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National Nuclear Security Administration

SUPPLEMENT ANALYSIS

FABRICATION OF MIXED OXIDE FUEL LEAD ASSEMBLIES IN EUROPE

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List of Acronyms

ANL–W	Argonne National Laboratory West
BNFL	British Nuclear Fuel Limited
Catawba	Catawba Nuclear Station
CFR	Code of Federal Regulations
DCS	COGEMA Stone & Webster
DOE	U.S. Department of Energy
EIS	environmental impact statement
FR	*Federal Register*
FRR EIS	*Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Fuel*
Hanford	Hanford Site
IMO	International Maritime Organization
INEEL	Idaho National Engineering and Environmental Laboratory
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LLNL	Lawrence Livermore National Laboratory
McGuire	McGuire Nuclear Station
MEI	maximally exposed individual
MOX	mixed oxide
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
NS	Naval Station
NWS	Naval Weapons Station
ORNL	Oak Ridge National Laboratory
PNTL	Pacific Nuclear Transport Limited
ROD	Record of Decision
SA	supplement analysis
SPD EIS	*Surplus Plutonium Disposition Environmental Impact Statement*
SRS	Savannah River Site
SST	safe, secure trailer
SST/SGT	safe, secure trailer/SafeGuards Transport
Storage and Disposition PEIS	*Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*
TA	Technical Area

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1.0 INTRODUCTION

The U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) is proposing to fabricate, on a one-time basis, mixed oxide (MOX) fuel lead assemblies[1] in existing facilities in Europe (referred to as Eurofab) rather than at Los Alamos National Laboratory (LANL) as previously decided (65 *Federal Register* [FR] 1608, January 11, 2000). In May 2000, DOE determined that cost and schedule impacts and programmatic considerations precluded lead assembly fabrication at LANL and discontinued related activities (Holgate 2000). As a result, an initial assessment of alternatives for lead assembly fabrication was conducted by Duke COGEMA Stone & Webster (DCS), the team that was awarded the contract for MOX fuel fabrication and irradiation services. This assessment concluded that fabrication of lead assemblies in Europe is feasible.

DOE/NNSA is considering the potential environmental impacts of this proposed change in lead assembly fabrication location before deciding to proceed.[2] Council on Environmental Quality regulations at Title 40, Section 1502.9(c) of the Code of Federal Regulations (40 CFR 1502.9[c]) require Federal agencies to prepare a supplement to an environmental impact statement (EIS) when an agency makes substantial changes in the proposed action that are relevant to environmental concerns or there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. DOE regulations at 10 CFR 1021.314(c) direct that when it is unclear whether a supplement to an EIS is required, a Supplement Analysis (SA) be prepared to assist in making that determination.

This SA evaluates the potential environmental impacts of fabricating lead assemblies in Europe with plutonium oxide from LANL in accordance with these requirements to determine if either of DOE's previous EISs evaluating surplus plutonium disposition, the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (*Storage and Disposition PEIS)* (DOE/EIS-0229, December 1996) (DOE 1996a), or the *Surplus Plutonium Disposition Environmental Impact Statement* (SPD EIS), (DOE/EIS 0283, November 1999) (DOE 1999a), should be supplemented; a new EIS should be prepared; or that no further National Environmental Policy Act (NEPA) documentation is necessary. This SA includes an analysis of activities that could affect the global commons outside the jurisdiction of any nation, e.g., the oceans or Antarctica. As discussed in Section 5.4 of this SA, DOE/NNSA has concluded that the environmental impacts associated with fabricating lead assemblies in Europe are not significantly different than those for lead assembly fabrication alternatives evaluated in DOE EISs, including an alternative to fabricate some fuel assemblies in Europe. Therefore, no further NEPA documentation is necessary.

[1] Lead assemblies are small quantities of nuclear fuel used by commercial nuclear power plant operators to confirm that a new fuel design will perform safely and predictably.

[2] If DOE/NNSA decides not to proceed with Eurofab, the first MOX fuel assemblies produced by the MOX Fuel Fabrication Facility at the Savannah River Site would be used as lead assemblies.

2.0 PURPOSE

To implement the MOX fuel disposition alternatives considered in the *Storage and Disposition PEIS* and the SPD EIS, fuel lead assemblies need to be fabricated, irradiated, and inspected to support U.S. Nuclear Regulatory Commission (NRC) licensing activities and fuel qualification efforts. The lead assembly program would collect data from irradiation of lead assemblies fabricated with surplus weapons-grade plutonium[3] under actual operating conditions to confirm that the fuel can be used safely in the domestic, commercial nuclear reactors that would be used for the MOX fuel program.

3.0 BACKGROUND

Storage and Disposition PEIS. The *Storage and Disposition PEIS* evaluated environmental impacts of fabricating lead assemblies (and some initial MOX assemblies) in Europe in the event that it would be necessary to begin production more quickly than could be accomplished in the U.S. This PEIS evaluated overland transport of plutonium oxide using DOE's safe, secure trailer (SST) system from a storage facility at an existing DOE site to a U.S. port (hypothetically located at Sunny Point, NC); material handling at the U.S. port; ocean transport to the European ports of Barrow, United Kingdom, and Cherbourg, France; ocean transport of MOX fuel back to the U.S.; and SST transport of MOX fuel from the U.S. port to either an existing commercial reactor site or a storage site in the United States (DOE 1996a:4-827). The shipping schedule projected two shipments of plutonium oxide and a maximum of four shipments of fresh MOX fuel assemblies per year (DOE 1996a:G-3). The *Storage and Disposition PEIS* also discussed the potential effect of ocean transport on the global commons, citing other studies including an environmental assessment of the import of Russian plutonium-238 and the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Fuel* (FRR EIS) (DOE/EIS-0218) (DOE 1996b).

Section 4.4 of the *Storage and Disposition PEIS* presents the potential impacts of transportation related to MOX fuel fabrication, including lead assembly fabrication. The analysis indicates that total transportation fatalities resulting from both radiological and nonradiological risk to the public and workers for both routine and accident conditions associated with European MOX fuel fabrication of the entire 50-metric-ton surplus plutonium inventory would range from 1.69 to 4.62 fatalities, depending on the hypothetical distance to be traveled (i.e., 1,000 km to 4,000 km) (DOE 1996a:4-827–4-829).

Port handling impacts associated with fabricating MOX fuel in Europe are addressed in Appendix G of the *Storage and Disposition PEIS*. The analysis determined that annual accident risks from exporting two shipments of plutonium oxide and importing four shipments of MOX fuel would not result in any latent cancer fatalities (LCFs) among workers or the general public. Additionally, the *Storage and Disposition PEIS* indicates that the probability that these shipments would be involved in a maritime accident of sufficient severity to cause release of radioactive materials resulting in catastrophic consequences would be extremely small (on the order of 1.0×10^{-7}/yr to 1.0×10^{-8}/yr) (DOE 1996a:G-5, G-6).

[3] This material is part of the U.S. program to disposition plutonium surplus to defense needs by fabricating it into MOX fuel for use in civilian nuclear power reactors in accordance with the September 2000 *Agreement Between the Government of the United States and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation* (U.S.–Russia Agreement).

SPD EIS. Domestic fabrication of lead assemblies was evaluated in detail as part of the MOX fuel fabrication alternatives in the SPD EIS. Specific facilities at five DOE sites were considered for this effort, based on site capabilities existing at that time: the Hanford Site (Hanford) in Washington, Idaho National Engineering and Environmental Laboratory (INEEL) Argonne National Laboratory West (ANL–W) facilities in Idaho, the Savannah River Site (SRS) in South Carolina, LANL in New Mexico, and Lawrence Livermore National Laboratory (LLNL) in California.

The SPD EIS evaluated the environmental impacts, including those from transportation, of fabricating up to 10 lead assemblies using plutonium oxide from LANL. This evaluation includes archive and scrap material storage at the lead assembly fabrication site, irradiation of the lead assemblies at existing commercial reactors (Catawba Nuclear Station [Catawba] in South Carolina, or McGuire Nuclear Station [McGuire] in North Carolina) and post-irradiation examination at the Oak Ridge National Laboratory (ORNL) or ANL-W. The SPD EIS transportation analysis includes shipping:

- 320 kg of plutonium dioxide from LANL in SST/SafeGuards Transport (SSTs/SGTs)[4] to the lead assembly fabrication site (SRS, ANL-W, Hanford, and LLNL)
- MOX fuel assemblies to the reactor site (Catawba or McGuire) for irradiation and unirradiated archive and scrap material fuel rods from each of the proposed lead assembly fabrication facility sites to each of the proposed MOX facility sites (Hanford, INEEL, the Pantex Plant, and SRS)
- Irradiated fuel assemblies or fuel rods from the reactor to either ORNL or ANL-W for post-irradiation examination
- Uranium dioxide and additional materials needed to complete the fuel assemblies (i.e., new, empty fuel rods, end caps and other metallic components)

Section 2.18 of the SPD EIS presents a summary of potential impacts from lead assembly fabrication. The analyses, detailed in Section 4.27 of the SPD EIS, indicate that potential environmental impacts from modification and routine operation of lead assembly fabrication facilities would be relatively small; no LCFs would be expected in the general population from the postulated bounding design basis accident; nor would there be any traffic fatalities or LCFs expected from the associated transportation.

