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Environmental Assessment for the Transportation of Highly Enriched Uranium from the Russian Federation to the Y-12 National Security Complex

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Draft

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Acronyms and Abbreviations

AFB	Air Force Base
CFR	*Code of Federal Regulations*
CO	carbon monoxide
DOE	U.S. Department of Energy
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ES-2100	DOE/NNSA shipping container
HEU	highly enriched uranium
LCF	latent cancer fatality
LEU	low enriched uranium
MEI	maximally exposed individual
NAAQs	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
NO_2	nitrogen dioxide
O_3	ozone
Pb	lead
PM_x	particulate matter less than x microns in diameter
SO_2	sulfur dioxide
SST	Safe Secure Transport
TI	Transportation Index
TN-BGC1	Transnucleaire shipping container
U.S.	United States
Y-12 Complex	NNSA Y-12 National Nuclear Security Complex

1.0 Introduction

The U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA) has prepared this environmental assessment (EA) pursuant to the National Environmental Policy Act (NEPA), DOE implementing regulations at 10 *Code of Federal Regulations* (CFR) 1021, and Council on Environmental Quality regulations at 40 CFR 1500-1508. It evaluates the potential environmental impacts associated with the transport of highly enriched uranium (HEU) derived from the Russian Federation nuclear stockpile to the NNSA Y-12 National Security Complex (Y-12 Complex).

The United States and the Russian Federation share a mutual interest in providing security for weapons-usable fissile materials to prevent the proliferation of nuclear weapons. To that end, the United States and Russia are evaluating mechanisms by which excess fissile materials can be removed from their respective stockpiles and rendered unattractive as weapons materials. The two countries propose to augment the actions being undertaken under an existing agreement to remove additional HEU from the Russian stockpile. A supplement to the agreement would provide for U.S. purchase of Russian HEU for use as fuel in U.S. research reactors performing solely peaceful missions.

1.1 Framework for the Current Action

The proposal to remove weapons-usable fissile material from the Russian stockpile and apply it to a peaceful purpose is one action in a long line of continuing efforts to support the common interest of the United States and Russia in guaranteeing the irreversibility of nuclear disarmament, strengthening nonproliferation, and combating terrorism by accelerating the disposition of excess nuclear weapons materials.

Highly Enriched Uranium-Low Enriched Uranium (HEU-LEU) Agreement Background

The *Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons* was signed on February 18, 1993 (see Appendix A). This agreement, which remains in force until 2013, was developed to further arms control and nonproliferation efforts of both the U.S. Government and the Governments of the former Soviet Union, with a specific goal of facilitating the objectives of the *Treaty on the Nonproliferation of Nuclear Weapons of July 1, 1968*.

The HEU-LEU Agreement provides for U.S. purchase of low enriched uranium (LEU) derived from 500 metric tons (551 tons) of HEU extracted from Russian nuclear warheads (the equivalent of approximately 20,000 nuclear warheads) dismantled as a result of the reduction of nuclear weapons through arms control agreements and other commitments. The Russians would blend HEU, in this case, uranium with an average assay of 90 percent or greater of the isotope uranium-235, with other uranium to yield LEU with a maximum assay of 20 percent of uranium-235. LEU would be purchased by a U.S. corporation for use in the fabrication of commercial nuclear reactor fuel. As of December 31, 2002, 171 metric tons (189 tons) of weapons-grade HEU had been converted to 5,027 metric tons (5,542 tons) of LEU. This is the equivalent to the elimination of approximately 6,850 nuclear warheads.

Supplementary Nonproliferation Efforts—To further the efforts of nonproliferation and national security associated with keeping weapons-usable nuclear material out of the hands of hostile nations and terrorists, President George W. Bush and Russian President Vladimir Putin signed a Joint Declaration during their May 2002 Summit in Moscow, Russia (White House 2002). The Joint Declaration established a Joint Expert Group to examine means to further reduce stockpiles of weapons-usable nuclear material beyond the levels set forth in existing agreements.

In September 2002, Secretary of Energy Abraham and Russian Minister of Atomic Energy Rumyantsev issued a Joint Statement regarding the work of the Joint Expert Group on Accelerated Nuclear Material Disposition (see Appendix B). The Joint Expert Group identified a number of initiatives that could lead to reduction of HEU beyond commitments already in place. Among these initiatives are two proposed as separate supplements to the existing 1993 HEU-LEU Agreement. One is the creation of a strategic reserve in the United States from Russian HEU down-blended into LEU. The second is the use of Russian HEU to fuel selected U.S. research reactors until their cores are converted to operate on LEU. Unlike the original agreement, the second supplement proposes transferring uranium to the United States in its highly enriched form.

An initiative to accelerate development of low enriched fuel for use in both Soviet-designed and U.S.-designed research reactors has been proposed in parallel with the initiative to use Russian HEU in research reactors.

The proposed supplement to the HEU-LEU Agreement regarding fuel for research reactors provides for the United States to purchase 150 kilograms (331 pounds) of HEU per year, on average, over a 10-year period, from the Russian Federation. HEU, with an average assay of 93 percent or greater of uranium-235 would come from existing Russian stock. The Russian Federation would be responsible for ensuring that the chemical and isotopic composition of the material conforms with agreed to technical specifications such that it would be usable as fuel for the research reactors. Contracts implementing the supplemental agreement would provide for U.S. employees or contractors to observe the packaging of HEU into containers for shipment and the sealing of the containers. HEU would be utilized to manufacture fuel for the following research reactors:

- the National Bureau of Standards Research Reactor located at the National Institute of Standards and Technology in Gaithersburg, MD,
- the Massachusetts Institute of Technology Research Reactor located at the Massachusetts Institute of Technology in Cambridge, MA,
- the University of Missouri Research Reactor located at the University of Missouri in Columbia, MO, and

- the High Flux Isotope Reactor located at the Oak Ridge National Laboratory in Oak Ridge, TN.

Reason for the Supplemental Agreement

The proposed supplemental agreement for transfer of HEU for research reactor fuel complements ongoing U.S.-Russian cooperation under the existing HEU-LEU Agreement by concentrating on areas not covered by the original agreement. Thus, it provides for more rapid disposition of HEU. Both the HEU-LEU Agreement and the proposed supplemental agreement fulfill similar nonproliferation and national security-related objectives:

- Safe and prompt disposition, for peaceful purposes, of HEU that exceeds defense requirements;
- Preventing the theft or diversion of HEU by hostile nations and terrorists;
- Providing for the fulfillment of all applicable nonproliferation, materials protection control and accountability, and environmental requirements of each party; and
- Providing funds to the Russian Federation for the conversion of defense enterprises, enhancing the safety of nuclear power plants, and environmental clean-up of contaminated areas.

1.2 Key Issues Addressed

This EA addresses the environmental impacts associated with the transportation of HEU over the Atlantic Ocean to the NNSA Y-12 Complex. Transportation modes included in the analysis are military air transport and ground transport by truck.

The location at which the U.S. would take possession of the material has not yet been determined, but could be St. Petersburg, another location in Russia, or a venue in Europe. Consistent with the direction of Executive Order 12144, *Environmental Effects Abroad of Major Federal Actions*, this EA will evaluate impacts associated with air transportation of HEU over the global commons, that is, those parts of the Earth that are outside the jurisdiction of any specific nation. Actions such as this one, that potentially affect the environment in a foreign nation, but take place with the participation or involvement of the foreign nation, are not subject to analysis in a U.S. environmental document. The U.S. intends to secure permission for overflight of any countries that must be traversed in transporting HEU to the United States. Packaging of the material and transportation to the location at which the United States takes possession would be the responsibility of the Russian Federation. Therefore, the EA begins at the time the aircraft enters the global commons and does not evaluate the impacts of actions taken in Russia or from the overflight of any foreign nations.

The proposed action involves the use of existing infrastructure in the way of air fields and roadways. In addition to evaluating impacts to the global commons, impacts associated with normal operations and accident conditions related to ground transportation will be evaluated. However, this EA does not analyze in detail the potential impacts to biological, cultural, geologic, or water resources or to socioeconomics. Since there would be no construction or processing of any sort, there would be no land disturbance that could potentially affect biota, cultural resources, or geologic media. No water would be withdrawn or discharged to surface or groundwaters. The proposed action would not have any appreciable effect on socioeconomic conditions at any of the analyzed locations. All work would be accomplished making temporary use of existing personnel. The duration of personnel involvement would be a relatively small portion of any given year, avoiding the need to add to the workforce.

The EA analysis ends at the point the trucks bearing HEU arrive at the Y-12 Complex. Activities that occur at the Y-12 Complex such as unloading HEU, transferring it to a storage location, and monitoring it while in storage are within the scope of the *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2001) and therefore are not addressed in this document.

1.3 Relationship to Other DOE NEPA Documents

The *Environmental Assessment for the Purchase of Russian Low Enriched Uranium Derived from the Dismantlement of Nuclear Weapons in the Countries of the Former Soviet Union, (HEU-LEU Agreement EA)* DOE/EA-0837, was prepared to evaluate the impacts of the 1993 HEU-LEU Agreement (USEC 1994). DOE issued a finding of no significant impact associated with the purchase, the ship and truck transport of LEU derived from up to 500 metric tons (551 tons) of Russian HEU to the United States and making the material available for fuel fabrication. The current action supplements the purchase of 500 metric tons (551 tons) of HEU, but was not included in the original assessment.

Two supplemental agreements that involve different means of augmenting the HEU-LEU Agreement are under consideration. The supplemental agreement to purchase and transfer additional LEU for use as a strategic reserve involves transportation and environmental impacts similar to those addressed in the *HEU-LEU Agreement EA*. The supplemental agreement that is the basis for the proposed action assessed in the current EA is for the purchase and transport of uranium that is different in nature from that assessed in the *HEU-LEU Agreement EA*. The uranium would be transported in its highly enriched form rather than being down-blended to a low enrichment prior to transfer.

DOE previously made a decision regarding the storage location of HEU. The *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE/EIS-0229), includes evaluation of various programmatic alternatives for providing secure storage of fissile materials (DOE 1996a). Included within the scope of the analysis was the storage of 994 metric tons (1,096 tons) of HEU. Subsequently, DOE issued the January 21, 1997 Record of Decision (62 FR 3014) which named the Y-12 Complex as the central repository for storage of HEU. This environmental impact statement (EIS) and Record of Decision established the Y-12 Complex as the storage location for HEU, such as that acquired from the Russian Federation, pending H3 fabrication into research reactor fuel.

The *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex (Y-12 Site-Wide EIS)* (DOE/EIS-0309) evaluated the impacts associated with various levels of operational activities (DOE 2001). In the March 13, 2002 Record of Decision (67 FR 11,296) DOE announced its decision to implement its planning basis alternative, which meets mission requirements, including storage of HEU, and includes the construction of two new facilities, including the HEU Materials Facility for storage of HEU. The Y-12 Complex currently has six buildings that are used for storage of HEU. The *Y-12 Site-Wide EIS* addresses onsite management of activities associated with HEU including the receipt and unloading of Safe Secure Transports (SSTs) and the transfer of HEU into storage. Therefore, those activities are not addressed in the current EA.

There have been two previous actions that were analyzed in environmental assessments that are similar to the proposed action. The *Environmental Assessment for Project Partnership - Transportation of Foreign-Owned Enriched Uranium from the Republic of Georgia,* DOE/EA-1255 (DOE 1998) evaluated the environmental impacts of transporting 5.26 kilograms (11.6 pounds) of HEU from the Republic of Georgia to the United Kingdom. The transported material consisted primarily of unirradiated fuel, but did contain less than a kilogram of partially spent fuel. The similarity to the current EA is that the Project Partnership assessment evaluated the impact on the global commons associated with U.S. military air transport of HEU. The Department found that there was no significant impact from the action.

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) evaluated the environmental impacts of transporting 566 kilograms (1,248 pounds) of HEU contained in 2,200 kilograms (2.4 tons) of material from Kazakhstan to the Y-12 Complex. The assessment's scope included transport by military aircraft over the global commons to an aerial port of entry, transfer from the aircraft to the SST, ground transportation by SST, and transfer from the SST to the Y-12 Complex. The aerial ports of entry included those addressed in the current EA. DOE made a finding of no significant impact associated with the air-land transportation of the Kazakhstan HEU. Because the action evaluated in the Kazakhstan EA parallels the current action, data and analyses from that document will be used where applicable and appropriate in this EA.

