000. Operations of the A Line for blending down for commercial reactor LEU fuel continued through 2011. SRS produced 301 MT of LEU for use in TVA reactors by blending down HEU in the form of uranyl nitrate between 2003 and 2011 (Bates, 2020). The facility has not been operated since.

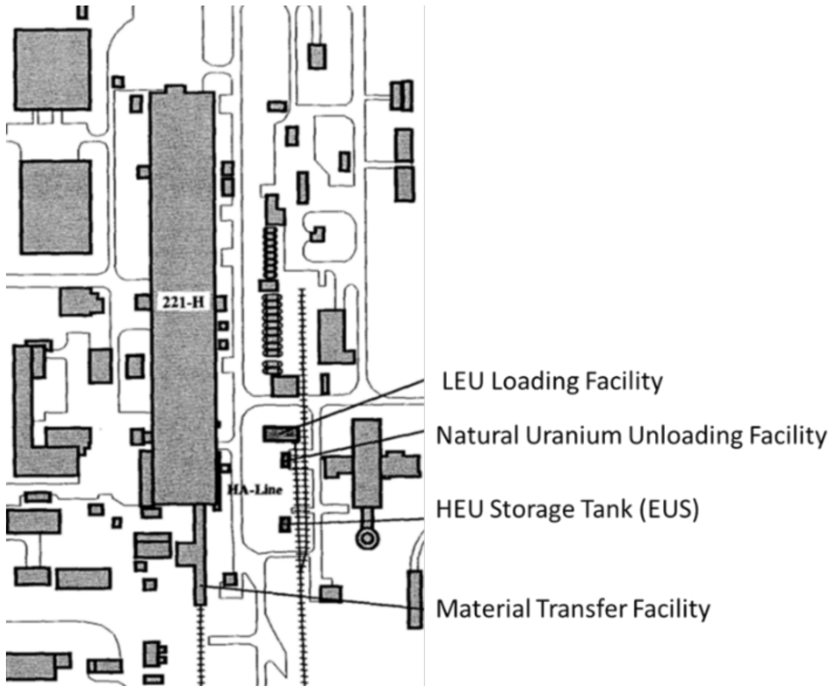
Because the facility has not operated since 2011, several steps would be taken to restart the A Line and assure it could be operated safely for the production of HALEU versus LEU. The activities associated with the restart of H-Canyon outside facilities for blend down operations include:

- Inspection and repair of systems;
- Training of operators;
- Revision of procedures[4];
- Readiness Assessment to begin operations; and
- Start-up testing (cold runs) (Bentley, 2022).

[2] The contract to supply LEU to the TVA was subsequently canceled.

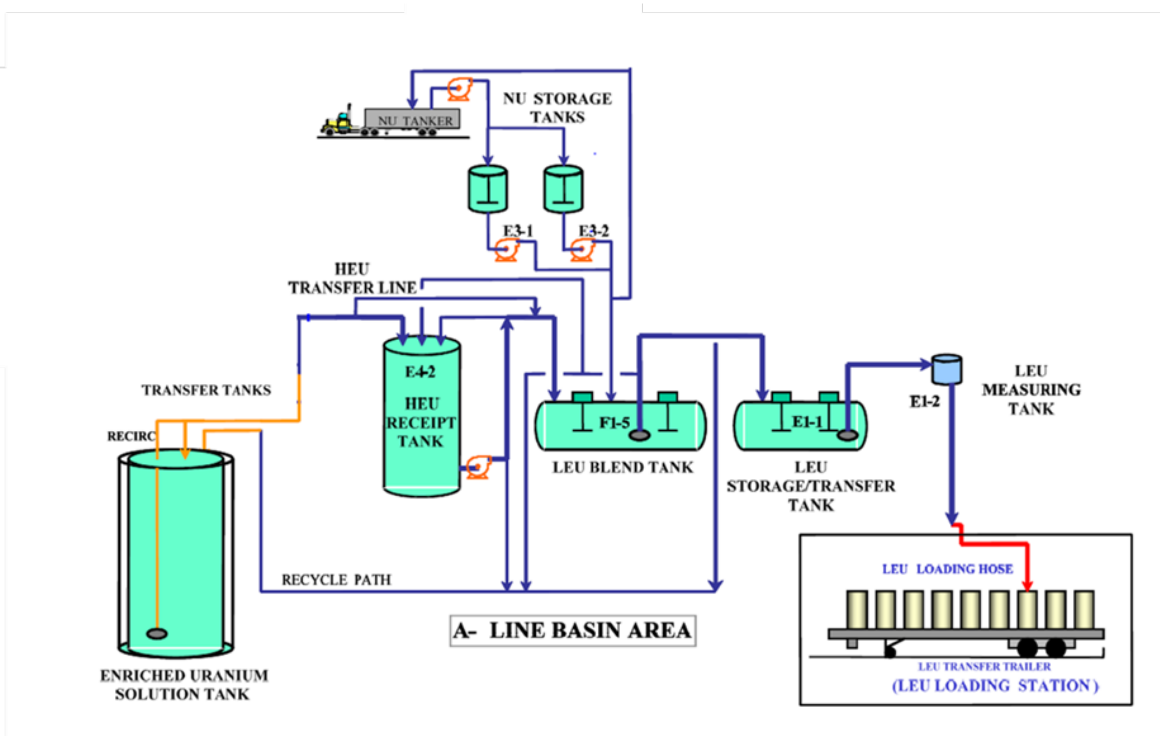
[3] This EA addressed facility modifications to allow the blend down of HEU to LEU and facility operation for LEU production.

[4] One of the key aspects of both training operators and revising procedures will be the treatment of criticality control addressing the stricter requirements associated with producing and packaging for transport of HALEU versus LEU.



Source: Adapted from (DOE, 2000b)

Figure 1-2. Highly Enriched Uranium Blend Down Facilities at H-Area



Source: Adapted from (SRS, 2011)

Figure 1-3. H-Area A Line

Blending down the HEU requires natural uranium in addition to the HEU. The natural uranium is used to blend down the HEU to about 19.7 5 weight percent U-235 HALEU. Natural uranium (0.711 percent U-235) in the form of liquid uranyl nitrate to support the HEU Blend Down Project is available onsite and would be temporarily stored in A Line natural uranium storage tanks (Tanks E3-1 and E3-2). HEU solution is stored in either the HEU Receipt Tank (E4-2) or the Enriched Uranium Storage tank until it is required for blending. The HEU solution in Tank E4-2 is transferred to the LEU Blend Tank (F1-5) for blending as required. Natural uranium solution in Tanks E3-1 or E3-2 is also transferred to Tank F1-5 to be blended (SRS, 2007).

Once blended, the uranium nitrate solution (DOE, 2007) is transferred from the LEU blend tank to the LEU storage/transfer tank (E1-1) and subsequently to the LEU measuring tank (E1-2). These LEU tanks would be used for HALEU. The HALEU would be transferred from the measuring tank to the shipping containers (already loaded on the transport truck) when shipping containers are available, and the fuel fabrication facility is ready to receive a shipment. The HALEU would not be transferred to shipping containers for temporary storage at SRS (SRS, 2007).

Only the transfer of solutions from tank E4-2 to F1-5, and from the natural uranium storage tanks (E3-1 and E3-2), require the solutions to be pumped. All other transfers are fed by gravity.

The *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE, 1996) (hereafter referred to as the HEU EIS), estimated the capacity for SRS blend down operations to be as high as 37 MT per year (MT/yr) of HEU although the HEU EIS analyzed processing 10 MT/yr of HEU in the H-Area facilities (DOE, 1996). A production rate for HALEU of between 1 and 1.5 MT/yr was quoted in another document (Bates, 2020). The 1 to 1.5 MT/yr production rate considers other factors (e.g., shipment constraints, fuel fabrication facility capabilities).

1.3 Shipment of HALEU Product

Shipping containers suitable for HALEU would need to be certified. While certification of shipping containers is not a part of this SA, it could affect the shipment campaign and possible public and worker health effects from transporting the HALEU. While there are shipping containers capable of being used to transport HEU, these containers would impose limitations on the shipment of HALEU (primarily resulting in an ability to ship small quantities of HALEU in one package and in a single shipment) that may not be desirable for shipments of multiple MT of HALEU to commercial fuel fabrication facilities.

It is anticipated that a version of the Liqui-Rad (LR) container would be used in support of this effort. The current certificate for this container authorizes its use for uranium solutions with a maximum enrichment of 5 percent U-235. Design and certification of this container, or a modified version capable of transporting HALEU is being pursued. This container is capable of holding 230 gallons of HALEU nitrate solution with 9 containers per truck shipment. Shipment by rail is not anticipated and therefore, was not analyzed.

2 Purpose and Need and Supplemental Proposed Action

The purpose and need are described in Section 2.1, and a description of the Supplemental Proposed Action (hereinafter referred to as the Proposed Action) is provided in Section 2.2. A comparison of the Proposed Action to activities evaluated in the HEU EIS, HEU Facilities EA, and SRS SNF EIS, is presented in Section 4.

2.1 Purpose and Need

The Purpose and Need, as stated in Section 1.2 of the 1996 HEU EIS (DOE, 1996):

The Department of Energy proposes to blend down surplus HEU from the weapons program to LEU to eliminate the risk of diversion for nuclear proliferation purposes and, where practical, to reuse the resulting LEU in peaceful, beneficial ways that recover its commercial value. The purpose of the proposed action is to reduce the threat of nuclear weapons proliferation worldwide in an environmentally safe manner by reducing stockpiles of weapons-usable fissile materials, setting a nonproliferation example for other nations, and allowing peaceful, beneficial reuse of the material to the extent practical.

Comprehensive disposition actions are needed to ensure that surplus HEU is converted to proliferation-resistant forms consistent with the objectives of the President's nonproliferation policy. These proposed actions would essentially eliminate the potential for reuse of the material in nuclear weapons and would demonstrate the U.S. commitment to dispose of surplus HEU and encourage other nations to take similar actions toward reducing stockpiles of surplus HEU. The proposed actions would begin to reduce DOE's HEU inventory and costs associated with storage, accountability, and security rather than depending upon indefinite storage of all such material.

The objectives of the Purpose and Need remain valid for the Supplemental Proposed Action, as described below.

2.2 Supplemental Proposed Action

HALEU fuels are being developed to support the replacement of HEU fuels used in U.S. High-Performance Research Reactors as well as advanced nuclear power reactor designs. The projected demand for HALEU far exceeds the current supply. The current inventory of HEU solution in storage in H-Area can be blended down to HALEU, which could help satisfy the nation's needs until other commercial initiatives can begin HALEU production. For several decades, the H-Area facilities at SRS have processed SNF to produce 4.95 percent U-235 LEU for the TVA's commercial power reactor market. The production of LEU in H-Area can be readily transitioned to HALEU production. The effects of such a change must be evaluated in accordance with NEPA.

DOE proposed to blend down approximately 2.2 MT of HEU to produce approximately 3.1 MT of HALEU enriched to 19.75 percent U-235[5] at H-Area at SRS. DOE anticipates this activity would begin as early as 2025 and continue for approximately 2 to 4 years, consistent with program and policy priorities, and funding. When blended down, the resulting HALEU would meet reactor fuel production criteria limiting the amount of impurities (other elements and isotopes) in the fuel. Therefore, no further refinement of the HALEU would be required. DOE will transport the HALEU liquid to an offsite commercial vendor for fabrication into reactor fuel for use in nuclear reactors.

3 Related NEPA Documents

All NEPA documents and associated Records of Decision (RODs) related to the Proposed Action were reviewed. These documents are listed below and described in more detail hereafter.

- HEU EIS, DOE/EIS-0240, June 1996
- ROD for the HEU EIS (61 Federal Register [FR] 40619), August 5, 1996
- SRS SNF EIS, DOE/EIS-0279, March 2000

[5] This SA assumes that HEU would be blended down to 19.75 percent U-235 HALEU. The 19.75 percent enrichment would bound the environmental effects of lower enrichment levels for most resource areas. Section 5.6 of this SA evaluates the environmental effects of blending down to lower enrichment levels.

- ROD for the SRS SNF EIS (65 FR 48224), August 7, 2000
- HEU Facilities EA, DOE/EA-1322, November 2000
- FONSI for HEU Facilities EA, DOE/EA-1322, November 3, 2000
- *Supplement Analysis - Disposition of Surplus Highly Enriched Uranium*, DOE/EIS-0240-SA1, October 2007
- Amended ROD for the HEU EIS (76 FR 51358), August 18, 2011
- *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* – revision to change processing of 3.3 metric tons of heavy metal (MTHM) al fuel from melt and dilute to conventional processing, DOE/EIS-0279-SA-01 and DOE/EIS-0218-SA-06, March 2013
- Amended ROD for the SRS SNF EIS (78 FR 20625), April 5, 2013
- *Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin De-inventory Mission for H-Canyon at the Savannah River Site*, DOE/EIS-0279-SA-07, March 2022
- Amended ROD for the SRS SNF EIS (87 FR 23504), April 19, 2022

HEU EIS (DOE/EIS-0240) (ROD 8/5/1996) – In the HEU EIS, DOE proposed to blend down surplus HEU from the weapons program to LEU to eliminate the risk of diversion for nuclear proliferation purposes and, where practical, to reuse the resulting LEU in peaceful, beneficial ways that recover its commercial value. This EIS assessed the disposition of a nominal 200 MT of surplus HEU. This surplus HEU included materials with enrichment levels of 20 percent or greater by weight of the isotope U-235.[6] DOE's inventory of surplus HEU consists of a variety of chemical, isotopic, and physical forms. A portion of the surplus HEU is in the form of irradiated fuel (SNF). There are no current or anticipated DOE plans to process irradiated fuel solely for the purposes of extracting HEU. However, activities associated with the irradiated fuel for purposes of stabilization; facility cleanup; treatment; waste management; safe disposal; or environment, safety, and health reasons could result in the separation of HEU in weapons-usable form that could pose a proliferation threat and thus be within the scope of the HEU EIS. Under the HEU EIS Preferred Alternative, DOE would recycle any such recovered HEU and blend it to LEU.

The Preferred Alternative was to blend the material for sale as LEU and use over time in commercial nuclear reactor fuel to recover its economic value. Material that could not be economically recovered would be blended to LEU for disposal as low-level radioactive waste (LLW). Both 4 percent LEU in the form of commercial SNF and 0.9 percent LEU oxide for disposal as LLW—and any allocation between them—fully serve the nonproliferation objective.

The HEU EIS analyzed four alternatives that represented different proportions of the resulting LEU being used in commercial reactor fuel or disposed of as waste. The Preferred Alternative was Alternative 5, the Maximum Commercial Use Alternative, which represented blending about 85 percent of the material to fuel (170 MT) and about 15 percent (30 MT) of the material to LLW. Maximum commercial use would reduce the amount of blending that would be required for disposition (a 14 to 1 blending ratio of blendstock to HEU[7] as opposed to 70 to 1 for waste) and minimize U.S. Government waste disposal costs that would be incurred if all (or a greater portion) of the material were blended to waste. It analyzed the blending of HEU using three different processes at four potential sites, including SRS. Three blending technologies are analyzed, including uranyl nitrate hexahydrate (UNH) blending. The transportation of UNH is also analyzed.

[6] The analysis of impacts in the HEU EIS assumes an average U-235 enrichment of 50 percent.
[7] The 14 to 1 blending ratio assumes the HEU is 50 percent U-235 and it is blended with natural uranium.

At SRS, blending down HEU to LEU would be done in the H-Area, using a blending tank. Blending could theoretically occur at a rate of 37 MT/yr of HEU for UNH blending of 50 percent assay HEU to 4 percent assay LEU or 7.5 MT/yr to 0.9 percent assay LEU (both canyons, all dissolvers). The analysis in the HEU EIS assumed an HEU throughput of 10 MT/yr[8] with an average starting U-235 enrichment of 50 percent HEU blended to a final enrichment of 4 percent U-235 LEU.

Figure 3-1 shows the activities evaluated in the HEU EIS, which include many that would not be required under the Proposed Action evaluated in this SA. The HEU would not need to be size reduced, oxidized, dissolved, or purified. Natural uranium would not need to be dissolved. Under the Proposed Action evaluated in this SA, the HEU and natural uranium solutions would need to be blended, and then the solution piped into the transportation containers for shipment to the commercial sites for fabrication into reactor fuel. Denitrification and drying of HALEU solution to produce uranyl nitrate crystals would also not be needed. In addition, less natural uranium would be needed to blend the HEU down to HALEU than would be needed to blend down to LEU. Therefore, the Proposed Action evaluated in this SA would require much less effort and resources, and have far fewer environmental effects than the activities evaluated in the HEU EIS.