4.0 PROPOSED ACTION

DOE/NNSA proposes, on a one-time basis, to use U.S. surplus plutonium from LANL to fabricate up to four lead assemblies in existing facilities in France. Lead assemblies would be

[4] The SST/SGT is a specially designed component of an 18-wheel tractor-trailer vehicle. Although the details of the vehicle enhancements are classified, key characteristics are not, and include: enhanced structural supports and a highly reliable tie-down system to protect cargo from impact; heightened thermal resistance to protect the cargo in case of a fire; deterrents to protect unauthorized removal of cargo; couriers who are armed Federal officers that receive rigorous training and are closely monitored through DOE's Personnel Assurance Program; an armored tractor to protect the crew from attack, equipped with advanced communications equipment; specially designed escort vehicles containing advanced communications and additional couriers; 24-hour-a-day real-time monitoring of the location and status of the vehicle; and stringent maintenance standards.

returned to the U.S. and transported to Catawba for irradiation. After irradiation, selected rods from the lead assemblies would be transported to ORNL for post-irradiation examination. Irradiation and post-irradiation examination would occur as described and analyzed in the SPD EIS and decided in the January 2000 Record of Decision (ROD). (See Sections 2.17, 2.18.2, and 4.27 of the SPD EIS.) Archive and scrap material would be returned to the United States along with the lead assemblies, then transported to LANL for storage. As described in Section 5.1 of this SA, DOE plans to transport materials between the U.S. and Europe by sea in special dedicated ships designed for transport of fresh and spent MOX fuel.

Air transport is not considered for these shipments, primarily because there is no certified air transportation package for plutonium, and certifying a package for this isolated effort is not warranted since both an available mode of transportation and certified packages exist. Packages for air transport of plutonium must meet the special requirements delineated in 10 CFR 71.64. This section specifies that in addition to satisfying the requirements of 10 CFR 71.41 through 71.63 (which includes requirements for certification of Type B packages at 10 CFR 71.51), the package must be designed, constructed and prepared for shipment so that the acceptance criteria of this section are met when the package is subjected to the series of tests specified in 10 CFR 71.74. These tests and acceptance criteria, more rigorous than for Type B packages, are designed to ensure package integrity in the event of an air transport accident. Since there would be only one shipment to Europe and one return shipment, it is not reasonable to expend the time or the money to certify packages. In addition, the schedule for insertion of the lead assemblies does not allow for the time required to complete package certification. Furthermore, previous NEPA evaluations have demonstrated that ocean transport is safe, and would involve minimal environmental impacts. Analyses performed for this SA and discussed in Section 5 confirm those findings.

The following activities are evaluated in this SA:

- Overland truck transport (one shipment, consisting of 3 SST/SGTs) of approximately 150 kg of plutonium oxide from LANL to one of three Atlantic ocean ports—Charleston Naval Weapons Station (NWS) (South Carolina), Naval Station (NS) Norfolk (Virginia), or Yorktown NWS (Virginia)

- Transfer of plutonium oxide from SST/SGTs to Pacific Nuclear Transport Limited (PNTL) ships at the port

- Impact on the global commons of ocean transport of plutonium oxide and lead assemblies between the U.S. port and Cherbourg, France (one shipment each direction, consisting of a two-ship convoy)

- Transfer of lead assemblies from the PNTL ships to SST/SGTs at the port

- Transport of lead assemblies from one of the three ports to either Catawba or McGuire[5] (one shipment consisting of 4 SST/SGTs)

- Transport of archive and scrap material from one of the three ports to LANL for storage (one shipment consisting of 2 SST/SGTs)

- Transport of archive and scrap material from LANL to SRS (one shipment consisting of 2 SST/SGTs)

Scrap material discussed in this SA consists of pellets that have been formed from broken or otherwise out-of-specification MOX fuel pellets, and the remains from the pellet-grinding process. Scrap material is routinely returned to the MOX fuel fabrication process for reuse in pellet formation. All stored archive (MOX pellets meeting fuel specifications) and scrap materials would be in the form of MOX pellets. These archive and scrap pellets would be loaded into extra fuel rods (separate rods for archive and scrap materials) and welded closed in the same way that the MOX fuel rods used in the lead assemblies would be, then loaded into FS65 shipping packages for transport to the United States. It is anticipated that the archive and scrap materials would be stored in their Type B shipping packages at LANL. Once the MOX facility becomes operational, these archive and scrap materials would be used as feed material during pellet production for MOX fuel that would be irradiated in existing U.S. commercial nuclear reactors.

Figure 1 is a flowchart of the activities required to complete this effort. The shaded areas of the figure are outside the scope of this SA. Transportation of materials such as new, empty fuel rods, depleted uranium and process chemicals that will be supplied in Europe are not evaluated in this SA. **Figure 2** shows the locations of facilities involved in the proposed activities.

This SA focuses on the potential impacts of the transportation aspects (including cargo-handling activities at the potential U.S. ports and effects on the global commons) of the proposed action. This is because the domestic activities proposed, other than those associated with transportation, remain essentially unchanged compared to the manner in which they were analyzed in other NEPA documents, in particular the *Storage and Disposition PEIS* and the SPD EIS.[6] Canister and SST/SGT loading operations at LANL would be similar to those anticipated in the SPD EIS. However, only about half as much plutonium oxide would be involved as in the SPD EIS analysis. Therefore, there would not be as much waste generated, or dose received by those involved in the activities. There would be no modification to facilities or discharges to the environment associated with these proposed activities.

Ocean transit would occur as an armed convoy in PNTL vessels. PNTL vessels are special purpose vessels jointly owned by British Nuclear Fuel Limited (BNFL), COGEMA, and Japanese utilities and have transported fresh MOX fuel, spent fuel, and vitrified residues between

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[5] In February 2003, Duke Power Company submitted license amendment requests to the NRC for both Catawba and McGuire because the final decision about which plant would receive the lead assemblies would be based on the plants' refueling schedules. Subsequently, as the timing of the availability of the lead assemblies has become more refined, it appears that Catawba would be in position to receive the lead assemblies, and the license amendment request for McGuire was withdrawn.

[6] Transportation of the same materials was evaluated in detail in these documents, but the exact routes were not. Also, this SA updates these previous analyses with new population data from the 2000 census and uses a more recent revision to the computer code used for transportation impact analysis.