2.0 Purpose and Need for Action

The United States and Russia are pursuing development of supplements to the 1993 HEU-LEU Agreement to further reduce the amounts of excess weapons-usable fissile materials. One such supplement proposes the U.S. purchase and transfer of, on average, 150 kilograms (331 pounds) per year of HEU from the Russian Federation over a period of 10 years. HEU would be placed in secure storage in an existing facility at the Y-12 Complex.

In order to effect the proposed transaction, the United States needs to transport the HEU from a location in Russia to the storage facility in this country which is the subject of this EA. The Russian Federation would package HEU in transport containers and deliver it to a location at which the United States would take possession of the material and assume responsibility for its security and transport. To minimize the opportunity and potential for diversion of the material, the United States would provide security measures and transport the material in an expeditious manner.

3.0 Description of Alternatives

As discussed in Section 2.0, the United States and the Russian Federation are working cooperatively to reduce the threat of nuclear proliferation by managing excess fissile materials in a manner that makes them unusable for nuclear weapons. The action being addressed by this EA is the transfer of, on average, 150 kilograms (331 pounds) per year over a period of 10 years of HEU from Russia to the United States. The action would include U.S. military air transport of the packaged material to the United States, transfer of the material to a truck, and overland transport by the truck to the Y-12 National Security Complex. Offloading of the truck and storage at the Y-12 Complex are included in the *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2001) and not addressed in this EA.

The Russian Federation would be responsible for providing HEU that meets the technical specifications agreed to by the two countries (see **Table 3–1)**. The uranium would be enriched natural uranium, not recycled uranium, and would have a negligible amount of other actinides[1] and fission products. The chemical form of the material will be uranium oxide (U_3O_8). The uranium oxide would be a powder. In order to transfer 150 kilograms (331 pounds) of HEU, a shipment would consist of about 177 kilograms (390 pounds) of uranium oxide. Russia would also be responsible for packaging the material in the appropriate Type B packages that meet the International Atomic Energy Agency Safety Standard Series No. TS-R-1, *Regulations for the Safe Transport of Radioactive Materials* (IAEA 2000). Russia would transport the material to the location from which the U.S. military aircraft would depart. A range of ports of departure are possible, with the final location being decided on by negotiations between the Russian Federation, the United States, and possibly another country. Examples of the range of possible arrangements include: (1) Russia would transport the material to an airfield near the current storage location of the material and the U.S. military aircraft would depart from that airfield; (2) Russia would transport the material by truck, train, or aircraft to an airfield near St. Petersburg, Russia, from which the U.S. military aircraft would depart; or (3) Russia would transport the material by aircraft to an airfield in a European country where it would be transferred to the U.S. military aircraft for departure.

Table 3–1 HEU Specifications

Uranium-234	1.20%
Uranium-235	93.00%
Uranium-236	0.46%
Uranium-238	5.34%

Consistent with Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions,* this EA does not address the environmental effects of actions occurring in sovereign foreign nations. However, in accordance with Executive Order 12114, this EA does evaluate the potential impacts on the global commons, that is, the portion of the Earth that does not belong to

[1] *Actinides are elements with atomic numbers of 89 (actinium) or greater. Uranium and plutonium are actinides.*

a specific country. For this particular action, the global commons would include the airspace above the international waters that would be traversed by the U.S. military aircraft.

The action addressed by this EA is part of the U.S.-Russian program to prevent the proliferation of nuclear weapons. HEU being transported would be attractive to those wanting to acquire nuclear materials and therefore would occur under very high security. In order to prepare this EA as an unclassified document so that it is available to interested members of the public, specific information about the routing and security surrounding the transportation of the material is not included. Rather, information is included that bounds the actions to be taken and provides a basis for distinguishing between the environmental effects of the alternatives evaluated.

In the case of air transportation of HEU, the specific location of departure is not particularly important because the evaluation of environmental impacts starts at the point where the aircraft enters the global commons. For purposes of this evaluation, a specific route was not evaluated, but the distance for air travel was selected based on the distance from St. Petersburg, Russia to the U.S. aerial port of entry. The linear distance from St. Petersburg was increased by 25 percent to allow for variations in actual flight path (see **Table 3–2**). Because of the 25 percent additional mileage and the fact that part of that distance might not be over the global commons (i.e., could be over the airspace of a European country), this approach bounds the distance that would actually be traveled by air (see **Figure 3–1**).

Table 3–2 Representative Air Travel Distances

Alternative	Flight to [a]	Total Air Travel	
		Kilometers [b] (miles)	Time [c] (hr:min)
Proposed Action	McGhee Tyson Air National Guard Base	9,800 (6,100)	12:15
Alternative 1	Dover Air Force Base	8,900 (5,500)	11:00

[a] It is assumed that flights start at St. Petersburg, Russia for all action alternatives. Since the environmental assessment analysis does not start until entering the global commons, the place of origin in western Russia or Europe is not significant.
[b] The flight distance is sufficient to accommodate any reasonable routes. Distance is the direct distance from St. Petersburg plus 25 percent, rounded to the nearest 100 miles.
[c] Flight times are based on a nominal cruising speed of 805 kilometers per hour (500 miles per hour) for a C-17. Times are rounded up to the next quarter hour.

To assess the impacts from ground transportation of the material, the specific routing of the material is not analyzed. Instead, representative routes are selected for analysis (see **Figure 3–2**).

3.1 Proposed Action – Transport to McGhee Tyson Air National Guard Base

The proposed action for transferring the Russian HEU to the Y-12 Complex is to transport it in a C-17 Globemaster III aircraft to the McGhee Tyson Air National Guard Base near Knoxville, TN. The Air National Guard Base is located at the McGhee Tyson Airport. The material would be transferred to a SST in a secure area of the base and then transported to the Y-12 Complex at the Oak Ridge Reservation. McGhee Tyson Air National Guard Base is the air field nearest the Oak Ridge Reservation, so its use minimizes the ground transportation required.

Figure 3–1 Air Transport Will Be from Russia or Europe to an Aerial Port of Entry near Knoxville, TN or Dover, DE

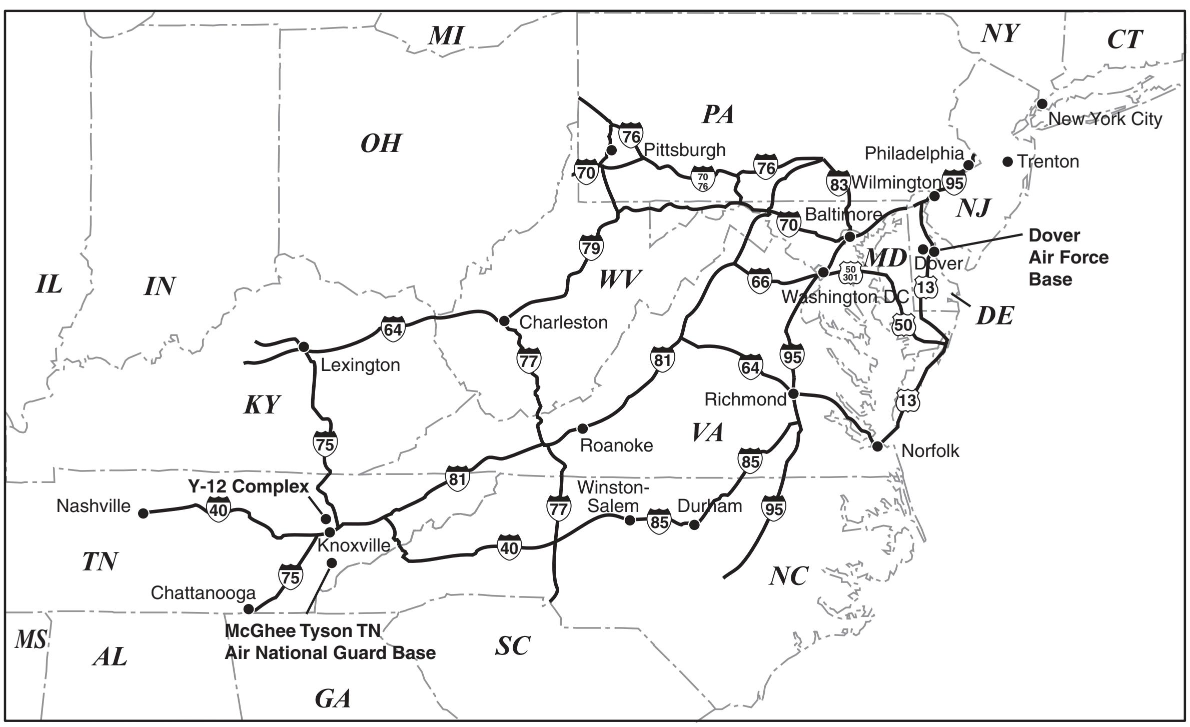

Figure 3–2 Ground Transport Would Be from McGhee Tyson Airport near Knoxville, TN or Dover Air Force Base (AFB) in Delaware

Included in this alternative is the use of either of two shipping packages. Initially, a TN-BGC1 shipping package (see **Figure 3–3**) would be used, limiting a single shipment to 150 kilograms (331 pounds) of HEU. The TN-BGC1 is limited to carrying 7 kilograms (15.4 pounds) of uranium-235 so transport of the 150 kilograms (331 pounds) would require 22 shipping packages. Subsequent shipments could be made using the ES-2100 shipping package (see **Figure 3–4**), with the possibility of transferring two years worth of HEU, or 300 kilograms (662 pounds) in a single shipment. The uranium-235 mass limit for an ES-2100 is approximately twice that of the TN-BGC1 so twice as much can be placed in a single package. Transport of 300 kilograms (662 pounds) of HEU would require 22 ES-2100 shipping packages.

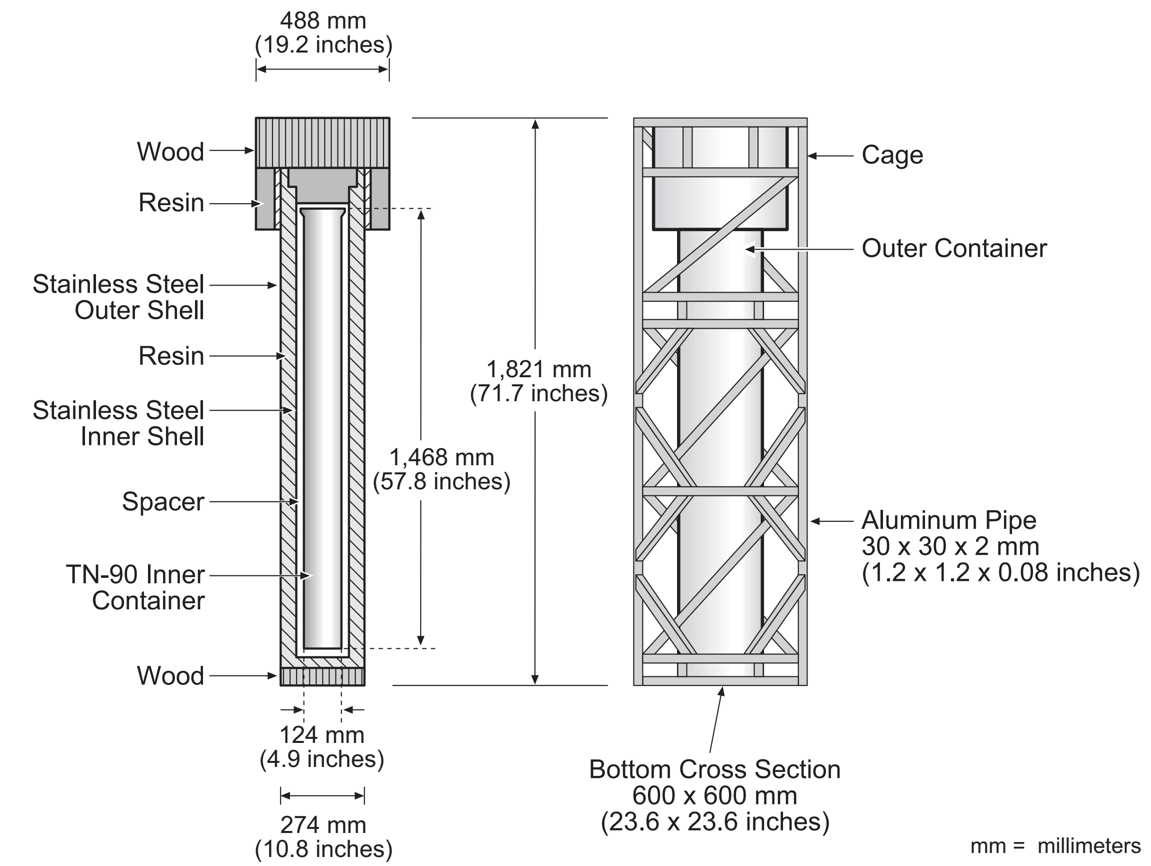

Figure 3–3 TN-BGC1 Transportation Package Includes the Confinement/Containment Barriers and a Protective Cage

