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SUPPLEMENT ANALYSIS

DISPOSITION OF SURPLUS HIGHLY ENRICHED URANIUM

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Acronyms

BWXT	BWXT Nuclear Operations Division
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
DOE/NNSA	U.S. Department of Energy/National Nuclear Security Administration
DOT	U.S. Department of Transportation
EIS	environmental impact statement
FRR SNF EIS	*Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*
INL	Idaho National Laboratory
ISO	International Organization for Standardization
LCF	latent cancer fatalities
LEU	low-enriched uranium
LLW	low-level radioactive waste
MEI	maximally exposed individual
MEOI	maximally exposed offsite individual
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services, Inc.
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ROD	Record of Decision
SA	supplement analysis
SRS	Savannah River Site
SST	DOE safe, secure transport
SST/SGT	SST/SafeGuards Transport
TRAGIS	Transportation Routing Analysis Geographic Information System
UF_6	uranium hexafluoride
UN	uranyl nitrate
UO_3	uranium trioxide
U_3O_8	triuranic octaoxide
UNH	uranyl nitrate hexahydrate
U-235	uranium-235
WSRC	Westinghouse Savannah River Company/Washington Savannah River Company
Y–12	Y–12 National Security Complex

SUPPLEMENT ANALYSIS

DISPOSITION OF SURPLUS HIGHLY ENRICHED URANIUM

1.0 INTRODUCTION AND PURPOSE

The U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) maintains an ongoing program for disposition of surplus U.S.-origin highly enriched uranium (HEU). The purposes of this program are to support U.S. nuclear weapons nonproliferation policy by reducing global stockpiles of excess weapons-usable fissile materials and to recover the economic value of the materials to the extent feasible. Activities supporting disposition of this HEU have been underway for more than a decade in accordance with the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (*HEU EIS*) (DOE 1996a) and the associated Record of Decision (ROD) (61 FR 40619; August 5, 1996).

This supplement analysis (SA) summarizes the status of HEU disposition activities conducted to date and evaluates the potential impacts of continued program implementation. In addition, this SA considers the potential environmental impacts of proposed new DOE/NNSA initiatives to support the surplus HEU disposition program. Specifically, DOE/NNSA is proposing new end-users for existing program material, new disposal pathways for existing program HEU discard material, and down-blending additional quantities of HEU.

Council on Environmental Quality (CEQ) regulations under Title 40, Section 1502.9(c) of the *Code of Federal Regulations* (CFR) (40 CFR 1502.9(c)) require Federal agencies to prepare a supplement to an environmental impact statement (EIS) when an agency makes substantial changes to a proposed action that are relevant to environmental concerns, or when there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. CEQ also recommends careful re-examination of EISs that are more than 5 years old and concern ongoing programs to determine whether a supplement to the EIS is required. DOE regulations under 10 CFR 1021.314(c) further direct that, when it is unclear whether a supplement to an EIS is required, an SA should be prepared to assist in that determination.

This SA evaluates the potential environmental impacts of both the current ongoing program and proposed new initiatives in accordance with these requirements to determine whether the existing *HEU EIS* should be supplemented, a new EIS should be prepared, or no further National Environmental Policy Act (NEPA) analysis is necessary.

2.0 BACKGROUND

Surplus U.S.-origin HEU is primarily stored at the Y–12 National Security Complex (Y–12) on the Oak Ridge Reservation (ORR) in Tennessee in accordance with the RODs for the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996b; ROD: 62 FR 3014; January, 21, 1997) and the *Final Site-Wide Environmental Impact Statement for the Y–12 National Security Complex* (DOE 2001; ROD: 67 FR 11296; March 13, 2002). Disposition of this material is conducted in accordance with the *HEU EIS* ROD, which specifically analyzes down-blending and subsequent management of a nominal 200 metric tons of surplus HEU.

Uranium enriched in the isotope uranium-235 (U-235) to 20 percent or above is considered highly enriched and is suitable for use in nuclear weapons. Down-blending HEU involves diluting this material to lower enrichment levels by blending it with other uranium materials (blendstock) to produce low-enriched uranium (LEU), which is considered unsuitable for use in weapons. Blendstock materials used in this process may include LEU, natural uranium, or depleted uranium.

2.1 Scope of the *HEU EIS*

The *HEU EIS* evaluates down-blending HEU to LEU at U-235 enrichment levels that would be suitable for either fabrication into commercial nuclear fuel (typically 3 to 5 percent U-235 enrichment) or disposal as low-level radioactive waste (LLW) (0.9 percent U-235 enrichment) using one or more of three blending technologies: uranyl nitrate (UN); molten metal; and uranium hexafluoride (UF_6).[1] In addition, the *HEU EIS* evaluates conducting this down-blending at up to four existing U.S. facilities: Y–12; the Savannah River Site (SRS) in South Carolina; Babcock and Wilcox (now BWXT Nuclear Operations Division [BWXT]) in Lynchburg, Virginia; and Nuclear Fuel Services, Inc., (NFS) in Erwin, Tennessee. These sites were considered because they have technically viable HEU conversion and blending capabilities and could blend surplus HEU to LEU for use as commercial fuel or disposal as waste. BWXT and NFS are the only commercial enterprises in the United States licensed by the U.S. Nuclear Regulatory Commission (NRC) to process HEU.

Because of the many possible permutations of end products, blending technologies, and blending sites, DOE analyzed several options that encompassed the range of reasonable alternatives. In the associated ROD, DOE announced selection of its preferred alternative: to blend down up to 85 percent (approximately 170 metric tons) of the surplus HEU to LEU for use in fabricating commercial fuel for nuclear power plants; and to blend down the remaining 15 percent (approximately 30 metric tons) for disposal as waste. In addition, DOE announced a programmatic decision to distribute down-blending services among the four facilities considered in the *HEU EIS* over a period of 15 to 20 years.

2.2 Status of Surplus HEU Disposition Activities

The *HEU EIS* explained that approximately 175 of the nominal 200 metric tons of HEU analyzed had already been declared surplus. DOE/NNSA subsequently defined disposition pathways for specific batches of the material. As of March 2007, approximately 100 of the 175 metric tons initially declared surplus has been down-blended using a combination of the four blending sites considered in the *HEU EIS*. Disposition of another approximately 10 metric tons of the material is in progress under ongoing campaigns.

DOE/NNSA has identified the characteristics of the balance of the 200 metric tons of HEU analyzed in the *HEU EIS*. Disposition of these batches of HEU is proposed or anticipated to occur as part of future down-blending campaigns or other initiatives:

- Approximately 17.4 metric tons of HEU were recently proposed for down-blending to support the Reliable Fuel Supply Initiative (described in **Section 3.1** of this SA).

- Approximately 28 metric tons of HEU are presently unallocated material that DOE/NNSA expects to dispose of in future down-blending campaigns similar to those completed or in progress (anticipated between 2008 and 2030).

[1] In the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*, the uranyl nitrate and uranium hexafluoride blending technologies are evaluated for down-blending surplus highly enriched uranium to 4 percent uranium-235 enrichment for commercial use; the uranyl nitrate and molten metal technologies are evaluated for down-blending to 0.9 percent uranium-235 enrichment for disposal as waste.

- Approximately 18 metric tons of HEU are currently considered unsuitable for beneficial reuse and are expected to be disposed of as waste in either a geologic repository for spent nuclear fuel or a LLW facility. Most of this material is in the form of spent nuclear fuel. No timeframe for this activity has been established.

- Approximately 25 metric tons of HEU would come from future declarations of surplus material that would be disposed of consistent with the *HEU EIS* ROD.

Some aspects of the proposed action to complete future disposition of specific quantities of HEU differ from or extend beyond the activities considered in the *HEU EIS*. These aspects are the subject of this SA.

3.0 PROPOSED ACTION

Since the mid-1990s, DOE/NNSA has maintained an ongoing program for disposition of surplus U.S.-origin HEU. In addition to continuing these activities, DOE/NNSA proposes to implement new initiatives and modify certain elements of the existing surplus HEU disposition program, including:

- Supplying potential new end-users with LEU from surplus HEU (approximately 17.4 metric tons) in support of the Reliable Fuel Supply Initiative;

- Establishing new disposition pathways for HEU discard material (approximately 18 metric tons);

- Down-blending additional quantities of HEU (approximately 20 metric tons).

3.1 New End-Users of Existing Program Material

The Reliable Fuel Supply Initiative is a series of mechanisms to be instituted by the United States to ensure that foreign countries with good nonproliferation credentials that refrain from developing and deploying uranium enrichment and reprocessing technologies continue to have access to the nuclear fuel market and the benefits of nuclear power. As one component of this initiative, DOE plans to down-blend and hold a supply of LEU to serve as backup in case other market mechanisms fail. Specifically, DOE/NNSA has procured commercial services to down-blend 17.4 metric tons of surplus U.S.-origin HEU to LEU, and maintain this supply of LEU until needed. The primary components of this proposed action consist of:

- Processing and packaging the material for offsite shipment at Y–12 in Tennessee.