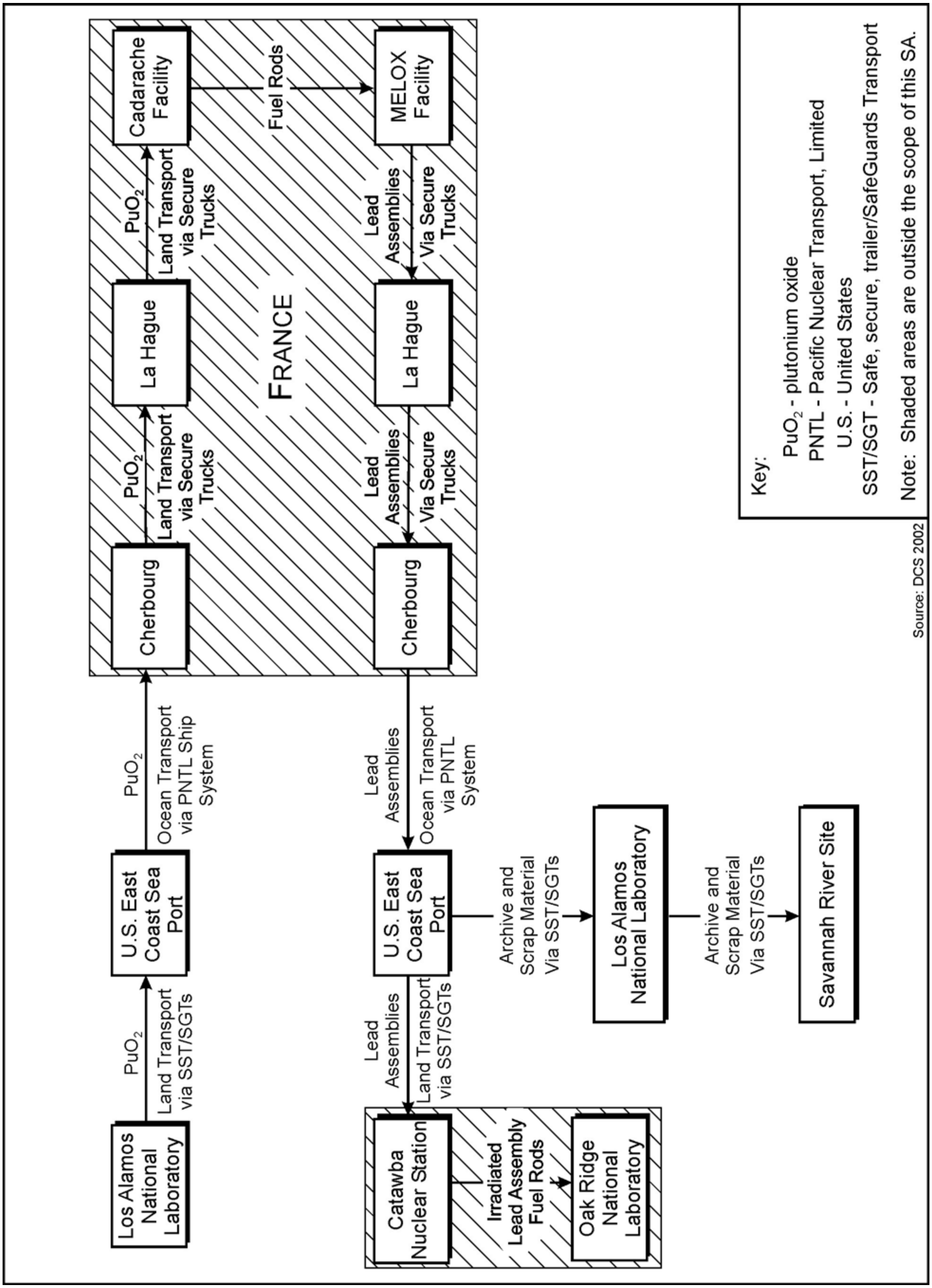


Figure 1. Eurofab Activities

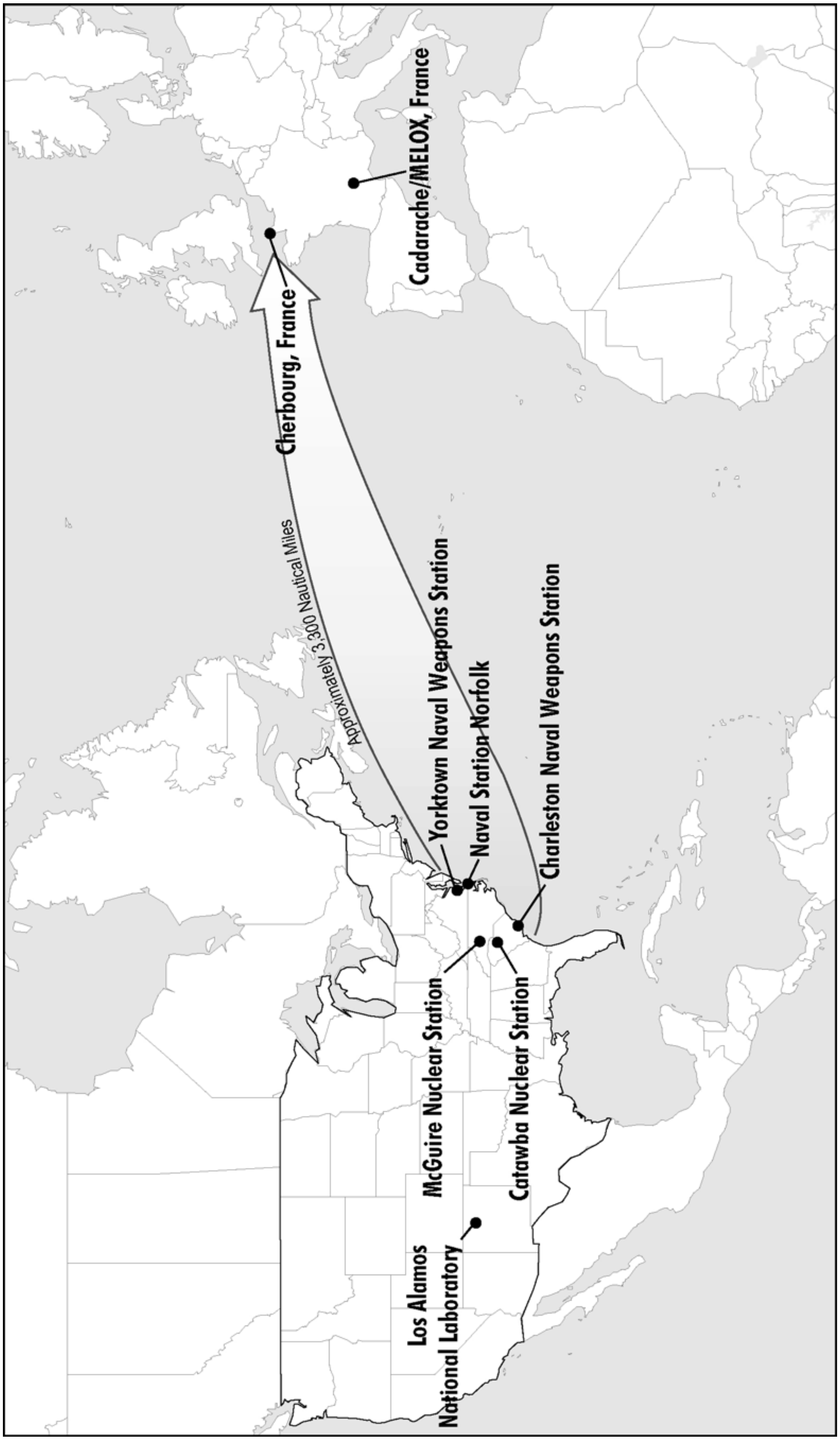


Figure 2. Facility Locations

Europe and Japan for more than 20 years without a radiological incident. These ships have covered more than 4.5 million miles and transported more than 4,000 casks in over 160 shipments (BNFL, COGEMA, ORC 2001).

Activities occurring within the territorial limits of other countries are not being evaluated in this SA. Only those activities potentially affecting the global commons, in this case only ocean transit, are addressed. Activities occurring within the territorial limits of other countries such as lead assembly fabrication at an existing MOX fuel fabrication facility or transportation to and from the facility will be evaluated by the owner/licensee of the MOX fuel fabrication facility in accordance with regulatory requirements in that country.

4.1 Ports Being Considered

Marine ports are generally located at the confluence of major rivers and oceans. These regions are commonly referred to as estuaries and provide a fragile habitat for much of the marine life found in the oceans. An estuary is a semi-enclosed body of water with a free connection to the open ocean, where the saltwater is considerably diluted with freshwater. In general, the freshwater flowing into the estuary eventually exits the system in the upper (water) layer of the estuary, while the denser seawater enters the estuary through lower subsurface layers (DOE 1996b).

The ports under consideration are military ports near the Atlantic Ocean, and are within or near large commercial port areas. Only military ports are considered to ensure maximum control and security for the cargo and the availability of port workers experienced in handling nuclear or other sensitive cargo.

4.1.1 Charleston Naval Weapons Station, Charleston, South Carolina

Charleston is the largest port city in South Carolina, and the greater Charleston area is one of the major seaports on the east coast of the United States. The city of Charleston is at the confluence of the Cooper and Ashley Rivers, about 7 miles inland from of the Atlantic Ocean. The city of Charleston is on a peninsula, bounded on the west and south by the Ashley River and on the east by the Cooper River. In general, the elevation of the area ranges from sea level to about 20 ft on the peninsula (DOE 1996b:3-5). The Charleston area highway system includes Interstates 26 and 526 and U.S. Routes 17 and 52. These major highways provide access to the Charleston NWS. Interconnecting primary state highways supplement these major routes (DOE 1996b:D-41).

Charleston NWS is on the west bank of the Cooper River, north of the city of North Charleston. Charleston NWS is about 17,500 acres in size and is in southeastern Berkeley County, South Carolina, about 19 mi from the Atlantic Ocean (DOE 1996b:3-6, 3-7). Charleston NWS has four wharves. Wharf Alpha, the wharf best suited for the proposed activities, is equipped with a crane for cargo handling. Trucks can be driven onto the wharf and cargo can be loaded and unloaded directly between trucks and ships. The facility offers a secure site conducive to transferring plutonium oxide and lead assemblies. In addition to the restricted access to the NWS, there are secure parking areas within the site where the SST/SGT convoys can be staged prior to driving out onto the wharf for cargo loading or unloading.

Charleston NWS is part of DOE's Foreign Research Reactor Spent Nuclear Fuel Program. Since May of 1996, 22 spent nuclear fuel shipments have been received through Wharf Alpha at Charleston NWS (Nigam 2003). The spent nuclear fuel casks have been offloaded from ships to either trains or trucks and transported to DOE facilities.

4.1.2 Yorktown Naval Weapons Station, Virginia

Yorktown NWS is located on the Virginia Peninsula in the central portion of York County. It is on the west bank of the York River approximately 3 mi from the city of Yorktown, Virginia and the confluence of the York River and the Chesapeake Bay. Yorktown NWS encompasses about 10,624 acres. As part of the Navy's Mid-Atlantic installation claimant consolidation, Cheatham Annex, formerly an annex of the Fleet Industrial Supply Center, Norfolk, was incorporated with the station in 1998. Yorktown NWS is serviced by three major highways, Interstate 64, US 17, and US 60; one railroad; and two major commercial and two military air terminals (GS 2003a:1, 3). York County contains a portion of four watersheds: Lower Chesapeake Bay, Lower James, Lynnhaven-Poquoson, and York (ED 2003).

Yorktown NWS provides ordnance logistics, technical, supply and related services to the Navy's Atlantic Fleet. As one of the Navy's "explosive corridors" to the sea, supply, amphibious, and combatant ships use the station's two piers (GS 2003a:1). At these piers, the Navy loads and offloads weapons and ordnance from Navy ships and submarines. The piers are equipped with cranes for cargo handling. Trucks can be driven onto the wharf and cargo can be loaded and unloaded directly between trucks and ships. The facility offers a secure site conducive to transferring plutonium oxide and lead assemblies. In addition to the restricted access to the NWS, there are secure parking areas within the site where the SST/SGT convoys can be staged prior to driving out onto the wharf for cargo loading or unloading.

4.1.3 Naval Station Norfolk, Norfolk, Virginia

NS Norfolk occupies about 3,400 acres on the Sewells Point Peninsula in the Hampton Roads area of Virginia. The facility is located on the south side of the Port of Norfolk, adjacent to the Norfolk International Terminal on the Elizabeth River Channel. NS Norfolk is about 18 nautical mi west of the entrance to the Chesapeake Bay from the Atlantic Ocean. Channels are maintained at a minimum depth of 45 ft. Except for areas close to shore, the water outside the channel is about 18 ft deep from the Atlantic Ocean to Hampton Roads (GS 2003b:1, 2).