The C-17 has a payload of 77,520 kilograms (170,900 pounds) and can land and take off from a runway as short as 915 meters (3000 feet). The cruising speed is about 805 kilometers per hour (500 miles per hour). With an unrefueled range of about 4,400 kilometers (2,760 miles), it would be necessary to refuel the aircraft one or two times to complete a trip estimated to be up to 9,800 kilometers (6,100 miles). Refueling would be accomplished in air using KC-135 tanker aircraft. The KC-135s would depart from their airfields, rendevous with the C-17, then return to

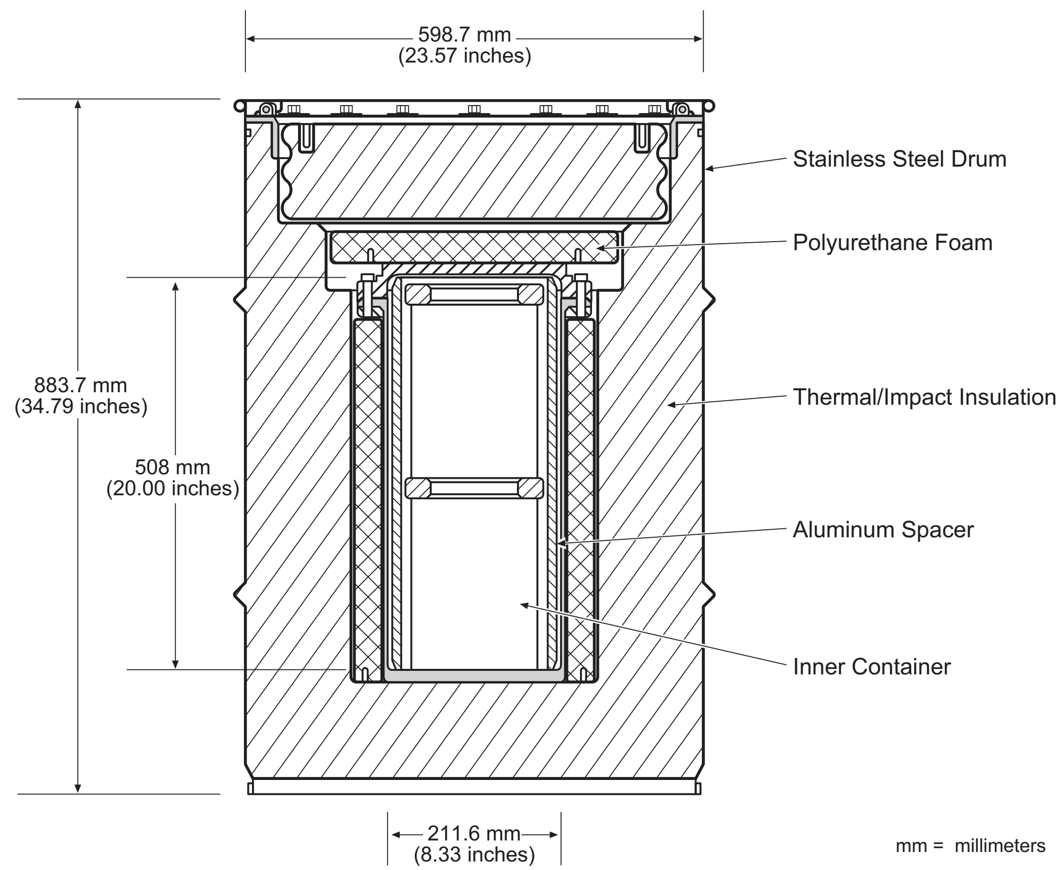

Figure 3–4 ES-2100 Transportation Package Uses a 55-Gallon Stainless Steel Drum as the Outer Confinement Layer

their airfield upon completion of the refueling. In-air refueling is a routine practice for U.S. military aircraft and the involved personnel are well-practiced in its execution.

Although the proposed action is to use a C-17 aircraft for air transport of the material, an alternative military aircraft could be used. The C-5 or the C-141 has the payload capacity and a cargo hold capable of accommodating 22 of either the TN-BGC1 or ES-2100 packages. Both of these aircraft would also need to be refueled to make a trip from Russia or Europe to the United States.

3.2 Alternative 1 – Transport to Dover AFB

An alternative to flying into the McGhee Tyson Air National Guard Base would be to fly to another military airfield that could provide a secure area for making the transfer from the aircraft to the SST. Dover AFB, near Dover, DE, is presented as an alternative aerial port of entry from which the material could be transported by SST to the Y-12 Complex. Under this alternative, the amount of time and distance flying over land is reduced; and, therefore, the distance and time for ground transportation is increased.

3.3 No Action Alternative

Under the No Action Alternative, the HEU would remain in Russia and not be packaged and transported to the Y-12 Complex. This alternative does not meet the objective of making this excess HEU unavailable for nuclear weapons by bringing it to the United States, where it would be consumed as fuel in U.S. research reactors.

3.4 Alternatives Considered but Not Evaluated

A number of other alternatives were recognized as physically possible, but were dismissed as unreasonable or inconsistent with decisions that have been made by the U.S. Government regarding nuclear security.

3.4.1 Alternate Storage Location

In the *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (62 FR 3014), DOE indicated its intent to continue the storage of weapons-usable HEU at the Y-12 Complex. Storing weapons-usable HEU at a single location enhances security while minimizing the costs of storage. Since HEU that would be transported under the proposed action needs only to be temporarily stored until it is used in the fabrication of research reactor fuel, it is not reasonable to develop separate capabilities at an alternate location.

3.4.2 Alternate Air Carrier

In lieu of a U.S. military aircraft, a U.S. commercial, Russian commercial, or Russian military aircraft could be used to transport the uranium. The air transport portion of the impacts for these alternate carriers would be similar to those of using U.S. military aircraft. However, under each of these alternatives, the U.S. Government would relinquish some degree of control over the material, posing a security concern when the aircraft enters U.S. airspace. Therefore, all of these alternatives were recognized as having impacts comparable to those analyzed, but providing less assurance of safety and security, so were not analyzed in any more detail.

3.4.3 Ship Transport

A possible alternate transportation mode could involve transport by a U.S. Navy ship or a ship of some other registration over the global commons. This mode would require significantly longer time than air transport. Once it takes ownership and responsibility for the HEU, the United States is committed to safeguarding it in a secure facility as rapidly as practical. The alternative of naval transport that would take days rather than the hours associated with air transport would not meet the security needs associated with transporting the material. There would also be a commensurate potential for radiation exposure associated with the increased time in transit.

4.0 Affected Environment

This section describes the affected environment of those areas potentially impacted by the proposed action, including the global commons, McGhee Tyson Air National Guard Base, and Dover AFB. The affected environment descriptions presented in this section provide the context for understanding the environmental consequences described in Chapter 5, Potential Environmental Impacts. As such, they serve as a baseline against which any changes resulting from implementation of the proposed action and alternatives can be identified and evaluated.

4.1 Global Commons

Since transport of HEU would involve flying across about 8,700 kilometers (5,400 miles) of the Atlantic Ocean (see Figure 3–1), Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*, is applicable. Thus, this section describes the global commons, specifically the ocean environment. Unless otherwise noted, material presented in this section is from 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 1994).

Within the northern hemisphere, waters of the Atlantic Ocean generally flow in a clockwise direction. In the western Atlantic, the Gulf Stream carries ocean waters in a generally northerly direction until they reach Cape Hatteras. At this point, the Gulf Stream turns eastward and continues in a northeasterly direction until it meets the southward flowing Labrador Current in the vicinity of the Grand Banks of Newfoundland. Flow across the North Atlantic is from west to east. Once waters reach the European continent, they flow both north (via the Norwegian Current) and south (via the Canaries Drift). Upon reaching the northwest coast of Africa, the North Equatorial Current flows westward toward the Caribbean Sea. The circular flow of the Atlantic creates the Central North Atlantic Eddy, or what is also known as the Sargasso Sea (Coker 1962).

Flow within the Gulf Stream is as high as 26×10^6 cubic meters (918×10^6 cubic feet) per second as it passes through the Florida Straits (Coker 1962). Within the North Atlantic, flows are around 5.0×10^6 cubic meters (177×10^6 cubic feet) per second for waters crossing the Iceland-Scotland Ridge, as well as for those flowing from the Greenland Sea through the Denmark Strait.

Although the salinity of seawater is around 35 parts per thousand, it is generally lower in high latitudes and higher in low latitudes. Within the Gulf Stream, salinity is relatively high, averaging 35 to 36.5 parts per thousand; however, within the Sargasso Sea it is even higher, averaging 38 parts per thousand (Coker 1962). Seawater contains the majority of the known elements. A significant feature of seawater is that while the total concentration of dissolved salt varies from place to place, the ratios of the more abundant components remain almost constant. This may be taken as evidence that over geologic time, the oceans have become well mixed.

Radiological Characteristics

Naturally occurring radionuclides are present in seawater and in marine organisms at concentrations generally greater than in terrestrial ecosystems. The ocean water concentrations of a number of isotopes are shown in **Table 4–1**. The high natural radionuclide levels make ocean ecosystems the highest background-radiation domains in the biosphere.

Table 4–1 Oceanic Concentrations of Naturally Occurring Radioisotopes

Radionuclide	Concentration (picocuries per liter)
Carbon-14	1.8
Potassium-40	486
Rubidium-87	3
Thorium-232	540
Tritium	3
Uranium-234	1.30
Uranium-235	0.05
Uranium-238	1.20

Source: DOE 1996
Note: 1 picocurie = 1.0×10^{-12} curies

Radionuclides have been discharged into the oceans since 1944. In 1981 it was estimated that the total input of radionuclides, essentially from waste disposal and nuclear weapons testing, approached 0.7 percent of the natural radioactivity present in the oceans. The total inventory of natural radioactivity in the oceans is approximately 5.0×10^{11} curies.

The relationship between environmental concentrations of radionuclides and the concentration found in organisms is important in the study of food web effects. Bioaccumulation, the increase in concentration in organisms progressively further up the food web, is observed in marine ecosystems. In the marine environment, uranium has not been found to bioaccumulate in fish and only slightly bioaccumulates in crustaceans and mollusks.

Ocean Depth and Biota

The North American continental shelf, which averages 65 kilometers (40 miles) wide and less than 200 meters (660 feet) deep, has the greatest biomass concentration in the Atlantic Ocean and is where most fisheries are located. The deep ocean is an average of 4 kilometers (2.5 miles) deeper than the continental shelf.

The deep-sea bottom dwellers, or benthos, are highly diverse, with many taxonomic groups being represented there by more species than most shallow-water communities. However, the number of individual organisms in a given volume decreases in the deep seas and this, together with a general tendency for the average size of the organisms to also decrease, results in a dramatic reduction in standing stock or biomass on the deep ocean floor. In round figures, the total wet weight of bottom-living organisms decreases from 10 to 100 grams per square meter (0.2 to 2.3 pounds per square foot) on the continental shelf, to 1 to 10 grams per square meter (0.02 to

0.2 pounds per square foot) on the continental slope, and to only 0.1 to 1.0 grams per square meter (.002 to 0.02 pounds per square foot) on the abyssal plain.

