DOE/ID-10636

SUPPLEMENT ANALYSIS FOR A CONTAINER SYSTEM FOR THE MANAGEMENT OF DOE SPENT NUCLEAR FUEL LOCATED AT THE INEEL

March 1999

U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho

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ACRONYMS and ABBREVIATIONS

ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
ASF	Atmospheric Screening Factors
ATR	Advanced Test Reactor
BWR	Boiling Water Reactor
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE-ID	U.S. Department of Energy-Idaho Operations Office
DPCs	Dual Purpose Canisters
DRR	Domestic Research Reactor
EBRII	Experimental Breeder Reactor II
EIS	Environmental Impact Statement
FR	Federal Registry
FRR	Foreign Research Reactor
GHI	Gross Hazard Index
HEU	Highly Enriched Uranium
HI	Hazard Index
HLW	High Level Waste
ICPP	Idaho Chemical Processing Plant
INEEL	Idaho National Engineering and Environmental Laboratory
INEL	Idaho National Engineering Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
ISU	Idaho State University
KgHM	Kilograms of Heavy Metal
LWBR	Light Water Breeder Reactor

MPCs	Multi-Purpose Canisters
MTHM	Metric Tons of Heavy Metal
MTU	Metric Tons of Uranium
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NRAD	Neutron Radiography Facility
ORNL	OakRidge National Laboratory
PWR	Pressurized Water Reactor
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RSWF	Radioactive Scrap and Waste Facility
SA	Supplement Analysis
SAIC	Science Applications International Corporation
SNF	Spent Nuclear Fuel
SRS	Savannah River Site
SST	Stainless Steel
T&E	Test and Experimental
TMI-2	Three Mile Island-2
TRIGA	Training, Research, and Isotope Reactors Built by General Atomics
URR	University Research Reactor
ZPPR	Zero Power Physics Reactor

SUPPLEMENT ANALYSIS FOR A CONTAINER SYSTEM FOR THE MANAGEMENT OF DOE SPENT NUCLEAR FUEL LOCATED AT THE INEEL

SUMMARY

The Settlement Agreement (U.S. District Court 1995) signed by the State of Idaho, the U.S. Department of the Navy, and the U.S. Department of Energy in October 1995 states in Section F.4, “DOE and the Navy shall employ Multi-Purpose Canisters (“MPCs”) or comparable systems to prepare spent fuel located at INEL for shipment and ultimate disposal of such fuel outside Idaho.”

The Department of the Navy published a Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel (Navy Container System EIS) (U.S. Navy 1996) and two Records of Decision in fulfillment of its action under Section F.4 of the Settlement Agreement. The Department of Energy Idaho Operations Office (DOE-ID) has prepared this Supplement Analysis pursuant to the requirements of 40 CFR 1502.9(c) to determine whether further review under the National Environmental Policy Act is required in fulfillment of its responsibilities under Section F.4 of the Settlement Agreement.

The Proposed Action evaluated in this Supplement Analysis considers the use of a dual-purpose canister system, or comparable multi-purpose canister system, for the storage and ultimate shipment of DOE-ID spent nuclear fuel out of the State of Idaho. The evaluation of the Proposed Action considers the potential environmental impacts for (a) the manufacturing of canister systems, (b) loading and storage of spent nuclear fuel at the Idaho National Engineering and Environmental Laboratory (INEEL), (c) transportation of DOE-ID spent nuclear fuel for ultimate disposition outside Idaho, and (d) cumulative impacts. Impacts of the Proposed Action were compared to impacts previously evaluated in the DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (SNF & INEL EIS) (DOE 1995) and the Navy Container System EIS.

The results of the supplement analysis indicate that the potential environmental impacts for loading and storage of spent nuclear fuel at the INEEL, and transportation of DOE-ID spent nuclear fuel for ultimate disposition outside Idaho, are bounded by, or are approximately equal to, the impacts analyzed in the SNF & INEL EIS. Likewise, the cumulative impacts associated with these activities are also bounded by, or are approximately equal to, the cumulative impacts analyzed in the SNF & INEL EIS.