Based on supported military population, NS Norfolk is the largest naval station in the world and is home to 78 ships, including 5 aircraft carriers. There are 14 piers available for cargo handling, repairs, refitting and training. Port Services controls more than 3,100 ship movements annually and oversees facilities that extend more than 4 miles along the waterfront and includes about 7 miles of piers and wharf space (GS 2003b:1). Cranes are available on every pier to handle cargo. Access to NS Norfolk is restricted and controlled. Because of its work for the U.S. Navy, the facility has security in place to support the transfer of plutonium oxide and lead assemblies between SST/SGTs and ships.

4.2 Global Commons

The Atlantic Ocean is the global commons area potentially impacted by the proposed action. The Atlantic Ocean is the second largest of the earth's four oceans and the most heavily traveled. It extends in a shape like the letter "S" from the arctic to the Antarctic regions between North and South America on the west and Europe and Africa on the east. It has a surface area of 32 million mi^2 and an average depth of 11,810 ft. Surface water temperatures range from 32 °F near the Arctic to 81 °F near the equator. The Atlantic Ocean contains some of the world's most productive fisheries, located on the continental shelves and marine ridges off the British Isles, Iceland, Canada, and the northeastern United States. Herring, anchovy, sardine, cod, flounder, perch, and tuna are the most important commercial species. Mineral resources are also actively mined in the Atlantic, including tin and iron ore, titanium, zircon, and monazite. The continental slopes of the Atlantic are also potentially rich in fossil fuels, with large amounts of petroleum already being extracted (Encarta 2003).

The Northern Right Whale (*Eubalaena glacialis*) is a federally endangered species that is also protected internationally under the convention for the regulation of whaling. There are currently about 300 right whales left in the North Atlantic, with ship strikes accounting for about 50 percent of their known deaths. Calving right whales usually winter in the waters between Savannah, Georgia, and West Palm Beach, Florida, with an area of high density between Brunswick, Georgia, and St. Augustine, Florida (NOAA 2003:1). The Maritime Safety Committee of the International Maritime Organization (IMO) adopted a mandatory ship reporting system that became effective in 1999. This system operates from November 15 to April 15 off the southeastern coast of the United States so as to include the calving season for the right whales in this area, and operates throughout the year on the northeastern coast, where the whales have been sighted year round (IMO 1998:5).

5.0 IMPACTS

This section presents estimates of both incident-free and accident risks associated with transportation in support of lead assembly fabrication in Europe. The risks of shipments of plutonium oxide from LANL through one of three Eastern U.S. ports to Europe; the return shipment of MOX lead assemblies and archive and scrap materials from Europe through the same three ports; and the transport of lead assemblies from each port to either Catawba or McGuire, the archive and scrap material to LANL, and the shipment of archive and scrap material from LANL to SRS have been evaluated. This section also presents estimates of the potential impacts from severe radiological accidents for the shipments and discusses the results in terms of individual risk.

The analysis uses methods similar to those used in the *Storage and Disposition PEIS* and the SPD EIS to facilitate comparison of potential impacts presented in these documents with impacts that are estimated in this SA. In addition, Section 5.5 discusses the potential impacts of the proposed activities on the global commons, and for completeness, Section 5.6 qualitatively discusses the potential impacts of the storage of archive and scrap materials. This section demonstrates that transportation-related impacts[7] associated with the current proposal to fabricate

[7] Transportation impacts are the only impacts evaluated in this SA because, as discussed in Section 4.0, the domestic activities proposed, other than those associated with transportation, remain unchanged compared to the manner in which they were analyzed in other NEPA documents.

lead assemblies in Europe are less than those previously evaluated in the *Storage and Disposition PEIS* for fabrication of lead assemblies in Europe or in the SPD EIS for fabrication in the United States.

5.1 Description of Transportation Activities

Shipments of plutonium would be made in approved Type B packages. Overland shipments in the United States containing plutonium, except irradiated assemblies, would be made in SST/SGTs. The plutonium oxide powder would be shipped from LANL in FS47 shipping casks to a European fabrication facility. At LANL, individual COGEMA convenience cans would be loaded with approximately 3.4 kg of plutonium oxide powder. Each can would be sealed and then loaded into an ARIES inner can. Five inner cans would be placed inside an AA-227 package. The AA-227 would in turn be loaded into a FS47 shipping cask. **Figure 3** illustrates this arrangement. It is anticipated that three SST/SGTs each containing three FS47 shipping casks would move all the plutonium oxide from LANL to the port. Once at the port, it is anticipated that the casks would be transferred directly to PNTL ships, which would travel in a two-vessel convoy across the Atlantic Ocean. The ships would sail as soon as the transfers, inspections, coordination with the port and escort vessels, and required documentation were complete. This two-vessel convoy approach is the same approach that the U.S. government approved for use in 1999 for shipment of commercial MOX fuel from Europe to Japan, and in 2002 for shipment back from Japan to the United Kingdom.[8] The U.S. government approved this plan only after an extensive review over several years including a formal review of the final plan by responsible Executive Branch agencies (BNFL, COGEMA, ORC 2001).

The procedure is for two PNTL ships to sail together, each providing armed escort for the other. The ships have a broad range of protection systems, including naval guns and armed officers. These officers would operate independently of the crew, would be responsible for constant surveillance and protection of the cargo, and would have authority to use deadly force in defense of the ships and their cargo.

The PNTL ships, among the safest in operation, are specially designed to carry radioactive materials. Special safety features include (BNFL, COGEMA, ORC 2001):

- Double hulls to withstand damage from a severe collision and remain afloat
- Enhanced buoyancy to ensure the ship stays afloat and maintains a stable attitude even in the most extreme circumstances
- Duplicate navigation, communications, electrical and cooling systems
- Dual propulsion systems, specialized fire fighting equipment, satellite navigation and tracking, and highly experienced crew members

[8] The 1988 U.S.–Japan Agreement for Cooperation Concerning Peaceful Uses of Nuclear Energy elaborates in detail the extensive physical protection measures required for the transportation of plutonium oxide or MOX fuel by sea. Prior to each shipment, representatives from the U.S. government, including experts from the defense, foreign affairs, naval, and intelligence agencies review the transportation plan and confirm that the physical protection measures are adequate. The U.S. government then officially notifies Japanese authorities of this decision.

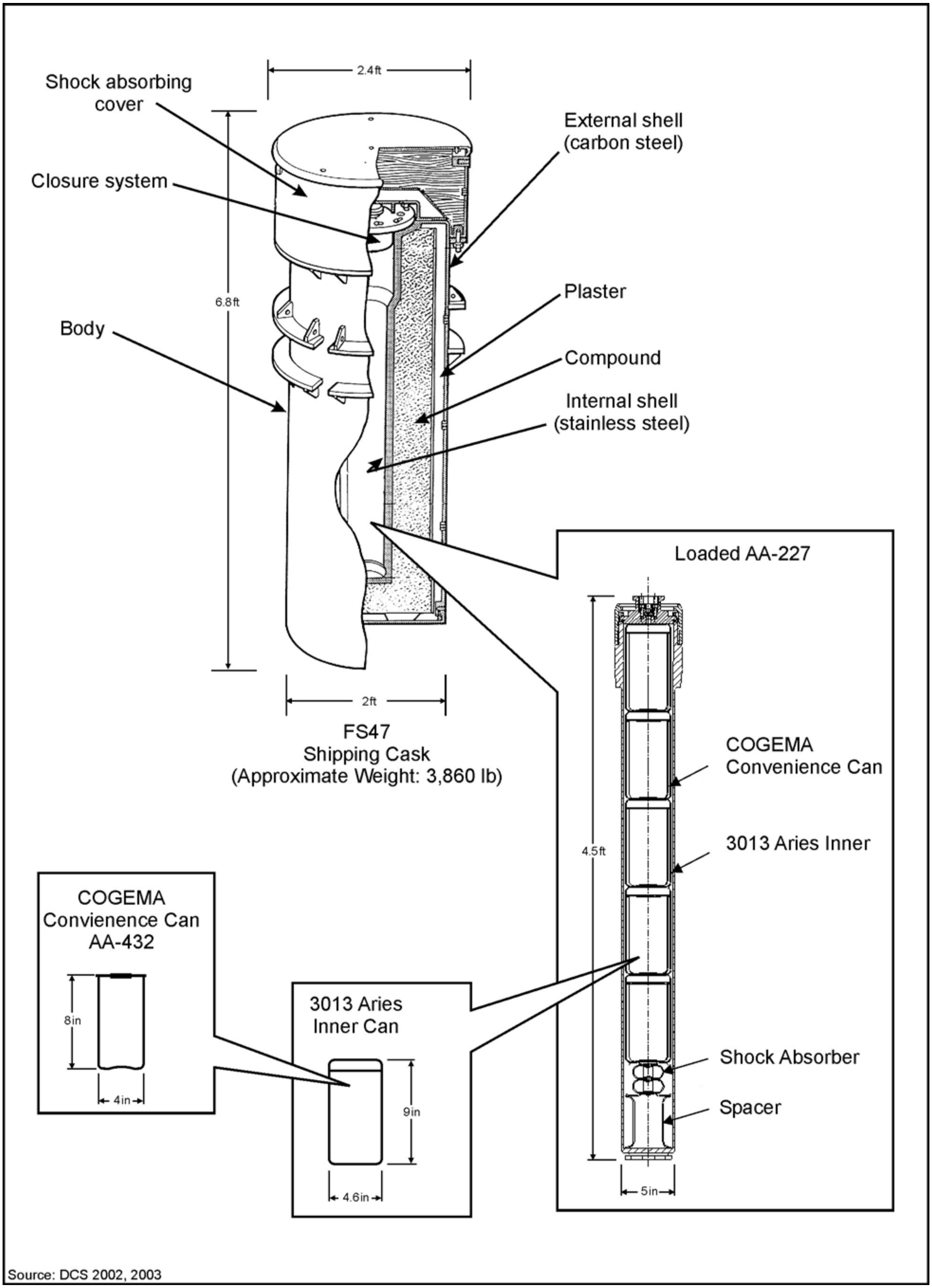


Figure 3. Plutonium Oxide Shipping Packages

Figure 4 is a cutaway view of a PNTL purpose-built ship showing some of the ship's protective features. The ship is approximately 350 ft long and 50 ft wide.