4.2 McGhee Tyson Air National Guard Base, TN

The McGhee Tyson Air National Guard Base is located at the McGhee Tyson Airport. McGhee Tyson Airport is one of five major air carrier airports in the state of Tennessee. It is located in Blount County, about 30 miles southeast of Oak Ridge, TN (see **Figure 4–1**). It is adjacent to the corporate limits of Alcoa, TN, and approximately 10 miles southwest of the Knoxville Central Business District (DOE 1994). The airport is situated on 910 hectares (2,250 acres) of land and has 2 parallel 2,740-meter (9,000-foot) runways. In 2000, the airport handled over 1.7 million passengers (MKAA 2003). There are an average of 149,000 aircraft operations per year at the airport, including all categories of aircraft (AirNav, LLC 2003). McGhee Tyson Airport is categorized in the National Plan of Integrated Airport Systems as a medium-haul commercial service airport. This category does not restrict or prevent its use by general aviation or military aircraft. Fuel storage and fueling services for general aviation, air cargo, and the airlines are handled onsite by fixed base operators (DOE 1994).

McGhee Tyson Airport shares its airfield facilities with the 134th Air Refueling Group of the Tennessee Air National Guard and the Army Aircraft Support Facility (DOE 1994). The 134th Air Refueling Group presently operates 10 KC-135E tankers and its mission is to train, equip, and maintain units and individuals to meet worldwide requirements for Federal day-to-day and mobilization missions and state emergencies (Global Security 2002). The Tennessee Air National Guard occupies 131 hectares (323 acres) on the west side of the airport. There are about 40 structures that support the operation of the Air National Guard, including an aircraft rescue and fire fighting facility. The Air National Guard and the Metropolitan Knoxville Airport Authority have an agreement to share rescue and fire fighting equipment and services as required (DOE 1994). Over 16,000 military aircraft operations take place at McGhee Tyson Airport each year (AirNav, LLC 2003).

Population

The population of Blount County is 105,823, while that of Knox County, located just to the north, is 382,032. These figures represent 1.9 and 6.7 percent of the population of Tennessee. Knoxville, the nearest major city to McGhee Tyson Air National Guard Base, has a population of 173,890 (DOC 2003). The population within an 80-kilometer (50-mile) radius of the airfield is 1,081,825. A workforce of 723 full-time personnel manages day-to-day activities; however on two weekends per month, the population increases to 1,700 during military training assemblies (Global Security 2002).

Air Quality

As directed by the Clean Air Act of 1970 (42 U.S.C. Sect 7401), the U.S. Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQS) for several criteria pollutants to protect human health and welfare (40 CFR 50). These pollutants include particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than

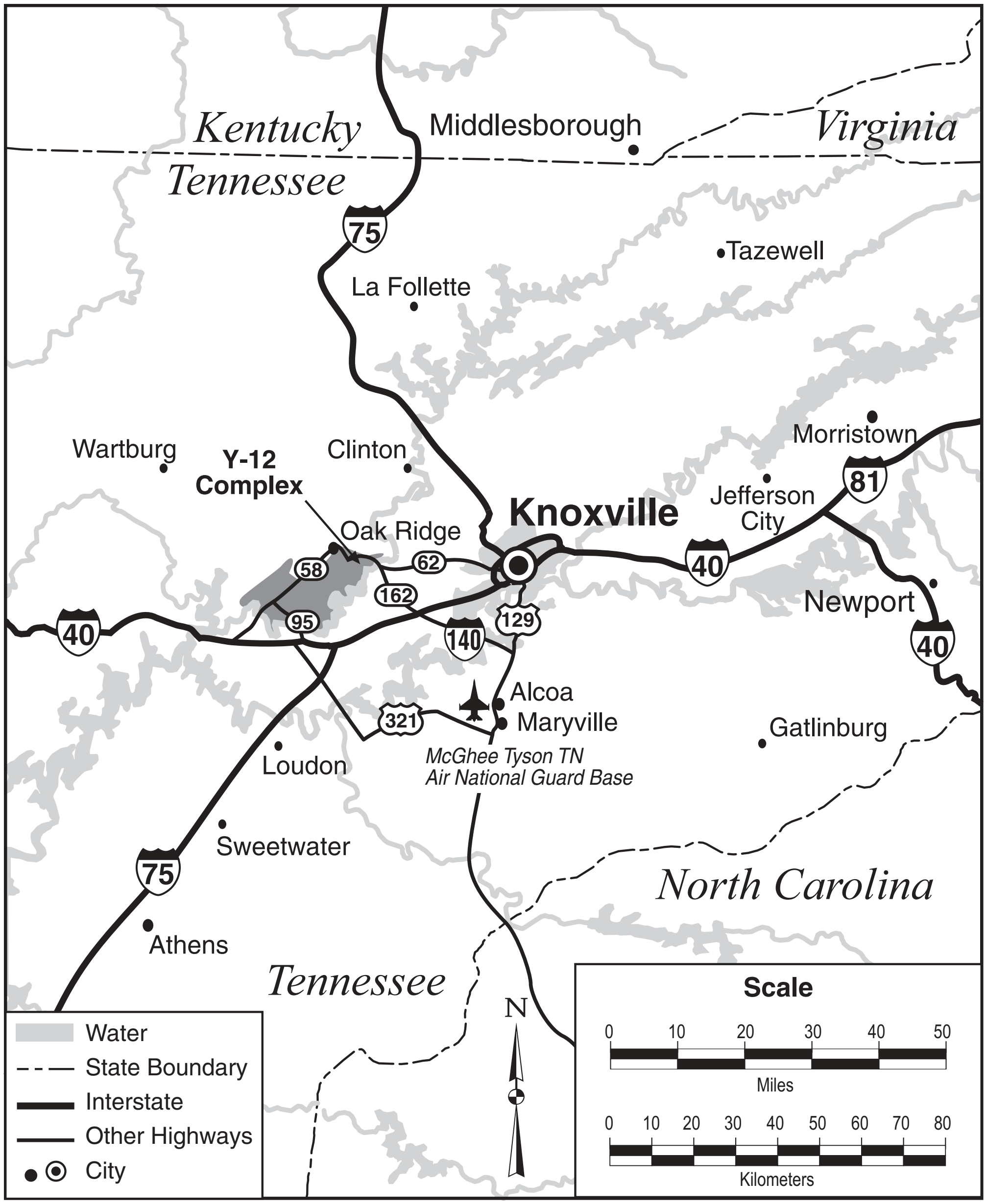

Figure 4–1 Region Around McGhee Tyson Air National Guard Base and the Y-12 Complex

2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), lead (Pb), and ozone (O_3). The area around McGhee Tyson Airport is in attainment for the NAAQS. The nearest area not in attainment is Atlanta, Georgia, for ozone. Attainment status designations have not been promulgated for PM_{10} and $PM_{2.5}$. Blount County is designated by EPA (40 CFR 81.343) as:

- "Better than national standards" for SO_2,
- "Unclassifiable/attainment" for CO and O_3,
- "Cannot be classified or better than national standards" for NO_2, and
- "Not designated" for Pb.

4.3 Dover AFB, DE

Dover AFB is located in Kent County, DE approximately 5.6 kilometers (3.5 miles) southeast of the city of Dover and 1.6 kilometers (1 mile) west of Delaware Bay (see **Figure 4–2**). The Base is about 80 kilometers (50 miles) southeast of Wilmington, DE, and 129 kilometers (80 miles) southeast of Philadelphia, PA (DOE 1994). Dover AFB covers about 1,580 hectares (3,900 acres), and has 1,700 buildings (436th Airlift Wing 2003). Dover AFB has two runways that are 2,930 meters (9,600 feet) and 3,930 meters (12,900 feet) in length (Delaware River and Bay Authority 2003).

Dover AFB is the home of the 436th Airlift Wing and, since 1973, has been the only all C-5 Galaxy aircraft base in the Air Mobility Command (DOE 1994). The 36 C-5s present on the base provide 25 percent of the nation's inter-theater airlift capability. The 436th provides worldwide movement of outsized cargo and personnel on scheduled, special assignment, exercise, and contingency airlift missions (436th Airlift Wing 2003).

In 1998, the 436th Airlift Wing flew more than 600 missions throughout the world projecting global reach to more than 90 countries on six continents. Additionally, the 436th Airlift Wing operates the largest and busiest aerial port in the U.S. Department of Defense, with its passenger terminal moving over 100,000 passengers in 1998 (436th Airlift Wing 2003).

Population

The population of Kent County is 126,697, or 16.2 percent of the population of Delaware. The population of Dover, the closest city to Dover AFB, is 32,135, while that of Wilmington is 72,664 (DOC 2003). The population within an 80-kilometer (50-mile) radius of the airfield is 1,751,843. There are more than 4,200 military, 1,200 civilians, and 2,500 reservists who work at the base.

Air Quality

The area around Dover AFB is in attainment for the EPA NAAQS criteria air pollutants, except for O_3. Attainment status designations have not been promulgated for PM_{10} and $PM_{2.5}$. Kent County is designated by EPA (40 CFR 81.308) as:

- "Better than national standards" for SO_2,
- "Unclassifiable/attainment" for CO
- "Nonattainment – Severe" for O_3,
- "Cannot be classified or better than national standards" for NO_2, and
- There is no designation for Pb.

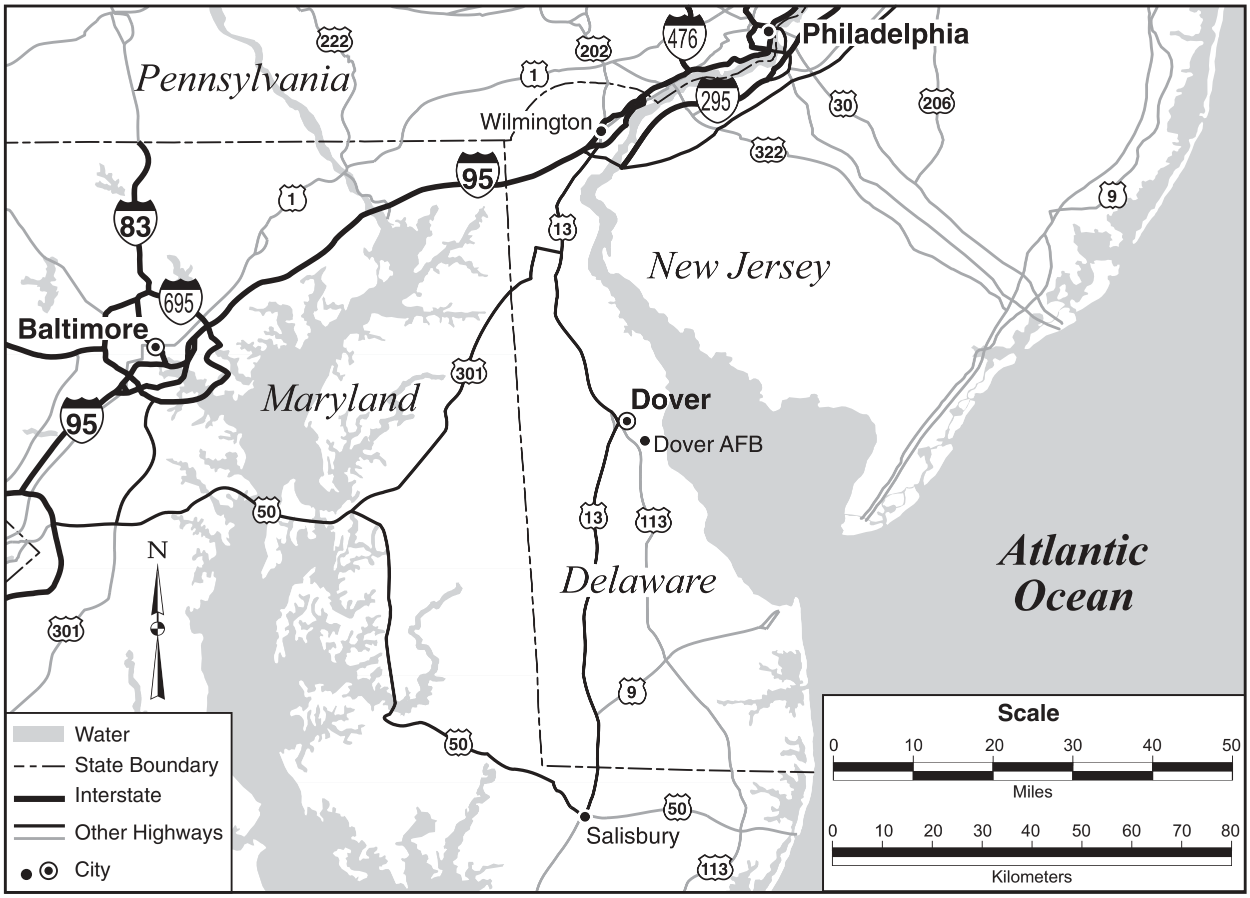

Figure 4–2 Region Around Dover Air Force Base

5.0 Potential Environmental Impacts

This section describes the environmental impacts from incident-free and accident conditions during air transport of HEU over the global commons, transfer of the material from the aircraft to Safe Secure Transports (SSTs), and ground transportation from the airfield to the Y-12 National Security Complex (Y-12 Complex) for the following:

- the Proposed Action to transport the material to the Y-12 Complex via the McGhee Tyson Air National Guard Base at the McGhee Tyson Airport, Alcoa, TN;
- Alternative 1, transport of the material to the Y-12 Complex through an alternate aerial port of entry, the Dover Air Force Base, Dover, DE; and
- the No Action Alternative.