The potential environmental impacts associated with the manufacturing of canister systems are not bounded by previous analyses because the Proposed Action would result in the manufacture of additional containers above what was analyzed in the Navy Container System EIS. The incremental increase in environmental impacts would be approximately 95% of the impacts analyzed in the Navy Container System EIS. However, the cumulative impacts resulting from

the manufacturing of container systems would still be small and would not result in discernible environmental consequences.

The results of this Supplement Analysis indicate that the potential environmental impacts of using a dual-purpose canister system, or comparable multi-purpose canister system, to store and transport DOE-ID spent nuclear fuel are bounded by, or are reasonably comparable to, the impacts analyzed in the DOE SNF & INEL EIS and the Navy Container System EIS.

SUPPLEMENT ANALYSIS FOR A CONTAINER SYSTEM FOR THE MANAGEMENT OF DOE SPENT NUCLEAR FUEL LOCATED AT THE INEEL

1.0 Purpose and Proposed Action

1.1 Introduction

On June 1, 1995, the U.S. Department of Energy (DOE) published a Record of Decision (ROD) (60 FR 28680) for the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203-F (SNF & INEL EIS) (DOE 1995). In the ROD, the DOE and the U.S. Department of the Navy, as a cooperating agency, announced their decision regarding management of existing and reasonably foreseeable inventories of spent nuclear fuel (SNF) through the year 2035. Several weeks before the ROD was signed, the Governor of Idaho initiated a lawsuit to stop all shipments of SNF into the State of Idaho until he had a legally binding commitment from DOE that nuclear waste would leave Idaho.

In October 1995, the State of Idaho, the U.S. Department of the Navy, and the U.S. Department of Energy signed a Settlement Agreement (U.S. District Court 1995) to resolve the lawsuit filed by the Governor of Idaho. The Settlement Agreement established limits on shipments of SNF into Idaho, established a schedule by which all SNF would be removed from Idaho, and established a number of milestones to be accomplished by the DOE Spent Fuel Program. As a result of the Settlement Agreement, DOE issued an Amended ROD on March 8, 1996 (61 FR 9441) to reflect changes in the number of shipments of SNF to and from several DOE sites, and the resulting inventories at those sites.

One of the Settlement Agreement milestones established for the DOE Spent Fuel Program concerns container systems for the management of SNF at the Idaho National Engineering and Environmental Laboratory (INEEL). Section F.4 of the Settlement Agreement states: “DOE and the Navy shall employ Multi-Purpose Canisters (“MPCs”) or comparable systems to prepare spent fuel located at INEL for shipment and ultimate disposal of such fuel outside Idaho.”

In November 1996, the Department of the Navy published the Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel, DOE/EIS-0251 (Navy Container System EIS) (U.S. Navy 1996). In the first ROD resulting from this EIS published in January 1997, (62 FR 1095) the Navy and the DOE, as a cooperating agency, announced their decision regarding selection of a dual-purpose canister system for the loading, storage, transport, and possible disposal of naval SNF. These actions, in addition to the issuance of a second ROD regarding location of loading and dry storage facilities for naval SNF, completed the Navy’s action required under Section F.4 of the Settlement Agreement.

The Navy Container System EIS and its resulting RODs address only naval SNF located at the INEEL. To complete all actions required under Section F.4 of the Settlement Agreement, further National Environmental Policy Act (NEPA) evaluation is required to address the non-Navy DOE SNF located at the INEEL. DOE has prepared this Supplement Analysis (SA) to determine what further NEPA review may be required in fulfillment of its responsibilities under Section F.4 of the Settlement Agreement.

On September 1, 1998, the DOE Assistant Secretary for Environmental Management (EM) and the Director of the Office of Civilian Radioactive Waste Management (RW) signed a Memorandum of Agreement (MOA) for acceptance of DOE SNF for ultimate disposal at a geologic repository located outside the State of Idaho (DOE 1998). The Proposed Action described in this SA is consistent with the terms and conditions of this MOA.

1.2 Purpose

The Council on Environmental Quality (CEQ) regulations for implementing the NEPA, 40 CFR 1502.9 (c), directs federal agencies to prepare a supplement to an environmental impact statement 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 impacts."