- Shipping 17.4 metric tons of HEU from Y–12 to a commercial blending site.

- Down-blending the HEU to LEU using the liquid UN process.

- Transporting the resulting LEU (approximately 290 metric tons) as uranyl nitrate hexahydrate (UNH) or oxide from the blending site to a U.S. commercial fuel fabrication facility. The fabricator would be required to maintain 40 metric tons of LEU in storage, and would be able to use the majority of the remaining LEU for working inventory, subject to contractual conditions for providing LEU when requested by DOE/NNSA. LEU storage would be accommodated within the facility's existing capacity and operating license, and would not require additional construction.

- Shipping quantities of LEU, in the form of UF_6, to participating foreign countries as directed by DOE/NNSA and in accordance with procedures and requirements governing the sale of this material.

DOE/NNSA awarded a contract for this down-blending work on June 29, 2007.[2] Shipments of HEU to the blending contractor began in August 2007, and down-blending is scheduled to be completed in approximately 4 years. Most of the activities necessary to support disposition of the 17.4 metric tons of surplus HEU allocated to the Reliable Fuel Supply have already been evaluated in the *HEU EIS*, including transport of the HEU from storage at Y–12 to the blending site; down-blending the HEU to LEU; and transporting the LEU from the blending site to a domestic commercial fuel fabricator. As such, potential impacts associated with these activities are not revisited in this SA. However, the proposed action in this SA also includes transporting LEU fuel to participating foreign countries, which would constitute potential new end-users of HEU disposition program material. Because transport of this material to these new end-users is not within the scope of the *HEU EIS*, this SA evaluates the potential impacts of its transportation from the commercial fuel fabricator to a U.S. ocean port and across the global commons. Overland and ocean shipments under this initiative are expected to be similar to routine commercial transport of LEU.

No decisions have been made regarding the potential sale and transport of Reliable Fuel Supply LEU to specific foreign countries. If DOE/NNSA ultimately decides not to implement the international component of this proposed action, the HEU could still be down-blended for commercial use within the United States consistent with the ongoing surplus HEU disposition program.

3.2 New Disposition Pathways for HEU Discard Material

This SA also evaluates the proposed direct disposition of HEU discards in the form of spent nuclear fuel and low equity materials.[3] The *HEU EIS* analyzed the potential down-blending of surplus HEU that could be separated from spent nuclear fuel—pursuant to health and safety, stabilization, or other nondefense activities—to LEU. The *HEU EIS* also evaluated down-blending a minimum of 30 metric tons of HEU to an enrichment level of 0.9 percent U-235 for disposition as waste, and assumes this waste would then be disposed of at a LLW facility. This disposition approach is analyzed in the *HEU EIS* partly to address "off-specification materials," which at the time had no economically viable pathway for fabrication to commercial reactor fuel.[4] Subsequent changes in HEU market conditions and establishment of the Tennessee Valley Authority Off-Specification Fuel Program in 2001 have provided an economical means of using such material as fuel. However, approximately 18 of the 175 metric tons of HEU initially declared surplus are still considered unsuitable for use in fuel. DOE/NNSA is no longer considering down-blending this material for disposition as waste, but intends to directly dispose of it in either a geologic repository or a LLW facility:

- Approximately 15 metric tons of HEU discard material in the form of spent nuclear fuel stored at Idaho National Laboratory (INL) are proposed for direct disposal in a geologic repository.
- Approximately 3 metric tons of HEU (not in the form of spent nuclear fuel) considered low-equity materials are proposed for direct disposal in a LLW facility.

The impacts of transporting this spent nuclear fuel from INL for disposal at the proposed Yucca Mountain geologic repository are addressed in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002a). The impacts of transporting HEU material suitable for disposal as low-level waste at the Nevada Test Site (NTS) are addressed in the *HEU EIS*.

[2] DOE/NNSA awarded the Reliable Fuel Supply contract to a team consisting of Wesdyne International (a subsidiary of Westinghouse Electric Company) and NFS. Under the terms of the contract, NFS will down-blend the 17.4 metric tons of surplus HEU to LEU at its facility in Erwin, Tennessee, and Wesdyne International will store the LEU at the Westinghouse fuel fabrication facility in Columbia, South Carolina (DOE 2007).

[3] Low-equity items include materials with varying enrichments no longer needed for programmatic needs, have no further defined use, and are commonly considered uneconomical for recovery due to low concentration of HEU or impurities.

[4] "Off-specification" highly enriched uranium refers to material possessing characteristics undesirable for use in commercial nuclear fuel.

Because the *HEU EIS* analyses already account for the potential impacts that would have been associated with down-blending surplus HEU for disposal as waste, the proposed direct disposal of this material would add approximately 18 metric tons to the blending margin available under the existing *HEU EIS* analyses, as described further in Section 3.3.

3.3 Down-Blending of Additional HEU

Lastly, this SA addresses the proposed future down-blending of additional quantities of HEU that were not associated with the surplus HEU disposition program at the time the *HEU EIS* was prepared. These additional quantities primarily derive from two sources: new material recently declared excess to weapons needs, and HEU returned to DOE from domestic and foreign research reactor programs. DOE/NNSA proposes to down-blend these additional quantities of HEU to LEU for use in fabricating commercial fuel for nuclear power plants.

HEU recently declared excess. In the fall of 2005, an additional 200 metric tons of HEU were declared excess to weapons needs. The U.S. Naval Reactors Program will use much of this material as fuel. However, DOE/NNSA anticipates that approximately 30 metric tons of this HEU will be unsuitable for use as naval reactor fuel and proposes to down-blend it to LEU. Another 20 metric tons of this material are already designated for down-blending. Disposition of these combined 50 metric tons of HEU is proposed to begin in 2008 and be incorporated into down-blending campaigns over the next several decades.

Domestic and foreign research reactor returns. DOE/NNSA is also considering down-blending approximately 10 metric tons of HEU from domestic and foreign research reactor returns.[5] The vast majority of these 10 metric tons of HEU would be processed and down-blended at SRS. The impacts of transporting spent nuclear fuel to SRS are evaluated in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995) and the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS)* (DOE 1996c). In 2004, DOE/NNSA extended the schedule for receipt of foreign research reactor spent nuclear fuel through 2019 (69 FR 69901; December 1, 2004).

Associated recovery operations are evaluated in the *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement (SRS SNF EIS)* (DOE 2000). DOE/NNSA may recover some or all of this spent nuclear fuel in H-Canyon consistent with the RODs for the *FRR SNF EIS* (61 FR 25092; May 17, 1996) and *SRS SNF EIS* (65 FR 48224; August 7, 2000). In addition, DOE is currently preparing the *Highly Enriched Uranium and Spent Nuclear Fuel Management SA* to address management activities for spent nuclear fuel stored at INL and SRS, including the use of H-Canyon for separation and recovery of HEU embedded in research reactor returns and certain other spent nuclear fuel.

While there are no current or anticipated DOE/NNSA plans to process spent nuclear fuel solely for the purposes of extracting HEU, activities associated with the fuel for the purposes of stabilization, facility cleanup, treatment, waste management, safe disposal, or other environment, safety, and health reasons could result in the separation of HEU in weapons-usable form that could pose a proliferation threat. Therefore, if HEU is recovered from spent HEU fuel, it would be available for down-blending consistent with the ROD for the *HEU EIS* and addressed within the scope of this SA.

This SA assumes the surplus HEU proposed for disposition would be located at either Y–12 or SRS. The blending sites, processes, and annual throughputs associated with disposition of these additional

[5] These approximately 10 metric tons may include other miscellaneous HEU materials, and are not a subset of the 200 metric tons of highly enriched uranium declared excess in the fall of 2005.

quantities of HEU (approximately 60 metric tons) are expected to be identical or similar to those evaluated in the *HEU EIS*. Because down-blending of approximately 25 metric tons of HEU presently remains available within the scope of analysis originally considered in the *HEU EIS* and the proposed direct disposal of HEU discard material (addressed in **Section 3.2** of this SA) would also increase the available blending margin another 18 metric tons, disposition of all but approximately 20 metric tons of these additional quantities of HEU would occur within the scope of the *HEU EIS*. However, because the total additional quantity of HEU involved and the timing of the actions would still exceed those evaluated in the *HEU EIS*, these aspects are addressed in this SA.

4.0 IMPACTS

This section evaluates the potential environmental impacts of continuing surplus HEU disposition activities at each of the blending sites evaluated in the *HEU EIS* (Y-12, BWXT, NFS, and SRS) and identifies where current key data or assumptions differ from those considered in the *HEU EIS* analyses. It also evaluates the potential environmental impacts of proposed disposition program initiatives for DOE/NNSA surplus HEU: specifically, new end-users for existing program material, new disposal pathways for existing HEU discard materials, and down-blending additional quantities of HEU. A discussion of potential impacts resulting from intentional destructive acts (i.e., acts of sabotage or terrorism) is also presented.