The activities addressed by this EA potentially impact the global commons and public and occupational health and safety. Accordingly, these two topics are evaluated in the following sections.

5.1 Impacts of Proposed Action

The Proposed Action is to transport HEU in a C-17 aircraft over the global commons between Europe and the United States and land at the McGhee Tyson Air National Guard Base. At the McGhee Tyson Air National Guard Base, the packages of HEU would be transferred from the aircraft to SSTs. The SSTs would then transport the material to the Y-12 Complex.

5.1.1 Air Transportation

Air transportation of the HEU from a location in Russia or Europe to the United States is to occur in a C-17, a military cargo aircraft. For purposes of evaluating impacts and comparing alternatives, representative transport distances are used. The distance used for the Proposed Action is based on a starting point of St. Petersburg, Russia and a terminating point at McGhee Tyson Air National Guard Base (see Table 3–1).

The Proposed Action has been evaluated based on the use of a U.S. military C-17 for transporting the HEU from Russia or Europe to the McGhee Tyson Air National Guard Base. As noted earlier, there are other military cargo aircraft that could also be used to perform the transport function. Both the C-141 and the C-5 are capable of transporting the 22 packages (either TN-BGC1 or ES-2100). The distance from the flight crew to the expected position of the cargo is approximately the same and, with similar cruising speeds, the travel time and time of exposure would also be similar. The accident analysis is based on the quantity of material transported (bounded by a payload of 300 kilograms [662 pounds] of HEU) so it would not be any different for these other aircraft. Therefore, the environmental impacts calculated for the C-17 would be comparable if either of these other aircraft were used.

5.1.1.1 Global Commons

The Proposed Action would involve air transport of HEU over the ocean so this environmental assessment examines the potential impacts on the global commons in accordance with Executive Order 12114. Potential impacts of the Proposed Action to the global commons could be due to normal operations or accident conditions.

Normal operations are not expected to have a significant impact to the air of the global commons. Air emissions from the flight of a single C-17 from the Russian Federation to the United States an average of once each year (as well as the flights of refueling aircraft) would represent a very small percentage of the thousands of flights crossing the north Atlantic annually. The consequent emissions from such flights would be a similar small percentage and have no appreciable impact on air quality of the global commons. There are no other potential impacts to the global commons from normal operations.

Impacts of an accident 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). In DOE/EA-1006, a C-5 aircraft was used to transport 556 kilograms (1,248 pounds) of HEU. It was concluded that in the case of an accident there could be some loss of life to marine organisms directly exposed to the enriched 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 short duration.

The C-17 aircraft to be used for the Proposed Action has an excellent safety record. Over its 12 years in service (1991 through 2002), it has an accident rate of 1.22 mishaps per 100,000 hours (USAF 2003). The flight time associated with the proposed action would be up to 12 hours 15 minutes with about 11 hours of the flight time occurring over the global commons. The amount of material to be shipped for the current action would be 150 or 300 kilograms (331 or 662 pounds), depending on whether TN-BGC1 or ES-2100 packages are used, so the impacts would be expected to be less than those evaluated in the DOE/EA-1006.

The response to and impacts of an in-flight accident over the global commons would be different depending on the location and the condition of the packages following the accident. It is assumed that packages that did not sink below 200 meters (670 feet) would be considered recoverable and would be retrieved. Undamaged packages that sink deeper than 200 meters (670 feet) would be breached by the pressure of the overlying water or corrosion and release their contents gradually. The contents of damaged packages would be immediately released into the ocean. As discussed in DOE/EA-1006, the volume of water coupled with the turbulence and mixing of the water column would dilute the material that is either leaked out gradually or released immediately. Only very localized and negligible impacts on the global commons are postulated for an air transport accident.

5.1.1.2 Impacts from Incident-Free Air Transportation

The transport of HEU in a military aircraft would result in radiological exposure only to the personnel on the aircraft. Because of the distance to the nearest members of the public, there would be no radiological exposure to the public. The radiological exposure to the persons on the cargo plane would be proportional to the package characteristic dimensions and to the travel time between the lift-off and landing at McGhee Tyson Air National Guard Base (see Table 3–2).

The HEU may be contained in either of two transportation packages. If the TN-BGC1 transportation package is used, one shipment would comprise 150 kilograms (331 pounds) of HEU contained in 22 packages. The expected aircraft loading configuration would be 2 containers wide by 11 rows long. If ES-2100 transportation packages are used, their greater capacity would allow a shipment to comprise 300 kilograms (662 pounds) of HEU contained in 22 containers. The ES-2100 design has a 208-liter (55-gallon) stainless steel drum as the outer confinement layer so it would be amenable to packing in a cargo restraint transporter which holds two layers of 4 drums each (see **Figure 5–1**). Using the cargo restraint transporter would result in an aircraft loading configuration that is 2 packages wide by 2 packages tall by 8 packages long (two packages would be excess to the requirements of the shipment). The analysis of impacts is based on 150 kilograms (331 pounds) per shipment when the TN-BGC1 is used and 300 kilograms (662 pounds) per shipment when the ES-2100 is used. Estimated doses to a member of the crew for transporting either of the packages is given in **Table 5–1.** The slightly higher

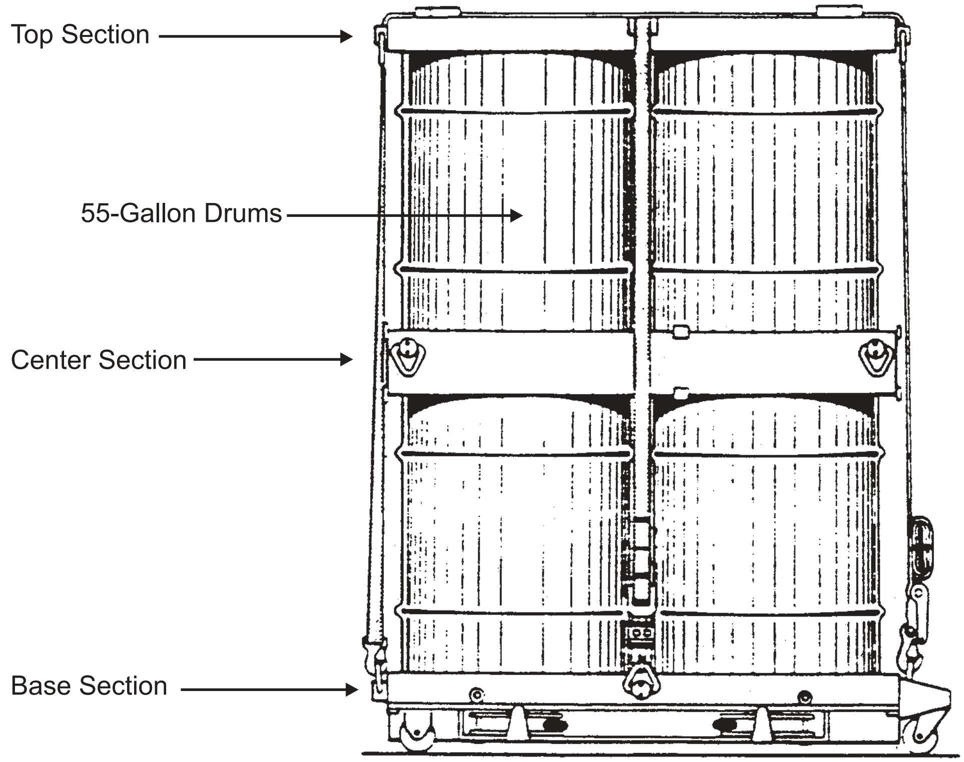

Figure 5–1 Configuration of ES-2100 Containers in a Cargo Restraint Transporter

dose from transporting the ES-2100 package is due to the packaging configuration which results in the packages being closer to the receptor.

Table 5–1 Human Health Impacts from Incident-Free Air Transport

Receptor	Transport Package and Number	HEU Payload (kilograms)	Transport to McGhee Tyson Air National Guard Base: Dose (person-rem)	Transport to McGhee Tyson Air National Guard Base: Latent Cancer Fatalities [a]
Member of Transportation Crew	TN-BGC1 22 packages	150	1.7×10^{-4}	6.8×10^{-8}
	ES-2100 22 packages	300	1.8×10^{-4}	7.2×10^{-8}

[a] Latent cancer fatalities are based on the risk factor of 0.0004 per person-rem for workers.

5.1.1.3 Impacts from an Air Transportation Accident

The radiological impacts from radiological releases associated with an accident of the aircraft used to transport HEU from Russia to the United States were calculated using the MACCS computer code, Version 1.12 (MACCS2).

As implemented, the MACCS2 model evaluates doses due to inhalation of airborne material, as well as direct exposure to the passing plume. This represents the major portion of the dose that an individual would receive as a result of an aircraft accident. The longer-term effects of radioactive material deposited on the ground after a postulated accident, including the resuspension and subsequent inhalation of radioactive material and the ingestion of contaminated crops, were not modeled for this environmental assessment. These pathways have been studied and found to contribute less significantly to the dose than the inhalation of radioactive material in the passing plume; they are also controllable through interdiction. Instead, the deposition velocity of the radioactive material was set to 0, so that material that might otherwise be deposited on surfaces remained airborne and available for inhalation. This adds a conservatism to inhalation doses that can become considerable at large distances. Thus, the method used in this environmental assessment is conservative compared with dose results that would be obtained if deposition and resuspension were taken into account.

The impacts were assessed for the offsite population surrounding McGhee Tyson Air National Guard Base and the maximally exposed individual (MEI). The offsite population is defined as the general public residing within 80 kilometers (50 miles) of the McGhee Tyson Air National Guard Base. The population distribution is based on the 2000 Census (DOC 2001, DOC 2002). These data were fitted to a polar coordinate grid with 16 angular sectors aligned with the 16 compass directions and radial intervals that extend outward to 80 kilometers (50 miles). The offsite population within 80 kilometers (50 miles) was estimated to be 1,081,825 persons near McGhee Tyson Air National Guard Base. For this analysis, no credit was taken for emergency response evacuations or temporary relocation of the general public. The MEI is defined as a hypothetical individual member of the public who would receive the maximum dose from an accident. This individual is assumed to be located 1.6 kilometers (1 mile) from the accident site.

One bounding aircraft accident was analyzed for air transport of 300 kilograms (662 pounds) of HEU over U.S. airspace. This accident is the stall and crash of the aircraft while attempting to land. The crash at the airfield results in a fire from the remaining fuel in the aircraft. The impact and fire cause failure of the confinement boundary of the transport packages resulting in a release of some of the material to the environment. This accident could occur regardless of the type of aircraft used to transport the HEU. MACCS input parameters were all set to maximize the calculated dose and produce a conservative and bounding radiological consequence to the public. Key input parameters that were set to result in higher calculated doses were: plume heat energy, plume height, plume time duration, and the fraction of available uranium that was released to the environment as respirable particles.

A maximum consequence landing-stall-fire accident has a 2.0×10^{-8} chance of occurring (DOE 1994). The total population dose to the 1,081,825 persons within an 80-kilometer (50-mile) radius of McGhee Tyson Air National Guard Base is 19.7 person-rem from a landing-stall-fire accident of one C-17 carrying 300 kilograms (662 pounds) of HEU. The latent cancer fatality (LCF) probability is 0.0099, equivalent to about 1 chance in 100, that any excess cancer fatalities would occur in the surrounding 80-kilometer (50-mile)-radius population. The risk of such a cancer fatality is much less when the 2.0×10^{-8} probability of occurrence of this accident is considered (see **Table 5–2**).