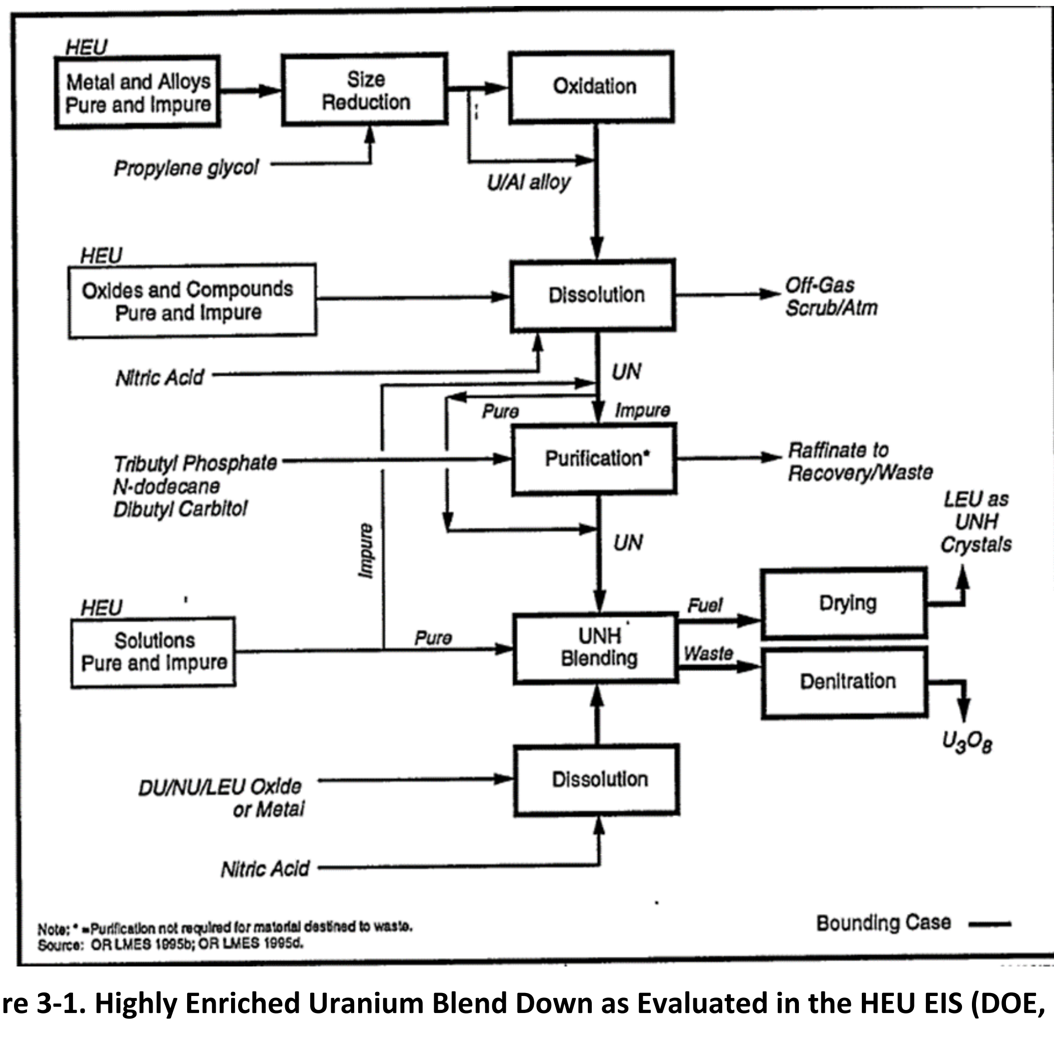


Figure 3-1. Highly Enriched Uranium Blend Down as Evaluated in the HEU EIS (DOE, 1996)

[8] The EIS stated that DOE anticipates providing 8 MT of HEU per year for blending down. The analyses conservatively assumed 10 MT of HEU per year.

In the ROD for the HEU EIS (61 FR 40619, August 5, 1996), DOE decided to implement a program to make surplus HEU non-weapons usable by blending it down to LEU, as specified in the Preferred Alternative. This implementation involved gradually blending up to 85 percent of the surplus HEU to a U-235 enrichment level of approximately 4 percent for eventual sale and commercial use over time as reactor fuel feed and blending the remaining surplus HEU down to an enrichment level of about 0.9 percent for disposal as LLW. This would take place over an estimated 15- to 20-year period.

In 2007, DOE prepared the *Supplement Analysis - Disposition of Surplus Highly Enriched Uranium* (DOE/EIS-0240-SA1) (hereafter referred to as the 2007 SA) (DOE, 2007) to determine if certain changes in the HEU disposition program required additional NEPA review. DOE proposed new end users for existing program material, proposed new disposition pathways for certain HEU, and proposed blending down of additional HEU. The new end users and disposition pathways would not affect SRS operations. Under the proposed blending down of additional HEU, DOE considered blending down approximately 10 MTs of HEU from domestic and foreign research reactor returns. The vast majority of these 10 MTs of HEU would be processed and blending down at SRS. In the 2007 SA, DOE also reviewed the blending down activities and quantities that had been evaluated in the HEU EIS. The 2007 SA found that the additional activities and amount of HEU DOE proposed to blend down at SRS would not substantially change the impacts analyzed in the HEU EIS or present significant new information relevant to environmental concerns, and that no further NEPA review was required.

In the Amended ROD for the HEU EIS (76 FR 51358, August 18, 2011), DOE decided to make the following changes to the HEU disposition program: (1) implement the American Assured Fuel Supply, including storage of LEU and, as needed, transportation of the LEU by ship across the ocean for use in foreign reactors; (2) dispose of certain HEU materials as LLW without prior blending down if the materials meet applicable waste acceptance criteria; and (3) increase the quantity of HEU available for blending down and continue blend down operations beyond the 20 years anticipated in the HEU EIS.

SRS SNF EIS (DOE/EIS-0279) (ROD 8/7/00, Amended ROD, April 5, 2013, Amended ROD, April 19, 2022) – Three documents related to the SRS SNF EIS were reviewed—the SRS SNF EIS itself (DOE/EIS-0279) along with two of the SAs: (1) DOE/EIS-0279-SA-01, DOE/EIS-0218-SA-06 - *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* – revision to change processing of 3.3 MTHM[9] ASNF from melt and dilute to conventional processing (March 2013), and (2) DOE/EIS-0279-SA-07 - *Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin De-inventory Mission for H-Canyon at the Savannah River Site* – revision to use the processing capabilities within H-Canyon to dissolve the SNF and immobilize the resulting liquid radioactive waste at the Defense Waste Processing Facility (March 2022).

The SRS SNF EIS considered an alternative (Maximum Impact Alternative) that processed 47.7 MTHM of ASNF through conventional processing at F- and H-Canyons over a period of up to 38 years of operation (almost 25 dissolver processing years, exclusive of downtime). In this technology, DOE would process SNF in the F- or H-Area Canyon. Because F-Canyon was scheduled to be shut down before all the fuel could be processed, and because F-Canyon was not suitable for HEU processing without modifications, H-Canyon also would be used. The process would chemically dissolve the fuel and separate fission products from the uranium by solvent extraction to produce a relatively pure and concentrated stream of uranyl nitrate, which would be stored in tanks. The uranium solution would be blended with depleted uranium as necessary, to bring the enrichment down to about 5 percent or less. Recovered uranium could be sold to a commercial producer of nuclear fuel.

Fuel types were identified that would be processed under the Maximum Impact Alternative: Group A –

[9] Quantities of unirradiated and spent nuclear fuel and targets are traditionally expressed in terms of MTHM (typically uranium) without the inclusion of other materials such as cladding, alloy materials, and structural materials.

uranium and thorium metals (mainly Experimental Breeder Reactor-II and Sodium Reactor Experiment material), Group B – material test reactor-like fuel, Group C – HEU/LEU oxides and silicides, and Group D – loose uranium oxide. Roughly 19 MTHM of this material, Experimental Breeder Reactor-II, and Sodium Reactor Experiment material, would be processed in F-canyon and the remainder, 28.7 MTHM, would be processed in H-Canyon. Options for NASNF in the EIS were continued storage and pack and ship to Idaho National Laboratory.

In the assessment of effects, the effects associated with the two facilities were not explicitly presented separately. However, some effects were presented by fuel group. Since the fuel being processed at F-Canyon comprised most of the fuel in Fuel Group A, these effects represent effects from operating that facility. The combined effects from processing Groups B through D are associated with H-Canyon operation. Effects were presented assuming only one dissolver was in operation at one time. But the statement is made that annual effect would double if two were used and the duration were effectively cut in half. Cumulative program total effects would not change.

Processing rates for metallic fuel and oxide fuel appear to be different based on the analysis in the SRS SNF EIS. F-Canyon processing of nearly 20 MTHM of metallic fuel requires a little over a year of facility operation. H-Canyon processing of 28 MTHM of other fuel types could take as long as 38 years.

In the ROD for the SRS SNF EIS (65 FR 48224, August 7, 2000), DOE decided to implement the Preferred Alternative identified in the EIS. As part of the Preferred Alternative, DOE was to develop and demonstrate the melt and dilute technology to manage about 97 percent by volume and 60 percent by mass of the aluminum-based SNF considered in the EIS (48 MTHM aluminum-based SNF). DOE also decided to use Conventional Processing (i.e., the existing canyons) to stabilize about 3 percent by volume and 40 percent by mass of the aluminum-based SNF.

The *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* (DOE/EIS-0279-SA-01, DOE/EIS-0218-SA-06) addresses switching the processing of 3.3 MTHM of ASNF from the melt and dilute process to conventional processing including blending down the resultant HEU to LEU for use in commercial nuclear reactor fuel. The quantities of HEU considered for recovery and blending down to LEU within this SA are subsumed within the quantities evaluated in the HEU EIS and 2007 SA for the HEU EIS. This SA also looked at adding a second dissolver to be used for ASNF processing. (A third was being dedicated to the processing of plutonium in support of surplus plutonium disposition.) The SA concluded that a second dissolver would bring the H-Canyon dissolution capacity to that evaluated in the SRS SNF EIS and that the effects of operating both dissolvers would not be significantly different from those reported in the SRS SNF EIS. This SA also added an intentional destruction acts evaluation, using the accident analysis of the SRS SNF EIS as a starting point for the assessment. In the Amended ROD (78 FR 20625, April 5, 2013), DOE decided to manage approximately 3.3 MTHM from the currently projected inventory of 22 MTHM at SRS using conventional processing at the H-Canyon facility at SRS, as described and evaluated under the Conventional Processing Alternative in the SRS SNF EIS. HEU recovered during conventional processing will be blended down to create LEU feedstock for fuel fabrication for commercial nuclear reactors. The HEU solution (approximately 2.2 MT of HEU) that would be blended down to HALEU under the Proposed Action is a portion of the 3.3 MTHM of material that was evaluated in the 2013 SRS SNF EIS SA (78 FR 20625, 2013).

The *Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin De-inventory Mission for H-Canyon at the Savannah River Site* (DOE/EIS-0279-SA-07) evaluated using the processing capabilities within H-Canyon to dissolve the SNF and immobilize the resulting liquid radioactive waste at the Defense Waste Processing Facility. The Proposed Action included processing about 29.2 MTHM SNF. If processed over 12 to 13 years, this equates to about 2.3 to 2.5 MTHM SNF per year. DOE concluded that the proposed change and new information was not a substantial change relative to the proposal analyzed in the SRS SNF EIS, and no further NEPA analysis was required. In the Amended ROD (87 FR 23504, April 20, 2022), DOE decided to manage approximately 29.2 MTHM of SNF and target materials (referred to collectively as SNF), using conventional processing without recovery of uranium at H-Canyon at SRS. The HEU solution (approximately 2.2 MT of HEU) that would be blended down to HALEU under the Proposed Action is a portion of the 29.2 MTHM of material that was evaluated in the 2022 SRS SNF EIS SA (87 FR 23504, 2022).

HEU Facilities EA (DOE/EA-1322), (FONSI 11/3/2000) – DOE and the TVA determined that it was technically feasible to convert off-specification HEU (approximately 60 percent U-235) to a less than 20 percent U-235 LEU product for use as commercial fuel in the TVA reactors. The purpose of the Proposed Action was to provide SRS with the onsite capability to purify, analyze, blend, and load the liquid uranyl nitrate into shipping containers for transport to an offsite commercial facility. The EA evaluated (1) construction of the LEU loading station; (2) upgrades to the SRS Central Analytical Laboratory modules in Buildings 772-F and 772-1F; (3) upgrades and added supplementary equipment to HA-Line, (4) upgrades to the railroad tunnel airlock material transfer station; and (5) upgrades to the fuel handling and shipping facilities in Building 105-K.

The upgrades and additions of equipment at HA-Line would involve changes in the U-235 existing process lines designed to blend down HEU to less than 20 percent LEU. These changes would be implemented at various points in the process from the existing 620,740-liter (164,000-gallon) HEU storage tank and natural uranium unloading station to the proposed LEU loading station. Based on conceptual design, these supplementary equipment additions would include installation of (1) five primary and eight secondary pumps to existing or proposed interim process line blending or storage tanks; (2) a natural uranium volume fine adjustment and batch controller; (3) a 15,140-liter (4,000-gallon) blend-grade HEU tank (and associated in-line sample unit); (4) an HEU isotopics fine adjustment and batch controller; and (5) in-line piping between the previously mentioned process components and the existing process equipment. All of these upgrades and additions would be implemented within existing facilities or developed locations within H-Area. The facilities would be operational for about 5 years.

The liquid uranyl nitrate solution would be shipped offsite to a TVA vendor facility for solidification (powdered form) to commercial enrichment levels. Shipping campaigns for uranyl nitrate would take place at 2-to-3-week intervals. The trucks carrying the shipping containers would be backed into the proposed facility. Each trailer would nominally contain nine shipping containers (U.S. Department of Transportation [DOT] Type B, Nuclear Regulatory Commission [NRC] licensed). The line from the blended LEU storage tank would lead into a header tank that would be sized to fill only one shipping container (i.e., approximately 250 gallons).

Based on the analyses in the Environmental Assessment (EA), DOE determined that the action was not a major Federal action significantly affecting the quality of the human environment within the meaning NEPA. Therefore, the preparation of an EIS was not required, and DOE issued a FONSI.

4 Comparison of Proposed Action to Activities Evaluated in Other NEPA Documents

This SA compares the Proposed Action primarily to the activities evaluated in the HEU EIS (DOE, 1996). This comparison was performed to determine whether the Proposed Action would result in a substantial change to the environmental consequences reported in the HEU EIS or if there were significant new circumstances or information relevant to environmental concerns related to the Proposed Action.

A portion of the HEU that was evaluated in the HEU EIS was from dissolution of SNF in H-Canyon at SRS and recovery of the U-235. That process (i.e., conventional processing including dissolving SNF and recovering the U-235) was evaluated in the SRS SNF EIS (DOE, 2000a) and subsequent SAs. Since the

Proposed Action (blending down HEU to HALEU) is most similar to the activities evaluated in the HEU EIS, it is the primary NEPA document relied on for the analyses in this SA.

The HEU solution (approximately 2.2 MT of HEU) that would be blended down to HALEU under the Proposed Action is a portion of the 3.3 MTHM of material that was analyzed in the *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* (DOE/EIS-0279-SA-01 and DOE/EIS-0218-SA-06, 2013) and authorized for conventional processing with HEU recovery and blending down to LEU as part of the Amended ROD to the SRS SNF EIS (78 FR 20625, April 5, 2013). As stated in the 2013 SRS SNF EIS SA, the quantities of HEU considered for recovery and blending down to LEU within that SA are subsumed within the quantities evaluated in the HEU EIS and 2007 SA for the HEU EIS.