4.1 Overview of Impacts Analysis

The following discussions provide an overview of the analyses and results originally presented in the *HEU EIS*, address key parameters or assumptions that have since changed, and describe the DOE/NNSA approach to determining impacts associated with the SA proposed action.

4.1.1 Key Assumptions and Impacts Presented in the *HEU EIS*

A number of key assumptions form the basis for the analyses presented in the *HEU EIS*:

- The analyses evaluated disposition of a nominal 200 metric tons of surplus HEU, resulting in two possible end products: (1) LEU that can be used as commercial nuclear reactor fuel feed (at a U-235 enrichment level of approximately 4 percent) and (2) LEU that can be disposed of as LLW (at a U-235 enrichment level of approximately 0.9 percent).

- To assess potential environmental impacts, the down-blending analyses assume that surplus HEU is enriched to 50 percent U-235 based on a weighted average of the surplus HEU in inventory at that time.

- Impacts are based on an annual HEU throughput of 10 metric tons at each of the sites when down-blending for use as commercial fuel and an annual HEU throughput of 2.1 to 3.1 metric tons when down-blending to waste. Construction of new facilities would not be required.

- For transportation analyses purposes, most of the surplus HEU would originate from Y–12. The transportation analyses also conservatively assume that the longest route (Hanford to all potential blending sites) would be representative for shipping the blendstock material necessary to support down-blending activities. The NTS is used as a representative site to evaluate the impacts of transportation from the blending sites to an LLW disposal site.

As discussed in **Section 2.1**, DOE developed and analyzed several alternatives to represent reasonable choices within the range of possible end products, blending technologies, and blending sites. In the *HEU EIS*, the results of Alternative 2, No Commercial Use, and Alternative 5, Maximum Commercial Use (the preferred alternative), generally envelope the range of potential impacts associated with the proposed action. Alternative 2, No Commercial Use, assumes that all 200 metric tons of surplus HEU would be down-blended to LLW using a combination of all four blending sites (Y–12, BWXT, NFS, and SRS). Conversely, Alternative 5 assumes gradually down-blending up to 170 metric tons of surplus HEU using a combination of the four sites, selling the resulting commercially usable LEU for use as reactor fuel, and down-blending the remaining surplus HEU that has no commercial value (up to 30 metric tons) to LEU for disposition as LLW. The other two action alternatives presented in the *HEU EIS* (Alternative 3, Limited Commercial Use, and Alternative 4, Substantial Commercial Use) represent additional fuel/waste blending ratios and points of reference along the continuum bounded by *HEU EIS* Alternatives 2 and 5.

Because no new construction would be required and the down-blending activities conducted to support the proposed action would be either identical or very similar to operations that have occurred at the analyzed facilities in the past, DOE concluded that the potential incremental impacts from the *HEU EIS* proposed action at the blending sites would be low. However, DOE acknowledged that impacts could change over the life of the campaign if the exact fuel/waste ratio or division among sites were different than evaluated. Accordingly, the *HEU EIS* analyzes the impacts of site variations for the preferred alternative that would involve down-blending 0, 25, 50, and 100 percent of the surplus HEU at each of the sites. Based on these analyses, DOE concluded that the expected impacts would be low for many parameters (including radiological impacts) during normal operations and would be within the regulatory limits for each site even if that site were to down-blend 100 percent of the inventory. Therefore, the impacts at any site from any possible distribution of the down-blending work among the facilities would similarly be low and would be bounded by the analyses in the *HEU EIS*.

4.1.2 Key Changes in the Past 10 Years

In preparing this SA, DOE/NNSA has compared the assumptions and down-blending operations evaluated in the *HEU EIS* against actual operational experience over the past 10 years and determined that the following core assumptions have not changed:

- Surplus HEU blending sites and processes are the same as those evaluated in the *HEU EIS*.
- Annual down-blending throughputs vary, but are within the parameters considered in the *HEU EIS*.
- Surplus HEU material forms are consistent with those evaluated in the *HEU EIS*.
- Average nonradiological emissions would be the same as those presented in the *HEU EIS*.
- No new accident scenarios or source terms associated with surplus HEU disposition activities have been identified.

However, changes in the following parameters have occurred since the *HEU EIS* impact analyses were conducted:

- The SA analyses assume that the remaining HEU feedstock is enriched to 80 percent U-235 to better reflect the actual weighted average of the HEU materials now proposed for down-blending. The *HEU EIS* assumed an average U-235 enrichment of 50 percent.
- The chemical form of the uranium oxide blendstock considered for down-blending as UN now includes the potential use of either triuranic octaoxide (U_3O_8) (as addressed in the *HEU EIS*) or uranium trioxide (UO_3).
- Total site worker populations have changed at the blending sites.

- The 80-kilometer (50-mile) radius population dose evaluated in the *HEU EIS* for each of the blending sites was based on 1990 census data extrapolated to 2010; updated population values are now available based on the 2000 census data extrapolated to 2020.

- The standard dose-to-latent-cancer-fatalities-risk (dose-to-LCF-risk) conversion factors used by DOE/NNSA to estimate radiological risk to workers and offsite populations have been revised.

4.1.3 Approach to *HEU SA* Analyses

Because surplus HEU disposition activities have generally continued as analyzed in the *HEU EIS*, the analysis presented in this SA employs a sliding-scale approach that focuses on those areas most likely to be affected by implementation of new surplus HEU disposition program initiatives, as well as by key parameters and assumptions known to have changed since preparation of the *HEU EIS*.

DOE/NNSA conducted an initial screening of all resource areas addressed in the *HEU EIS* to determine which would potentially be affected by the proposed actions, or by known changes to related site activities or environmental conditions. Each blending site's operational experience was reviewed to identify potential concerns relative to facility resource requirements, throughputs, and emissions. Based on this screening, DOE/NNSA determined the following resource areas would not likely be affected by the proposed action:

- Land resources (no new construction or land requirements)

- Site infrastructure (same annual facility water, electrical, and fuel requirements)

- Air quality and noise (same down-blending processes and annual non-radiological emissions)

- Water resources (same down-blending processes and annual discharges)

- Geology and soils (no new construction or land disturbance)

- Biotic resources (no new construction or land disturbance)

- Cultural resources (no new construction or land disturbance)

- Socioeconomics (same number of workers supporting down-blending operations)

Therefore, the impact analyses presented in the *HEU EIS* for these resources are still considered applicable and are not evaluated further in this SA. The resource areas likely to be impacted, and therefore evaluated in greater detail in this SA, include human health risk, facility accidents, transportation risk, and waste management. In addition, this SA addresses environmental justice concerns and potential impacts occurring as a result of sabotage or terrorism.

Because of the uncertainty as to when some materials would be received and made available to the disposition program over the next several decades, this SA does not identify an end date for implementation of the proposed action. Rather, impact estimates presented in this SA are annualized or tied to specific events (e.g., postulated accidents) based on an assumed down-blending throughput of approximately 10 metric tons per year. This material throughput is conservatively high, and would allow for disposition of all surplus HEU addressed under the proposed action by 2020. Should disposition activities extend beyond 2020 as anticipated, total campaign impacts would essentially remain the same. However, because these total impacts would be projected over a longer timeframe, associated annual impacts would be similar but proportionately lower. An exception to this correlation is the impact resulting from use of the H-Canyon at SRS, which is not expected to continue operating after completing the planned processing of the inventory of currently identified materials, including certain HEU materials. DOE projects completion of this processing by 2019.

4.2 Human Health and Facility Accidents

The analysis of human health and facility accidents includes evaluation of public and worker health data and assessment of changes that would affect the consequences and risks of accidents associated with the proposed action. Public health, worker health, and facility accidents are described for the four sites in the following sections, and relevant data are presented to update information developed since the *HEU EIS* was issued. **Table 4.2–1** compares the key radiological impact parameters cited in the *HEU EIS* with those used in this SA. Of particular note is the use of updated dose-to-risk conversion factors in the SA analyses. The *HEU EIS* used a factor of 0.0004 LCF per rem for workers and 0.0005 LCF per rem for the public, but current DOE guidance stipulates the use of 0.0006 LCF per rem for both workers and the public. This change results in a 50-percent increase in risk to workers and a 20-percent increase in risk to the public from the same radiological exposures reported in the *HEU EIS*.

4.2.1 Human Health

Normal Operations. A comparison of radiological consequences and risks evaluated in the *HEU EIS* and this SA from normal operations at each of the four blending sites is presented in **Table 4.2–2**. The *HEU EIS* normal operations analyses present doses resulting from potential offsite exposure to U-235 and U-238. These values have been adjusted to account for additional radionuclides (U-232, U-234, and U-236) consistent with the facility accident and transportation analyses presented in the *HEU EIS*, and provide a more comparable basis for assessing potential impacts associated with the proposed action.