The dose to the MEI located 1.6 kilometers (1 mile) from the plume release site, is 0.095 millirem. The MEI dose would result in 4.7×10^{-7} latent cancer fatalities which is about one chance in 2,100,000 that an excess cancer would occur in a person located 1.6 kilometers (1 mile) from the HEU plume release location. Results of the MACCS calculations for the landing-stall-fire accident are presented in Table 5–2 for an aircraft transporting 300 kilograms (662 pounds) of HEU. The results would be one half of the reported results for an aircraft transporting 150 kilograms (331 pounds) of material. The results are independent of the transportation package design or the aircraft design.

Table 5–2 Human Health Impacts of Bounding Landing-Stall-Fire Accident from Air Transport of 300 Kilograms of HEU

	Proposed Action – Land at McGhee Tyson Air National Guard Base
Accident Probability (per landing)	2.0×10^{-8}
Collective Population Dose [a] (person-rem)	19.7
Population Latent Cancer Fatalities [b]	0.0099
Population Radiological Risk [c]	2.0×10^{-10}
Maximally Exposed Individual Dose [a] (millirem)	0.95
MEI Latent Cancer Fatalities	4.7×10^{-7}
MEI Radiological Risk [c]	9.4×10^{-15}

[a] Doses are 50-year total effective dose equivalent.
[b] Latent cancer fatalities are based on the risk factor of 0.0005 per person-rem for members of the public.
[c] Radiological risk includes consideration of the accident probability.

The aforementioned doses are bounding for any other postulated aircraft accident over U.S. territory as shown by comparison to the in-flight accidents for a generic urban population presented in DOE/EA-1006. For an in-flight accident, DOE/EA-1006 assigned a probability of 1.3×10^{-9} for an aircraft traveling to McGhee Tyson Air National Guard Base. The DOE/EA-1006 in-flight accident assumed a cargo of 566 kilograms (1,248 pounds) of HEU and estimated a total population radiological consequence of 0.00078 latent cancer fatalities for an exposed population of 5,210,000. The landing-stall-fire accident evaluated in the current environmental assessment results in approximately ten times greater population latent cancer fatalities (0.0099) with about half of the amount of HEU, a smaller, about 20 percent, exposed population, and at a probability of occurrence that is about 10 to 100 times greater. Therefore, the landing-stall-fire accident with 300 kilograms (662 pounds) of HEU represents the bounding radiological consequence accident for air transport over U.S. territory for the Proposed Action.

Criticality Safety

Both the TN-BGC1 and the ES-2100 transportation packages are licensed in accordance with the appropriate United States and International Atomic Energy Agency regulations. These regulations include specific requirements and design criteria for nuclear criticality safety. The regulatory requirements subject packages to drop, puncture, fire, and water immersion conditions to demonstrate structural integrity and radioactive material confinement assurance.

By regulation, packages such as the TN-BGC1 and the ES-2100 must maintain their fissile material (in this case HEU) contents in a safe, subcritical condition even if: (1) The fissile material within the package is physically reformed into the most criticality-favorable geometric shape, (2) the package fills with optimum density water, (3) the package is surrounded by a water neutron reflector, and (4) multiple fissile material packages are in the most criticality-favorable geometric configuration with respect to each other. Analysis of such a bounding scenario is required to demonstrate subcriticality with a sufficient deterministic and probabilistic margin of safety. Therefore, any accident which could result in the damage of the HEU packages and their submersion in water would not cause a nuclear criticality.

5.1.2 Ground Transportation

The packages are transported from the aerial port of entry to the Y-12 Complex by SSTs, in accordance with the requirements of DOE Orders and U.S. Department of Transportation regulations. The SST vehicles are specially designed semi-trailers pulled by an armored tractor, which use penetration resistance and delay mechanisms to prevent unauthorized cargo removal. The SST transport design provides protection of the cargo from damage or release in the event of a severe accident.

Incident-free and accident impacts from HEU transport from the McGhee Tyson Air National Guard Base to the Y-12 Complex are estimated using the RADTRAN 5 code (SAND 2000). This code calculates the doses and corresponding risks of transportation to expected receptors, that is, the crew (truck drivers) and the public. The incident free radiological exposures to the receptors are calculated based on the package (or conservatively, the SST) external dose rate (a dose rate at 1 meter in terms of millirem per hour from the conveyance, known as the Transportation Index or TI), distance traveled along the designated transportation route, and the population density along the route (public residing within 800 meters [0.5 miles] of the route). The TI for the HEU packages is expected to be less than 1. This is consistent with the DOE experience in using Type B packages to transport HEU that does not contain uranium derived recycled fuel.

The impacts of hypothetical transportation accidents to the public are calculated based on the accident severity and its potential for leading to radiological releases. The release is a function of the material at risk (the amount of the material transported within an SST) and the fraction of material that is released from the SST. The accident severity category classifications and the corresponding fractional releases of the materials are based on the methodology described in NUREG-0170 (NRC 1977) and summarized in the DOE’s Transportation Resource Handbook (DOE 2002b). The likelihood of a transportation accident is based on the SST transport accident rates used in various DOE environmental impact statements such as DOE/EIS-0306 and DOE/EIS-0319 (DOE 2002a, DOE 2000).

A representative truck route was selected for the shipments from McGhee Tyson Air National Guard Base to the Y-12 Complex. The route was selected consistent with current routing practices and all applicable routing regulations and guidelines. The route was determined for traffic and radiological risk assessment purposes and may not be the actual route that will be used to transport radioactive materials in the future. Specific routes cannot be identified in advance.

Route characteristics that are important to the radiological risk assessment include the total shipment distance and the 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 are summarized in **Table 5–3**. The population densities along each route are derived from 2000 U.S. Bureau of Census data (WebTRAGIS 2002). Rural, suburban, and urban areas are characterized according to the following breakdown:

- rural population densities range from 0 to 54 persons per square kilometer (0 to 139 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 density includes all population densities greater than 1,284 persons 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 800 meters (0.5 mile) of each side of the road.

Table 5–3 Truck Route Characteristics for Ground Transport

From	*To*	*Nominal Distance (kilometers)*	*Percentage in Zones*			*Population Density in Zone (per square kilometer)*			*Number of Affected Persons*
			Rural	*Suburban*	*Urban*	*Rural*	*Suburban*	*Urban*	
McGheeTyson	Y-12 Complex	40	37.4	60.9	1.7	22.3	317.6	1764.7	10,898

5.1.2.1 Impacts from Transfer at Airfield

At the McGhee Tyson Air National Guard Base, the required number of SSTs would be parked at a secure location awaiting the arrival of the aircraft. Upon arrival, the packages of HEU would be unloaded from the aircraft by the air base personnel and loaded onto SSTs by NNSA personnel. The individuals who unload and load packages would receive some radiological exposure. Since these activities would be performed in a secure area at a distance from the public, the dose to the public under incident free conditions would be negligible.

The estimated incident-free handling dose to a representative worker is based on the assumption that unloading or loading activities would take about two hours. The dose to a representative worker, conservatively assuming the unloading and loading are being done by the same people is estimated to be 10 millirem. Assuming that other personnel and guards are approximately 10 meter away from any packages, the dose to a representative individual is estimated to be 0.75 millirem. Using the worker dose-to-risk conversion factor of 0.0004 latent cancer fatalities per person-rem, the risks to a worker handling packages and any nearby worker (e.g., guards or other personnel) would be 4×10^{-6} and 3×10^{-7} latent cancer fatalities, respectively.

In the process of transferring packages from the aircraft to the SST, there is a possibility of an environmental release of a small amount of uranium oxide powder if a handling accident breached a package (e.g., a puncture from a misguided forklift tine). The material release would lead to local contamination with very low potential hazards to the workers involved. The transfer of packages would be done in an open air or semi-open air environment so any release would be dispersed by ambient air currents leading to very small and localized concentration of uranium in the air that the workers might inhale. The air concentration of HEU that a worker would be exposed to would be a function of many variables such as wind speed, wind direction, worker location, degree of damage to the package, and response to the damage. Because the air concentration is dependent on so many variable, no meaningful quantitative dose assessment could be performed. NNSA personnel familiar with the contents of the containers would provide oversight of the transfer so that if there were a mishandling incident, actions to contain the material and mitigate any release would lead to very small consequences to the environment or workers. The public doses from potential incidents during handling activities would be bounded by the evaluated aircraft landing-stall accident which would release much more material.

5.1.2.2 Impacts from Incident-Free Ground Transportation

Per-shipment risk factors were calculated using RADTRAN 5 for the collective populations of exposed persons and for a representative member of the crew for a representative route and anticipated shipment configurations. Exposed persons include people living along the route (i.e., the affected persons from Table 5–3), pedestrians and drivers along the route, and the public at rest and fueling stops. The exposed population for transport from McGhee Tyson Air National Guard Base to the Y-12 Complex is estimated to be 19,400. The two scenarios analyzed are the use of 4 SSTs to transport 150 kilograms (331 pounds) in 22 TN-BGC1 packages and use of 1 SST to transport 300 kilograms (662 pounds) in 22 ES-2100 packages. The human health risks associated with transport of HEU are summarized in **Table 5–4**.

Table 5–4 Human Health Impact from Incident-Free Ground Transportation

Receptor	Transport Package (number of SSTs)	Proposed Action – Transport from McGhee Tyson Air National Guard Base	
		Dose (person-rem)	Latent Cancer Fatalities [a]
Member of Transportation Crew [b]	TN-BGC1 (4 SSTs)	2.1×10^{-4}	8.4×10^{-8}
Collective Public [c]		1.5×10^{-4}	7.5×10^{-8}
Maximally Exposed Individual [d]/4 SSTs		1.2×10^{-7}	6.0×10^{-11}
Member of Transportation Crew	ES-2100 (1 SST)	5.0×10^{-5}	2.0×10^{-8}
Collective Public [c]		4.6×10^{-5}	2.3×10^{-8}
Maximally Exposed Individual [d]/SST		3.7×10^{-8}	1.9×10^{-11}

[a] Latent cancer fatalities are based on the risk factor of 0.0004 per person-rem for the crews and 0.0005 per person-rem for members of the public.
[b] Maximum dose to a member of transportation crew assumes all shipments are made by one crew
[c] Exposed population along the route (residing within 800 meters of road and those in transit on the roads).
[d] A member of the public 30 meters from the highway along the route; assumes the individual is exposed to a convoy of 4 SSTs for transport of TN-BGC1 packages and a single truck for ES-2100 packages.

5.1.2.3 Impacts from Ground Transportation Accidents

As stated earlier, the impacts of potential accidents during transport were also analyzed using RADTRAN 5. The accident risks were calculated based on the SST accident rates along with the probability of accident severity in conjunction with population density along transportation route. Per shipment risk factors were calculated for nonradiological and radiological accidents in terms population fatalities. Important parameters for the transportation accident analysis, in addition to vehicle accident rate, are container or shipping cask accident response characteristics and release fractions. Only in the most severe accident category, NUREG-0170 (NRC 1977), Severity Category VIII, would there be any release from material transported in an SST. Category VIII represents a large crash force, high impact velocities, long fire duration, and a high puncture impact speed (a 55-miles per hour collision into the side of the vehicle and a 982 degrees Centigrade [1,800 degrees Fahrenheit] fire lasting 1.5 hours). The bounding accident is the highest category accident used in the analysis and is associated with the probability of occurrence for each population density.

Table 5–5 summarizes the potential human health risks due to HEU transport accidents summed over all segments of the shipment route. For conservatism, it was assumed that the SST transporter would be traveling at the maximum allowable speed (55 miles per hour) in all segments (rural, suburban, and urban routes).

Table 5–5 Population Health Impacts from Potential Ground Transport Accidents

Impact	Transport Package (number of SSTs)	Material at Risk (HEU kilograms)	Transport from McGhee Tyson Air National Guard Base	
			Risk (dose in person-rem) [a,b]	Risk (fatalities) [b,c]
Nonradiological (traffic fatalities)	TN-BGC1 (4 SSTs)	150	NA	1.1×10^{-6}
Radiological (population)			3.4×10^{-10}	1.7×10^{-13}
Nonradiological (traffic fatalities)	ES-2100 (1 SST)	300	NA	2.7×10^{-7}
Radiological (population)			6.8×10^{-10}	3.4×10^{-13}

[a] Doses are 50-year total effective dose equivalent.
[b] Risk values include the probability of an accident occurring.
[c] For radiological impacts, risk is from latent cancer fatalities. Latent cancer fatalities are based on the risk factor of 0.0005 per person-rem for members of the public.