When it is unclear whether a supplemental environmental impact statement is required, DOE regulations (10 CFR 1021.314) direct the preparation of a supplement analysis to assist in making that determination. This supplement analysis evaluates the impacts of employing dual-purpose canisters (DPCs) to prepare DOE SNF located at the INEEL for interim onsite storage and transport outside the State of Idaho. Impacts associated with DPC manufacturing, loading and storage of DOE-ID SNF into DPCs, transport of loaded DPCs outside Idaho, and the cumulative impacts are compared with the impacts previously analyzed in the SNF & INEL EIS and the Navy Container System EIS.

This SA provides information to determine whether:
(1) an existing EIS should be supplemented;
(2) a new EIS should be prepared; or
(3) no further NEPA documentation is required.

1.3 Proposed Action

Section F.4 of the Settlement Agreement states that DOE shall employ MPCs or comparable systems to prepare DOE-ID SNF for shipment out of Idaho. The Navy Container System EIS established that a DPC is a "comparable system" because it is similar to an MPC with the possible exception of its use as a disposal container. However, as discussed in the Navy Container System EIS, the design criteria for disposal containers have not yet been completely specified, so it is reasonable to assume that the DPC may also meet the disposal acceptance criteria, thus making the DPC an MPC. Therefore, the analyses presented in this SA are applicable to either DPCs or MPCs.

The Proposed Action evaluated in this SA considers the use of a DPC, or comparable MPC, for the storage and ultimate shipment of DOE-ID SNF out of the State of Idaho. For purposes of analysis, it is assumed that DOE-ID SNF will be shipped to a geologic repository or a centralized interim storage site located in Nevada. Because this analysis compares analyses for DOE-ID SNF with the analyses performed in the Navy Container System EIS, the DPC evaluated in this SA is similar to that analyzed in the Navy Container System EIS. The DOE National Spent Nuclear Fuel Program currently envisions use of standard canisters (see Glossary) for the storage and shipment of DOE-ID SNF. The analysis presented in this SA is intended to be sufficiently broad to encompass use of a large DPC, such as the one evaluated in the Navy Container System EIS, while also considering the use of the smaller standard canisters currently envisioned by the National Spent Nuclear Fuel Program.

For purposes of analysis, this SA describes models of DPC systems that could be used for the loading, storage and transport of DOE-ID SNF. The models and analyses are designed to be sufficiently broad to encompass a range of options, such as use of standard canisters, use of DPCs, and use of standard canisters in conjunction with DPCs. The models described in this SA do not prescribe any particular approach that DOE is obligated to implement; rather, the models establish bounding conditions for purposes of analysis under the National Environmental Policy Act. DOE may choose to implement systems similar to these models or other systems for the loading, storage and transport of DOE-ID SNF.

A commercial design, the NUHOMS-MP187® designed by Vectra[a] (VECTRA Fuel Services, 1995), was used in the Navy Container System EIS as the model DPC. The same design is used in the analyses in this SA with the exception that instead of using internal baskets to hold the SNF in place, this SA assumes that DOE-ID SNF is first sealed inside standard canisters which are then placed inside the DPC as shown in Figure 1. While DOE may ultimately choose to store and transport the standard canisters without use of the larger DPCs, the configuration shown in Figure 1 results in a conservative upper bound