The ships would cross the Atlantic Ocean and make port at Cherbourg, France. From there, the casks would be loaded onto trucks with armed escorts and transported to La Hague, France, where they would be reloaded onto French Secured Transport trucks for transport to Cadarache, the pellet and fuel rod fabrication plant (DCS 2002:9). Fuel rods would be transferred from Cadarache to MELOX, the assembly plant, as appropriate.

Lead assemblies, archive, and scrap material would be returned to the United States in FS65 packages (baskets and bodies) as shown in **Figure 5**. The FS65 package is a cylindrical cask placed into an aluminum frame and linked to the frame by anti-vibration pads.

Six FS65 packages (four with fuel assemblies and two with rods containing archive and scrap material) would be loaded onto French Secured Transport trucks at MELOX and transported to La Hague, France. In La Hague, the packages would be transferred to other trucks with armed escorts for transport to Cherbourg, France. In Cherbourg, the FS65 packages would be placed into specially designed overpacks for ocean transport. At the port, the casks would be loaded onto the PNTL ships for the return voyage. At the U.S. port, the lead assemblies would be loaded onto SST/SGTs and shipped overland to Catawba. Archive and scrap materials would be transported by SST/SGT to LANL for storage until the MOX fuel fabrication facility is operational (DCS 2002:12, 15).

There are a number of regulations and standards that govern international shipments of radioactive and fissile materials. Lead assembly shipments would meet requirements to ensure that the ships and their cargo are protected against threats of theft or sabotage. Physical protection measures would meet the recommendations published by the International Atomic Energy Agency in INFCIRC 225, Recommendations on the Physical Protection of Nuclear Material, and INFCIRC 274, Convention on the Physical Protection of Nuclear Material (BNFL, COGEMA, ORC 2001).

5.2 Risks of Truck Transportation

The risks of incident-free transportation as well as accidents for all overland shipments were calculated using the RADTRAN 5 code. For incident-free transportation risk, the RADTRAN 5 code calculates the dose and corresponding risk based on the external dose rate from the shipping vehicle, the transportation route and the population density along the route. For accident transportation risk, RADTRAN 5 also uses state-specific accident rates and a conditional accident frequency-severity relationship that considers the route conditions (urban, suburban, rural). For this analysis, the accident rate for SST/SGT transport and the accident severity category classifications of NUREG-0170 (NRC 1977) were used consistent with the SPD EIS analyses. The nonradiological accident risks (fatalities resulting from potential transportation accidents) were also calculated using RADTRAN 5.

An important determinant in transportation risk is the route, including its length, the states through which the route passes, and the population along the route. Representative routes for each of the shipments were selected using a code called WebTRAGIS. This code identifies routes consistent with current routing practices and applicable routing regulations and guidelines,

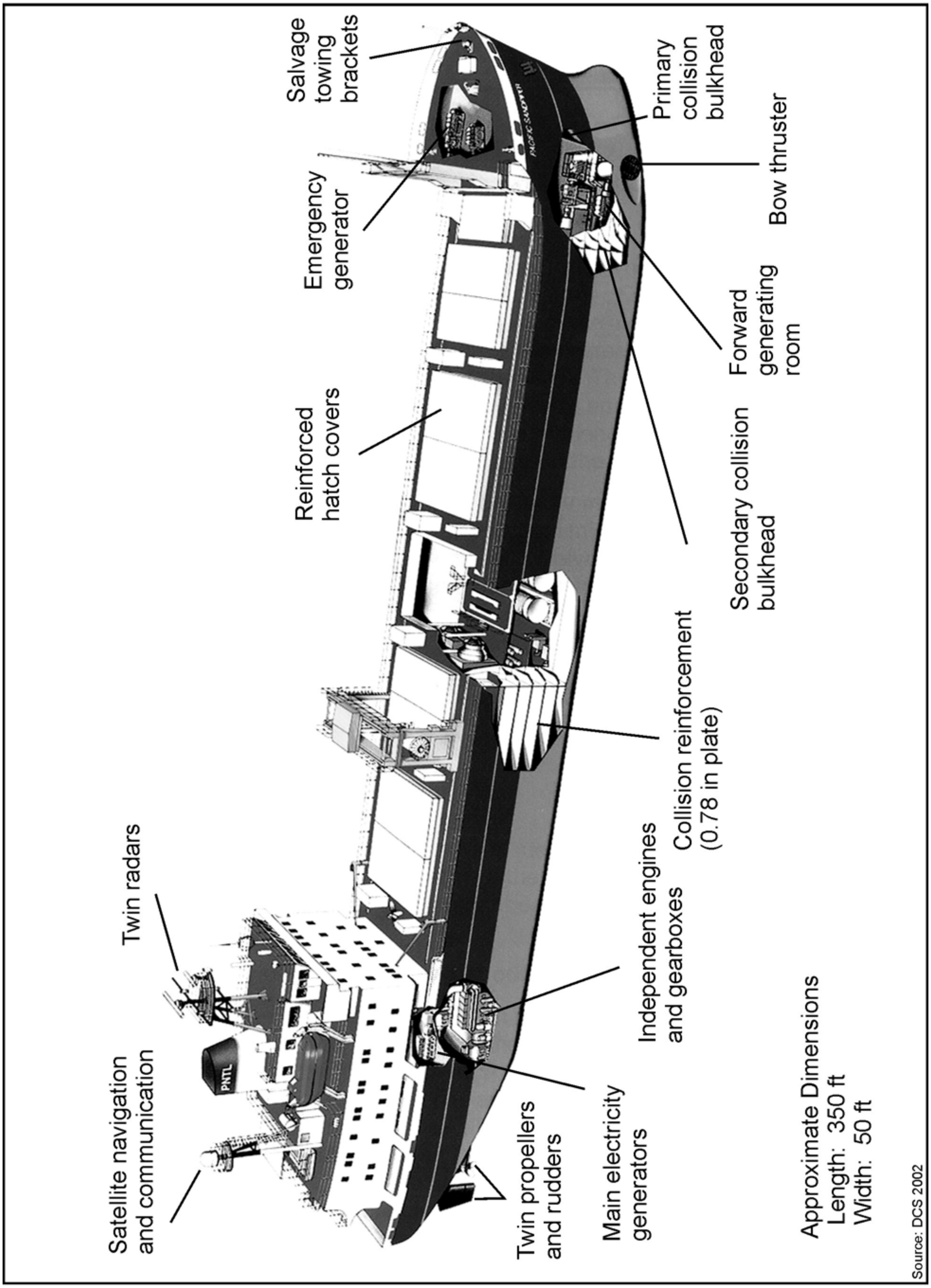
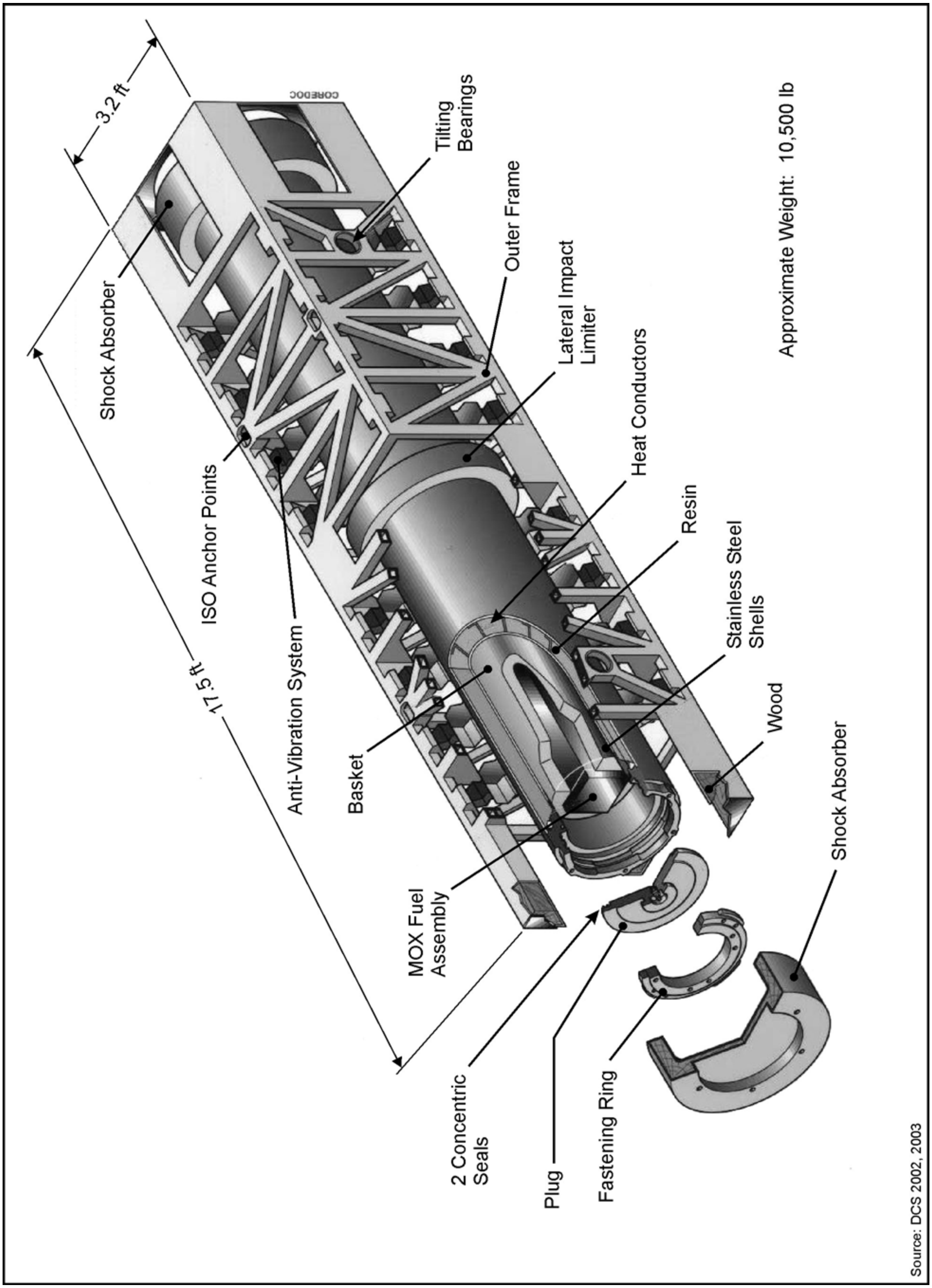