The *Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin De-inventory Mission for H-Canyon at the Savannah River Site* (DOE/EIS-0279-SA-07, 2022) analyzed conventional processing for 29.2 MTHM of SNF, but instead of recovering the HEU, it would be sent to the SRS liquid high-level waste (HLW) management system for disposal at the Defense Waste Processing Facility and related facilities. The HEU solution (approximately 2.2 MT of HEU) that would be blended down to HALEU under the Proposed Action is also a portion of the 29.2 MTHM that was to be disposed of using the SRS liquid HLW system as decided in the Amended ROD for the SRS SNF EIS (87 FR 23504, April 19, 2022). Therefore, this SA also evaluates modifications to decisions made with respect to the SRS SNF EIS and subsequent SAs.

In addition, construction and operation of all the facilities needed to perform the blend down to LEU and shipment of the uranyl nitrate solution to offsite commercial facilities for further processing in fuel for commercial reactors was evaluated in the HEU Facilities EA (DOE, 2000b) and an associated FONSI was issued (DOE, 2000c). No additional construction is needed for the activities evaluated in this SA.

Alternatives considered in the three primary NEPA documents were reviewed to determine the types of materials considered, the total amount of HEU processed, and the maximum annual rate of processing. The review was not limited to the Proposed Action or Preferred Alternative analyzed in the NEPA documents, nor to the alternatives selected in the associated RODs. Table 4-1 summarizes the key results of review of the Proposed Action compared to HEU already processed at SRS and conventional processing evaluated in the HEU EIS and related documents.

Table 4-1. Comparison of the Proposed Action to NEPA Coverage for Highly Enriched Uranium Blend Down and the Amount of Highly Enriched Uranium Already Processed at Savannah River Site

Effects Indicator	*HEU EIS (DOE/EIS-0240)*	*HEU Blend-Down Facilities at SRS (DOE/EA-1322)*	*SRS SNF EIS (DOE/EIS-0279)*	*HEU Blend Down at SRS*	*Proposed Action*
Applicable Alternative	Maximum Commercial Use Alternative	Proposed Action	Maximum Conventional Processing	Not Applicable	Not Applicable
Total HEU Processed (MT)	170 (includes ~72 MT of SNF and other materials)	Not Provided	47.7 MTHM [a] in F- or H-Canyons; 28.7 MTHM [a] in H-Canyon	14.9 blended down between 2003 and 2011 [b]	2.2 [c]
Total HALEU (19.75% U-235) Produced (MT)	HALEU not analyzed	Not Provided	HALEU not analyzed	HALEU not produced	3.1
Total LEU (4 to 5% U-235) Produced (MT)	2,380 (assuming 1 to 14 ratio)	Not Provided	Not Provided	301 between 2003 and 2011 [d]	Not Applicable
Processing Duration (years)	21	5	38	9	2 to 4

Effects Indicator	*HEU EIS (DOE/EIS-0240)*	*HEU Blend-Down Facilities at SRS (DOE/EA-1322)*	*SRS SNF EIS (DOE/EIS-0279)*	*HEU Blend Down at SRS*	*Proposed Action*
Annual HEU Blended Down (MT)	10	Not Provided	1.3 MTHM [a]	1.6 [b]	0.5 to 1
Annual HALEU Produced (MT)	HALEU not analyzed	Not Provided	HALEU not analyzed	HALEU not produced	0.75 to 1.5
Annual LEU Produced (MT)	140 (assuming 1 to 14 ratio)	Not Provided	Not Provided	33 [d]	Not Applicable
Shipping Container	BU-7 for 4% UNH crystals	LR for <5% uranyl nitrate solution	Not Analyzed	LR for <5% uranyl nitrate solution	LR for <20% uranyl nitrate solution
Uranyl Nitrate Liquid in Shipping Container (gal)	Not Analyzed [e]	250 (less than 100 g U/L)	Not Analyzed	225	225
Number of Containers Needed	5,000 packages per year	Not Provided	Not Analyzed	3,045	126
Annual Shipments	70	Not Provided	Not Analyzed	38	4 to 7
Total Shipments	2,800	Not Provided	Not Analyzed	338	14
Number of Operations Workers	125	270	600 existing workers	10 [f]	10 existing workers

Key: % = percent; < = less than; DOE = U.S. Department of Energy; EA = Environmental Assessment; EIS = Environmental Impact Statement; g = gram; gal = gallons; HALEU = high-assay low-enriched uranium; HEU = highly enriched uranium; L = liter; LEU = low enriched uranium; LR = Liqui-Rad; MTHM = metric tons of heavy metal; MT = metric ton; SNF = spent nuclear fuel; SRS = Savannah River Site; U = uranium; U-235 = uranium-235; UNH = uranyl nitrate hexahydrate

[a] Quantities of unirradiated and spent nuclear fuel and targets are traditionally expressed in terms of metric tons of heavy metal (typically uranium) without the inclusion of other materials such as cladding, alloy materials, and structural materials.

[b] (Bentley, 2022), "High Assay Low Enriched Uranium (HALEU) Down-blend Project," Citizen Advisory Board, March 14.

[c] Assumes HEU is 27.5% enriched in U-235. Current volume of HEU liquid in storage in H-Area at SRS is 28,264 gal.

[d] (Bates, 2020), "HALEU Production at the Savannah River Site (SRS)," GAIN-EPRI-NEI HALEU Webinar, April 28–29.

[e] Table G.1-3 of HEU EIS indicates each package would have 43 kilograms of UNH (solid), and 40 packages per truck shipment.

[f] The number of workers for blending down HEU to LEU is estimated to be approximately 10. Additional workers (estimated at 600 workers in the SRS SNF EIS) were involved in past activities including dissolving and processing the SNF and recovering the HEU in H-Canyon.

As described above, the HEU EIS describes a blending ratio of 1 to 14 between HEU and LEU. The values quoted in Bates 2020 and Bentley 2022 imply a blending ratio of 1 to 20 for LEU. Depending upon the average enrichment of the HEU, the amount of HEU to produce 3.1 MT of HALEU is assumed to be 2.2 MT. In any event, this is a very small percentage of the 170 MT of HEU analyzed in the HEU EIS. It is also a very small percentage of the 14.9 MT of HEU blended down and the 301 MT of LEU produced at SRS between 2003 and 2011 (a span of 9 years).

Potential NEPA Coverage

No facility construction would be needed. Therefore, construction is not discussed in this document. Based on the above information, the reviewed NEPA documents appear to provide the following NEPA coverage for the Proposed Action:

- The total HEU that would be processed under the Proposed Action of 2.2 MT would be a small portion of the 170 MT of HEU evaluated for blending down in the HEU EIS. As described in the *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* (DOE, 2013), the quantities of HEU considered for recovery and blending down to LEU in the 2013 SNF SA are subsumed within the quantities evaluated in the HEU EIS (DOE, 1996) and 2007 SA (DOE, 2007) for the HEU EIS.

- The rate of HEU blend down under the Proposed Action of 0.5 to 1 MT/yr would be bounded by the 10 MT/yr rate of blend down evaluated in the HEU EIS.
- The duration of the HEU blend down and packaging for offsite shipment under the Proposed Action of 2 to 4 years would be within the durations evaluated in the primary comparison NEPA documents (21 and 5 years).
- The number of HALEU containers needed under the Proposed Action of 126 would be within the 5,000 containers evaluated in the HEU EIS.
- The total number of HALEU shipments needed under the Proposed Action of 14 would be within the 2,800 shipments evaluated in the HEU EIS.
- The total number of employees needed under the Proposed Action of 10 would be a small fraction of the 125 employees evaluated in the HEU EIS. This is largely because the activities performed under the Proposed Action evaluated in this SA would be a small subset of the activities evaluated in the HEU EIS (see Figure 3-1).

The activities in H-Area Facilities to blend down existing HEU solutions and package for shipment offsite to commercial facilities under the Proposed Action would be similar to or less than the activities to blend down HEU to LEU, in H-Area facilities, as evaluated in the HEU EIS (DOE, 1996). Figure 3-1 shows that blending down HEU solutions and packaging for shipment offsite to commercial facilities are only a few steps in the HEU blending process evaluated in the HEU EIS. These few steps would be responsible for only a small portion of the total environmental effects. Therefore, the analyses in the HEU EIS would generally bound the effects of the Proposed Action.

5 Comparison of Environmental Consequences

The Proposed Action would be implemented in existing facilities at SRS. There would be no construction nor land disturbance under the Proposed Action. Therefore, construction effects are not discussed further. In addition, the administrative, maintenance, and testing activities associated with A-line restart (see Section 1.2), would have no effect on the impacts described below. Therefore, restart effects are not discussed further.

The Proposed Action would not send the 2.2 MT of HEU to the SRS liquid HLW management system for disposal as evaluated in the *Supplement Analysis for the Spent Nuclear Fuel Accelerated Basin De-inventory Mission for H-Canyon at the Savannah River Site* (DOE/EIS-0279-SA-07, 2022) and as decided in the Amended ROD for the SRS SNF EIS (87 FR 23504, April 19, 2022). The 2.2 MT of HEU is approximately 8 percent of the additional 29.2 MTHM analyzed in the 2022 SRS SNF EIS SA. Changing the disposition method for the 2.2 MT of HEU would result in the generation of approximately 192,000 fewer gallons of liquid radioactive waste and approximately 40 fewer HLW glass canisters. Therefore, the environmental effects of that action would be less than those evaluated in the 2022 SRS SNF EIS SA and are not discussed further.

This SA evaluates the environmental resource areas that were considered in the HEU EIS and adds analyses for resource areas/topics required by new laws, regulations, or guidance. Table 5-1 describes any new circumstances or information relevant to environmental concerns and the potential effects on each resource area. The analysis in the table relies on the most comprehensive recent NEPA document prepared for SRS, the *Final Environmental Impact Statement for the Surplus Plutonium Disposition Program* (hereafter referred to as the SPDP EIS) (DOE, 2023).

Table 5-1. New Circumstances or Information Relevant to Environmental Concerns and Effects of the Proposed Action

Resource Area	*New Circumstances or Information Relevant to Environmental Concerns*	*Effect of the Proposed Action* [a]
Land Resources	Based on the description of the affected environment in Chapter 3, Section 3.3.1 of the SPDP EIS (DOE, 2023)[b], there are no significant new circumstances or information relevant to environmental concerns for land resources.	Operation of H-Area facilities under the Proposed Action would not disturb any land or change any uses of the land. Therefore, the effects of the Proposed Action on land use would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Geology and Soils	Based on the description of the affected environment in Chapter 3, Section 3.3.2 of the SPDP EIS, there are no significant new circumstances or information relevant to environmental concerns for geology and soils.	Operation of H-Area facilities under the Proposed Action would not disturb any land and would not use any geologic or soils resources. Therefore, the effects of the Proposed Action on geology and soils would be similar to or less than, the effects described in the HEU EIS and are not discussed further.
Water Resources	Water use at SRS was 9.6 million gal per day in the HEU EIS (DOE, 1996) and was 2.51 million gal per day as reported in the SPDP EIS (DOE, 2023). The difference in water use is likely due to water conservation measures, fewer activities at SRS, and fewer employees at SRS (see Socioeconomics). Based on the description of the affected environment in Chapter 3, Section 3.3.3 of the SPDP EIS (DOE, 2023), there are no significant new circumstances or information relevant to environmental concerns for water resources.	Operation of H-Area facilities under the Proposed Action would not disturb any land, and annual water use and effluent discharge would be similar or less than evaluated in the HEU EIS, and H-Area is not in a floodplain. Therefore, the effects of the Proposed Action on water resources would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Air Quality and Noise	The HEU EIS (DOE, 1996) described areas around SRS as being in compliance with all National Ambient Air Quality Standards for criteria pollutants. As of 2023, the areas around SRS were still in attainment for all criteria pollutants (DOE, 2023). Based on the description of the affected environment in Chapter 3, Section 3.3.4 of the SPDP EIS (DOE, 2023), there are no significant new circumstances or information relevant to environmental concerns for meteorology, air quality, and noise.	Operation of the H-Area facilities under the Proposed Action would not disturb any land, and annual air emissions would be similar to or less than those evaluated in the HEU EIS (including GHGs). Therefore, the effects of the Proposed Action on air quality and noise would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Biotic Resources	The HEU EIS (DOE, 1996), stated that F- and H-Areas contain no habitat for any of the Federally listed threatened or endangered species found on SRS. Red-cockaded woodpeckers nest in old growth pine trees, and there are no suitable nesting sites in the vicinity of F- or H-Area. Smooth coneflower also is not found in F- or H-Area. The SPDP EIS (DOE, 2023) stated that F-Area (like H-Area) is a highly developed and industrialized landscape near the center of the site. Forty-two wildlife species are documented as occurring near H-Area. However, the area contains no native vegetation and only small patches of grass lawns, and it is unlikely that wildlife would be present in it. Based on the description of the affected environment in Chapter 3, Section 3.3.6 of the SPDP EIS (DOE, 2023), there are no significant new circumstances or information relevant to environmental concerns for biotic resources.	Operation of H-Area facilities under the Proposed Action would not disturb any land. As discussed elsewhere in this table, annual effects to other resources that may affect biotic resources (e.g., water effluents, air emissions, noise) would be similar to, or less than, the effects on biotic resources described in the HEU EIS. Therefore, the effects of the Proposed Action on biotic resources would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.

Resource Area	***New Circumstances or Information Relevant to Environmental Concerns***	***Effect of the Proposed Action [a]***
Socioeconomics	The population in the six-county region of influence (ROI) was 453,824 (1992) in the HEU EIS (DOE, 1996) and was 548,892 (2021) in a 4-county ROI as reported in the SPDP EIS (DOE, 2023). Employment in the 6-county ROI was 248,239 (1990) in the HEU EIS and was 239,114 (2022) in a 4-county ROI as reported in the SPDP EIS. The number of SRS employees was 19,208 (1992) in the HEU EIS and was 10,943 (2022) as reported in the SPDP EIS. The differences in population and ROI employment are likely related to differences in the six-county versus four-county ROI, as modified by population growth during that period.	Operation of H-Area facilities under the Proposed Action would not require any additional employment over current levels and would require 10 employees, much less than the 125 employees evaluated in the HEU EIS. Therefore, the effects of the Proposed Action on socioeconomics would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Cultural Resources	Based on the description of the affected environment in Chapter 3, Section 3.3.8 of the SPDP EIS (DOE, 2023), there are no significant new circumstances or information relevant to environmental concerns for cultural and paleontological resources.	Operation of H-Area facilities under the Proposed Action would not disturb any land or cultural resources. Therefore, the effects of the Proposed Action on cultural resources would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Public and Occupational Health	The projected population in the 50-mile SRS ROI was 710,000 (2010) as reported in the HEU EIS (DOE, 1996) and was 781,060 (2017–2018) and a projected 2030 population of 862,927 as reported in the Pit Production EIS (DOE, 2020). The dose conversion factors were 0.0005 latent cancer fatality (LCF) per person-rem for the general public, 0.0004 LCF per person-rem for workers in the HEU EIS and is now 0.0006 LCF per person-rem for both workers and the public as reported in the SPDP EIS (DOE, 2023).	Effects to human health for normal operations, accidents, and intentional destructive acts, are discussed in more detail in Sections 5.1 and 5.2.
Waste Management	The HEU EIS listed the 1993 generation of solid LLW, MLLW, and hazardous waste at SRS as 14,100 m^3, 18 m^3, and 74 m^3, respectively (DOE, 1996). The SPDP EIS listed the annual generation of LLW, MLLW, and hazardous waste at SRS as 10,000 m^3, 400 m^3, and 58 m^3, respectively (DOE, 2023). Although the annual waste generation rates are somewhat different, the infrastructure at SRS is sized to manage the current waste generation.	Operation of H-Area facilities under the Proposed Action would produce similar waste streams and similar or less annual volumes as evaluated in the HEU EIS. The point of generation for the waste streams would not change. Therefore, the annual effects of the Proposed Action on waste management would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.
Transportation	The Proposed Action would result in about 14 shipments of HALEU containers (Table 4-1). A total of 2,800 LEU shipments were analyzed in the HEU EIS (DOE, 1996) and a total of 338 LEU shipments were previously conducted (Table 4-1). The LEU shipments in the HEU EIS were analyzed as crystalline (solid) uranyl nitrate while the shipments of LEU previously made and the HALEU shipments under the Proposed Action would be uranyl nitrate solution (liquid).	Operation of H-Area facilities under the Proposed Action would not require any additional employment over current levels and would have lower levels of transportation as evaluated in the HEU EIS. The LEU previously analyzed in the HEU EIS was a uranyl nitrate solid while the Proposed Action would ship HALEU nitrate liquid[c]. Therefore, the transportation of HALEU to a commercial facility is evaluated in more detail in Section 5.3.