Maximally Exposed Individual Risk

The accident risk assessment takes into account the entire spectrum of potential accidents, from the fender-bender to the extremely severe. In order to provide additional insight into severity of accidents in terms of the potential dose to a MEI, an accident consequence assessment has been performed for a hypothetical accident scenario. This accident would fall into Severity Category VIII of the NUREG-0170 accident matrix (NRC 1977), which is the only category with a release of radioactive material. This analysis was performed irrespective of its potential likelihood (that is, a probability of 1). The MEI is assumed to be 33 meters (108 feet) directly downwind of the accident, and would receive a dose of 0.75 or 5.5 rem from transportation involving the

TN-BGC1 or the ES-2100 package, respectively (see **Table 5–6**). The likelihood of such an accident is a function of the highway characteristic accident frequency (i.e., urban, suburban, rural), the corresponding probability of a Severity Category VIII accident, and the distance traveled. Based on those factors, the likelihood of such an accident for transportation from McGhee Tyson Air National Guard Base to the Y-12 Complex ranges from one in 17 billion to one in 31 trillion. Using the high end of the range of likelihood, the radiological risk to an MEI is estimated to be 1.6×10^{-3} latent fatal cancers.

Table 5–6 MEI Health Impacts from Potential Ground Transport Accidents

Impact	Transport Package	Material at Risk [a] (HEU kilograms)	Transport from McGhee Tyson Air National Guard Base: Dose [b] (rem)	Transport from McGhee Tyson Air National Guard Base: Latent Cancer Fatalities [c]
MEI [d] Accident Consequence	TN-BGC1	42	0.75	3.8×10^{-4}
	ES-2100	300	5.5	2.8×10^{-3}
MEI [d] Radiological Risk [e]	TN-BGC1	42	4.4×10^{-11}	2.2×10^{-14}
	ES-2100	300	3.4×10^{-10}	1.6×10^{-13}

[a] The material at risk is based on the payload of 1 SST; 6 TN-BGC1s per SST or 22 ES-2100s per SST.
[b] Doses are 50-year total effective dose equivalent
[c] Latent cancer fatalities are based on the risk factor of 0.0005 per person-rem for members of the public.
[d] An individual located 33 meters (108 feet) downwind from the accident.
[e] Radiological risk to the maximally exposed individual is based on an accident probability of 5.9×10^{-11}.

SST Threat Assessment

The safeguards and security systems for SST transportation are designed to protect against sabotage and other adversarial actions. The approved DOE design-basis threat addresses acts of terrorism. The potential impacts associated with the threat of an attack on an SST shipment have been analyzed in other environmental assessments (DOE 1994, DOE 1995) and are summarized below:

> The most immediate and severe threat to workers or members of the public from a terrorist attack by militarily-equipped forces would be death or injury from weapons fire. The transportation workers who are trained and responsible for protecting the shipments would likely suffer fatalities during an attack. Casualties or fatalities to members of the public would be dependent on their proximity to an SST if it were to come under attack.
>
> A properly aimed energetic projectile could result in the breaching of the SST and packages, with the resulting dispersal of HEU into the atmosphere. The Transportation Safeguards Division has used the Explosive Release Atmospheric Dispersal model to analyze the consequences of an attack. Based on tests done by the Nuclear Emergency Search Team, the fraction of material aerosolized would be less than 5 percent for this type of event. The bounding conditions for the impacts from such an event were as follows: the event occurs in an urban area; the SST is carrying 1,000 kilograms (2,200 pounds) of 93 percent enriched uranium; and quiet night-time meteorological conditions prevail, resulting in low dispersion. Under these conditions, the contaminated area was estimated to be 3 square kilometers

(1.16 square miles), and the maximum individual dose would not exceed 30 millirem. The upper bound collective dose would be about 4,000 person-rem resulting in a risk of 2 excess cancer fatalities. Anticipated impacts would be less than the bounding case, resulting in a contaminated area of 1.5 square kilometers (0.58 square miles), a maximum individual dose of 5 millirem, and either 0 or 1 excess latent cancer fatalities in the collective population. The anticipated impacts are based on yearly average meteorological data.

The radiological impacts of an attack during the Proposed Action would likely be less than those postulated above. Depending on the container being used (TN-BGC1 or ES-2100), the amount of HEU in a single SST would be only 4.2 to 33 percent of the amount assumed in the above analysis. Therefore, the expected risk of a terrorist attack under the proposed action would be less than 1,320 person-rem. The corresponding expected increase in latent cancer fatalities in the exposed population would be 0 or 1.

5.1.3 Environmental Justice

As shown in Table 5–5, incident-free transportation of HEU along the representative ground transportation route would not have significant radiological impacts on the population residing along the route. The risk of a latent cancer fatality occurring among the population, including low-income and minority portions of the population, would be no more than 7.5×10^{-8}, or about 1 in 13 million. The corresponding risk to the MEI among the exposed population is no more than 6.0×10^{-11}, or essentially zero for all practical purposes.

Accidents that could occur during ground transportation of HEU pose even smaller radiological risks to populations residing along representative transportation routes. Table 5–5 shows the radiological consequences and risks that would result from accidents that are severe enough to breach the transportation package. An accident severe enough to breach the package is unlikely, and the radiological accident risks to the populations surrounding the accident site would be no more than 3.4×10^{-13}, or essentially zero. The radiological accident risk to the MEI among the public residing along representative transportation routes is no more than 1.6×10^{-13} (see Table 5–6). In the unlikely event of an aircraft landing-stall accident the radiological risk to the population would be 2.0×10^{-10} or essentially zero. As shown in Table 5–2, the radiological risk to the MEI from the landing-stall accident would be 9.4×10^{-15}, even smaller than that associated with a ground transportation accident.

Radiological risks attendant to accidents during ground transportation of HEU are relatively small compared to the maximum risk of 1.1×10^{-6} (approximately 1 chance in 900,000) for a non-radiological highway traffic accident fatality.

In summary, incident-free transportation of HEU, as well as potentially severe radiological accidents that could occur during transportation, do not pose significant risks to populations residing near McGhee Tyson Air National Guard Base or along representative transportation routes. Thus, no disproportionately high and adverse radiological risks to low-income populations and minority populations would be expected to result from implementation of the proposed action. Nonradiological highway fatalities are also small and could occur anywhere along the representative routes.

5.1.4 Cumulative Impacts

The *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2001) reported the estimated cumulative impacts associated with the ongoing operations of the Y-12 Complex, the Oak Ridge Reservation, and the Watts Bar Nuclear Power Plant (including tritium production). Impacts of the Proposed Action are compared to the cumulative impacts presented in the Site-Wide EIS since this action could add to the impacts of the public living near the Y-12 Complex. The contributions of the Proposed Action to the overall cumulative impacts of ongoing operations are shown in **Table 5–7**. For purposes of this comparison, the largest calculated results, regardless of whether they related to use of the TN-BGC1 or the ES-2100, are used.

Table 5–7 Estimated Annual Cumulative Radiological Impacts

	MEI Dose (mrem/yr)	Population Dose (person-rem/yr)	Population Latent Cancer Fatalities	Collective Worker Dose (person-rem/yr)	Worker Latent Cancer Fatalities
Oak Ridge Reservation [a] Total	8.0	90	0.045	125[b]	0.06
Surplus HEU Disposition [c]	0.039	0.16	8×10^{-5}	11.3	0.005
Watts Bar Nuclear Plant [d]	0.34	1.8	0.009	110	0.045
Spallation Neutron Source [e]	1.5	1.3	0.007	370	0.2
TRU Waste Treatment Facility [f]	0.023	0.12	6×10^{-5}	6.2	0.003
Transport of HEU from Russia	1.8×10^{-4}	1.5×10^{-4}	7.5×10^{-8}	0.02[g]	8×10^{-6}
Cumulative Effect	NA[h]	94	0.047	NA[h]	NA[h]

Source: DOE 2001.

[a] Includes Y-12 Complex, East Tennessee Technology Park, and Oak Ridge National Laboratory.

[b] Includes 106.5 person-rem from 1999 ORR operations (40.61 person-rem attributable to Y-12) and accounts for the Y-12 Site No Action - Planning Basis contribution of 59.5 person-rem.

[c] Source DOE/EIS-0240.

[d] Includes contribution from tritium production at Watts Bar Plant (DOE/EIS-0288).

[e] Values are conservatively based on the 4-MW power level (DOE/EIS-0247).

[f] Based on low-temperature drying alternative from DOE/EIS-0305.

[g] Cumulative worker dose assumes two workers receive the dose associated with transfer of packages from the aircraft to the SST.

[h] Cumulative effect is not relevant to the MEI and workers because different individuals receive the indicated doses.

5.2 Impacts of Alternative 1 - Transport to Dover Air Force Base

Rather than flying to McGhee Tyson Air National Guard Base, the Dover Air Force Base was selected as a potential alternative aerial port of entry. The transport aircraft would fly to Dover Air Force Base where the SSTs would be waiting. The packages (either TN-BGC1s or ES-2100s) would be unloaded from the aircraft and loaded into the SSTs. SSTs would then transport the HEU to the Y-12 Complex. The sections below highlight impacts that differ between Alternative 1 and the Proposed Action.

5.2.1 Alternative 1 Impacts from Air Transport

The flight time to cross the Atlantic Ocean would be essentially the same for Alternative 1 and the Proposed Action. Consequently, there would be no difference in impacts to the global commons. However, the total flight time for Alternative 1 would be shorter than for the Proposed Action (see Table 3–2). As a result, the aircraft crew would have a shorter time of exposure to the packages of HEU and would receive a smaller dose (see **Table 5–8**). As a result of the shorter time in the air, the probability of an in-air accident is slightly less for Alternative 1, but the risks are essentially equal to those for the Proposed Action. The impacts of the landing-stall accident would be lower for Alternative 1 than the Proposed Action (see Table 5–8) due to the distribution of the population. Although the population of 1,751,843 within 80 kilometers (50 miles) of Dover Air Force Base is larger than 80-kilometer (50-mile) population at McGhee Tyson Air National Guard Base (1,081,825), the population density closer to the accident site is lower resulting in a lower population dose. For both alternatives, the MEI is assumed to be 1.6 kilometers (1 mile) away so the impacts are the same.

Table 5–8 Differences in Impacts between Alternative 1 and the Proposed Action

		Proposed Action McGhee Tyson Air National Guard Base	Alternative 1 Dover Air Force Base
	Package	Fatalities or Latent Cancer Fatalities [a]	Fatalities or Latent Cancer Fatalities [a]
Air Transport			
Incident-Free: Air Crew Member Radiological Risk	TN-BGC1	6.8×10^{-8}	6.2×10^{-8}
	ES-2100	7.2×10^{-8}	6.8×10^{-8}
Accident: Landing-Stall Accident Collective Population Radiological Risk	NA[b]	2.0×10^{-10}	1.4×10^{-10}
Ground Transport			
Incident-Free: Member of SST Transport Crew Radiological Risk	TN-BGC1	8.4×10^{-8}	2.4×10^{-6}
	ES-2100	2.0×10^{-8}	6.0×10^{-8}
Incident-Free: Collective Public Radiological Risk	TN-BGC1	7.5×10^{-7}	2.1×10^{-6}
	ES-2100	2.3×10^{-8}	6.5×10^{-7}
Accident: Nonradiological Fatality Risk	TN-BGC1	1.1×10^{-6}	3.0×10^{-5}
	ES-2100	2.7×10^{-7}	7.4×10^{-6}
Accident: Collective Public Radiological Risk	TN-BGC1	$1.7 \text{ x} 10^{-13}$	4.9×10^{-12}
	ES-2100	3.4×10^{-13}	9.0×10^{-12}

[a] Latent cancer fatality risk accounts for the probability of the event occurring. For incident free operations, the probability is 1. For accidents, the probability of occurrence is substantially less than 1.

[b] The landing-stall accident is analyzed using the maximum expected HEU inventory of 300 kilograms (662 pounds).

5.2.2 Alternative 1 Impacts from Ground Transportation

Differences in the impacts of Alternative 1 and the Proposed Action for ground transportation are related to the differences in population distribution along the route and the time of travel. The representative travel distance for Alternative 1 is 1100 kilometers (680 miles) as compared to 40 kilometers (25 miles) for the Proposed Action.