Figure 4. PNTL Purpose Built Ship



Source: DCS 2002, 2003

Figure 5. FS65 MOX Lead Assembly Shipping Package

and identifies the population living within 0.5 mi of the route using 2000 U.S. Bureau of Census data. Route characteristics for all overland transportation legs are summarized in **Table 1**.

Table 1. Potential Truck Route Characteristics for Shipments to Support European Fabrication of Lead Assemblies

From	To	Distance (mi)	Percentage in Zones			Population Density in Zones (per mi^2)			Number of Affected Persons
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Plutonium Oxide									
LANL	Charleston NWS	1,887	69.8	26.7	3.6	30	856	5,941	865,410
LANL	NS Norfolk	2,011	70.2	27.0	2.8	33	780	5,770	790,161
LANL	Yorktown NWS	1,992	70.7	26.8	2.5	33	765	5,698	729,824
Lead Assemblies									
Charleston NWS	McGuire	236	50.9	44.7	4.4	37	986	6,022	169,312
Charleston NWS	Catawba	204	57	39.8	3.2	36	902	6,171	116,844
NS Norfolk	McGuire	381	45.2	49.6	5.2	49	950	5,575	297,080
NS Norfolk	Catawba	406	42.7	52.0	5.3	50	936	5,663	326,380
Yorktown NWS	McGuire	362	46.9	49.6	3.5	50	913	5,189	236,925
Yorktown NWS	Catawba	387	44.2	52.1	3.7	51	903	5,363	266,010
Archive and Scrap Materials									
Charleston NWS	LANL	1,887	69.8	26.7	3.6	30	856	5,941	865,410
NS Norfolk	LANL	2,011	70.2	27.0	2.8	33	780	5,770	790,161
Yorktown NWS	LANL	1,992	70.7	26.8	2.5	33	765	5,698	729,824
LANL	Savannah River Site	1,732	71.4	24.9	3.7	30	861	5,902	783,380

Key: LANL, Los Alamos National Laboratory; NS, Naval Station; NWS, Naval Weapons Station.

The results of this transportation risk analysis, summarized in **Table 2**, are human health risk estimates that reflect the estimated number of fatalities resulting from the proposed transportation. The radiological risk is the estimated number of LCFs resulting from exposure of the affected populations. The nonradiological risk is the estimated number of fatalities that would result from traffic accidents involving movement of materials, and is independent of the type of material being transported. As can be seen in Table 2, the risk (the product of consequence and estimated frequency of occurrence) that would result from the proposed activities is very small, very much less than 1 LCF, is related to the distance traveled, and is the same for both Catawba and McGuire.

Table 2. Human Health Risk for Overland Shipments in Support of European Fabrication of Lead Assemblies

Port	Incident-Free Transportation Risk[a]		Accident Risk[a]	
	Radiological			Non-
	Crew	Public	Radiological	Radiological
Irradiation at Catawba				
Charleston NWS	3.7×10^{-6}	3.0×10^{-6}	1.9×10^{-7}	1.6×10^{-4}
Yorktown NWS	3.9×10^{-6}	3.2×10^{-6}	2.1×10^{-7}	1.7×10^{-4}
NS Norfolk	4.0×10^{-6}	3.2×10^{-6}	2.1×10^{-7}	1.7×10^{-4}
Irradiation at McGuire				
Charleston NWS	3.7×10^{-6}	3.0×10^{-6}	1.9×10^{-7}	1.6×10^{-4}
Yorktown NWS	3.9×10^{-6}	3.2×10^{-6}	2.1×10^{-7}	1.7×10^{-4}
NS Norfolk	4.0×10^{-6}	3.2×10^{-6}	2.1×10^{-7}	1.7×10^{-4}

[a] The risk is expressed as the expected number of latent cancer fatalities, except for the accident nonradiological risk which is expressed as the expected number of accident fatalities.

Key: NS, Naval Station; NWS, Naval Weapons Station; PuO_2, plutonium oxide.

The consequences of a severe accident for a maximally exposed individual (MEI) have also been estimated. The consequences of an accident that breaches a plutonium oxide shipping package would be greater than an accident that breaches a lead assembly shipping package because the plutonium oxide powder is more readily dispersed than the ceramic mixed plutonium/uranium oxide. The severe accident considered for estimating the dose to the MEI is one that damages a single Type B package (an FS47) with 17 kg of plutonium oxide. For this severe accident, it is estimated that the dispersed, respirable fraction is 3.5×10^{-2}, which means that 595 g of respirable plutonium oxide would be transported downwind toward the MEI. Using meteorological parameters consistent with those used in the SPD EIS, the dose to the MEI situated 330 ft downwind from the accident would be 2.2×10^{3} rem. The probability of occurrence of this severe truck transportation accident is estimated to be 1×10^{-8}, 2×10^{-10}, and 1×10^{-11} for rural, suburban, and urban segments, respectively. Although the consequences to the MEI of the severe truck transportation accident are high, the probability of occurrence is very low, and therefore, the risk is also very small.

This severe truck transportation accident has greater consequences for the MEI than the severe plutonium oxide shipment accident considered in the SPD EIS because the Type B package evaluated in the SPD EIS would hold only one can of plutonium oxide containing 4.3 kg of plutonium. As a result, less plutonium is available for release following the accident. The MEI dose in the SPD EIS is 684 rem for neutral meteorological conditions, and 23 rem for stable meteorological conditions. Because of the larger number of shipments and longer shipping distances, the SPD EIS estimates the probability of occurrence for this accident to be on the order of 1×10^{-7} in rural areas where the accident is most likely to occur. The estimated MEI risk for this SPD EIS accident is 3.5×10^{-8}, which is slightly higher than the MEI risk (1×10^{-8}) for the Eurofab accident.

The consequences of a severe truck accident involving lead assemblies or archive and scrap material were also considered. The impacts would be much lower because the ceramic MOX material is less dispersible than the plutonium oxide powder. The amount of material released is estimated to be about 0.001 percent of the same accident involving plutonium oxide based on the reduced aerosol fraction and respirable fraction estimates for immobile material (ceramic MOX pellets) and fine powder (plutonium oxide powder) presented in *A Resource Handbook on DOE Transportation Risk Assessment, DOE National Transportation Program* (DOE 2002).

5.3 Risks of Port Operations and Ship Transportation

5.3.1 Port Operations

The risk of both incident-free operations and potential port accidents are analyzed in this SA. Implementation of the proposed action would involve a very small increase in the use of the port facilities. There would be no construction at or modification of port facilities. Only three trucks (SST/SGTs) would arrive at the port to deliver the plutonium oxide to the dock and plutonium oxide would be loaded on PNTL ships, which would travel as a two-ship convoy. The lead assemblies, archive and scrap material would be transported back to the United States on PNTL ships, and would leave the port in a total of six trucks (SST/SGTs). It is not expected that the minimal additional transportation and cargo handling activities associated with the proposed action would result in any impacts to the local environment.

The risk from incident-free port operations was estimated assuming that the number of personnel and length of time required for cask handling and inspection are the same as those used in the FRR EIS analysis[9]. For plutonium oxide cask inspection and handling, the cumulative dose is estimated to be 5.1×10^{-4} person-rem per cask. This would result in a total occupational dose at the port of 4.5×10^{-3} person-rem and a collective population risk of 1.8×10^{-6} LCF. For the lead assemblies and archive and scrap material, the occupational dose for cask inspection and handling is estimated to be 1.1×10^{-4} person-rem/cask. This would result in a total port occupational dose from these materials of 6.6×10^{-4} person-rem and a collective risk of 2.6×10^{-7} LCF. It is estimated that the various inspectors (i.e., Coast Guard and other Federal personnel) and observers, including some members of the ship's crew, would receive 85 percent of this dose while longshoremen handling the cask would receive 14 percent of the dose. Truck drivers and crane operators would receive the remaining population dose.