Resource Area	New Circumstances or Information Relevant to Environmental Concerns	Effect of the Proposed Action [a]
Site Infrastructure	Annual SRS ground water usage was 3,500 million gal as reported in the HEU EIS (DOE, 1996) and was 288 million gal as reported in the SPDP EIS (DOE, 2023). Annual SRS electricity usage was 659,000 MWh as reported in the HEU EIS and was 320,000 MWh as reported in the SPDP EIS. The differences in utility use are likely due to conservation measures, fewer activities at SRS, and fewer employees at SRS (see Socioeconomics). Based on the description of the affected environment in Chapter 3, Section 3.3.10 of the SPDP EIS, there are no significant new circumstances or information relevant to environmental concerns for infrastructure	Operation of H-Area facilities under the Proposed Action would require similar or less annual utility use as evaluated in the HEU EIS. Therefore, the annual effects of the Proposed Action on site infrastructure would be similar to, or less than, the effects described in the HEU EIS and are not discussed further.

Key: EIS = Environmental Impact Statement; ft = feet; gal = gallons; GHGs = greenhouse gases; HEU = high enriched uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; m^3 = cubic meters; MLLW = mixed low-level radioactive waste; MWh = megawatt-hours; NEPA = National Environmental Policy Act; rem = roentgen equivalent man; ROI = region of influence; SNF = spent nuclear fuel; SPDP EIS = *Final Environmental Impact Statement for the Surplus Plutonium Disposition Program*; SRS = Savannah River Site; TRU = transuranic

[a] As described in the introduction to Section 4, there would be no construction and no land disturbance required under the Proposed Action. Therefore, construction effects are not discussed further.

[b] The SPDP EIS (DOE, 2023) is the most recent major NEPA document prepared for SRS and includes an evaluation of the affected environment at SRS as well as an analysis of cumulative effects, including the management of SNF.

[c] In the HEU Facilities EA (DOE, 2000b) DOE analyzed offsite shipment of LEU as uranyl nitrate solution (liquid) in the same container and configuration as proposed for the HALEU shipments, although the EA does not specify the amount of HEU blended down, the amount of LEU produced, nor how many shipments would be made.

Because blend down of 170 MT of HEU to LEU already has NEPA coverage, the 2.2 MT of HEU evaluated in this SA is a portion of the 170 MT of HEU already evaluated and blend down of 2.2 MT of HEU to HALEU instead of LEU would be less effort, the environmental effects of blending down to HALEU are largely covered in the HEU EIS. As described in Table 5-1, the resource areas that were evaluated in the HEU EIS, but require further review and discussion in this SA, are (1) public and occupational health – normal operations, (2) public and occupational health – facility accidents and intentional destructive acts, and (3) transportation. These resource areas are addressed below.

The commercial facilities that receive the shipments of HALEU are, or would be, licensed to operate by the NRC or an Agreement State. The effects of activities at the commercial facility (or facilities) would be within the operating envelop for the facility (or facilities) as evaluated in environmental documentation, licenses, and permits. The effects of operations at these facilities are outside the scope of DOE's Proposed Action.

5.1 Public and Occupational Health – Normal Operations

In the HEU EIS (DOE, 1996), DOE estimated radiation doses and effects (in terms of latent cancer fatalities [LCFs] to workers and the public) from options for the disposition of surplus HEU by several means including blending down the HEU to LEU suitable for use in commercial reactors. Worker doses (to both involved and non-involved workers) were estimated to be less than the SRS administrative limit of 500 millirem (mrem) per year, resulting in no LCFs on an annual basis. Over the life of the disposition of surplus HEU campaign (for the processing of 200 MT of HEU, DOE estimated that operations would result in no LCFs). In addition, DOE estimated in the HEU EIS that the small radiation doses to the public would result in no LCFs in the population surrounding SRS, and the maximum exposed individual (at the nearest SRS boundary) would have a less than one-in-one-million chance of developing an LCF.

The human health analyses have been updated to incorporate more recent population projections and updated dose conversion factors. In addition, this section evaluates the differences in material release source terms representative of the material being processed in this HEU to HALEU conversion and the different processing rates (and total quantities) in the two campaigns.

Overall, four items were considered in assessing differences between the Maximum Commercial Use Alternative of the HEU EIS (the production of fuel from 170 MT of HEU and waste from 30 MT of HEU) and the Proposed Action (the processing of 2.2 MT of HEU and the production of approximately 3.1 MT[10] of HALEU enriched to 19.75 percent U-235). These four items are population, dose conversion factors, production rate, and source terms. Possible changes to the effects stated in the HEU EIS are discussed below and effects of the Proposed Action are provided in Table 5-2.

Table 5-2. Effects to Individuals, the Surrounding Population, and Workers from Normal Operations

Maximally Exposed Individual	***Proposed Action***		***HEU EIS Maximum Commercial Use Alternative[a]***	
	Dose (mrem)	***LCF Risk[b]***	***Dose (mrem)***	***LCF Risk[b]***
Annual radiological air emissions	0.011	7×10^{-9}	0.0025	1.3×10^{-9}
Program Total	0.023	1×10^{-8}	0.078	3.9×10^{-8}
Population	***Dose (person-rem)***	***LCF Risk[b]***	***Dose (person-rem)***	***LCF Risk[b]***
Annual radiological air emissions	0.81	5×10^{-4}	0.16	8.0×10^{-5}
Program Total	1.8	0.001	5.01	2.5×10^{-3}
Average Individual[c]	***Dose (mrem)***	***LCF Risk[b]***	***Dose (mrem)***	***LCF Risk[b]***
Annual radiological air emissions	0.00094	6×10^{-10}	0.00023	1×10^{-10}
Program Total	0.0021	1×10^{-9}	0.00071	4×10^{-9}
Worker	***Dose (mrem)***	***LCF Risk[b]***	***Dose (mrem)***	***LCF Risk[b]***
Annual involved worker	90	5×10^{-5}	90	3.6×10^{-5}
Annual non-involved worker	18	1×10^{-5}	18	7.2×10^{-6}
Program total involved worker	200	1×10^{-4}	---	---
Program total non-involved worker	40	2×10^{-5}	---	---
Workforce	***Dose (person-rem)***	***LCF Risk[b]***	***Dose (person-rem)***	***LCF Risk[b]***
Annual Total – Involved Workforce	0.9	0.0005	11	0.005
Program Total – Involved Workforce [d]	2	0.001	524	0.21

Key: --- = not applicable; EIS = environmental impact statement; LCF = latent cancer fatality; mrem = millirem; HEU = Highly Enriched Uranium

[a] Data is from Tables 2.4-1, 4.3.1.6-1, and 4.3.1.6-2 of the HEU EIS (DOE, 1996).

[b] Values are based on a conversion factor of 0.0006 LCF per rem or person-rem for the Proposed Action and 0.0005/0.0004 LCF per rem (population and worker) for the HEU EIS.

[c] For the Proposed Action the average individual dose is the total population dose divided by the projected 2030 population of 862,967. The HEU EIS did not provide an average individual dose; this is the total population dose divided by the projected 2010 population of 710,000.

[d] A workforce of 10 workers has been assumed for the Proposed Action.

Material Processed: The HEU EIS evaluated an alternative to use blend down for up to 200 MT of HEU. The Maximum Commercial Use Alternative addressed converting a total of 200 MT of HEU, at a rate of 10 MT/yr, into LEU fuel (170 MT at 4 percent enrichment) plus 30 MT of waste (nominally at 0.9 percent enrichment). As noted above, the Proposed Action would process approximately 2.2 MT[11] of HEU over a

[10] For analysis purposes, 3.1 MT has been selected conservatively. The quantity that could be produced may be lower depending upon the amount of HEU suitable for blending down to advanced reactor fuels.

[11] The amount of HEU enriched to 27.4 percent required to produce 3.1 MT of HALEU enriched to 19.75 percent.

2- to 4-year period. Effects associated with the processing of the total amount of HEU under the Proposed Action have been scaled based on the reduced quantity of material processed (i.e., conservatively analyzed at 2.2 MT of HEU instead of 200 MT of HEU). Annual average effects were quantified assuming a 2-year[12] program processing 1 MT per year (a factor of 0.1 times the amount assumed in the HEU EIS).

Population Growth: The potential population doses for normal operations reported in the HEU EIS were based on the projected 2010 population of 710,000 people within a 50-mile radius of H-Canyon. Current estimates show that the population will grow to 862,957 people by 2030 (DOE, 2020). The analysis in this SA assumes the estimated 2030 population over the life of the Proposed Action. Therefore, for the collective population dose within 50 miles, a revised estimate of the person-roentgen equivalent man (rem) and LCFs for normal operations would increase by the factor of projected population growth. This factor would be about 1.2 because of an approximately 20 percent greater population. Population growth would not affect estimates of individual dose such as average individual doses and maximally exposed individual (MEI) doses.

Dose Conversion Factors: The dose-to-LCF-risk conversion factors for both workers and the public have been updated since the publication of the HEU EIS. The updated conversion factors produce higher LCFs than the conversion factors used in the HEU EIS. For worker doses, the HEU EIS used the then preferred dose-to-LCF-risk conversion factor of a probability of 0.0004 LCFs per rem of exposure (up to 20 rem). More current dose conversion calculations use a factor of 0.0006 LCF per rem of exposure (DOE, 2003). Thus, for worker exposures, the LCF estimates would increase by a factor of 1.5 (0.0006/0.0004) from those in the HEU EIS, due to the updated dose conversion factor.

For public doses, including the MEI and the collective population within 50 miles, the HEU EIS used the then-preferred dose-to-LCF-risk conversion factor of a probability of 0.0005 LCFs per rem of exposure (up to 20 rem). More current does conversion calculations use a factor of 0.0006 LCF per rem of exposure (DOE, 2003). Thus, for public exposures and exposures to the MEI, the LCF estimates would increase by a factor of 1.2 (0.0006/0.0005) from those in the SRS SNF EIS, due to the updated dose conversion factor.

Source Terms: The HEU EIS used only two isotopes of uranium for the material released, U-235 and uranium-238 (U-238). While not a significant contribution to the isotopic content of the HEU being blended down under the Proposed Action of this SA, uranium-234 (U-234), and to a lesser degree uranium-236 (U-236), has a much higher specific activity than U-235 and U-238. As such, it would be a significant contributor to the dose from material released. The source terms from the HEU EIS were converted from curies to grams, and the quantities released were distributed over the 4 isotopes of uranium, in concentrations identified for the HALEU product (0.26 percent U-234, 19.75 percent U-235, 1.3 percent U-236, and 78.7 percent U-238). This was converted to a release in curies. Per unit mass of uranium released, this results in a factor of 43 increase in the number of curies released with the isotopic mix assumed in this SA compared to the isotopic mix assumed in the HEU EIS.

Table 5-2 summarizes the radiological effects to workers and the public for the Proposed Action of blending down 2.2 MT HEU to produce approximately 3.1 MT of HALEU over a 2-year period at H-Area facilities[13]. Should the HEU be processed over a 4-year period, the average annual effects would be about 50 percent lower than those presented in the table. Information on the effects of blending down 200 MT of HEU to LEU, primarily at 4 percent for use in commercial reactors, as provided in the

[12] Should the program be extended to 4 years, average annual effects would be reduced by about 50 percent. Total effects would not change.

[13] The HEU being blended down under the Proposed Action of this SA is a portion of the 200 MT addressed in the HEU EIS. The assessed effects are not in addition to the effects assessed in the HEU EIS but rather update the HEU EIS assessment of the effects of blending down a portion of the 200 MT of HEU.

HEU EIS Maximum Commercial Use Alternative, is included for comparison.

5.1.1 Effects from the Proposed Action

Under the Proposed Action, the doses to the average individual and the MEI are all well below limits established in Federal regulations and DOE orders. For instance, 40 CFR Part 61, Subpart H, establishes an annual limit of 10 mrem via the air pathway to any member of the public from DOE operations, and DOE Order 458.1 establishes an annual limit of 100 mrem from all sources of ionizing radiation and exposure pathways. In 2023 the population doses from air pathways and all pathways were 0.016 mrem and 0.16 mrem, respectively (Savannah River Nuclear Solutions, LLC, 2024). The addition of the estimated 0.011 mrem from the Proposed Action to these totals would not result in the exceedance of either dose limit to a member of the public. As in the HEU EIS, radiation doses to the public would result in no LCFs (calculated value 0.001) in the population surrounding SRS, and the average individual and maximum exposed individual (at the nearest SRS boundary) would have a less than one-in-one-million chance of developing an LCF.

Worker effects were estimated for both the involved worker and a non-involved worker. To protect workers from effects from radiological exposure, 10 CFR Part 835 imposes an annual individual effective dose limit of 5,000 mrem. In addition, SRS maintains controls to limit the annual individual worker dose below an administrative limit of 500 mrem. No single worker would receive a dose above 500 mrem per year.

Worker population doses associated with processing the HEU addressed in the Proposed Action were derived using the same average individual worker doses (90 mrem per year for involved workers and 18 mrem per year for non-involved workers) identified for the Maximum Commercial Use Alternative (conventional processing) in the HEU EIS (DOE, 1996). Conservatively, individual worker doses were not adjusted to reflect the lower processing rate and associated reduced exposure times for individual workers.

The combined average annual worker dose of those workers involved in the blend down of HEU at H-Area facilities of 11 person-rem per year, results in no probable LCF (calculated value of 0.007). Based on a program duration sufficient to process about 2.2 MT of HEU, the estimated workforce dose would be 25 person-rem with no LCFs (calculated value of 0.01). Should the program extend through 4 years (instead of the assumed 2 years), the total worker dose would not be expected to change, but the annual dose would be 50 percent lower.

A maximum annual dose and a program total dose to a noninvolved worker[14] from air emissions associated with HEU blend down was estimated in the HEU EIS. The noninvolved worker average annual dose from the Maximum Commercial Use Alternative in the HEU EIS (18 mrem) was used for the Proposed Action. This result was used for the noninvolved worker annual dose for the Proposed Action. An annual worker dose of 18 mrem would be well below the 5,000 mrem per year limit from 10 CFR Part 835 and the 500 mrem per year SRS administrative limit. The addition of this dose to the non-involved worker's total dose should not significantly impact that worker's total dose and would not affect the ability of SRS to manage the worker dose so that the administrative limit would not be exceeded. This small dose would result in the risk of an LCF of 1×10^{-5} and a program total LCF risk of 2×10^{-5}.

5.2 Public and Occupational Health – Accidents and Intentional Destructive Acts

The Proposed Action would not introduce new radiological or chemical accident scenarios for H-Canyon/H-Area operations but does resume the blend down operations of A Line of the H-Canyon

[14] A non-involved worker is a worker not directly involved in the Proposed Action but located at SRS. For the analysis in the SRS SNF EIS, this worker was assumed to be located 640 meters from the point of release, in the direction of the plume with the greatest concentration.

complex. Because a significant amount of time has passed since these accidents were evaluated, the accident analyses have been updated to incorporate more recent source terms, population projections, and updated dose and risk conversion factors.

The specific activities associated with down bending HEU to LEU have been previously evaluated in a separate EA (DOE, 2000b) in the same general timeframe as the SRS portion of the HEU EIS (DOE, 1996). From an accident risk point of view, the activities associated with the Proposed Action—blending down HEU to HALEU—are functionally equivalent to the previous analyses of blending down HEU to LEU. Under that action, a LEU loading station was built in the A Line Facility of H-Area to handle the transfer of LEU product solution into DOT certified containers for shipment. The principal accidents of concern are an accidental nuclear criticality or a major fire that results in the uranyl nitrate solution being heated and aerosolized. A nuclear criticality would be associated with the material in the HEU storage vessel, the mixing activities, or associated with the product containers. This accident has been considered for H-Canyon safety and in the HEU EIS (DOE, 1996), and adequate controls are in place to make the probability of an accidental criticality extremely low. This accident was also considered in the previous HEU Facilities EA (DOE, 2000b). New criticality analyses have been performed for the HALEU product containers (Areva, 2024) that demonstrate that design features and operations associated with product containers provide an adequate margin of safety.