Annual doses to the involved workforce at each site are expected to remain unchanged because the number of involved workers and their average exposure levels have not changed. Involved workers are not expected to be affected by the higher U-235 enrichment of the HEU feedstock because their exposure is limited by facility design features, operational procedures, and health physics monitoring programs. These factors enable the blending sites to adjust levels of shielding, the distances of involved workers from radioactive source terms, and the duration of their exposures. In contrast, increases in the maximally exposed offsite individual (MEOI) dose would occur due to the higher assumed U-235 enrichment of the HEU feedstock. Increases in the offsite population dose would also occur due to the higher assumed U-235 enrichment as well as the updated population values presented in Table 4.2–1. All risks resulting from normal operations would also increase because of the larger dose-to-LCF-risk factor used in this SA for both workers and the public. However, all annual radiation doses would remain a small fraction of applicable regulatory limits (detailed below) and normal background radiation exposure (0.36 rem per year).

The measured annual dose to the MEOI from all radiological emissions at each of the blending sites from 2002 to 2005 is presented in **Table 4.2–3**. All annual doses are less than 0.001 rem, or less than 1 percent of the DOE annual public dose limit of 0.1 rem (DOE 1993), and represent an increase in lifetime fatal cancer risk of less than 1 in 2 million. These MEOI doses are due to radiological emissions from all activities at each site; the actual MEOI dose (and LCF risk) attributable solely to surplus HEU disposition activities would therefore be lower than the values presented.

Table 4.2–1. Comparison of Key Blending Site Radiological Impact Parameters

Parameter	*HEU EIS*[a]	Supplement Analysis[b]
Y–12		
Stack height	10 meters (33 feet)	20 meters (66 feet)[e]
MEOI distance	619 meters (2,031 feet)	Same
Noninvolved worker distance	644 meters (2,113 feet)	Same
Total onsite workforce	17,000 at ORR; 6,400 at Y–12	17,000 at ORR; 5,000 at Y–12
80-kilometer (50-mile) population	1,040,000[c]	1,523,573[d]
BWXT		
Stack height	11 meters (36 feet)	24 meters (79 feet)[e]
MEOI distance	540 meters (1,772 feet)	Same
Noninvolved worker distance	230 meters (755 feet)	Same
Total onsite workforce	2,200	2,300
80-kilometer (50-mile) population	730,000[c]	789,917[d]
NFS		
Stack height	33 meters (108 feet)	Same
MEOI distance	250 meters (820 feet)	Same
Noninvolved worker distance	250 meters (820 feet)	Same
Total onsite workforce	325	850
80-kilometer (50-mile) population	1,260,000[c]	1,287,973[d]
SRS		
Stack height	10 meters (33 feet)	Same
MEOI distance	11,750 meters (38,550 feet)	Same
Noninvolved worker distance	644 meters (2,113 feet)	Same
Total onsite workforce	12,000	8,900
80-kilometer (50-mile) population	710,000[c]	889,341[d]
All Sites		
Involved workforce	125	Same
Average HEU feedstock U-235 enrichment	50 weight percent	80 weight percent
Worker dose-to-LCF-risk factor	0.0004 per rem	0.0006 per rem
Public dose-to-LCF-risk factor	0.0005 per rem	0.0006 per rem

[a] DOE 1996a.
[b] BWXT 2007a, 2007b; NFS 2007a; NRC 2003a; WSRC 2007.
[c] Projected 2010 population extrapolated from 1990 census data.
[d] Projected 2020 population extrapolated from 2000 census data.
[e] The larger stack height would result in lower radiation doses; therefore this parameter is bounded by the lower stack height evaluated in the *HEU EIS*.

Key: BWXT=BWXT Nuclear Operations Division; DOE=U.S. Department of Energy; *HEU EIS=Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*; LCF=latent cancer fatalities; MEOI=maximally exposed offsite individual; NFS=Nuclear Fuel Services, Inc.; ORR=Oak Ridge Reservation; and SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.

Table 4.2–2. Comparison of *HEU EIS* and Supplement Analysis Normal Operations Radiological Doses and Risks

Impact Parameter	Involved Workforce		MEOI		Offsite Population	
	HEU EIS	**SA**	***HEU EIS*** [a]	**SA**	***HEU EIS*** [a]	**SA**
Y-12						
Annual Dose (person-rem)	11.3	11.3	7.0×10^{-4} (rem)[b]	7.8×10^{-4} (rem)[b]	2.9	4.7
Risk (LCF per year)	4.5×10^{-3}	6.8×10^{-3}	3.5×10^{-7}	4.7×10^{-7}	1.5×10^{-3}	2.9×10^{-3} [c]
BWXT						
Annual Dose (person-rem)	11.3	11.3	3.4×10^{-5} (rem)[b]	3.8×10^{-5} (rem)[b]	0.30	0.37
Risk (LCF per year)	4.5×10^{-3}	6.8×10^{-3}	1.7×10^{-8}	2.3×10^{-8}	1.5×10^{-4}	2.3×10^{-4} [c]
NFS						
Annual Dose (person-rem)	11.3	11.3	2.5×10^{-3} (rem)[b]	2.8×10^{-3} (rem)[b]	21	25
Risk (LCF per year)	4.5×10^{-3}	6.8×10^{-3}	1.3×10^{-6}	1.7×10^{-6}	1.1×10^{-2}	1.5×10^{-2} [c]
SRS						
Annual Dose (person-rem)	11.3	11.3	4.5×10^{-5} (rem)[b]	5.0×10^{-5} (rem)[b]	2.9	4.0
Risk (LCF per year)	4.5×10^{-3}	6.8×10^{-3}	2.3×10^{-8}	3.0×10^{-8}	1.5×10^{-3}	2.4×10^{-3} [c]

[a] Adjusted to include uranium-232, uranium-234, and uranium-236.
[b] Unit for MEOI dose is rem because the receptor is a single individual.
[c] This SA's calculated offsite population risk is equivalent to the following increased annual risk of an LCF occurring in the total offsite population: 1 chance in 357 for Y-12; 1 chance in 4,545 for BWXT; 1 chance in 71 for NFS; and 1 chance in 416 for SRS.

Key: BWXT=BWXT Nuclear Operations Division; DOE=U.S. Department of Energy; *HEU EIS=Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*; LCF=latent cancer fatalities; MEOI=maximally exposed offsite individual; NFS=Nuclear Fuel Services, Inc; SA=supplement analysis; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: Derived from DOE 1996a.

Table 4.2–3. Public Maximally Exposed Offsite Individual Radiation Doses (rem) from Annual Radionuclide Releases from All Site Activities

Site	2002	2003	2004	2005
Y–12	3.0×10^{-4}	2.0×10^{-4}	4.0×10^{-4}	8.0×10^{-4}
BWXT	3.7×10^{-4}	5.1×10^{-4}	3.9×10^{-4}	1.4×10^{-4}
NFS	5.0×10^{-5}	3.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}
SRS	1.8×10^{-4}	1.9×10^{-4}	1.5×10^{-4}	1.3×10^{-4}

Key: BWXT=BWXT Nuclear Operations Division; NFS=Nuclear Fuel Services, Inc.; ORNL=Oak Ridge National Laboratory; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: BWXT 2007c; NFS 2007b; ORNL 2003–2006; WSRC 2003–2006.

Whereas Table 4.2–2 presents analytically derived conservative estimates of MEOI dose due to down-blending activities, Table 4.2–3 presents recent measured dose information for the MEOI at each blending site. The conservative assumptions inherent in the calculated values in Table 4.2–2 include a high atmospheric release of radioisotopes and low air filter particle removal efficiency, as compared to actual measured releases and filter efficiencies that have occurred at each site. The largest calculated MEOI dose from down-blending activities would be 2.8×10^{-3} and would occur at NFS primarily due to the much closer proximity of the MEOI. In contrast, actual measured MEOI doses at all four sites from all activities during these years are much lower and range between 2.0×10^{-5} and 8.0×10^{-4} rem. Because actual MEOI doses attributable solely to down-blending operations are not measured, a direct correlation cannot be made between the data presented in Tables 4.2–2 and 4.2–3. However, both estimated project and measured total site MEOI doses are presented in this SA to illustrate that they are all well below the DOE public annual dose limit of 0.1 rem.

The proposed use of higher U-235-enriched HEU feedstock or UO_3 as alternate blendstock material would not measurably affect non-radiological facility emissions. As such, annual quantities of chemicals that would be released at each of the blending sites during normal operations under the proposed action are expected to be approximately the same as those presented in the *HEU EIS*. In addition, no new chemicals other than those presented in the *HEU EIS* are expected to be used for the proposed action (BWXT 2007a, 2007b; NFS 2007a; WSRC 2007). Therefore, environmental impacts to the public from chemical releases during normal operations would be unchanged from those presented in the *HEU EIS*.