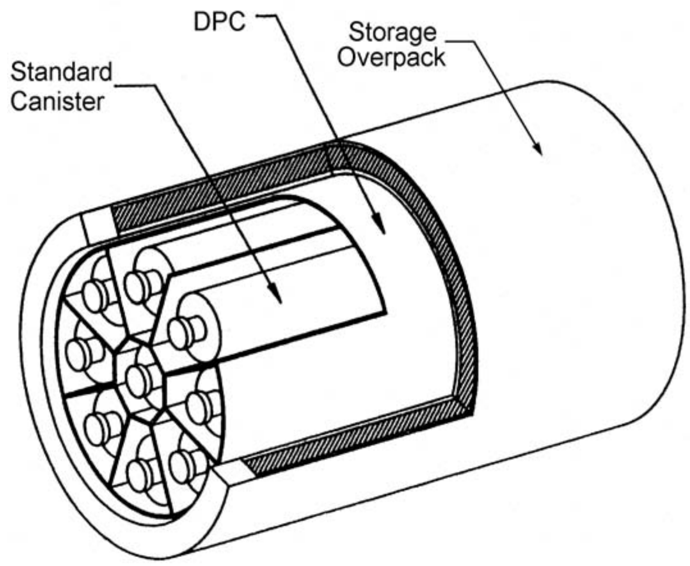

Figure 1. Overview of Standard Canister and DPC Configuration

[a] Vectra Technologies Inc. declared bankruptcy on October 2, 1997. Transnuclear Inc. acquired certain assets of Vectra Technologies Inc., including the NUHOMS and MP187 technologies on December 8, 1997.

on the potential manufacturing impacts. Similar DPCs or MPCs may become available in the future and any one of the available designs might be selected. However, the design requirements for any other canister that might be selected would be comparable to the DPC analyzed in this SA.

This SA evaluates the transportation of SNF by two modes: 100% rail and 100% truck. Rail is the preferred mode of transport for the type of DPC evaluated in this SA, although use of heavy haul trucks may be feasible for short distances. However, the use of truck transportation for the entire shipment route between INEEL and Nevada would not be feasible by heavy haul truck and would necessitate the use of canisters smaller than the NUHOMS-MP187® that could be transported by legal weight or over weight truck. Consequently, this SA evaluates different transportation models for rail and truck shipments.

Rail Model

Figure 2 depicts the overall process for storage, transport, and disposal of DPCs for the rail transportation model. This model was selected to establish bounding conditions for purposes of analysis under the National Environmental Policy Act. DOE may choose to implement systems similar to this model or other systems for the loading, storage and transport of DOE-ID SNF.

The rail transportation model assumes that DOE-ID SNF would be sealed inside standard canisters and loaded into DPCs at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly known as the Idaho Chemical Processing Plant (ICPP). If the SNF were to be stored prior to shipment, each DPC would be placed into a storage overpack or facility designed to provide shielding and other characteristics needed for safe storage. When a geologic repository or centralized interim storage site is ready to accept the SNF, the DPCs would be removed from the storage system and be placed into transportation overpacks which would satisfy shielding, structural strength, and other requirements for shipment.

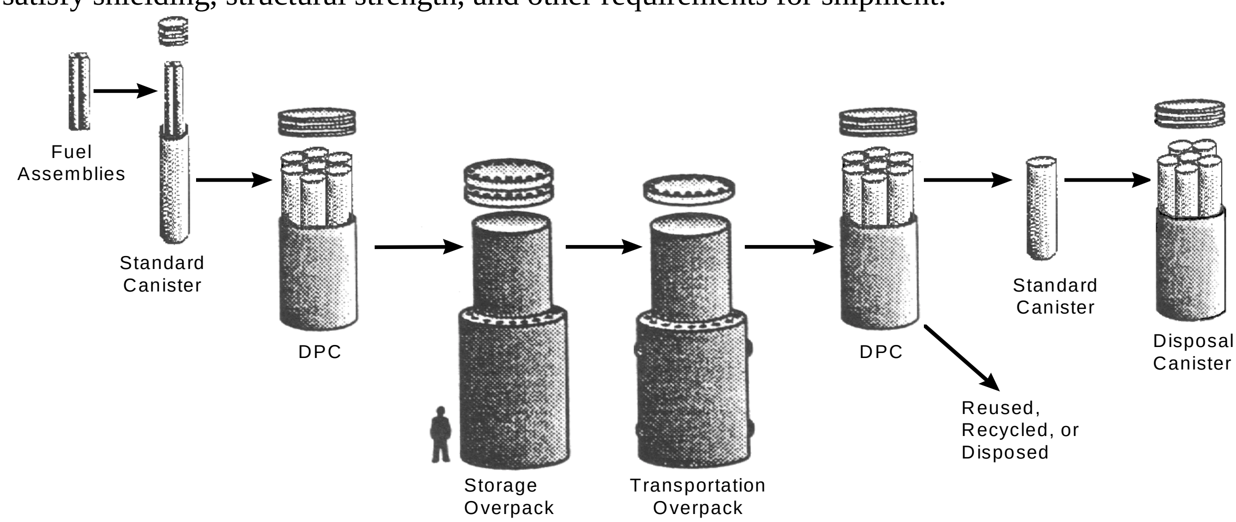

Figure 2. Storage, Transport, and Disposal for the Dual-Purpose Canister System Rail Transportation Model