The major fire scenario associated with the blend down of HEU to HALEU is functionally equivalent to the fire scenario associated with the blend down of HEU to LEU. The only substantial difference is the detailed isotopic mix of the HALEU product solution that might be aerosolized. The HEU Facilities EA assumed the following scenario (DOE, 2000b):

> *The scenario envisions a fire starting in the LEU loading station. The fire is assumed to begin after the nine shipping containers on the trailer truck have been filled with LEU solution. The loading station is essentially an outdoor facility that would be similar in design to a carport-type structure. Any fire detection/suppression system located within the facility is assumed to fail. It is also assumed that the fire at the trailer loading dock will not spread to the H-Canyon affecting the LEU and HEU storage tanks. The LEU solution is assumed to contain uranium with an enrichment of up to 20 percent U-235 in solution with a concentration of less than 100 g U/L. The fire would consume the inventory in the nine shipping containers on the trailer bed (i.e., a total of 8,5l6 liters or 2,250 gallons). It is also assumed that the fire at the trailer loading dock will not spread to the H-Canyon affecting the LEU and HEU storage tanks LEU. The fire is also postulated to damage the piping from the LEU storage tank to the LEU loading station in a manner consistent with release. It is assumed that valving is in place on this transfer line to terminate flow to the loading station. It is also assumed that the valve between the storage tank and the loading dock area is not closed by the operator until an additional 946 liters (250 gallons) of LEU solution is leaked to the loading area. It is assumed that the fire will consume a total of 9,463 liters or 2,500 gallons of the LEU solution. Because the facility is outside, the release will be a direct airborne release. No chemical inventories, other than the LEU solution, are assumed to be located on the loading station. The release would involve radiological material and nitric acid. The nitric acid release was modeled assuming a 50 percent nitric acid solution with a puddle area of 167 rn2 (1,800 ft^2 and a volume of 8,516 liters (2,250 gallons). Input parameters include meteorological data such as Stability Class E with a wind speed of 1.7 meters/second (5.6 feet/second) and an air temperature of 29°C (84°F). This bounding fire is assumed to be in the 'unlikely' frequency range, with a probability of occurrence of less than once in 100 years but greater than once in 10,000 years. Facility personnel must fail to detect and control the fire before it has progressed beyond the incipient stage and the automatic fire suppression systems, if there are any, must fail to control the fire to the place of*

> *origin.*

In the HEU Facilities EA, the consequences of the fire were reported as follows (DOE, 2000b):

> *The consequences resulting from a fire in the LEU loading station would be quite low. The accident is expected to result in the onsite worker being exposed to 1.3 rem and the offsite individual being exposed to 0.0015 mrem (WSMS 1999).*
>
> *The onsite population total effective dose equivalent (TEDE) is 25 person-rem (WSMS 1999). Based on a dose-to-risk conversion factor of 4.0 x 10^{-4} (onsite) latent cancer fatalities (LCFs) per person_rem, 0.01 LCFs per year would be expected to result from the postulated scenario. The general public TEDE is 2.4 person-rem (WSMS 1999). Based on a dose-to-risk conversion factor of 5 x 10^{-4} (offsite) LCFs per person-rem, 0.0012 LCFs per year would be expected to result from the postulated accident scenario.*
>
> *In general, the symptoms of exposure to the aqueous nitric acid and uranium (in nitric acid) may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea and vomiting. Aqueous nitric acid may be fatal if inhaled, swallowed, or absorbed through the skin. Nitric acid causes burns. Nitric acid and uranium (in nitric acid) are extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin.*

The HEU Facilities EA indicates that based on the exposure scenario presented, there would be potential toxicological effects associated with such an event (DOE, 2000b). The severity of consequences depends on the extent of exposure and the specific location of the affected individual(s). Toxicological consequences are based on concentrations of a specific material in parts per million (ppm) of the material in air.

The Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association and are intended for emergency planning and response operations (similar to acute exposure guideline levels), but ERPGs are only based on a 1-hour exposure duration (FEMA, 2024a). ERPGs are intended to protect most persons in the general population, but not particularly sensitive persons. They are reviewed at regular intervals as new information becomes available.

Definitions of the three levels of ERPG values are as follows (FEMA, 2024a):

- ERPG-1: The maximum airborne concentration below which it is believed nearly all persons could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.
- ERPG-2: The maximum airborne concentration below which it is believed nearly all persons could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair a person's ability to take protective action.
- ERPG-3: The maximum airborne concentration below which it is believed nearly all persons could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

The HEU Facilities EA indicates the toxicological consequences to the onsite worker would be approximately 1.97 ppm, which is below the ERPG-1 threshold of 2 ppm (DOE, 2000b). Toxicological consequences to the offsite individual would be 0.089 ppm, which is also below the ERPG-1 threshold. Therefore, the analyzed accident would not result in any fatalities, the development of any irreversible or serious health effects, or any other serious effects. In the HEU Facilities EA, a fire in the LEU loading station was considered the single, most bounding credible accident associated with the HEU to LEU blend down operations (DOE, 2000b).

Summary of Accidents from Operation of H-Canyon and A Line: The potential accident probabilities, consequences if an accident occurred, and accident risks associated with implementation of the Proposed Action would be substantially reduced from those projected in previous EISs supporting operations in H-Canyon, including the HEU EIS (DOE, 1996) and the SRS SNF EIS (DOE, 2000a), due to the simplification of the processing activities in H-Canyon. With the implementation of the Accelerated Basin De-inventory operations at H-Canyon (DOE, 2022a), the key historical process steps in H-Canyon, including head end, first-cycle solvent extraction, and second-cycle solvent extraction would not occur.

These simplifications of H-Canyon processing activities should both reduce the likelihood of several types of accidents and reduce the radiological materials at risk for some of the potential accidents. The remaining accident effects and risks are dominated by fires associated with H-Canyon operations, transfer errors in which radioactive material is transferred from the shielded H-Canyon to an outside area, earthquakes, and a criticality. Previous safety analyses for H-Canyon have evaluated the accident potential for each of these major operations and found the dominant accident risks to be those identified in Table D-3 of the SRS SNF EIS (DOE, 2000a). The accident scenarios that are directly relevant to the Proposed Action and the blend down fire are reproduced below as Table 5-3. The blend down operations in the A-Line area were previously evaluated in *Consequence Analysis for Off-spec HEU Blend Down Project Loading Facility* (hereafter referred to as WSMS 1999) and reported in the HEU Facilities EA. Those results are also included in Table 5-3. The effects in the SRS SNF EIS (DOE, 1996) and the HEU Facilities EA (DOE, 2000b) were based on the 1990 offsite population within 50 miles of H-Canyon and the then current dose conversion factors. Projected future effects would be increased relative to the values in Table 5-3 due to population growth and differences in the dose conversion factors (see Section 5.1) but would also be lowered in some instances for the reasons discussed below.

Table 5-3. H-Area Radiological Accidents and Effects

Accident	*Maximum Curies Released*	*Accident Frequency*	*Noninvolved Worker (rem)*	*MEI (rem)*	*Offsite Population (person-rem)*	*LCF*
Fire: H-Canyon operations [a]	0.57	Once in 1,600 years	0.53	0.055	3.300	1.6
Fire: A-Line blend down operations [b]	0.0368	Once in 100 to once in 10,000 years	1.2	0.0000015	2.4	0.001
Design-basis earthquake [a]	800	Once in 5,000 years	1.8	0.246	14,000	7.0
Transfer error to Building 211-H [a]	3,700	Once in 14,000 years	1.5	0.16	9,200	4.6
Criticality [a]	47,000	Once in 77,000 years	0.029	0.0012	18	0.009

Key: EIS = environmental impact statement; LCF = latent cancer fatality; MEI = maximally exposed individual
[a] (DOE, 2000a): Table D-3
[b] For the A-Line blend down fire: (DOE, 2000b) Sect. 3.3.3; (WSMS, 1999), Table 1.

The accident analyses for H-Canyon presented in the SRS SNF EIS are based on the H-Canyon safety analyses current at the time of the EIS (SRS, 2007) and include the then current and projected inventory of materials that might be processed. For most of the accidents postulated in the Safety Analysis Report (SAR) and SRS SNF EIS, the potential material at risk (MAR) and releases from the dissolution process were only a fraction of the overall H-Canyon source term. With the implementation of the Accelerated Basin De-inventory program, spent fuel processing to recover U-235 has ceased.

Fires: The primary fires considered in the SRS SNF EIS, and the then current H-Canyon SAR, are associated with large quantities of organics and solvents, primarily associated with the solvent extraction processes. These solvents are the primary source of flammable materials in association with process materials.

Under the Proposed Action, the primary and secondary solvent extraction processes would not occur. Thus, the radiological risk of radioactive material releases due to fires are substantially reduced or eliminated.

Earthquakes: The SRS SNF EIS evaluated the potential effects from a design-basis earthquake, with an estimated accident frequency of once in 5,000 years. During this large earthquake, the SRS SNF EIS and the then current H-Canyon SAR assume that there would be widespread spillage of process liquids from the tanks and piping associated with the full H-Canyon processes. The largest tank in each unit operation is assumed to be spilled onto the process cell floor. Subsequent fires among the flammable materials might also be expected. More recent safety analyses, including the current documented safety analysis (SRNS, 2014), have concluded that the earlier assumptions on the extent of tank and piping spillage during design-basis earthquakes were unrealistic and less spillage was more likely.

Since most of the H-Canyon processes, including the first- and second-cycle solvent extraction processes, would not occur with the Proposed Action and with the Accelerated Basin De-Inventory Program in place, the radioactive materials normally in the tanks and piping for those activities may not be present. Remaining materials from previous operation would still be at risk in a severe earthquake. In addition, under the Proposed Action, some of the liquids could be temporarily stored in some of these tanks. It is expected that the total amount of radioactive liquids at risk, including those associated with dissolution and transfers outside of H-Canyon, would be less than those normally present during the periods of full H-Canyon operation evaluated in the SRS SNF EIS. Most of the flammable materials, solvents, and organics would not be a part of the current MAR. Thus, it is the seismic source term would be less than that reported in the SRS SNF EIS, and the effects to individuals and the public would be proportionally less.

Transfer Errors to the Outside Facilities: One of the potential pathways for release of highly radioactive liquids from the H-Canyon building is through an inadvertent transfer of highly radioactive liquids to one of the processing facilities immediately adjacent to H-Canyon that is only intended to receive low-activity radioactive materials. The inadvertent transfer could occur from any of the H-Canyon process operations. Under the Proposed Action, and with the Accelerated Basin De-inventory program in place, most of the processes that have the potential for transfer of highly radioactive liquids to the outside tanks would not be operating. The dissolver operations would continue and have the potential for inadvertent transfers. The source term would be no greater than that evaluated in the SRS SNF EIS. With fewer operations in H-Canyon, the probability of this accident would be reduced.

Criticality: The H-Canyon safety documents and the SRS SNF EIS evaluate the potential consequences of an inadvertent criticality involving solutions of fissile materials. The H-Canyon processes are designed to maintain concentrations of fissile materials sufficiently low, so that a criticality is not possible. Failures of controls, however, could lead to an accident. Under the Proposed Action to blend down HEU to HALEU, the processes that have the potential to pose a risk of criticality involving highly radioactive liquids would be operating on the same manner as with the previous HEU to LEU blend down operations. The potential for a criticality would be similar. The source term would be no greater under the Proposed Action than that evaluated in the SRS SNF EIS. In addition, with fewer overall operations in H-Canyon due to implementation of other programs, the probability of this accident would be reduced. New criticality analyses have been performed for the HALEU product containers (Areva, 2024) that demonstrate that design features and operations associated with product containers provide an adequate margin of safety.

5.2.1 Effects of Changes in Dose and Latent Cancer Fatality Risk since the 2000 *SRS SNF EIS* on Postulated Accident Effects

Since publication of the SRS SNF EIS (DOE, 2000a) and the HEU Facilities EA (DOE, 2000b), several changes have occurred that would cause the estimated radiological effects and LCF risks identified in that EIS and

EA to differ. These changes include updated dose conversion factors, population growth, and dose modeling.

Reduction of MAR for Accident Scenarios – The MAR would be reduced for most accidents in H-Canyon, since the major traditional processes in H-Canyon would not operate while the HEU to HALEU blend down would occur. Major fire accident scenarios in H-Canyon would be eliminated with the elimination of the solvent extraction processes. In addition, many radionuclides important to offsite dose would have decayed substantially in the 20 years since the SRS SNF EIS evaluations.

Dose Conversion Factors – Dose conversion factors for workers and the public have changed as described in Section 5.1.

Population Growth – The expected population over the life of the Proposed Action within a 50-mile radius of H-Area has changed as described in Section 5.1. Thus, for a collective population dose within 50 miles, the estimate of person-rem and LCFs for each accident identified in the SRS SNF EIS would increase by the 1.2 factor of projected population growth.

Dose Modeling – The radiological dose consequence modeling in the 2000 SRS SNF EIS was performed using the then current Federal Guidance Report (FGR)-11 (EPA, 1988) dose models for each radioisotope. Since then, more complex models have been developed and reported in FGR-13 (EPA, 1999). The changes in estimated radiological dose per curie inhaled or ingested vary with radioisotope. For the key isotopes affecting dose from aged SNF, the difference in overall individual and population dose between estimates in the SRS SNF EIS with FGR-11 and the newer FGR-13 are small, with the FGR-13 rem/curie values for the key radionuclides generally being smaller. Radioactive decay would likely result in even lower dose estimates that could now be made taking into account the radiological decay that has occurred since the 2000 SRS SNF EIS. The net effect of using current dose modeling parameters from FGR-13 and adjusting dose estimates for radioactive decay would result in overall impact estimates lower than those in the 2000 SRS SNF EIS.

Specific Changes in Source Term and Dose Modeling for Uranium Isotopes – Uranium presents both a radiological and toxicological hazard. In general, natural uranium is considered to be a chemical hazard instead of a radiation hazard (Health Physics Society, 2018). For radiological impacts from enriched uranium, the dose from U-234 dominates the impacts and contributes about 86.65 percent (LEU) to 95.8 percent (current HALEU) to 96.6 percent (HEU) percent of the radiological hazard. For the Proposed Action (19.75 percent U-235), the assumed mix of uranium isotopes is about 0.26 weight-percent U-234 which contributes about 95.8 percent of the total dose. Thus, the difference in U-234 content for the HALEU in the proposed action would result in an increase in radiological effects of about 30 percent increase from the HEU Facilities EA values just due to the differences in the assumed U-234 content (U-234 0.26 percent in HALEU versus 0.20 percent in LEU).

Changes in Accident Frequencies – With the implementation of the Accelerated Basin De-inventory Program, the overall accident frequencies should be lower than that reported in the SRS SNF EIS.

5.2.2 Combined Effects of Changes on Accident Consequence Projections

- **Reduction of MAR for SRS SNF EIS Accident Scenarios**: MAR reduced for most accidents, since major processes in H-Canyon would not operate under the Proposed Action. Major fire accident scenarios would be eliminated with the elimination of the solvent extraction processes.
- **Population Growth from 1990 SRS SNF EIS to 2030**: There would be a factor of 1.2 increase for population doses (see Section 5.1). Population growth would not affect estimates of average individual doses and MEI doses.
- **Dose Modeling for Uranium:**

  - The U-234 content is assumed to be about 30 percent higher for the HALEU operations than that assumed for the HEU Facilities EA (DOE, 2000a), or a factor of 1.3 higher dose than reported in WSMS 1999 (WSMS, 1999).
  - The dose to LCF risk conversion factor for U-234 has changed when using the value in the HEU Facilities EA to the current practice. Changing from the FGR-11 (assuming Type Y as assumed in WSMS 1999) to FGR-13 (assuming Type M as recommended by the International Commission on Radiological Protection), the LCF risk is reduced by a factor of about 0.135. Thus, a current estimation of the dose is about 13.5 percent of the dose reported in WSMS 1999 and the HEU Facilities EA.
- **Worker and Public Dose to Risk Conversion Factors**: For worker exposures, Section 5.1 indicates the LCF estimates would increase by 50 percent (0.0006/0.0004) from those in the HEU EIS, due to the updated dose conversion factor. For public exposures and exposures to the MEI, Section 5.1 indicates the LCF estimates would increase by 20 percent (0.0006/0.0005) from those in the SRS SNF EIS, due to the updated dose conversion factor.
- **Accident Frequencies**: Processing of the HEU to blend down to HALEU in A-Line of H-Area should be independent of other operations in H-Canyon and should not affect the overall H-Canyon accident probabilities previously reported. However, elimination of many of the processes in H-Canyon for other reasons such as the ADB program would reduce the frequency of accidents.