The potential for cask handling accidents during port operations was also considered. Consistent with the *Storage and Disposition PEIS*, the potential for a port handling accident that would result in the release of radioactive material is considered to be negligible because of the robustness of Type B packages. These packages are designed and tested for a drop from 30 ft into an unyielding surface, a drop on a punch bar, and exposure to a 1,470 °F fire for 30 minutes (10 CFR 71). No cask handling accidents on docks were postulated that would involve situations more hazardous than those for which the casks were designed, so releases are not considered credible.

The nonradiological risk of port operations was also estimated using cask-handling information presented in the FRR EIS and fatality accident frequency statistics reported by the Bureau of

[9] The FRR EIS evaluates the potential environmental impacts that could result from the adoption of a joint DOE/Department of State policy to manage spent nuclear fuel from foreign research reactors that contains highly enriched uranium provided by the U.S. Implementation of this policy involves return of this spent nuclear fuel to the U.S. Evaluations in the FRR EIS include the receipt of this spent nuclear fuel at one or more U.S. marine ports of entry. In particular, the FRR EIS presents detailed environmental information for the global commons and 10 potential ports of entry, including the ports evaluated in this SA. The FRR EIS also established certain cask handling assumptions for the ports and accident scenarios that are used in both the *Storage and Disposition PEIS* and this SA.

Labor Statistics (Toscano and Windau 1996). The FRR EIS reports that up to four longshoremen in the hold and two on the dock may be necessary to move a cask from a ship hold to a dock and that the time required for the movement may be up to 3 minutes. Assuming the same labor requirements for loading of plutonium oxide casks, 1.3×10^{-3} worker-years would be required to accomplish the transfer of nine casks from the dock to the ship's hold. Using a fatality accident rate of 25 fatalities per 100,000 worker-years, the nonradiological risk estimate for loading the plutonium oxide casks at the U.S. port is 3×10^{-7}. On the return trip, six casks would be unloaded. Using the same labor productivity assumptions and fatality accident rate assumptions, the nonradiological risk for unloading the MOX and archive/scrap material casks would be 2×10^{-7}.

5.3.2 Ship Transportation

The exposure to members of the ship's crew during the voyage across the Atlantic Ocean has also been estimated. Ocean transit would not take longer than 1 week. Therefore, to estimate potential worker dose, it is assumed that a single cargo inspection would be conducted by a single crewmember during the trip to verify the security of the casks. The inspection would be of limited duration (about 15 minutes) and at a moderate distance, estimated to be 5 ft from the casks. The total dose to the crew from inspections during the two voyages would be 0.37 mrem. This represents a total risk of 1.5×10^{-7} LCF. Because there is minimal radiation emanating from the casks, and the casks are isolated from the crew by steel bulkheads and decking, there would be no other exposure to the crew.

5.3.3 Ship Accidents

This SA analyzes a severe accident that involves a collision between the PNTL ship and another ship with an ensuing fire. This severe accident is consistent with the severe accident analyzed in the FRR EIS. The FRR EIS considered but did not analyze accidents where a ship containing a nuclear cargo hits a fixed structure (e.g., a bridge) or runs aground because these accidents usually do not involve cargo damage.

The severe accident analysis in this SA is postulated to damage all nine FS47 shipping packages that contain the entire inventory of 150 kg of plutonium oxide. The release periods for this collision/fire scenario are similar to those considered in the FRR EIS. The size of the release is adjusted from the FRR EIS to account for differences in the material properties and composition of the plutonium oxide powder.

The MACCS2 computer code was used to model the radiological consequences of the postulated severe PNTL accident resulting in the release of plutonium oxide powder. The identical accident scenario was analyzed for the three proposed ports. Both dock and channel locations were identified for each of the three ports. The 50-mile radius population distributions for both dock and channel locations were estimated using 2000 census data. This information was used to determine for each port whether the dock or channel location would result in higher consequences. Based on this analysis, higher consequences would occur at the dock for Yorktown NWS and NS Norfolk and in the channel for Charleston NWS. Therefore, these maximum consequence locations were used in the quantitative analysis of the severe accident, and are the locations at each port for which results are reported.

Consistent with the severe accident analysis in the FRR EIS, the source term was estimated to consist of two sequential plumes. The first plume would release 150 g of respirable plutonium oxide powder over a 10-minute period without any energy imparted to the plume. The second plume would release 600 g of respirable plutonium oxide powder over a 60-minute time period with 150 kilowatts of energy from the fire. Both releases were assumed to occur at an elevation of 33 ft, which corresponds to the estimated PNTL deck elevation. The fraction of plutonium estimated to be released and in a respirable form (5×10^{-3}) is consistent with that used in the SPD EIS severe accident analyses involving plutonium oxide powder. The population doses for this accident were estimated to be 49,000 person-rem in the channel leading to the Charleston NWS, 8,400 person-rem at the NS Norfolk dock, and 13,900 person-rem at the Yorktown NWS.

Combining these accident doses with a frequency estimate produces a risk estimate. The *Storage and Disposition PEIS* estimated the frequency of a maximum accident that results in the release of material from a Type B package as 5×10^{-9} accidents per port transit (DOE 1996a:G-4). The FRR EIS estimated the frequency of a ship collision involving serious cargo hold damage and a fire as 6×10^{-10} (DOE 1996b:4-23). Using the conservative estimate of 5×10^{-9} accidents per port transit results in a population accident risk of 1.2×10^{-7} LCF for Charleston NWS, 1.1×10^{-7} LCF for NS Norfolk, and 3.5×10^{-8} LCF for Yorktown NWS.

The dose to the MEI is estimated to be 14 rem for Charleston NWS, 17.2 rem for NS Norfolk, and 8 rem for Yorktown NWS. Using the conservative accident frequency of 5×10^{-9} accidents per port entry previously discussed, the resulting individual LCF risk to the MEI is 4.3×10^{-11} for NS Norfolk, 3.5×10^{-11} for Charleston NWS, and 2.0×10^{-11} for Yorktown NWS.

As with the severe truck accident, the consequences to both the population and the MEI from a severe accident involving a MOX assembly would be about 0.001 percent of that for plutonium oxide because of the smaller release and reduced respirable fractions.

The results of the risk analysis for port operations are summarized in **Table 3**. The table shows low radiological risk levels to port workers and no radiological risk to the public from incident-free operations. These risk estimates are the same regardless of the port. Accident radiological risks are also small, but they vary with the port. The port workers (longshoremen) have a nonradiological accident risk that is estimated to be comparable to the incident-free radiological risk.

Table 3. Human Health Risk of Port Operations in Support of European Fabrication of Lead Assemblies

Shipment	Incident-Free Risk[a]		Accident Risk[a]	
	Radiological			
	Crew	Public	Radiological	Nonradiological
Charleston NWS	2.1×10^{-6}	none	1.2×10^{-7}	5×10^{-7}
Yorktown NWS	2.1×10^{-6}	none	3.5×10^{-8}	5×10^{-7}
NS Norfolk	2.1×10^{-6}	none	1.1×10^{-7}	5×10^{-7}

[a] The risk is expressed as the expected number of latent cancer fatalities, except for the accident nonradiological risk which is expressed as the expected number of accident fatalities.

Key: NS, Naval Station; NWS, Naval Weapons Station.

5.4 Comparison of Impacts

Table 4 presents a comparison of the potential U.S. human health risk for transportation of materials for MOX lead assembly fabrication. The table compares the potential impacts of the Eurofab option with the potential impacts of the transportation component of two of the lead assembly fabrication alternatives analyzed in the SPD EIS. These two SPD EIS alternatives were selected for comparison because LANL was selected as the lead assembly site in the SPD EIS ROD, and SRS is in the region of the ports that would be used for the shipments to and from Europe. None of the estimates includes transportation of irradiated fuel rods to the post-irradiation examination facility because these impacts would be the same for each of the alternatives, and including them would dominate the overall human health risk impact (approximately 85 percent of the total transportation impact). Including this impact would therefore overshadow and mask the differences between the alternatives.

Table 4. Comparison of Human Health Risk Estimates for SPD EIS and European Lead Assembly Fabrication Options

Alternative	Risk[a]		
	Worker (radiological)	Public (radiological, incident-free and accident)	Nonradiological
SPD EIS[b]			
Lead Assembly Fabrication at LANL	5.8×10^{-6}	4.3×10^{-4}	3.3×10^{-4}
Lead Assembly Fabrication at SRS	4.2×10^{-6}	5.5×10^{-4}	2.8×10^{-4}
Fabrication of Lead Assemblies in Europe			
Irradiation at Catawba			
Use of Charleston NWS	5.9×10^{-6}	3.3×10^{-6}	1.6×10^{-4}
Use of Yorktown NWS	6.1×10^{-6}	3.4×10^{-6}	1.7×10^{-4}
Use of NS Norfolk	6.2×10^{-6}	3.6×10^{-6}	1.7×10^{-4}
Irradiation at McGuire			
Use of Charleston NWS	5.9×10^{-6}	3.4×10^{-6}	1.6×10^{-4}
Use of Yorktown NWS	6.1×10^{-6}	3.4×10^{-6}	1.7×10^{-4}
Use of NS Norfolk	6.2×10^{-6}	3.6×10^{-6}	1.7×10^{-4}

[a] The risk is expressed as the expected number of latent cancer fatalities, except for the accident nonradiological risk which is expressed as the expected number of accident fatalities.
[b] SPD EIS estimates include only transportation components so as to compare the same set of activities for the SPD EIS and lead assembly fabrication in Europe. Data from Table L-4, page L-21 and associated calculation package (DOE 1999a).
Key: LANL, Los Alamos National Laboratory; NS, Naval Station; NWS, Naval Weapons Station.