Although disposal is not included within the scope of this SA, for completeness Figure 2 also shows the process that would take place when the DPCs arrive at a repository. At a repository the individual standard canisters would be removed from the DPCs and transferred to disposal containers to be prepared for placement in a repository. The transportation overpacks would be returned to the INEEL for reuse, recycled, or disposed. As previously discussed, design criteria for disposal containers have not yet been completely specified, so it is reasonable to assume that the DPC may also meet the disposal acceptance criteria, thus making the DPC an MPC. In this event, the standard canisters would not be removed from the MPC at the repository, and the MPC would function as a disposal container.

It is anticipated that most, but not all, of the DOE-ID SNF located at the INEEL would be prepared for offsite shipment using DPCs, MPCs, or comparable systems. A small fraction of the SNF (10% or less) may be suitable for shipment using existing transportation casks which have been approved in accordance with Nuclear Regulatory Commission and U.S. Department of Transportation requirements. However, to assess the upper bound of potential impacts associated with the use of DPCs, it is assumed that all DOE-ID SNF located at the INEEL will be prepared for offsite shipment using DPCs. This assumption is made for assessment purposes only and does not preclude DOE’s option to utilize existing transportation casks for a small fraction of the SNF inventory located at the INEEL.

Truck Model

Figure 3 depicts the overall process for storage, transport, and disposal of DOE-ID SNF for the truck transportation model. This model was selected to establish bounding conditions for purposes of analysis under the National Environmental Policy Act. DOE may choose to implement systems similar to this model or other systems for the loading, storage and transport of DOE-ID SNF.

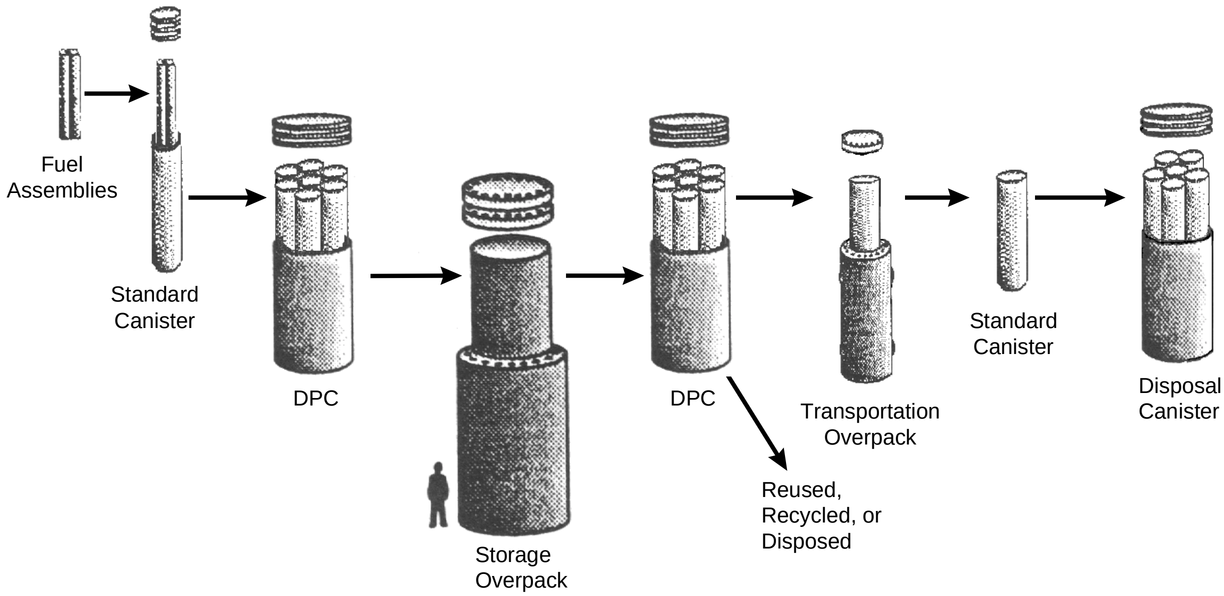

Figure 3. Storage, Transport, and Disposal of DOE-ID SNF for the Truck Transportation Model