Workers transferring packages of HEU from the aircraft to the SSTs and other workers in the vicinity would receive the same dose regardless of the airfield at which the action would occur. Under Alternative 1, workers involved in the ground transport would receive higher doses and therefore have a higher risk of a latent cancer fatality due to the longer time they spend transporting the packages (see Table 5–8).

Impacts to the public, measured in terms of latent cancer fatalities, are greater for Alternative 1 than for the Proposed Action (see Table 5–8). Due to the longer travel distance and differences in population densities, the number of affected persons (people living within 800 meters (0.5 miles) of the road) for Alternative 1 is 384,613 as compared to 10,898 for the Proposed Action. The exposed population which, in addition to the affected persons, includes pedestrians and drivers along the route, is also significantly larger for Alternative 1. The larger exposed population accounts for the larger population impact.

Radiation exposure of the MEI is not a function of the distance traveled. Therefore, the MEI for both incident-free and ground transportation accident scenarios receives the same impact under both alternatives.

For ground transportation accidents, nonradiological and radiological risks are a function of the distance traveled. In addition, radiological risks are dependent on the population density along the route. Both of these factors contribute to higher risks for Alternative 1 compared to the Proposed Action (see Table 5–8).

In summary, Alternative 1 has slightly smaller human health impacts than the Proposed Action for the air transport portion of the trip. Conversely, the human health impacts of the ground transport portion of the trip are higher for Alternative 1. The human health impacts are extremely small regardless of the alternative selected.

5.3 Impacts of the No Action Alternative

Under the No Action Alternative, the HEU would remain in Russia and not be packaged and transported to the Y-12 Complex. Thus, there would be no impacts to the global commons or populations in the vicinity of the Y-12 Complex, the destination airport, or along the land transportation route. Further, crews of the C-17 aircraft and SSTs would not be exposed to radiation associated with transporting the material. However, this alternative does not meet the objective of removing excess HEU from the Russian stockpile and bringing it to the United States for use in research reactors.

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Appendix A

Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons

AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND THE GOVERNMENT OF THE RUSSIAN FEDERATION
CONCERNING THE DISPOSITION OF
HIGHLY ENRICHED URANIUM EXTRACTED FROM NUCLEAR WEAPONS

The Government of the United States of America and the Government of the Russian Federation, hereinafter referred to as the Parties,

Desiring to arrange the safe and prompt disposition for peaceful purposes of highly enriched uranium extracted from nuclear weapons resulting from the reduction of nuclear weapons in accordance with existing agreements in the area of arms control and disarmament,

Reaffirming their commitment to ensure that the development and use of nuclear energy for peaceful purposes are carried out under arrangements that will further the objectives of' the Treaty on the Non-Proliferation of Nuclear Weapons,

Affirming their commitment to ensure that the nuclear material transferred for peaceful purposes pursuant to this Agreement will comply with all applicable non-proliferation, physical protection, nuclear material accounting and control, and environmental requirements,

Have agreed as follows:

ARTICLE I

PURPOSE

The Parties shall cooperate in order to achieve the following objectives:

(1) The conversion as soon as practicable of highly enriched uranium (HEU) extracted from nuclear weapons resulting from the reduction of nuclear weapons pursuant to arms control agreements and other commitments of the Parties which is currently estimated at approximately 500 metric tons in the Russian Federation, having an average assay of 90 percent or greater of the uranium isotope 235 into low enriched uranium (LEU) for use as fuel in commercial nuclear reactors. For purposes of this Agreement, LEU shall mean uranium enriched to less than 20 percent in the isotope 235; and

(2) The technology developed in the Russian Federation for conversion of HEU resulting from the reduction of nuclear weapons in the Russian Federation may be used for conversion of United States HEU in the United States of America; and

(3) The establishment of appropriate measures to fulfill the non-proliferation, physical protection, nuclear material

accounting and control, and environmental requirements of the Parties with respect to HEU and LEU subject to this Agreement.

ARTICLE II

IMPLEMENTATION CONTRACTS AND AGREEMENTS

1. The Parties, through their Executive Agents, shall within six months from entry into force of this Agreement seek to enter into an initial implementing contract to accomplish the objectives set forth in Article I of this Agreement. The Parties may conclude additional implementing contracts or agreements pursuant to this Agreement, as required. For any purchase, the Executive Agents shall negotiate terms (including price), which shall be subject to approval by the Parties.

2. It is the intent of the Parties that the initial implementing contract shall provide for, inter alia:

(i) The purchase by the United States Executive Agent of LEU converted from HEU at facilities in the Russian Federation and sale of such LEU for commercial purposes. The United States will provide information to the Russian Federation on all commercial disposition of such LEU;

(ii) Initial delivery of LEU converted from HEU extracted from nuclear weapons resulting from the reduction of nuclear, weapons pursuant to arms control agreements and other commitments of the Parties by October 1993, if possible;

(iii) Conversion of no less than 10 metric tons having an average assay of 90 percent or greater of the uranium isotope 235 in each of the first five years, and, in each year thereafter, conversion of no less than 30 metric tons of HEU having an average assay of 90 percent or greater of the uranium isotope 235; however, specific amounts will be stipulated in the first and subsequent implementing contracts or agreements;

(iv) The participation of the United States private sector and of Russian enterprises;

(v) The allocation among the United States of America, private sector firms of the United States of America, the Russian Federation, and Russian enterprises of any proceeds or costs arising out of activities undertaken pursuant to any implementing contracts;

(vi) The use by the Russian side of a portion of the proceeds from the sale of LEU converted from HEU for the conversion of defense enterprises, enhancing the safety of nuclear power plants, environmental clean-up of polluted areas and the construction and operation of facilities in the Russian Federation for the conversion of HEU to LEU;

(vii)By agreement of the Parties an equivalent amount of HEU can substitute for the corresponding amount of LEU planned for purchase by the United States Executive Agent.

ARTICLE III

EXECUTIVE AGENTS

Each Party shall designate an Executive Agent to implement this Agreement. For the United States side, the Executive Agent shall be the Department of Energy. For the Russian side, the Executive Agent shall be the Ministry of the Russian Federation of Atomic Energy. After consultation with the other Party, either Party has the right to change its Executive Agent upon 30 days written notice to the other Party. If a governmental corporation is established under United States law to manage the uranium enrichment enterprise of the Department of Energy, it is the intention of the United States Government to designate that corporation as the Executive Agent for the United States side.

ARTICLE IV

PRIORITY OF AGREEMENT

In case of any inconsistency between this Agreement and any implementing contracts or agreements, the provisions of this Agreement shall prevail.

ARTICLE V

ADDITIONAL MEASURE

1. The Executive Agent of the Russian Federation shall ensure that the quality of LEU derived from HEU subject to this Agreement is such that it is convertible to LEU usable in commercial reactors. Specifications shall be agreed upon in the process of negotiating the initial and subsequent implementing contracts.

2. The conversion of HEU subject to this Agreement shall commence as soon as possible after the entry into force of the initial implementing contract.

3. The Parties shall, to the extent practicable, seek to arrange for more rapid conversion of HEU to LEU than that provided for in Article II (2) (iii).

4. The United States of America shall use LEU acquired pursuant to this Agreement and its implementing contracts and agreements, when subject to United States jurisdiction and control, for peaceful purposes only.

5. LEU acquired by the United States of America pursuant to this Agreement, and implementing contracts and agreements related

to it, shall be subject to safeguards in accordance with the November 18, 1977, Agreement: Between the United States of America and the International Atomic Energy Agency (IAEA) for the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons.

6. The Parties shall maintain physical protection of HEU and LEU subject to this Agreement. Such protection shall, at a minimum, provide protection comparable to the recommendation set forth in IAEA document INFCIRC/225/REV.2, concerning the physical protection of nuclear material.

7. If the Parties enter into an agreement for cooperation concerning the peaceful uses of nuclear energy, nuclear material acquired by the United States of America pursuant to this Agreement and its implementing contracts and agreements, when subject to United States jurisdiction or control, shall be subject to the terms and conditions of that Agreement for cooperation.

8. The activities of the United States Government under this Agreement, or any implementing contract or agreement, shall be subject to the availability of United States Government funds.

9. In the event the United States Government does not have funds available for implementation of this Agreement, the Executive Agent of the Russian Federation reserves the option to obtain funding for implementation of this Agreement from any private United States company.

10. Prior to the conclusion of any implementing contract, the Parties shall establish transparency measures to ensure that the objectives of this Agreement are met, including provisions for nuclear material accounting and control and access, from the time that HEU is made available for conversion until it is converted into LEU. Specific transparency measures shall be established in the same time frame as the negotiation of the initial implementing contract, and shall be executed by a separate agreement.

11. Prior to the conclusion of any implementing contract, the Parties shall agree on appropriate governing provisions for entry and exit, liability, and status of Personnel, exemptions for taxes and other duties, and applicable law.

12. The Executive Agent of the United States of America shall use the LEU converted from HEU in such a manner so as to minimize disruptions in the market and maximize the overall economic benefit for both Parties. This Agreement shall have no effect on contracts between Russian enterprises and United States companies for the delivery of uranium products which are currently in force and consistent with United States and Russian law.

13. This Agreement places no limitations on the right of the Russian Federation to dispose of LEU derived from HEU extracted from nuclear weapons resulting from the reduction of nuclear weapons pursuant to arms control agreements and other commitments of the Parties beyond the specific commitments set forth herein.

ARTICLE VI

ENTRY INTO FORCE, DURATION AND AMENDMENTS

1. This Agreement shall enter into force upon signature and shall remain in force until the full amount of HEU, provided for in paragraph 1 of Article I is converted into LEU, delivered, and supplied to commercial customers.

2. Each Party may propose amendments to this Agreement. Agreed amendments shall enter into force upon signature and shall remain in force so long as this Agreement remains in force.

3. Each Party shall have the right to terminate this Agreement upon 12 months written notification to the other Party.

Done at Washington this 18th day of February, 1993, in duplicate in the English and Russian languages, both texts being equally authentic.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:

FOR THE GOVERNMENT OF THE RUSSIAN FEDERATION:

Appendix B

Joint Statement
Secretary Abraham and Minister Rumyantsev

Joint Statement
Secretary Abraham and Minister Rumyantsev
September 16, 2002

In their May 2002 Summit in Moscow, the President of the United States of America George W. Bush and the President of the Russian Federation V.V. Putin agreed to establish a joint experts group to work out proposals on near-and long-term, bilateral and multilateral means to reduce inventories of highly enriched uranium (HEU) and plutonium. The United States and Russia recognize their common interest in guaranteeing the irreversibility of nuclear disarmament, strengthening nonproliferation and combating terrorism by accelerating the disposition of excess nuclear weapon materials.

Ambassador Linton Brooks and First Deputy Minister Mikhail Solonin co-chaired the Expert Group on Accelerated Nuclear Material Disposition. We highly appreciate the results of the Expert Group. We are pleased with the accelerated pace the group maintained, finishing the report three months earlier than their initial deadline. The report will be forwarded to Presidents George W. Bush and V.V. Putin.

The Expert Group identified several areas where joint cooperation could lead to reduction of HEU over-and-above commitments already in place under existing agreements. These include:

1. Creation of a strategic reserve in the United States from Russian HEU down blended into Low Enriched Uranium (LEU);
2. Increase in the rate and quantity of HEU converted to LEU under the Nuclear Material Consolidation and Conversion Project;
3. Use of LEU down blended from Russian HEU to fuel reactors in Western countries;
4. Use of Russian HEU to fuel selected United States research reactors, until cores are converted to LEU, and
5. In parallel, work on accelerated development of LEU fuel for both Soviet-designed and United States-designed research reactors.

The Expert Group also identified potential new areas of near-term cooperation for weapon plutonium disposition. These include:

1. Fabrication of additional mixed oxide fuel (MOX) for use in Russian reactors, utilizing additional weapons-grade plutonium under the 2000 Agreement, and
2. A variation of this scenario that would provide for the possible use of some MOX fuel in Russia and for leasing or exporting of the remainder for use in other countries.

The Expert Group will continue to study additional options that could be relevant in the future, taking into account their technical feasibility, impacts on commercial nuclear fuel market industries and required financial resources.

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