Worker Health. Reported total site worker radiation doses for the years 2002 through 2005 are presented in **Table 4.2–4**. Year-to-year variations in the number of workers with a measurable dose and the total workforce dose at each site are a function of specific radiological activities conducted at the site for that year. All average worker doses continue to be a small fraction of both the DOE occupational annual dose limit of 5 rem (DOE 1993) and normal annual background radiation exposure.

Table 4.2–4. Historical Total Site Worker Radiation Doses from 2002 to 2005 from All Site Activities[a]

Parameter	2002	2003	2004	2005
Y–12[b]				
Workers with measurable dose	2,304	2,389	2,132	1,988
Total worker dose (person-rem)	107.8	116.0	115.5	101.4
Average worker dose (rem)	0.047	0.049	0.054	0.051
BWXT[c]				
Workers with measurable dose	238	246	252	277
Total worker dose (person-rem)	32	29.2	24.6	26.9
Average worker dose (rem)	0.14	0.12	0.10	0.10
NFS				
Workers with measurable dose	783	763	725	617
Total worker dose (person-rem)	96.8	56.3	13.2	11.2
Average worker dose (rem)	0.12	0.07	0.018	0.018
SRS				
Workers with measurable dose	3,217	3,446	2,996	2,360
Total worker dose (person-rem)	199.1	258.6	201.2	121.3
Average worker dose (rem)	0.062	0.075	0.067	0.051

[a] All reported site worker doses are based on both external dose measurements and calculations of estimated internal dose from facility air radioisotope concentrations.
[b] Values represent contributions from all Oak Ridge Reservation facilities, including Y–12.
[c] BWXT reported average worker doses are higher than Y–12, NFS, and SRS because BWXT uses a more conservative method to estimate internal dose to workers.

Key: BWXT=BWXT Nuclear Operations Division; DOE=U.S. Department of Energy; NFS=Nuclear Fuel Services Inc; NRC=U.S. Nuclear Regulatory Commission; SA=supplement analysis; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: DOE 2004a, 2005; NRC 2003b, 2004–2006.

Whereas Table 4.2-2 presents analytically derived estimates of doses from workers involved only in down-blending activities, Table 4.2-4 presents available measured dose information for the total workforce at each site. The involved workforce doses presented in Table 4.2-2 are the same as those presented in the *HEU EIS*, and were calculated with the conservative analytical assumptions that 125 workers would be involved in HEU down-blending operations and that each involved worker would receive an annual dose of 0.09 rem, resulting in a total annual involved workforce dose of 11.3 person rem. Each blending site has confirmed the continued validity of these worker dose estimates with respect to the proposed actions considered in this SA (BWXT 2007a, 2007b; NFS 2007a; WSRC 2007). The actual measured average worker doses presented in Table 4.2–4 range between 0.018 and 0.14 rem, and account for all workers exposed to radiation at each site. Because each site is involved in numerous other radiological activities, the total number of workers with a measurable dose is larger than the 125 assumed for down-blending operations. Because actual worker doses attributable solely to down-blending operations are not available, a direct correlation cannot be made between the data presented in Tables 4.2–2 and 4.2–4. However, both estimated project and measured total site worker doses are presented in this SA to illustrate that they are all well below the DOE occupational annual dose limit of 5 rem.

4.2.2 Facility Accidents

Potential impacts to workers and the public from facility accidents are evaluated in this SA by identifying applicable *HEU EIS* accident scenarios and calculating revised consequences and risks based on the updated key parameters presented in Table 4.2–1.

Unlike the *HEU EIS*, the proposed action in this SA involves only down-blending HEU to LEU in the chemical form of UN (4 percent U-235 UN). Whereas four accident scenarios are analyzed for down-blending as UN in the *HEU EIS* at all four sites, only three of these accident scenarios are analyzed in this SA because DOE/NNSA is no longer proposing down-blending to 0.9 percent U-235 UN. **Tables 4.2–5** and **4.2–6** compare the doses and risks to the public and workers expected from the SA proposed action under the applicable accident scenarios analyzed in the *HEU EIS*.

Accident consequences and risks have increased due to the changes in five radiological impact parameters in Table 4.2–1: total onsite workforce, offsite population, worker and public dose-to-LCF-risk factors, and average HEU feedstock U-235 enrichment. Noninvolved worker and offsite population consequences have changed in direct proportion to their respective updated site-specific numerical values. Because the higher average HEU U-235 enrichment results in larger uranium source terms for the filter fire and earthquake accidents (the criticality accident releases fission products and not uranium isotopes), the consequences of these two accidents also increase for all three dose receptors: the noninvolved worker, MEOI, and offsite population. Finally, risks for all three accident scenarios and all three dose receptors increase due to the larger dose-to-LCF-risk factors used in this SA for workers and the public.

Approximately 125 involved workers directly support down-blending operations at each of the sites. In the event of an accident, nearby involved workers could receive relatively higher doses and be at risk of serious injury or death. Potential impacts to these workers are addressed qualitatively for each accident scenario because no adequate method exists for calculating meaningful consequences at or near the location where the accident could occur:

- *Filter Fire Accident*—Involved workers could inhale some radioactive particles before evacuating the area, but the relative location of filters and the short exposure time is not expected to result in fatalities from radiological consequences.

- *Criticality Accident*—Involved workers could receive substantial or potentially fatal doses from the initial pulse of neutron and gamma radiation. After this initial pulse, workers would evacuate the area on the initiation of criticality monitoring alarms.

- *Earthquake*—Involved workers could receive lethal injuries from structural damage associated with an earthquake, but no fatalities are expected from radiological consequences.

Table 4.2–5. Comparison of *HEU EIS* and Supplement Analysis of Radiological Accident Doses

Evaluation Basis Accident Scenario	Noninvolved Worker Dose (person-rem)		MEOI Dose (rem)		Population Dose (person-rem)	
	HEU EIS	**SA**	***HEU EIS***	**SA**	***HEU EIS***	**SA**
Y–12						
Filter fire accident	11	22	0.01	0.02	1.5	4.4
Criticality accident	38	38	0.051	0.051	3	4.4
Earthquake	320	576	0.31	0.56	44	64
BWXT						
Filter fire accident	24	50.4	0.012	0.024	0.9	1.94
Criticality accident	80	84	0.056	0.056	1.9	2.1
Earthquake	760	1,436	0.36	0.65	26	50
NFS						
Filter fire accident	1.6	8.4	0.002	0.004	1.3	2.6
Criticality accident	8.7	22.8	0.014	0.014	2.2	2.2
Earthquake	67	317	0.078	0.140	38	709
SRS						
Filter fire accident	2.3	3.4	6.6×10^{-5}	1.3×10^{-4}	0.37	0.92
Criticality accident	8.5	6.3	3.0×10^{-4}	3.0×10^{-4}	0.33	0.41
Earthquake	70	94	0.0019	0.0034	11	25

Key: BWXT=BWXT Nuclear Operations Division; *HEU EIS=Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement;* MEOI=maximally exposed offsite individual; NFS=Nuclear Fuel Services, Inc.; SA=supplement analysis; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: Derived from DOE 1996a.

As discussed in **Section 4.2.1**, the quantities of chemicals that would be used for the proposed action and the processes involving these chemicals would be essentially identical to those evaluated in the *HEU EIS* accident analyses. As such, postulated chemical accidents and associated impacts are expected to be the same as those analyzed in the *HEU EIS*.

4.3 Transportation

Two types of transportation activities are addressed in this SA: (1) transport activities similar to those evaluated in the *HEU EIS*, and (2) transport of LEU to foreign countries as part of the Reliable Fuel Supply Initiative. The methods and data used to evaluate transportation impacts in the *HEU EIS* were analyzed and used as the basis for estimating impacts of similar transportation activities in this SA. This analysis is summarized in **Section 4.3.1**. Transport of LEU to a fuel fabricator in a foreign country was not considered in the *HEU EIS*; therefore, a more detailed analysis of this activity is provided in **Section 4.3.2**.