The truck transportation model differs from the rail transportation model only in how transport of the SNF is accomplished. As in the rail model, the truck model assumes that DOE-ID SNF would be sealed inside standard canisters and loaded into DPCs for interim storage at INTEC. When a geologic repository or centralized interim storage site is ready to accept the SNF, the standard canisters would be removed from the storage overpacks and DPCs and placed into transportation overpacks for shipment.

The transportation overpacks would be designed to hold a single standard canister and would be of two designs: an overpack designed for 10-foot long standard canisters and an overpack designed for 15-foot standard canisters. It is anticipated that the 10-foot long standard canisters could be shipped by legal weight truck, while the 15-foot standard canisters would require use of an over weight truck.

At a repository the standard canisters would be removed from the transportation overpacks and transferred to disposal containers to be prepared for placement in a repository. The transportation overpacks would be returned to the INEEL for reuse, recycled, or disposed.

A small fraction of the SNF located at the INEEL, specifically commercial pressurized-water reactor (PWR) fuel assemblies, may not be transportable by truck using this transportation model due to weight restrictions. It is anticipated that this SNF would be shipped using existing transportation casks which have been approved in accordance with Nuclear Regulatory Commission and U.S. Department of Transportation requirements.

2.0 Analysis of Environmental Impacts

2.1 Manufacturing Canister Systems

The Navy Container System EIS provides the baseline data from which manufacturing impacts were derived for the Proposed Action. Chapter 4.0 of the Navy Container System EIS discusses the methodology and assumptions used to estimate impacts from a variety of container systems, including a dual-purpose canister system. A summary of the methodology is provided here, and a more detailed description can be found in the Navy Container System EIS. Environmental impacts from the manufacture of the canister systems for the Proposed Action are estimated based on the impacts from the manufacture of similar canister systems documented in the Navy Container System EIS.

The evaluation of manufacturing impacts focuses on ways in which manufacturing the canister systems could affect environmental attributes and resources at a representative manufacturing site. The assessment is not site-specific because the ultimate location or locations of facilities chosen to manufacture hardware components is not known. To perform the assessment, the Navy Container System EIS defined a representative manufacturing site based on five facilities that currently produce casks, canisters, and related hardware for the management of SNF. The operations of the five manufacturing facilities were used as the basis for the assessment of manufacturing impacts on air quality, health and safety, waste generation, and socioeconomics. Impacts on material use were based on the quantity of materials used for fabrication of each hardware component using information provided by existing manufacturers.

For purposes of analysis, it was assumed that the major components required for the DOE-ID canister systems would be similar to the DPC system described in the Navy Container System EIS, i.e., DPCs, storage overpacks, transportation overpacks, and disposal containers. In addition, the DOE-ID canister systems would include standard canisters. A brief description of these hardware components is provided below. With the exception of the standard canisters, the hardware components are modeled after those described in the Navy Container System EIS. The DOE-ID canister systems described in this SA are models for analysis; the canister systems ultimately chosen by DOE may differ from these models.

Standard canisters would likely be cylinders made from stainless steel, sized to accommodate the range of SNF types stored at the INEEL. Currently, four standard canister designs are under consideration (18 or 24 inches in diameter; 10 or 15 feet in length). After the SNF is placed inside the canister, a stainless steel lid would be welded over the open end to seal the canister.

DPCs would likely be cylinders made from stainless steel. After inserting the standard canisters containing the SNF, a shield plug would be placed over the open end and a stainless steel inner lid would be welded in place over the shield plug to close the DPC. A spacer would be placed over the inner lid and a stainless steel outer lid would be welded to the DPC.

Storage overpacks, also referred to as storage vaults, would consist of large concrete and steel structures designed to hold sealed DPCs during periods of dry storage. Either horizontal or vertical dry storage systems could be used.