5.2.3 Comparison of Current Dose and Risk Projections for Blend Down Fire with Comparable Projections in the 1996 HEU EIS

The HEU EIS (DOE, 1996) assumed a different, generic fire scenario for the HEU blending operations while the later HEU Facilities EA (DOE, 2000b) characterized proposed operations in A-Line. The later EA evaluated a fire scenario that was directly applicable to the proposed operations in A-Line rather than a generic filter fire in a generic facility. Both the HEU EIS and the HEU Facilities EA assumed the HEU blending fire had a frequency of about 1-in-100 to 1-in-10,000 years. The source term in the HEU EIS assumed a release of 0.0040 curies of U-234, the dominant isotope in terms of dose. The source term in the HEU Facilities EA assumed a total release of 0.0313 curies, about 13 percent of the EIS release. Estimated effects for the HEU EIS and HEU Facilities EA were 2.3 and 1.2 rem to the worker (1×10^{-3} and 7×10^{-4} LCFs, respectively), 6.6×10^{-5} and 1.5×10^{-6} rem to the MEI (4×10^{-8} and 9×10^{-10} LCFs, respectively), and 0.37 and 2.4 person-rem to the population (2×10^{-4} and 1×10^{-3} LCFs, respectively), respectively. The estimated MEI worker and member of the public impacts projected in the HEU Facilities EA for A-Line operations were lower than those projected in the HEU EIS for a generic HEU blending facility at SRS. The accident frequencies assumed in both the HEU EIS and HEU Facilities EA were identical. Therefore, the overall worker and MEI accident risks projected in the HEU Facilities EA are lower than those reported in the HEU EIS. Although the HEU Facilities EA projected a higher population risk than projected in the HEU EIS, no LCFs are expected under any A-Line blend down accident scenario.

5.2.4 Conclusion

Implementation of the Proposed Action in H-Area would only introduce the fire at the A-Line blend down operations that was previously evaluated in the HEU Facilities EA (DOE, 2000b) and, generically, the HEU EIS (DOE, 1996). The consequences of blending down HEU to HALEU are small and similar to the previously evaluated accident scenario.

- U-234 source term: a factor of about 1.3 higher than the EA
- Uranium dose to LCF risk conversion factor (FGR-13 versus older FGR-11): a factor of about

0.135 higher than the EA (which results in a substantial decrease)

- Population growth: a factor of about 1.2 higher than the EA
- Worker dose conversion factor: a factor of about 1.5 times higher than the EA
- Public dose conversion factor: a factor of about 1.2 times higher than the EA

Effects of Changes to HEU Facilities EA Impact Using Today's Best Estimates:

- Workers: 1.3 x 0.135 x 1.5 = 0.26 times (26 percent of) the EA values
- Public – Population: 1.3 x 0.135 x 1.2 x 1.2 = 0.25 times (25 percent of) the EA values
- Public – MEI: 1.3 x 0.135 x 1.2 = 0.21 times (21 percent of) the EA values

For other accidents identified in the SRS SNF EIS and the HEU EIS, the projected population growth and changes in dose risk values would increase expected impacts for most accidents than those presented in the SRS SNF EIS. For the blend down accident presented in the HEU Facilities EA, in spite of the changes described above that increase dose, the changes in the dose to risk values for uranium with the adoption of the latest FGR values in FGR-13 would result in smaller potential consequences (LCF risk is reduced by a factor of about 0.135). For the other H-Area accidents, the results of the accident analyses as presented in Table 5-3 are still bounding.

5.2.5 Intentional Destructive Acts

As noted above, the *Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* (DOE, 2013) added an intentional destruction acts evaluation, using the accident analysis of the SRS SNF EIS as a starting point. In that SA, DOE found that while it was "not possible to predict whether or where intentional acts of destruction would occur, or the nature or types of attacks, the consequences of a terrorist attack on the SNF storage and processing facilities are not likely to be greater than the consequences of the severe accidents DOE evaluated." This determination continues to be valid with the changes analyzed in this SA.

5.3 Transportation

This section presents human health considerations associated with transporting HALEU under the Proposed Action. Both radiological and nonradiological transportation impacts would result from shipment of radioactive materials. Radiological impacts are those associated with the effects from low levels of radiation emitted during incident-free transportation and from the accidental release of radioactive materials. Nonradiological impacts are independent of the nature of the cargo being transported and are expressed as traffic accident fatalities resulting only from the physical forces that accidents could impart to humans.

Transportation packages containing radioactive materials emit low levels of radiation; the amount of radiation depends on the characteristics of the transported materials and the amount of shielding provided by the package.

For incident-free transportation, the potential human health impacts from the radiation field surrounding the radioactive packages were estimated for transportation workers and populations along the route (termed off-traffic or off-link), people sharing the route (termed in-traffic or on-link), and people at rest areas and stops along the route. The System for Analyzing the Radiological Impact of the Transportation of Radioactive Materials (RADTRAN) 6.02.1 computer program (Weiner et. al., 2013) was used to estimate impacts on transportation workers and populations, as well as the impact to a MEI, who may be a worker or a member of the public (for example, a resident along the route, a person struck in traffic, a gasoline station attendant, or an inspector). Incident-free radiological health impacts are expressed in terms of additional LCFs. Radiological health impacts from accidents are also expressed as additional LCFs [15], and nonradiological accident risk as additional immediate (traffic) fatalities.

Transportation accidents involving radioactive materials present both nonradiological and radiological risks to workers and the public. Nonradiological impacts of transportation accidents include traffic accident fatalities. The radiological impact of a specific accident is expressed in terms of probabilistic risk (i.e., dose risk), which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences (i.e., dose). The overall radiological risk is obtained by summing the individual radiological risks for a range of accidents. The analysis of accident risks considers a spectrum of accident severities ranging from high-probability accidents of low severity (e.g., a fender bender) to hypothetical high-severity accidents having low probabilities of occurrence. Because it is impossible to predict the specific location of an off-site transportation accident, generic atmospheric conditions (the United States averaged atmospheric data) as included in RADTRAN computer program were selected for the risk and consequence assessments.

Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain the package contents and provide radiation shielding. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. As indicated in Chapter 1 (Section 1.3) of this SA, the HALEU product would be uranyl nitrate in liquid form to be transported in a certified package called Liquid Radioactive, LR Transport Unit Package, with a Certificate of Compliance No. USA/9291/B(U)F-96 (NRC, 2024). The LR package is designed to transport Type B quantities of fissile uranyl nitrate solutions of up to 5 percent U-235, or a maximum of 12 pounds (5,647 grams) of U-235 and up to 230 gallons of solution per package. The package is currently being re-certified to transport uranyl nitrate of up to 20 percent U-235.

Liqui-Rad Transport Package

The SA analysis of off-site transportation involves the shipment of uranyl nitrate solutions from SRS to the existing BWX Technologies (BWXT) facility in Lynchburg, Virigina, or to the TRISO-X facility being constructed in Oak Ridge, Tennessee. The HALEU transport would occur by truck trailers carrying nine LR packages per transport.

Transportation of the HALEU solution would occur on exclusive and dedicated use vehicles (e.g., trucks). Offsite transportation of the radioactive material has a defined regulatory limit of 10 mrem per hour at about 6.6 feet (ft) from the outer lateral surfaces of the vehicle (10 CFR 71.47 and 49 CFR 173.441). The external dose rate of the package is driven by the radiological characteristics of its contents. Given the composition of HALEU solution, a dose rate of 2 mrem per hour at 3.3 ft from the transporter (truck) was assumed for assessment purposes.

[15] LCFs associated with radiological exposure were estimated by multiplying the occupational (worker) and public dose by a dose conversion factor of 0.0006 LCFs per rem or person-rem of exposure (DOE, 2003).

Potential human health impacts from transportation accidents were evaluated. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (accident frequency) multiplied by the accident consequence. The RADTRAN computer program estimates the overall risk by summing individual risks from all reasonably conceivable accidents. The analysis of accident risks accounts for a spectrum of accidents ranging from high-probability accidents of low severity (a fender-bender) to hypothetical high-severity accidents that have a corresponding low probability of occurrence.

Nine Liqui-Rad Packages on a Truck Trailer

In the event of a radiological release from a shipment along a route, local emergency response personnel would be the first to arrive at the accident scene. It is expected that response actions would be taken in accordance with the guidance in the *National Response Framework* (DHS, 2019). Based on the initial assessment at the scene, training, and available equipment, first responders would involve Federal and state resources as necessary. First responders and/or Federal and state responders would initiate actions in accordance with the DOT *Emergency Response Guidebook* (DOT, 2024) to isolate the incident and perform the actions necessary to protect human health and the environment (such as evacuations or other means to reduce or prevent impacts to the public). Cleanup actions are the responsibility of the carrier.

All motor carriers selected for transport of the wastes would be thoroughly vetted through a formalized selection process and must have DOT Satisfactory Safety Ratings and DOE Motor Carrier Evaluation Program approvals. To mitigate the possibility of an accident, DOE issued DOE Order 460.2B (DOE, 2022b), which replaces the DOE Manual 460.2-1A (DOE, 2008), *Radioactive Material Transportation Practices Manual for Use with DOE O 460.2A*[16]. As specified in this manual, carriers are expected to exercise due caution and care in dispatching shipments. According to the manual, the carrier determines the acceptability of weather and road conditions, whether a shipment should be held before departure, and when actions should be taken while en-route. The manual emphasizes that shipments should not be dispatched if severe weather or bad road conditions make travel hazardous. Current weather conditions, the weather forecast, and road conditions would be considered before dispatching a shipment. Conditions at the point of origin and along the entire route would be considered.

Incident-free radiological health impacts are expressed as additional LCFs. Radiological accident health impacts are also expressed as additional LCFs, and nonradiological accident risks are expressed in terms of additional immediate (traffic) fatalities. LCFs associated with radiological exposure were estimated by multiplying the occupational (transport crew) and public dose by a risk factor of 0.0006 (6.0×10^{-4}) LCFs per rem or person-rem of exposure (DOE, 2003). Impacts were calculated assuming that the materials are shipped by truck, only.

In determining transportation risks, per-shipment risk factors were calculated for incident-free and accident conditions using the RADTRAN 6.02 computer program (Weiner et. al., 2013) in conjunction with the Web-Transportation Routing Analysis Geographic Information System (Web-TRAGIS) computer

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[16] DOE Manual 460.2-1A was published in 2008 for the action in DOE Order 460.2A, which is now cancelled with the issuance of DOE Order 460.2B.

program (Peterson, 2018) to choose transportation routes in accordance with DOT regulations, as specified in 49 CFR Part 397. The Web-TRAGIS program provides population density estimates for rural, suburban, and urban areas along the routes based on the 2012 U.S. census. The 2012 population density estimates were escalated to 2025 population density estimates using state-level 2010 and 2020 census data and assuming population growth between 2010 and 2020 would continue through 2025. The ROI of this analysis is the affected population, including individuals living within 0.5 miles (804 meters) of each side of the road for incident-free operations and, for accident conditions, individuals living within 50 miles (80 kilometers) of the accident. The MEI was assumed to be a receptor located 330 ft directly downwind from the accident.

Route-specific accident and fatality rates for commercial truck transports were used to determine the risk of traffic accident fatalities. For offsite transport, a weighted average accident and fatality rate was calculated based on the state-level distances travelled and their associated accident and fatality rates. The accident and fatality values selected were the state-level total accident and fatality rates provided in the Saricks and Tompkins report (Saricks & Tompkins, 1999); adjusted for underreporting using (UMTRI, 2003). The rates in the Saricks and Tompkins report are cited in terms of accident and fatality per truck-kilometer traveled.

Route characteristics that are important to the radiological risk assessment include the total shipment distance and population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Route characteristics for routes analyzed in this SA are summarized in Table 5-4. Rural, suburban, and urban areas were characterized according to the following breakdown (Peterson, 2018):

- Rural population densities range from 0 to 54 persons per square kilometer (0 to 140 persons per square mile);
- Suburban population densities range from 55 to 1,284 persons per square kilometer (140 to 3,326 persons per square mile); and
- Urban population densities include all population densities greater than 1,284 person per square kilometer (3,326 persons per square mile).

The affected population for route characterization and incident-free dose calculation includes all persons living within 805 meters (0.5 miles) of each side of the transportation route.

Table 5-4. Offsite Truck Route Characteristics

Origin	Destination	Nominal Distance (kilometers)	Distance Traveled in Zones (kilometers)			Population Density in Zone [a] (number per square kilometers)			Number of Affected Persons [b]
			Rural	Suburban	Urban	Rural	Suburban	Urban	
SRS near Aiken, SC	BWXT near Lynchburg, VA	733	384	337	13	26	431	2,396	298,660
	TRISO-X in Oak Ridge, TN	618	326	247	45	22	535	2,085	374,670

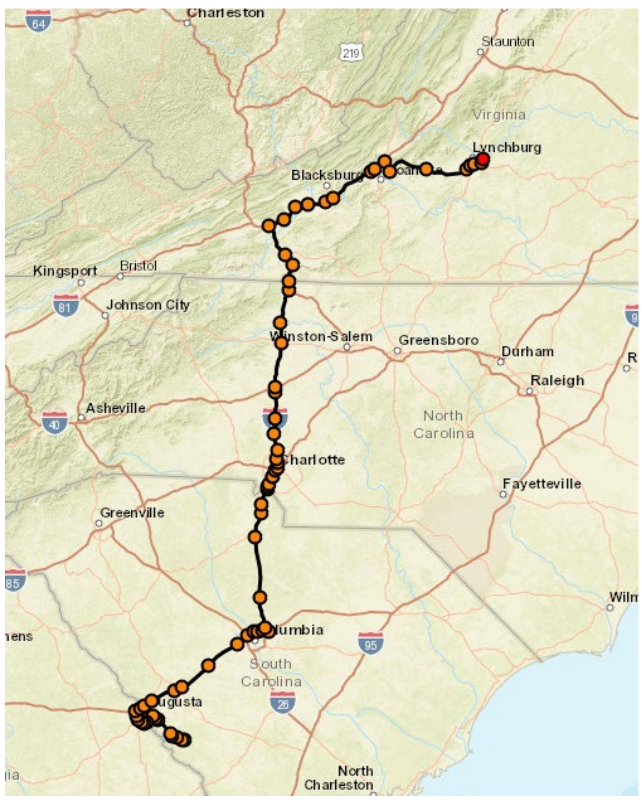
Key: BWXT = BWX Technologies; SC = South Carolina; SRS=Savannah River Site; TN = Tennessee; VA=Virginia

[a] Population densities were projected to 2025 using state-level data from the 2020 census and assuming state population growth rates from 2010 to 2020 continue to 2025.

[b] For offsite shipments, the estimated number of persons residing within 0.5 miles along the transportation route, projected to 2025.

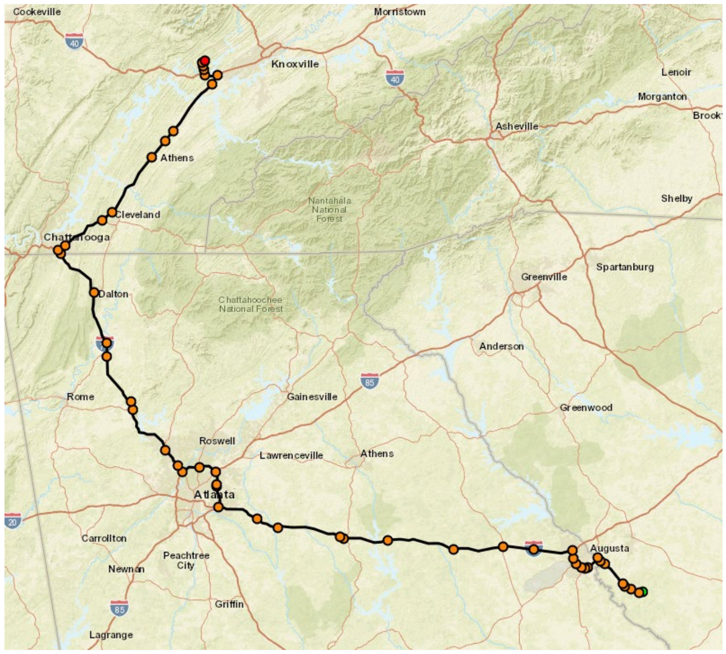
Note: Because all numbers are rounded to nearest digit, total distance may be different from some of individual segments.