Table 4.2–6. Comparison of *HEU EIS* and Supplement Analysis of Radiological Accident Risks (LCF per year)

Evaluation Basis Accident Scenario	Noninvolved Worker Risk		MEOI Risk		Population Risk	
	HEU EIS	SA	*HEU EIS*	SA	*HEU EIS*	SA
Y–12						
Filter fire accident	4.4×10^{-6}	1.3×10^{-5}	5.0×10^{-9}	1.2×10^{-8}	7.5×10^{-7}	2.6×10^{-6}
Criticality accident	1.5×10^{-6}	2.3×10^{-6}	2.6×10^{-9}	3.1×10^{-9}	1.5×10^{-7}	2.6×10^{-7}
Earthquake	1.3×10^{-5}	3.6×10^{-5}	1.6×10^{-8}	3.4×10^{-8}	2.2×10^{-6}	6.8×10^{-6}
BWXT						
Filter fire accident	9.6×10^{-6}	3.0×10^{-5}	6.0×10^{-9}	1.4×10^{-8}	1.9×10^{-7}	5.6×10^{-7}
Criticality accident	3.2×10^{-6}	5.0×10^{-6}	2.8×10^{-9}	3.4×10^{-9}	9.5×10^{-8}	1.3×10^{-7}
Earthquake	3.0×10^{-5}	8.6×10^{-5}	1.8×10^{-8}	4.0×10^{-8}	1.3×10^{-6}	3.1×10^{-7}
NFS						
Filter fire accident	6.4×10^{-7}	5.0×10^{-6}	1.0×10^{-9}	2.4×10^{-9}	6.5×10^{-7}	1.6×10^{-6}
Criticality accident	3.5×10^{-7}	1.4×10^{-6}	7.0×10^{-10}	8.4×10^{-10}	1.1×10^{-7}	1.3×10^{-7}
Earthquake	2.7×10^{-6}	2.0×10^{-5}	3.9×10^{-9}	8.5×10^{-9}	1.9×10^{-6}	4.1×10^{-6}
SRS						
Filter fire accident	9.2×10^{-7}	2.0×10^{-6}	3.3×10^{-11}	8.0×10^{-11}	1.9×10^{-7}	5.6×10^{-7}
Criticality accident	3.4×10^{-7}	3.8×10^{-7}	1.5×10^{-11}	1.8×10^{-11}	1.7×10^{-8}	2.5×10^{-7}
Earthquake	2.8×10^{-6}	5.6×10^{-6}	9.5×10^{-11}	2.0×10^{-10}	5.5×10^{-7}	1.5×10^{-6}

Note: *HEU EIS* risks are based on the dose-to-LCF-risk factor of 0.0004 per rem for workers (i.e., noninvolved workers) and 0.0005 per rem for public (i.e., MEOI and population); SA risks are based on the dose-to-LCF-risk factor of 0.0006 per rem for both workers and public. Filter fire accident annual frequency=0.001 per year. All other accident annual frequencies=0.0001 per year. All accident annual frequencies are from the *HEU EIS* and are identical for this SA.
Key: BWXT=BWXT Nuclear Operations Division; *HEU EIS=Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*; LCF=latent cancer fatalities; MEOI=maximally exposed offsite individual; NFS=Nuclear Fuel Services, Inc.; SA=supplement analysis; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: Derived from DOE 1996a.

4.3.1 Transport Activities Similar to those Evaluated in the *HEU EIS*

Transport activities similar to those evaluated in the *HEU EIS* include transport of surplus HEU and blendstock to blending sites, transport of LEU to fuel fabricators, and transport of associated wastes. The various materials are and would continue to be transported in DOE-, NRC- and U.S. Department of Transportation (DOT)-certified packaging, as appropriate.

The *HEU EIS* analyses assume that DOE safe, secure transports (SSTs) would be used to ship HEU to the blending sites, and commercial trucks would be used for all other overland transport activities. Transportation impacts in the *HEU EIS* are conservatively estimated using the RADTRAN 4 computer program and default RADTRAN input parameters (Neuhauser and Kanipe 1992). For example, the *HEU EI*S assumes that there would be frequent stops (1 hour every 91 kilometers of travel) and that these stops could occur anywhere along the route in either rural, suburban, or urban areas. The analyses also assume constant population densities of 6; 719; and 3,861 people per square kilometer, respectively, for rural, suburban, and urban areas irrespective of the routes and locations. At the time the *HEU EIS* was prepared, these estimates were considered conservative and appropriate when analyzing aggregate route characteristics, which only consider the total distance between the origin and destination for each transport and the fractions of travel in the rural, suburban, and urban areas.

Current population density estimates are based on route-specific characteristics using the Transportation Routing Analysis Geographic Information System (TRAGIS) computer code (DOE 2003b), which generates population densities using 2000 census statistics. Comparisons of population data for transport between locations similar to those used in the *HEU EIS* indicate that today, population densities for highway routes in rural areas are higher, and population densities in the suburban and urban areas are much lower. DOE has also developed additional transportation risk assessment guidelines since the *HEU EIS* was prepared (DOE 2002b).

To determine the degree to which the updated analytical methods and data would affect the results, one transportation segment (transporting a shipment of HEU from Y–12 to a representative blending site [BWXT]) was analyzed using the new methodology, and the results were compared to the *HEU EIS* analysis. Comparison of the doses and risks indicates that the dose estimates in the *HEU EIS* remain valid and would envelope the impacts from similar activities under this SA (SAIC 2007). However, independent of the transportation analyses, application of revised dose-to-LCF-risk conversion factors (discussed in **Section 4.2**) increases the risk to exposed workers by 50 percent and to the exposed population by 20 percent over those presented in the *HEU EIS*. Updating the *HEU EIS* analyses with these revised conversion factors, the combined annual impacts of transporting surplus HEU and blendstock to each of the blending sites, and then transporting the resulting LEU to a fuel fabrication facility, are summarized in **Table 4.3–1** and discussed in the paragraphs that follow. These results indicate that the proposed activities would be similar to those analyzed in the *HEU EIS*, and the associated transportation impacts would continue to be low. Consistent with the impacts presented in the *HEU EIS*, the largest contributor to overall transportation risks would be nonradiological impacts from traffic accidents.

Table 4.3–1. Annual Transportation Risks from Surplus Highly Enriched Uranium Disposition Activities[a]

Blending Sites	Incident-free Risks[b]		Accident Population Risks[c]	
	Crew[c]	Population	Radiological	Traffic
Y–12	9.3×10^{-3}	1.3×10^{-2}	4.8×10^{-4}	3.4×10^{-2}
BWXT	1.0×10^{-2}	1.4×10^{-2}	5.7×10^{-4}	3.7×10^{-2}
NFS	1.0×10^{-2}	1.4×10^{-2}	5.1×10^{-4}	3.6×10^{-2}
SRS	1.0×10^{-2}	1.4×10^{-2}	5.5×10^{-4}	3.7×10^{-2}

[a] Total annual health effects from transport of surplus HEU from Y–12 to blending sites, transport of blendstock materials from Hanford to blending sites, and transport of resulting LEU to fuel fabricator site.
[b] Incident-free risks are in terms of LCF.
[c] Radiological risks are in terms of LCF. Traffic risks are in terms of nonoccupational traffic fatalities.
Note: The values in this table include adjustments for the worker and population risk factors to 0.0006 LCF per person-rem of exposure.
Key: BWXT=BWXT Nuclear Operations Division; DOE=U.S. Department of Energy; LCF=latent cancer fatalities; NFS=Nuclear Fuel Services, Inc.; SRS=Savannah River Site; and Y–12=Y–12 National Security Complex.
Source: Derived from DOE 1996a.

Transport of Surplus HEU to Blending Sites. Surplus HEU materials are assumed to originate at Y–12 and to be shipped to the blending sites as either metal, oxides, or alloys. Annually, about 10 metric tons of HEU would be transported from Y–12 to the blending sites. Transport characteristics and packaging are expected to be similar to those evaluated in the *HEU EIS*.

Accident risks for radiological accidents are identified in terms of increased LCFs in the exposed population, while traffic risks are in terms of potential nonoccupational (public) fatalities resulting from traffic accidents. The values presented assume the accident rates used in the *HEU EIS* are still valid. Because the HEU materials are transported in SSTs, the expected accident rates for these transports are much smaller than those associated with commercial trucks.

Transport of Blendstock Materials to Blending Sites. The *HEU EIS* evaluates the impacts of transporting various blendstocks to each of the blending sites. For analysis purposes in this SA, the blendstock is assumed to be natural uranium in the form of U_3O_8 or UO_3. This material could be provided from several Government or commercial sources and transported directly to the blending site. Consistent with the *HEU EIS*, this SA analyzes the DOE Hanford Site as a representative source for the blendstock material because its location is farthest from the blending sites. Because of the distance and material form, this assumption would envelope the impacts of transporting other blendstock materials from other locations. The required amount of blendstock is a function of initial enrichment (U-235) in the HEU feed and the desired final enrichment of the resulting LEU. This SA assumes the same final product enrichment as in the *HEU EIS*. However, this SA assumes a higher initial HEU feedstock enrichment (80 percent) to better reflect the actual average assay of HEU now proposed for down-blending, which corresponds to an annual blendstock requirement of about 280 metric tons of natural uranium (as UO_3). Assuming packaging and shipping characteristics similar to those used in the *HEU EIS*, this would result in about 26 shipments annually, or approximately 11 more per year than originally estimated in the *HEU EIS*.

Transport of LEU to Fuel Fabricators. Following down-blending, the resulting LEU would be transported in certified packaging to a domestic fuel fabricator. The *HEU EIS* evaluates such transport to a number of fuel fabrication sites, with distances ranging from 0 kilometers (where the fuel fabricator is at the blending site) to more than 4,400 kilometers (a fuel fabrication site in Richland, Washington). For this SA, the LEU feed stock is assumed to be UNH and the fuel fabricator is assumed to be in Washington State. These assumptions lead to higher transportation risk estimates, a larger number of shipments (about 70 shipments per year), and longer travel distances than are expected based on DOE/NNSA having selected a fuel fabricator in South Carolina.