The results summarized in Table 4 show that the potential impacts of the Eurofab option using any of the three port alternatives are comparable or lower than for the lead assembly alternatives analyzed in the SPD EIS. This is primarily the result of fewer shipments. Minor differences also result from updated population estimates and revisions to the RADTRAN code.

The *Storage and Disposition PEIS* presented estimates of potential fatalities from transportation of 50 metric tons of plutonium oxide from the United States to Europe and the return of MOX fuel assemblies fabricated with that material using a range of representative shipping distances.

Scaling the transportation fatality estimates developed in the *Storage and Disposition PEIS* to reflect the transportation parameters analyzed in this SA results in 1.3×10^{-3} fatalities, which is approximately a factor of 10 higher than that calculated in this SA. Both analyses conclude that the risk is dominated by the nonradiological risk of transportation accidents. The fatalities estimated by the scaled *Storage and Disposition PEIS* analysis are higher than those estimated by this SA primarily because the *Storage and Disposition PEIS* used fatality frequency estimates for conventional truck transportation while this SA uses estimates that are specific to SST/SGT transport.

5.5 Impact on the Global Commons

The *Storage and Disposition PEIS* reported an earlier DOE study that estimated the likelihood of a maritime accident of sufficient severity to cause significant release of radioactive material to be in the range of 1.0×10^{-8} to 1.0×10^{-9} per port call (DOE 1996a:G-6). The probability of an accident at sea involving the PNTL is very unlikely because of the limited number of shipments (one two-ship convoy each way) as well as the redundant modern navigation systems on the ship. The probability of a significant release is further reduced because of the ruggedness of the PNTL design and the Type B packages.

If plutonium oxide were released to waters of the global commons, the *Storage and Disposition PEIS* reports that plutonium oxide would dissolve very slowly, and would preferentially combine with sediments rather than remaining dissolved in the ocean water (DOE 1996a:G-6).

5.6 Archive and Scrap Material Storage

The SPD EIS considered that fuel rods containing archive and scrap materials (stable, non-reactive ceramic pellets similar to fresh MOX fuel) would be stored in a metal box in an isolated area at the lead assembly fabrication site. At LANL, the SPD EIS assumed that an area in the basement of a facility in Technical Area (TA)-55, where the lead assemblies were proposed to be fabricated, would be used to store these materials. The dose rate at 1 m from storage of these materials is estimated to be 0.15 mrem/hr (Eble 2003).

Under the Eurofab option, as discussed in Section 4.0, archive and scrap materials from lead assembly fabrication would be stored in two Type B shipping packages (FS65s) at TA–55 at LANL. There would be very little hazard associated with storage and maintenance activities because the archive and scrap materials would have multiple levels of confinement and the external dose rate from the package would be minimal. The archive and scrap materials would be in the form of stable, non-reactive ceramic pellets inside fuel rods with an inert environment. The fuel rods would be welded closed, leak-tested, and inspected to insure their integrity. Each fuel rod would be inventoried and engraved with a unique identifier, and its contents would be recorded. Prior to shipment and subsequent storage, the fuel rods would be placed inside a stainless steel shell that would then be inserted into an FS65 package. The FS65 package would provide robust leak-tight double containment (the basket providing one barrier and the body providing the second).

The archive and scrap materials would meet the stabilization criteria of DOE Standard DOE-STD-3013-2000, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials* (3013 Standard) (DOE 2000) for long-term storage. From a safety perspective, storing these fuel rods would be even less of a concern than storing plutonium oxide powder or other forms of plutonium envisioned to be stored pursuant to this standard. The pellets would contain less than 6 percent plutonium, similar to the plutonium content of fresh MOX fuel. There is very little risk of either an inadvertent criticality, or dispersion of plutonium in the event of an accident, because the plutonium would be incorporated in a non-dispersible ceramic material. The dose rate at 1 m from the packages would not exceed 0.1 mrem/hr, which would result in only minimal personnel exposure, and would not exceed the dose rate (0.15 mrem/hr) estimated for storage of archive and scrap materials described in the SPD EIS. The present proposal to store archive and scrap materials at LANL would be consistent with ongoing activities at TA–55, and analyses in and RODs for the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (DOE 1999b) and the SPD EIS (DOE 1999a).

5.7 Sabotage or Terrorist Attack

Both the *Storage and Disposition PEIS* (at Section G.1.2.6) and the SPD EIS (at Section L.6.5) acknowledged that a threat could be presented by sabotage or terrorism, and concluded that adequate safeguards are in place to meet such a threat. In the aftermath of September 11, 2001, DOE is continuing to consider measures to minimize the risk and consequences of potential terrorist attacks on DOE facilities. LANL, both the source for the plutonium dioxide to be used in lead assembly fabrication and the facility where archived material would be stored, offers certain unique features from a safeguards perspective: a remote location, restricted access afforded by Federal land ownership, restricted airspace above the site, and access to a highly effective rapid-response security force. DOE expects that the safeguards applied to protecting LANL will involve a dynamic process of enhancement to meet threats, and that those safeguards will evolve over time.

There is also the potential for attempts at acts of sabotage or terrorist attacks during transport. DOE's proposed action includes physical safeguards aimed at protecting the public from harm. These protective measures include the use of SST/SGT vehicles for overland shipments and dedicated purpose-built vessels for ocean shipment. Safety features of transportation casks that provide containment, shielding, and thermal protection also provide protection against sabotage. The candidate ports analyzed in this SA are military ports that provide a heightened level of security, including trained security personnel and physical barriers such as perimeter fencing with controlled access and surveillance. DOE continues to examine the protections built into its transportation system. DOE would modify its methods and systems as appropriate based on the results of this examination to reduce the potential for sabotage or terrorist attack to be successful.

A company that has extensive experience in international shipping of nuclear fuels would conduct the overseas shipments using specially designed ships, as described in Section 5.1. Land transportation in Europe would be handled by existing specially designed safe and secure transport system developed for shipment of nuclear materials. MOX fuel shipments between the fuel fabrication facilities and nuclear reactors in Europe have been conducted safely for more than 20 years.

Although the likelihood of an attempted act of sabotage or terrorism occurring is not precisely knowable, the chance of success of any such attempt is judged to be very low, particularly in light of the transport methods to be employed by DOE in these shipments, which are specifically designed to afford security against sabotage or terrorism, as well as safety in the event of an accident. In preparing this SA, DOE has again considered sabotage or terrorism and determined that adequate safeguards remain in place to meet such threats.

6.0 CONCLUSIONS

In accordance with Council on Environmental Quality regulations at 40 CFR 1502.9(c) and DOE regulations at 10 CFR 1021.314(c), this SA evaluates proposed changes in the surplus plutonium disposition program to determine whether the *Storage and Disposition PEIS* or SPD EIS should be supplemented, a new EIS should be prepared, or no further NEPA documentation is necessary.

Based on the analyses in this SA, the proposed fabrication of lead assemblies in Europe, specifically, overland transportation of plutonium oxide from LANL to any of the three military ports on the east coast of the United States, ocean transport to Europe, the return shipment of fresh MOX fuel lead assemblies and ancillary materials to the United States, and subsequent transport of the lead assemblies to Catawba and ancillary materials to LANL, would not result in impacts significantly different from or greater than those described in either the *Storage and Disposition PEIS* or the SPD EIS. Where there are differences in impacts, they are small changes to impacts that are themselves small. Therefore, the activities evaluated in this SA do not represent substantial changes in any proposed actions or result in any new circumstances relevant to environmental concerns.

Impacts additional to or different from those previously evaluated would result from transportation of materials to implement this activity, such as movement of archive and scrap materials from the port to LANL. Some of the origins and destinations, hence the routes, would be different than previously evaluated, and the shipping packages, although also approved Type B packages, would be different. However, there would be fewer shipments of material than previously anticipated. The greater consequences estimated in this SA from the overland transport of plutonium oxide occurs because there would be more plutonium available for release in the extremely unlikely event of a transportation accident involving a breach of the Type B package. However, the frequency of this accident is extremely low, and therefore, the risk to the MEI is extremely small. Furthermore, the human health risk from transportation of the materials for fabrication of lead assemblies and transportation of lead assemblies to the reactor constitutes only about 1 percent of the total risk of the MOX fuel fabrication program, which in itself represents very little risk.

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7.0 DETERMINATION

The analyses in this SA indicate that the activities and potential environmental impacts associated with the proposed fabrication of lead assemblies in Europe as part of the MOX fuel fabrication program for surplus plutonium disposition are within the impacts evaluated in the *Storage and Disposition PEIS* and the SPD EIS. Fabricating lead assemblies at existing MOX fuel fabrication facilities in Europe would not constitute significant new circumstances or information relevant to environmental concerns and bearing on the previously analyzed action or its impacts either in the United States or affecting the global commons. Therefore, pursuant to 10 CFR 1021.314(c), no additional NEPA analyses are required in order to fabricate MOX fuel lead assemblies in Europe.

Issued in Washington, D.C., this 7th day of November, 2003.

Linton F. Brooks
Administrator
National Nuclear Security Administration

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