Figure 5-1 and Figure 5-2 show the specific routes for the truck transports generated using Web-TRAGIS computer program (Peterson, 2018). Truck transports from SRS use the State Route 125 and I-520 toward Augusta, Georgia. From there, transports to BWXT would follow I-20 toward Columbia, South Carolina, and transports to Oak Ridge would follow I-285 toward Atlanta, Georgia.



(455 miles [733 kilometers])

Figure 5-1. Truck Transport Route to BWX Technologies near Lynchburg, Virginia



(384 miles [618 kilometers])

Figure 5-2. Truck Transport Route to TRISO-X in Oak Ridge, Tennessee

The uranium weight fractions and the corresponding uranium activity of the HALEU solution in an LR package are listed in Table 5-5. This composition is based on the results of analytical chemistry of the existing high enriched uranyl nitrate solution and its dilution with a highly concentrated natural uranyl nitrate solution (SRNL, 2024). The blended down HALEU uranyl nitrate solution will have a mass of about 3.1 metric tons of uranium, a volume of 107,275 liters (about 28,338 gallons), and a uranium density of about 29 grams per liter. Given the characteristics of the LR packages, up to 230 gallons of the uranyl nitrate could be transported per package that would lead to about 14 truck shipments. Also, in each LR package, there would be about 5 kilograms (11 pounds) of U-235, which would be less than the maximum amount allowed (e.g., 12 pounds) per the package Certificate of Compliance (NRC, 2024).

Table 5-5. Uranium Content of an Liqui-Rad package with HALEU

Radioisotope	***Weight Fraction***	***Activity*** [a] ***per LR (Ci)***
Uranium-234	0.0026	4.04×10^{-1}
Uranium-235	0.1975	1.08×10^{-2}
Uranium-236	0.0128	2.09×10^{-2}
Uranium-238	0.7873	6.67×10^{-3}
Others	parts per billion U	
Cesium-137	1.33×10^{-3}	2.91×10^{-6}
Neptunium-237	$2.56 \times 10^{+3}$	4.58×10^{-5}
Bismuth-212	2.60×10^{-6}	9.85×10^{-4}
Lead-212	2.67×10^{-5}	9.43×10^{-4}
Thorium-228	4.33×10^{-2}	8.96×10^{-4}

Source: (SRNL, 2024)

Key: Ci = curie; HALEU = high-assay low-enriched uranium; LR = Liqui-Rad package; U = uranium

[a] Activity refers to the decay rate of a radionuclide. One Curie (Ci) is defined

Radioisotope	Weight Fraction	Activity [a] per LR (Ci)

as 3.7 x 10^{10} disintegrations per second.

5.3.1 Incident-Free Transportation Risks

During incident-free transportation of radioactive materials, a radiological dose results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers, their length of time of exposure, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crew members (truck drivers) and the general population during incident-free transportation. The general population is composed of the persons residing within 0.5 mile on either side of the truck route (off-link), persons sharing the road (on-link), and persons at stops. Exposures to workers who would load and unload the shipments are not included in this analysis, but are included in the occupational estimates for plant workers. Exposures to inspectors are evaluated and presented separately in this section.

Collective doses for the crew and general population were calculated by using the RADTRAN 6.02 computer code (Weiner et. al., 2013; Weiner et. al., 2014). The radioactive material shipments were assigned an external dose rate based on their radiological characteristics. Offsite transportation of the radioactive material has a defined regulatory limit of 10 mrem per hour at 6.6 ft from the outer lateral surfaces of the vehicle (10 CFR 71.47 and 49 CFR 173.441). The external dose rate of a package is driven by the radiological characteristics of its content. Given the composition of HALEU listed in Table 5-5, a dose rate of 2 mrem per hour at 3.3 ft was assumed for the packages containing uranyl nitrate solution.

To calculate the collective dose, a unit risk factor for a single shipment (a per-shipment risk factor) between a given origin and destination was developed to estimate the impact of transporting one shipment of radioactive material over the shipment distances in various population density zones. The unit dose is a function of the distance and exposure time for both the driver and the exposed public. To include the potential for traffic congestion, the analysis assumed that for 10 percent of the time, travel through suburban and urban zones would encounter rush hour conditions, leading to a lower average speed and higher traffic density.

For truck shipments, three hypothetical scenarios were evaluated to determine the dose to the MEI in the general population. These scenarios are as follows:

- A person caught in traffic and located 4 ft (1.2 meters) from the surface of the shipping transporter for 30 minutes.
- A resident living 98 ft (30 meters) from the highway used to transport the shipping transporter.
- A service station worker at a distance of 52 ft (16 meters) from the shipping transporter for 50 minutes (DOE, 2002).

The hypothetical MEI doses were accumulated over a single year for all transportation shipments, but for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated for only one event, because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments.

The radiological risks from transporting the radioactive materials are estimated in terms of the number of LCFs among the crew and the exposed population. A health risk conversion factor of 0.0006 LCF per rem or person-rem of exposure is used for both the public and workers (DOE, 2003).

5.3.2 Transportation Accident Risks

The transportation risk assessment considers the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by NRC (NRC, 1977). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective "dose risk" to the population within 50 miles were determined using the RADTRAN 6.02 computer program (Weiner et. al., 2013; Weiner et. al., 2014).

The accident consequence assessment considers the potential impacts of severe transportation accidents. In terms of risk, the severity of an accident must be viewed in terms of potential radiological consequences, which are directly proportional to the fraction of the radioactive material within a transport package that is released to the environment during the accident. Although accident severities span the entire range of mechanical and thermal accident loads, they are grouped into accident categories that can be characterized by a single set of release fractions and are, therefore, considered together in the accident consequence assessment (NRC, 1977). The accident category severity fraction is the sum of all conditional probabilities in that accident category. For this SA, the severity categories in the *Radioactive Material Transportation Study* (NRC, 1977) were used.

For the spectrum of accidents considered in the analysis, the RADTRAN 6.02 computer program (Weiner et. al., 2013) sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to as "dose risk," to the population within 50 miles, which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts to individuals and populations should an accident occur, maximum radiological consequences were calculated if an accidental release with a likelihood of greater than 1 chance in 10 million per year were to occur in an urban or suburban population zone. However, given the duration of the HALEU operation (about 4 years) and the potential number of shipments per year (about 4), the likelihood of such an accident for the highest severity category accident in urban or suburban areas is less than 1 chance in 10 million per year, and therefore, no such analysis is needed.

For offsite transportation of radioactive materials, route-specific accident rates and accident fatality risks were determined. The values selected were the total state-level accident and fatality rates provided in ANL/ESD/TM-1507 (Saricks & Tompkins, 1999). For the truck transports, the state-level rates were then adjusted based on the distance traveled in each state to derive a route-specific accident and fatality rate per truck-kilometer. Because of the potential underreported data that were used in the Saricks and Tompkins report (UMTRI, 2003), state-level truck accident and fatality rates in the Saricks and Tompkins report were increased by factors of 1.64 and 1.57, respectively, to account for the underreporting (Saricks & Tompkins, 1999; UMTRI, 2003).

Radiological consequences were calculated by assigning radionuclide release fractions on the basis of the type and form of radioactive material, the type of shipping container, and the accident severity category. For this analysis, release fractions were selected based on the radionuclide composition listed in Table 5-5 and guidance in the *Radioactive Material Transportation Study* (NRC, 1977).

Table 5-6 presents the per-shipment risk factors (unit risk factor for a single shipment) calculated for the collective population of exposed persons and for the crew for the anticipated routes and shipment configurations. Radiological risks are presented in terms of doses and LCFs per shipment for each unique route. The radiological risks would result from potential exposure of people to external radiation emanating from the packaged material. The exposed population includes the off-link public (people living along the route), on-link public (pedestrian and car occupants along the route), and public at rest and fuel stops. LCF risk factors were calculated by multiplying the accident dose risks by a health risk conversion factor of 0.0006 LCF per rem or person-rem of exposure (DOE, 2003).

For transportation accidents, the risk factors are given for both radiological impacts, in terms of potential LCFs in the exposed population, and nonradiological impacts, in terms of nonoccupational number of traffic fatalities. LCFs represent the expected number of additional cancer fatalities among the exposed population. Under accident conditions, the population would be exposed to radiation from released radioactivity (if the package were damaged) and would receive a direct dose (even if the package is unbreached). For accidents that had no release, the analysis conservatively assumed that it would take about 12 hours to remove the package or transport vehicle from the accident area (DOE, 2002).

Table 5-6. Risk Factors per Shipment of HALEU

Transportation Modes	*Origin*	*Transport Destination*	*Incident-Free*				*Accident*	
			Crew Dose (person-rem)	*Crew Risk (LCF)* [a]	*Population Dose (person-rem)* [b]	*Population Risk (LCF)* [a]	*Radiological Risk (LCF)* [a]	*Non-radiological Risk (Traffic Fatalities)*
Truck	SRS, SC	BWXT, VA	2×10^{-2}	1×10^{-5}	3×10^{-2}	2×10^{-5}	2×10^{-9}	0.00004
		TRISO-X, TN	1×10^{-2}	8×10^{-6}	2×10^{-2}	1×10^{-5}	3×10^{-9}	0.00004

Key: BWXT = BWX Technologies; LCF = latent cancer fatality; SRS = Savannah River Site; SC = South Carolina; TN = Tennessee; VA = Virginia

[a] Risk is expressed in terms of LCFs. Radiological risk is calculated for one-way travel while nonradiological risk is calculated for two-way travel. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE, 2003). LCF risks are rounded to one non-zero digit.

[b] Person-rem is the exposure of a population to radiation and is the average dose per individual (in rem) multiplied by the number of people exposed. Rem is a unit of effective absorbed dose of ionizing radiation in human tissue.

Table 5-7 shows the risks of transporting HALEU uranyl nitrate solutions. The risks are calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program.

Table 5-7. Risks of Transporting HALEU Uranyl Nitrate

Route	*Number of Shipments*	*One-way Kilometers Traveled*	*Incident-Free*				*Accident*	
			Crew		*Population*		*Radiological Risk* [b]	*Non-radiological Risk*
			Dose (person-rem) [a]	*LCFs* [b]	*Dose (person-rem)* [a]	*LCFs* [b]		
SRS to BWXT	14	10,280	0.2	1×10^{-4}	0.4	2×10^{-4}	3×10^{-8}	0.0006
SRS to TRISO-X	14	8,650	0.2	1×10^{-4}	0.3	2×10^{-4}	4×10^{-8}	0.0005

Key: BWXT = BWX Technologies; LCF = latent cancer fatality; rem = roentgen equivalent man; SRS = Savannah River Site

[a] Person-rem is the exposure of a population to radiation and is the average dose per individual (in rem) multiplied by the number of people exposed. Rem is a unit of effective absorbed dose of ionizing radiation in human tissue. Assumes two truck crew members.

[b] Risk is expressed in terms of LCFs. Radiological risk is calculated for one-way travel while nonradiological risk is calculated for two-way travel. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE, 2003). LCF risks are rounded to one non-zero digit.

As indicated in Table 5-6 and Table 5-7, all shipment risk factors are less than one. This means that no LCFs or traffic fatalities are expected to occur during these transports.

The maximum estimated doses to workers and the public MEIs are presented in Table 5-8, considering all shipments. Doses are presented on a per-event basis (rem per event, per exposure, or per shipment), because it is generally unlikely that the same person would be exposed to multiple events. A member of the public living along the route would likely receive multiple exposures from passing shipments during the period analyzed. The cumulative dose to this resident is calculated by assuming all the shipments pass his or her home. The cumulative dose was calculated assuming the resident is present for every shipment and is unshielded at a distance of about 98 ft from the route. Therefore, the cumulative dose depends on the number of shipments passing a particular point and is independent of the actual route being considered.

Table 5-8. Estimated Dose to Maximally Exposed Individual Under Incident-Free Transportation Conditions

Receptor	*Dose to Maximally Exposed Individual*
Workers	
Crew member (truck driver)	2 rem per year [a]
Inspector	0.012 rem per event per hour of inspection
Public	
Resident (along the truck route)	0.00000025 rem per event
Person in traffic congestion	0.005 rem per event per half an hour stop
Person at a rest stop/gas station	0.0002 rem per event per hour of stop
Gas station attendant	0.0006 rem per event

Key: DOE = U.S. Department of Energy; DOT = U.S. Department of Transportation; rem = roentgen equivalent man

[a] In addition to complying with DOT requirements, a DOE employee would also need to comply with 10 CFR 835, which limits worker radiation doses to 5 rem per year. DOE's goal is to maintain radiological exposure as low as reasonably achievable. DOE has, therefore, established the administrative control level of 2 rem per year (DOE, 2017). Based on the number of commercial shipments and the total crew dose to two drivers in Table 5-7, a commercial driver dose would not exceed this administrative control limit. Therefore, the administrative control limit is reflected in this table for the maximally exposed truck crew member.

If one considers the maximum resident dose provided in Table 5-8 (e.g., 2.5×10^{-7} rem), then the maximum dose to this resident (if all the materials were shipped via this route [a total of 14 shipments]) would be about 0.0035 mrem, with a risk of developing an LCF of about 2×10^{-9} (0.000000002). This 0.0035 mrem dose would be a very small fraction of the 100 mrem annual limit from all sources of ionizing radiation and exposure pathways establishes in DOE Order 458.1.

5.4 Cumulative Effects

As described in Section 4.6.2 of the HEU EIS (DOE, 1996), because no new facilities would be constructed and wastewater discharges constituting more than 1 percent of stream flow would not occur as a result of the implementation of the Proposed Action, the alternatives analyzed would not contribute to cumulative effects for land resources, biotic resources, geology and soil resources, or cultural resources. As described in Table 5-1, there is no new information to indicate that this has changed substantially, so these resource areas are not discussed further. Cumulative effects for site infrastructure, air quality and noise, water resources, socioeconomic, public and occupational health, and waste management were evaluated in Section 4.6.2 of the HEU EIS (DOE, 1996). These effects are summarized in Table 5-10.

Table 5-9. Summary of Cumulative Effects from the HEU EIS

Resource Area	*Summary of Cumulative Effects*
Site Infrastructure	The cumulative effect of implementing the proposed blending facilities in conjunction with other proposed activities was expected to have little or no effect on the onsite road and rail network. The cumulative electrical power requirements for the proposed activities would be limiting. This results primarily from consideration of the accelerator production of tritium alternative of the Tritium Supply and Recycling Program.[a] Cumulative fuel consumption and water/steam supply requirements for all the proposed actions are readily available in the area or can be satisfied through normal contractual means.
Air Quality and Noise	Cumulative concentrations of criteria pollutants would be in compliance with Federal and state regulations. Little or no increase in cumulative noise effects to individuals offsite was expected to occur.

Resource Area	Summary of Cumulative Effects
Water Resources	After treatment, most of the surface water used at SRS is returned to the Savannah River through its onsite tributaries and would not affect downstream users. Pumping from the deep aquifer to meet domestic, process and other water uses has continued since the early 1950s. This usage has not adversely affected water levels in the deep aquifer. The proposed blending facility would account for 0.008% of the total cumulative water usage. The blending down would account for 0.14% of total cumulative wastewater discharge to the Savannah River and 2.2% of the wastewater treated at the Centralized Sanitary Wastewater Treatment Plant. The expected total cumulative wastewater discharge would continue to meet NPDES limits and reporting requirements. Therefore, there would be no substantial adverse cumulative effect.
Socioeconomic	The effects resulting from the proposed blending facilities at SRS on the regional economy, population, housing, community services, and local transportation would be minor. Therefore, this activity would not substantially add to cumulative effects.
Public and Occupational Health	The total cumulative SRS site dose to the MEI would not exceed the 100 mrem/yr limit; however, the 10 mrem/yr limit due to airborne releases (Clean Air Act) could be exceeded if key potential activities at the site were operational at the same time as the blending processes. This potential limit exceedance, however, conservatively assumes that the MEI would have to be located at several different receptor points simultaneously, therefore representing an upper-bounding scenario. Doses from the blending down activities would be a small portion of these estimated totals and would not substantially contribute to cumulative effects.[b]
Waste Management	The surplus HEU blending would have consistently smaller impacts than other foreseeable activities. Therefore, the overall effect of blending down would not contribute significantly to cumulative effects at SRS.