Transport of LLW. As described in **Section 3.2**, the amount of surplus HEU that would be suitable for disposal as LLW at NTS has been reduced to approximately 3 metric tons, or approximately 10 percent of the amount analyzed in the *HEU EIS*. The method of transportation and nature of impacts are expected to be the same. Therefore, the risks evaluated in the *HEU EIS* for transporting HEU down-blended to LLW are higher than the potential impacts associated with the current proposed action.

4.3.2 Transport of LEU to Support the Reliable Fuel Supply Initiative

This SA evaluates the potential impacts of transporting about 220 metric tons of LEU UF_6 feedstock from a domestic fuel fabricator to a foreign country in support of the Reliable Fuel Supply Initiative. These materials would be transported in packaging that is specially designed and certified for fissile material transports. The DOT-certified packaging currently used consists of four 30-B UF_6 cylinders configured on a specially designed structure for transport within a standard 6.1-meter International Organization for Standardization (ISO) container. Each cylinder would contain 2,277 kilograms of UF_6, so each ISO container would transport about 9.1 metric tons of LEU UF_6 feedstock. This quantity of UF_6 is consistent with the amount assumed in the *HEU EIS* for transport of similar materials within the United States.

For analysis purposes in this SA, it is conservatively assumed that the LEU feedstock would be transported across the United States from a fuel fabricator on the West Coast to a port on the East Coast, and placed on a commercial vessel for marine transport to a fuel fabricator in a foreign country.[6] Each potential shipment is assumed to comprise approximately 40 metric tons of LEU, the quantity sufficient for one standard refueling cycle of a pressurized water nuclear reactor. Therefore, approximately six or seven shipments would be required to transport all 220 metric tons of LEU UF_6. In addition, each LEU shipment is assumed to require four ISO containers that would be transported as a convoy of commercial truck trailers, consistent with current practices in civilian commerce.

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[6] Under the Reliable Fuel Supply contract, the Westinghouse fuel fabrication facility in Columbia, South Carolina, will serve as the actual LEU storage location and point of origin for subsequent transport to a marine terminal. Any decision to select a specific West or East Coast port would be predicated upon the geographic location of the participating foreign country. Therefore, the transportation analysis presented in this SA conservatively assumes maximum shipping distances (a West Coast fuel fabricator and an East Coast marine terminal) in order to bound all potential domestic LEU transportation impacts (including the possible use of an East Coast fuel fabricator and a West Coast marine terminal).

A number of East Coast ports regularly transport fissile materials between the United States and foreign countries. DOE/NNSA evaluated the impacts of transporting spent nuclear fuel and mixed oxide fuel through multiple U.S. East Coast ports in the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE 1996c); the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement,* (DOE 1996b); and the *Supplement Analysis for the Fabrication of Mixed Oxide Fuel Lead Assemblies in Europe* (DOE 2003a). Previous NEPA analyses have demonstrated that ocean transport is safe and would involve minimal environmental impacts. These NEPA analyses considered commercial ports such as Newport News, Norfolk International, and Portsmouth Marine Terminals in Virginia, as well as military ports such as the Military Ocean Terminal at Sunny Point, North Carolina; Charleston Naval Weapons Station in South Carolina; and Yorktown Naval Weapons Station in Virginia. Norfolk International is the assumed port of departure used in this SA to evaluate the distance traveled and the impacts from port activities during container loading. The following activities are evaluated in association with transporting Reliable Fuel Supply Initiative LEU:

- Overland transport of UF_6 from a fuel fabricator to Norfolk International Terminal, in Norfolk, Virginia.

- Port transfer of the UF_6 ISO containers from trucks to an ocean container ship.

- Ocean transport of UF_6 across the global commons.

Overland Transport of UF_6. Table 4.3–2 summarizes the impacts from transporting LEU UF_6 feed materials, assuming transport characteristics and packaging similar to those used in the *HEU EIS*. It is conservatively assumed that the materials would be transported from a West Coast fuel fabricator (in Richland, Washington), to the Norfolk International Terminal. The one-way distance between these two locations is 4,530 kilometers, with fractions of travel in rural, suburban, and urban areas essentially unchanged from those evaluated in the *HEU EIS.*

Table 4.3–2. Impacts of Overland Transport of Uranium Hexafluoride Low-Enriched Uranium (per shipment)

Transport	Incident-free Risks[a]		Accident Population Risks[b]	
	Crew	Population	Radiological	Traffic
UF_6 to the port	4.0×10^{-4}	6.1×10^{-4}	2.7×10^{-5}	1.6×10^{-3}

[a] The risks are in terms of LCF.
[b] Radiological risks are in terms of LCF. Traffic risks are in terms of nonoccupational traffic fatalities.
Note: The values in this table include adjustments for the workers and population risk factors to 0.0006 LCF per person-rem of exposure.
Key: DOE=U.S. Department of Energy; LCF=latent cancer fatalities; UF_6=uranium hexafluoride.
Source: Derived from DOE 1996a.

Port Activities. These activities include loading of the ISO containers onto a commercial vessel, container-handling activities while on board, and subsequent movement of the vessel from the port out to the open sea. Assuming incident-free transfer of the ISO containers to the vessel, the only radiation exposures anticipated would be those to persons directly involved in the transfer (inspectors, port handlers, guards, etc.). Members of the public would be too distant to receive measurable radiation exposures. The dose to an exposed worker would be a function of the exposure time and the distance from the ISO container. Port activity impacts were evaluated in Appendix D of the *FRR SNF EIS*. Assuming for this analysis that the activities involved in loading the ISO containers at ports would be similar to those analyzed in the *FRR SNF EIS* and the external dose rate of the containers would be similar to those considered in the *HEU EIS*, the potential impacts to port workers from loading four containers of UF_6 are provided in **Table 4.3–3**.

Table 4.3–3. Human Health Effects from Incident-Free Port Operations (per shipment)

Exposed Personnel	MEI Dose (rem)	MEI Risk (LCF)	Collective Dose[a] (person-rem)	Collective Risk[a] (LCF)
Longshoremen	1.8×10^{-4}	1.1×10^{-7}	6.1×10^{-4}	3.6×10^{-7}
Crane Operators	3.4×10^{-5}	2.0×10^{-8}	4.5×10^{-5}	2.7×10^{-8}
Inspectors	5.2×10^{-4}	3.1×10^{-7}	2.2×10^{-3}	1.3×10^{-6}
Observers	3.2×10^{-5}	1.9×10^{-8}	1.6×10^{-3}	9.6×10^{-7}

[a] Collective dose and risk represent the total dose and risk to all potentially exposed personnel in each category (i.e., longshoremen, crane operators, inspectors, and observers).

Key: DOE=U.S. Department of Energy; LCF=latent cancer fatalities; and MEI=maximally exposed individual.

Source: Derived from DOE 1996c.

A handling accident at the port would not be expected to result in cask failure leading to any release of radioactive material. Only an accident involving a ship collision and ensuing fire has a potential to damage the cask. The *FRR SNF EIS* evaluated such a scenario; the analysis was very site-specific in terms of population distributions, land use, meteorology, and other factors. Given security provisions, port proximity, and awareness of the shipment, the potential severity of a ship collision is limited, and the consequences of accidents are enveloped by those in Appendix D of the *FRR SNF EIS.* The consequences of similar accidents at the port would be much lower than those described in the *FRR SNF EIS* due to the substantially lower total radioactivity content.

Global Commons. Transporting the Reliable Fuel Supply Initiative LEU reserves to participating foreign countries by ship is expected to add up to seven ocean trips to the thousands of commercial and military vessel trips crossing the oceans of the world each year. Therefore, a few ships transporting this LEU over the course of the program would not have a noticeable impact on the global commons.[7]

Impacts of an accident during transport of enriched uranium over the global commons would be similar to those discussed in the *Environmental Assessment for the Proposed Interim Storage at the Y-12 Plant Oak Ridge, Tennessee of Highly Enriched Uranium Acquired from Kazakhstan by the United States* (DOE/EA 1006) (DOE 1994) and the *Environmental Assessment for the Transportation of Highly Enriched Uranium from the Russian Federation to the Y-12 National Security Complex and Finding of No Significant Impact* (DOE/EA-1271) (DOE 2004b). These analyses conclude that in the case of an accident there could be some loss of marine life to organisms directly exposed to the uranium. However, as a result of the large volumes of water, the mixing mechanisms within it, the existing background uranium concentrations, and the radiation-resistance of aquatic organisms, the radiological impact of an accident would be localized and of minor impact.