Key: % = percent; EIS = Environmental Impact Statement; FR = Federal Register; HEU = highly enriched uranium; MEI = maximally exposed individual; mrem = millirem; NPDES = National Pollutant Discharge Elimination System; rem = roentgen equivalent man; SRS = Savannah River Site; yr = year

[a] Accelerator production of tritium was not implemented at SRS. Therefore, this cumulative effect was not realized.

[b] A number of the activities evaluated in the HEU EIS that could contribute to the possible exceedance of dose limits and other impacts did not occur as expected or have been largely completed. This includes activities evaluated in the Interim Management of Nuclear Materials EIS, DOE/EIS-0220, (DOE 1995) and the F-Canyon Plutonium Solutions EIS, DOE/EIS-0219, (DOE 1994). Therefore, the potential higher level of cumulative effects predicted in the HEU EIS did not occur. See the cumulative effects estimated in the SPDP EIS (DOE, 2003) for updated analyses.

The *Final Environmental Impact Statement for the Surplus Plutonium Disposition Program* (SPDP EIS) (DOE, 2023) provides the most recent comprehensive cumulative effects analysis for SRS. The cumulative effects evaluated in the SPDP EIS include activities in H-Area. The SPDP EIS (DOE, 2023) considered additional activities that were not considered in the HEU EIS cumulative effects analysis. Activities that could be considered "new circumstances or information relevant to environmental concerns" are listed in Table 5-11.

Table 5-10. Reasonably Foreseeable Actions that may not have been Considered in the HEU EIS Cumulative Effects Analysis

Project Name	Description
Pit Production Mission (DOE/EIS-0541)	Repurposing of the partially constructed MFFF to produce a minimum of 50 war reserve pits a year and to develop a short-term surge capacity of not less than 80 war reserve pits a year. Operations would begin in 2030.
H-Canyon processing of Spent Nuclear Fuel (DOE/EIS-0279, DOE/EIS-0279-SA-01, DOE/EIS-0218-SA-06, and DOE/EIS-0279-SA-07)	Program that is projected to operate through 2034, and possibly through 2040, to receive, dissolve, and process SNF. It includes the Accelerated Basin De-inventory mission that transfers spent nuclear fuel from L-Basin to H-Canyon for conventional processing with no uranium recovery. DOE would use the processing capabilities within H-Canyon to dissolve the SNF for immobilization of the resulting liquid radioactive waste at the Defense Waste Processing Facility.
K-Area processing of 6 MT of non-pit surplus plutonium for disposal at the WIPP facility	Program that is currently processing 6 MT of non-pit surplus plutonium using the dilute and dispose strategy in the KIS glovebox.
K-Area tie into the SRS Central Sanitary Wastewater Treatment Facility	Proposed project to tie in the KAC wastewater system to the SRS Central Wastewater Treatment Facility. Pumping the sanitary wastewater from KAC will require approximately 21,000 ft of forced main piping and two new lift stations
Tritium Finishing Facility (DOE/EA-2151)	Project to replace key capabilities in H-Area. This is a 1950s vintage building that presents a potential risk to the tritium mission. Two new buildings would be added and Building 249-H and a portion of Building 234-7H would be renovated. Three warehouses would be removed, one warehouse replaced, and utilities and infrastructure upgrades made as needed to support the facilities.
EnergySolutions LLW Disposal facility	Project to process and dispose of commercial LLW.
Disposal of decommissioned, defueled ex-Enterprise (CVN 65) aircraft carrier	Proposed disposal of the decommissioned, defueled ex-Enterprise (CVN 65) aircraft carrier, including its associated naval reactor plants. Preferred Alternative include disposal of LLW at Waste Control Specialists, EnergySolutions, and SRS.
Commercial Disposal of SRS Contaminated Process Equipment (DOE/EA-2154)	Proposed disposal of certain SRS-contaminated process equipment at a commercial LLW disposal facility outside of South Carolina (licensed by either the NRC or an Agreement State pursuant to the NRC's regulations).
Alvin W. Vogtle Electric Generating Plant	Project for ongoing operation of Units 1 and 2, and construction of Units 3 and 4; two Westinghouse AP1000 nuclear reactors (1,117 MW each). Unit 3 entered commercial operation in July 2023 and Unit 4 entered commercial operation in April 2024.
Starmet (previously known as Carolina Metals, Inc.)	Project to process uranium-contaminated metal. Construction related to this project is not expected to affect transportation to and from SRS, and annual monitoring reports indicate that the decommissioning activities do not noticeably affect radiation levels in the air or water in the vicinity of SRS. Therefore, this project is not included in this cumulative effect assessment.
I-20 Augusta Canal and Savannah River Bridges	Georgia and South Carolina DOT have agreed to replace the existing I-20 Augusta Canal and Savannah River Bridges (currently two 2-lane structures) with a 6-lane bridge (3 lanes in each direction). Construction was initiated in January 2019 and is expected to be complete in 2024. Construction related to this project is not expected to affect transportation to and from SRS. Therefore, this project is not included in this cumulative effect assessment.
U.S. Cyber Command Center, Fort Gordon	DoD Initiative with significant influx of personnel (1,200 workers) into the Augusta metro area.

Source: (DOE, 2023)

Key: DoD = U.S. Department of Defense; DOE = U.S. Department of Energy; DOT = U.S. Department of Transportation; EIS = environmental impact statement; ft = feet; KAC = K-Area Complex; KIS = K-Area Interim Storage; LLW = low-level radioactive waste; MFFF = Mixed-Oxide Fuel Fabrication Facility; MT = metric ton; MW = megawatt; NRC = U.S. Nuclear Regulatory Commission; SA = Supplement Analysis; SNF = spent nuclear fuel; SRS = Savannah River Site

As summarized in Section 2.5 of the SPDP EIS, potential cumulative effects for the associated resource areas range from none to minor for all resource areas except for cultural resources and transportation.

Cultural Resources – The SPDP EIS states that potential cultural resources cumulative effects may occur because cultural resources are considered nonrenewable and adverse effects from any action on any National Register of Historic Places-eligible or potentially eligible historic resource would substantially contribute to cumulative effects within the SRS ROI. There would be no contribution to cumulative effects on cultural resources from the Proposed Action evaluated in this SA because no construction or land disturbance would occur.

Transportation – Potential transportation cumulative effects may arise from offsite transportation throughout the United States. Under the alternatives evaluated in this SPDP EIS, when combined with past, present, and reasonably foreseeable future actions, the collective worker dose was estimated to be 430,000 person-rem (260 LCFs). The collective general population dose was estimated to be 440,000 person-rem (260 LCFs). The total number of LCFs (among the workers and general population) estimated to result from radioactive material and waste transportation over the period between 1943 and 2073 is 520, or an average of about 4 LCFs per year. The transportation-related LCFs represent about 0.0007 percent of the overall annual number of cancer deaths in the United States in 2019. Most of the cumulative risk to workers and the general population would be due to the general transportation of radioactive material and waste unrelated to activities evaluated in the SPDP EIS. Potential transportation cumulative effects may also arise from traffic fatalities. In the United States, the average number of highway traffic fatalities was 34,860 per year for the 10-year period from 2010 through 2019. It is estimated that there could be an additional increase in the number of traffic fatalities of up to 1 (0.3 to 0.6) under the Preferred Alternative over about 30 years. As described in Section 5.3 of this SA, the Proposed Action would not add substantial to the cumulative transportation effects described in the SPDP EIS.

As described in Section 5.3 of this SA, transportation of HALEU under the Proposed Action evaluated in this SA would result in no worker or public fatalities or LCFs, and therefore would not add substantial to the cumulative transportation effects described in the SPDP EIS.

In summary, as described in Section 2 of this SA, implementing the Proposed Action would entail activities at H-Area that are the same as or comparable to existing or historic operations and much lower in intensity than activities evaluated in the HEU EIS. Therefore, as described in this section, the Proposed Action is not expected to result in a substantial increase in cumulative effects.

5.5 Effects of Blending Down to Lower Enrichments

As part of the Proposed Action, this SA analyzes blending down HEU to HALEU at 19.75 percent U-235 enrichment. It is possible DOE may be asked to provide HALEU at lower enrichment levels. This section evaluates blending down to lower enrichments and includes a paragraph for each the three resource areas of interest: (1) Human Health – Normal Operations; (2) Human Health – Accidents; and (3) Transportation. Blending down to 15.5 percent enrichment is specifically covered, but blending down to lower enrichments is also discussed.

Human Health – Normal Operations: The impacts associated with the Proposed Action were evaluated based on the throughput of HEU which does not change due to differences in the enrichment of the HALEU product. These results were scaled (see Section 5.1 of this SA) from the impacts presented in the HEU EIS (DOE, 1996) which were also based on HEU throughput. The most significant change to the analysis from that EIS to this SA analysis was the inclusion of U-234 in the normal operations source term for the Proposed Action. The human health impacts from the release of uranium during the blending process are dominated by the potential release of U-234 (over 90 percent of the curies released from normal operations is attributable to U-234). Most of the U-234 is contained within the HEU feed as the U-234 content is significantly higher in the HEU feed (0.36 percent U-234) than in the natural uranium feed (0.005 percent U-234). Since the amount of HEU being blended down does not change with the enrichment of the HALEU product (only the quantities of HALEU produced and natural uranium feed increase), the U-234 available to be released does not change appreciably with different HALEU enrichments. Therefore, the impacts associated with the production of HALEU enriched to 19.75 percent are representative of the impacts for the production of lower enriched, for example 15 percent, HALEU.

Human Health – Accidents: The accident risks are dominated by the U-234. As discussed earlier, the fraction of U-234 decreases as the product enrichment is lowered. Therefore, going from a fire involving 19.75 percent U-235 enriched HALEU to a fire involving 15.5 percent or 10 percent enriched HALEU lowers the amount of U-234 that would be released. The reduced consequences are directly proportional to the U-234 content. Therefore, the environmental consequences of facility accidents with 19.75 percent enriched HALEU would bound the impacts of lower HALEU enrichments. The following transportation discussion presents more details on the U-234 content with various enrichments.

Transportation: The Proposed Action in this SA is to blend down about 2.2 MT of HEU uranyl nitrate solution with natural uranyl nitrate solution to produce HALEU. Depending on the final U-235 enrichment, which could range between 10 percent, 15.5 percent, and 19.75 percent, the HEU blend down would lead to a range of HALEU mass of about 6.4 MT (at 10 percent U-235), to 4.0 MT (at 15.5 percent U-235), to 3.1 MT (at 19.75 percent U-235) of HALEU uranyl nitrate solution (SRNL, 2024). The uranium contents in the HALEU solution would range between about 55.5 to 29 grams per liter for the HALEU solution with a U-235 enrichment of 10 and 19.75 percent, respectively.

Table 5-12 lists the uranium weight fractions and the corresponding uranium activity of the 10 and 15.5 percent U-235 solutions in an LR package. Given the volume of the LR packages, there would be a total of 15 truck shipments for the 10 percent and 15.5 percent U-235 enrichments, and in each LR package, there would be about 5 kilograms (11 pounds) of U-235, which would be less than the maximum amount allowed (e.g., 12 pounds) per the package Certificate of Compliance (NRC, 2024).

Table 5-13 shows the risks of transporting 15 shipments of 15.5 percent U-235 HALEU uranyl nitrate solutions. This would bound the impacts of transporting 15 shipments of 10 percent U-235 solutions. The table also shows the 15.5 percent HALEU solutions would have similar environmental effects as the 19.75 percent U-235 solutions; shipment risk factors are less than one, and no LCFs or traffic fatalities are expected to occur during the transports.

Table 5-11. Uranium Content of an Liqui-Rad Package with 10 and 15.5 Percent Uranium-235 Enrichment

Radioisotope	*Weight Fraction*		*Activity [a] per LR (Ci)*	
	10 percent U-235	***15.5 percent U-235***	***10 percent U-235***	***15.5 percent U-235***
Uranium-234	0.0013	0.0020	3.85×10^{-1}	3.98×10^{-1}
Uranium-235	0.10	0.1550	1.04×10^{-2}	1.07×10^{-2}
Uranium-236	0.0062	0.0099	1.95×10^{-2}	2.05×10^{-2}
Uranium-238	0.8925	0.8331	1.45×10^{-2}	8.92×10^{-3}
Impurities (parts per billion U)				
Cesium-137	6.48×10^{-4}	1.03×10^{-3}	2.72×10^{-6}	2.86×10^{-6}
Neptunium-237	$1.25 \times 10^{+3}$	$1.99 \times 10^{+3}$	4.28×10^{-5}	4.49×10^{-5}
Bismuth-212	1.27×10^{-6}	2.02×10^{-6}	9.21×10^{-4}	9.66×10^{-4}

Radioisotope	Weight Fraction		Activity [a] per LR (Ci)	
	10 percent U-235	15.5 percent U-235	10 percent U-235	15.5 percent U-235
Lead-212	1.30×10^{-5}	2.07×10^{-5}	8.81×10^{-4}	9.25×10^{-4}
Thorium-228	2.11×10^{-2}	3.37×10^{-2}	8.38×10^{-4}	8.80×10^{-4}
Others (mass volume and density of final HALEU products)				
HALEU Mass [b]	6.37	4.0	6.37	4.0
HALEU Volume [c]	114,729	109,316	114,729	109,316
HALEU Density [d]	55.5	36.6	55.5	36.6

Source: (SRNL, 2024)

Key: Ci = curie; HALEU = high-assay low-enriched uranium; LR = Liqiu-Rad package; U = uranium; U-235 = uranium-235

[a] Activity refers to the decay rate of a radionuclide. One curie is defined as 3.7×10^{10} disintegrations per second.

[b] Total mass of HALEU in uranyl nitrate solution in MT.

[c] Volume of HALEU solution in liters. To convert into gallons, divide the number by 3.7856.

[d] HALEU density in grams per liter. To convert into pounds per gallon, multiply the number by 0.0083.

Table 5-12. Risks of Transporting HALEU Uranyl Nitrate Enriched to 15.5 Percent Uranium-235

Route	Number of Shipments	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population		Radiological Risk [b]	Non-radiological Risk
			Dose (person-rem) [a]	LCFs [b]	Dose (person-rem) [a]	LCFs [b]		
SRS to BWXT	15	11,010	0.2	1×10^{-4}	0.4	2×10^{-4}	3×10^{-8}	0.0006
SRS to TRISO-X	15	9,270	0.2	1×10^{-4}	0.4	2×10^{-4}	4×10^{-8}	0.0005

Key: BWXT = BWX Technologies; LCF = latent cancer fatality; rem = roentgen equivalent man; SRS = Savannah River Site

[a] Person-rem is the exposure of a population to radiation and is the average dose per individual (in rem) multiplied by the number of people exposed. Rem is a unit of effective absorbed dose of ionizing radiation in human tissue. Assumes two truck crew members.

[b] Risk is expressed in terms of LCFs. Radiological risk is calculated for one-way travel while nonradiological risk is calculated for two-way travel. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE, 2003). LCF risks are rounded to one non-zero digit.

5.6 Conclusions

DOE proposes to use existing H-Area facilities to blend down existing stocks of HEU to HALEU. DOE would implement the Proposed Action evaluated in this SA by mixing HEU and natural uranium solutions to produce a HALEU solution. The HALEU solution would be loaded into LR containers and shipped by tractor trailer truck to offsite commercial facilities for further processing into HALEU fuel for use in advanced reactors[17].

This SA updates the principal potential environmental effects that could result from the Proposed Action. These effects were determined to be small, and would not result in releases to the environment, or

[17] The processing of HALEU into fuel for advanced reactors and its use in advanced reactors would be within the operating envelope of those facilities. The environmental effects are, or would be, evaluated in the NEPA documents prepared for those facilities and are not evaluated in this SA.

radiation doses or risks to members of the public or workers that would be substantially larger than those evaluated in the HEU EIS.

6 Determination

In accordance with the NEPA and DOE's (10 CFR 1021.314) implementing NEPA regulations, DOE prepared this SA to evaluate whether the proposed change and new information requires supplementing the existing SRS SNF EIS (DOE, 2000a), the HEU EIS (DOE, 1996), or preparing a new EIS. DOE concludes that the proposed change and new information is not a substantial change relative to the proposals analyzed in the SRS SNF EIS and the HEU EIS. Therefore, no further NEPA analysis is required. DOE will amend the RODs for the SRS SNF EIS and HEU EIS to reflect the decision with respect to blending down HEU to HALEU in H-Area at SRS.

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4/18/25
Date