It is also possible that a ship containing LEU could pass through an area known to be routinely inhabited by the right whale, an endangered species. There are two identified habitats for this species: one located mainly off the coast of Massachusetts and one off the coasts of Florida and Georgia (66 FR 58066; November 20, 2001). Before a ship enters such an area, it is required to contact the Mandatory Ship Reporting System operated by the U.S. Coast Guard and endorsed by the International Maritime Organization to report its name, call sign, location, course, speed, destination, and route. This system reduces the likelihood of a ship striking a right whale by providing ships in the area with contact information for data on the most recent whale sightings and avoidance procedures that could prevent a collision (DOE 2006).

[7] The actual number of annual commercial LEU shipments is considered sensitive information. However, the seven additional LEU shipments that could result under the proposed action would represent only a small fraction of the total LEU commercially transported overseas each year.

4.4 Waste Management

Down-blending surplus HEU to LEU generates LLW, mixed LLW, hazardous waste, and nonhazardous waste. The *HEU EIS* analyses identified that generation of such wastes would not greatly impact the waste management infrastructure at any of the blending sites. Similarly, the proposed use of higher U-235-enriched HEU feedstock or UO_3 as alternate blendstock would not measurably affect waste generation. Because the overall down-blending processes have not changed and the down-blending rates remain within the parameters evaluated in the *HEU EIS*, the amounts of wastes generated annually at each of the blending sites as a result of the SA proposed action would be similar to those previously analyzed. Accordingly, the offsite transportation of down-blending process wastes are also expected to be similar to those analyzed in the *HEU EIS*.

The *HEU EIS* proposed action considers down-blending at least 30 metric tons of surplus HEU to 0.9 percent-enrichment LEU for disposal as LLW. Establishing a new disposal pathway for surplus HEU discard material through direct disposal would reduce the volume of waste to be disposed of, compared to first down-blending the surplus HEU to 0.9 percent-enrichment LEU and then disposing of it as LLW as evaluated in the *HEU EIS*. It would also reduce the total campaign impacts presented in the *HEU EIS* that are associated with transporting substantial quantities of resulting LLW to a DOE or commercial LLW management facility. On a per unit basis, down-blending HEU to LEU for commercial use would reduce LLW and nonhazardous waste, although the total quantities of mixed LLW and hazardous waste would increase due to the addition of a purification process required to meet fuel specifications.

Considering the additional down-blending increment afforded under the *HEU EIS* analyses by not down-blending surplus HEU discard materials to waste, the proposed disposition of new quantities of HEU would exceed the envelope analyzed in the *HEU EIS* by approximately only 20 metric tons, corresponding to an approximate 10 percent increase in waste management impacts. However, the timeframe for disposition of all the additional HEU would likely extend for several decades. Because the incremental impacts associated with disposition of this additional material would be incurred over this extended timeframe, no discernable increase in annual impacts is expected.

4.5 Environmental Justice

As described in **Sections 4.2** and **4.3**, potential health impacts to surrounding populations resulting from associated normal operations, facility accidents, and transportation activities would continue to be low. Therefore, it is unlikely that disproportionate adverse impacts to minority and low-income populations would result from the proposed action considered in this SA.

4.6 Sabotage or Terrorist Attack

In the aftermath of September 11, 2001, DOE/NNSA and NRC have implemented measures to minimize the risk and consequences of potential terrorist attacks on DOE and NRC-licensed facilities. The safeguards applied to protecting Y–12, BWXT, NFS, and SRS involve a dynamic process of enhancement to meet threats; these safeguards will evolve over time. It is not possible to predict whether intentional attacks would occur at the sites addressed in this SA, or the nature or types of such attacks. Nevertheless, DOE/NNSA and NRC, as appropriate, have re-evaluated security scenarios involving malevolent, terrorist, or intentionally destructive acts at Y–12, BWXT, NFS, and SRS to assess potential vulnerabilities and identify improvements to security procedures and response measures (Brooks 2004; NRC 2002, 2003c). Security at these facilities is a critical priority for both DOE/NNSA and NRC, which continue to identify and implement measures to defend and deter attacks against them. DOE/NNSA and NRC maintain a system of regulations, orders, programs, guidance, and training that form the basis for maintaining, updating, and testing site security to preclude and mitigate any postulated terrorist actions (Brooks 2004; NRC 2007a–c). The conservative assumptions inherent in the accidents analyzed in **Section 4.2.2** for Y–12, BWXT, NFS, and SRS assume initiation by natural events, equipment failure, or inadvertent worker actions. These same events could be caused by intentional malevolent acts by one or more saboteurs or terrorists. For example, a criticality could be purposefully created, or high explosives could be used to damage buildings in the same way as an earthquake. However, the resulting radiological release and consequences to workers and the public would be similar, regardless of the nature of the initiating event.

The site physical security protection strategy is based on a graded and layered approach supported by an armed guard force that is trained to detect, deter, and neutralize adversary activities and is backed up by local, state, and Federal law enforcement agencies. The sites use both staffed and automated access-control systems to limit entry into areas and/or facilities to authorized individuals. Automated access-control systems use controlled booths, turnstiles, doors, and gates. Escorting requirements provide access controls for visitors. Barriers, electronic surveillance systems, and intrusion detection systems form a comprehensive site-wide network of monitored alarms. Various types of barriers would delay, channel personnel, or deny access to classified matter, HEU, LEU, and vital areas. Barriers direct the flow of vehicles and deter and/or prevent penetration by motorized vehicles where they could significantly increase the likelihood of a successful malevolent act. Some barriers are passive and would require the use of special tools and high explosives to penetrate them. Other barriers have an active component designed to dispense an obscuration agent, viscous barrier, or sensory irritant. Tamper-protected surveillance, intrusion detection, and alarm systems designed to detect an adversary action or anomalous behavior inside and outside the facilities are paired with assessment systems that evaluate the nature of the adversary action. Random patrols and visual observation are also used to deter and detect intrusions. Penetration-resistant, alarmed vaults and vault-type rooms are used to protect classified materials.

There is also a potential for attempted sabotage or terrorist attacks during transport. As such, transportation activities would incorporate existing physical safeguards aimed at protecting the public from harm, including SST/SafeGuards Transport (SST/SGT) for inter-site transport of HEU and enhanced monitoring and coordination of commercial transport of LEU to minimize the possibility of sabotage and facilitate recovery of shipments that could come under control of unauthorized persons. The safety features of the transportation casks that provide containment, shielding, and thermal protection also protect against sabotage. Although it is not possible to predict the occurrence of sabotage or terrorism or the exact nature of such events if they were to occur, DOE/NNSA has previously examined several transportation accident scenarios that would have the types of consequences that could result from such acts in the *FRR SNF EIS* (DOE 1996c). However, because the materials being considered for transport under this SA would have substantially less total radioactivity than those analyzed in the *FRR SNF EIS*, the corresponding impacts resulting from such events would be much lower.

5.0 CONCLUSION

In accordance with CEQ regulations 40 CFR 1502.9(c) and DOE regulations 10 CFR 1021.314(c), this SA evaluates ongoing and proposed surplus HEU disposition program activities to determine whether the *HEU EIS* should be supplemented, a new EIS should be prepared, or no further NEPA documentation is necessary.

Based on the analyses in this SA, continued implementation of ongoing disposition activities and the addition of new disposition initiatives described herein would not substantially change the environmental impacts from those described in the *HEU EIS*. Although some relatively large percentage increases to certain impacts presented in the *HEU EIS* have been identified, they represent only small changes to these impacts in absolute terms. Therefore, the activities evaluated in this SA do not represent substantial changes in any proposed actions or result in any new circumstances relevant to environmental concerns.

Proposed down-blending processes and rates would remain within the parameters evaluated in the *HEU EIS*; therefore, similar annual non-radiological emissions, waste generation, and transportation activities associated with ongoing surplus HEU disposition activities are expected. Projected radiological risks from normal operations and facility accidents to both workers and the public would increase from those presented in the *HEU EIS* as a result of incorporating the higher average U-235 enrichment of the HEU now proposed for down-blending, updated population statistics, and larger dose-to-LCF-risk factors. However, operation of surplus HEU disposition facilities continues to pose no more than a small risk to human health, and no new or different bounding accident scenarios have been identified. Transportation activities supporting the Reliable Fuel Supply Initiative would add small additional impacts associated with transfer activities at the port of departure, and impacts of associated additional overseas shipments on the global commons would be negligible. Although proposed down-blending of additional HEU would increase total campaign impacts by approximately 10 percent, these additional impacts would be distributed over an expanded timeframe and continue to be well within applicable DOE limits and each site's capacity to manage.

6.0 DETERMINATION

The analyses in this SA indicate that the activities and potential environmental impacts associated with ongoing activities and proposed new initiatives supporting the DOE/NNSA disposition program for surplus HEU do not constitute substantial changes in the proposed action that are relevant to environmental concerns. Similarly, no significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts have been identified. Therefore, pursuant to 10 CFR 1021.314(c), no additional NEPA analyses are required.

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