Transportation overpacks would likely consist of inner and outer cylindrical shells made from stainless steel, sized to accommodate DPCs or standard canisters, as appropriate. Lead or depleted uranium would be formed and inserted between the two shells to provide gamma shielding. With the DPC or standard canister inserted, shield plugs would be placed over the open end and the cover plate bolted on. Large removable impact limiters made of wood, plastic foam, aluminum honeycomb, or other crushable, impact-absorbing material would be placed over the ends to protect the overpack and its contents during transportation.

Disposal containers would be made of stainless steel or other corrosion-resistant material and manufactured in the same general manner as DPCs. For added longevity, an outer cylindrical steel container of slightly larger dimensions would be manufactured, the loaded inner container would be placed into the outer container, and a steel cover plate would be welded to the open end of the outer container as a final closure and seal of the contents. (Note: Impacts associated with disposal of DOE-ID SNF are not within the scope of this SA. However, the Navy Container System EIS included manufacturing impacts for disposal containers in a manner that is not readily broken out from impacts of other hardware components. Because the Navy Container System EIS is used as the basis for estimating manufacturing impacts for the Proposed Action in this SA, the impacts of manufacturing disposal containers are also included.)

Table 2.1 identifies the hardware requirements for implementation of a DPC system for the DOE-ID SNF located at the INEEL. Naval hardware requirements are also shown as the basis for a comparative analysis. The DOE-ID hardware requirements were determined by first estimating the number of standard canisters and DPCs needed for the DOE-ID SNF inventory (see Appendix A). The number of storage overpacks are estimated to be the same as the number of DPCs because most of the anticipated DOE-ID SNF inventory is already in interim storage at INEEL, and all of it is expected to be placed in the DPC storage system before shipments to a repository are begun. The number of transportation overpacks were estimated based on the ratio of transportation overpacks to DPCs in the Navy Container System EIS (i.e., 18/345). The number of disposal containers are assumed to be equal to the number of DPCs.

DOE-ID hardware requirements are similar for both the rail and truck transportation models. The only difference in hardware requirements for the two models is in the number and size of transportation overpacks required. For the rail model, approximately 12 transportation overpacks would be needed based on the ratio of transportation overpacks to DPCs in the Navy Container System EIS. For the truck model, more transportation overpacks may be needed, but they would be smaller in size to meet the load limits for truck transportation. A transportation overpack for rail would weigh approximately 110 tons compared to approximately 35 tons for a truck transportation overpack. Therefore, on a mass basis, one rail transportation overpack would be the equivalent of three truck transportation overpacks. The 12 transportation overpacks shown for DOE-ID SNF in Table 2.1 are considered to be bounding on a mass basis for both rail and truck models because it is anticipated that fewer than 36 transportation overpacks would be needed to implement the truck transportation model.

Table 2.1. Hardware Requirements for Implementing Use of Dual-Purpose Canister System for Naval and DOE-ID SNF

Hardware Component	Total Life of Project Requirement		
	Naval SNF[a,b]	**DOE-ID SNF**	**Total Naval and DOE-ID SNF**
Standard canisters	None	1,485[c]	1,485
DPCs	345	227[d]	572
Storage overpacks	173	227	400
Transportation overpacks	18	12	30
Disposal containers[e]	360	227	587

a. Source: Dept. of Navy, 1996. Includes naval SNF and special case waste.
b. Assumes a repository or centralized interim storage site will be available by 2010.
c. The number and type of standard canisters needed for the DOE-ID SNF inventory is estimated in Appendix A.
d. The number of DPCs needed for the DOE-ID SNF inventory is estimated in Appendix A.
e. Impacts associated with disposal of DOE-ID SNF are not within the scope of this SA. However, disposal containers are included in this table because they were included in the Navy Container System EIS which is used as the basis for estimating manufacturing impacts for the Proposed Action in this SA.

The environmental impacts associated with the manufacture of a dual-purpose canister system for DOE-ID SNF were estimated based on the analysis performed for naval SNF in the Navy Container System EIS. Chapter 4.0 of the Navy Container System EIS contains a complete description of the methodology used to estimate the impacts from DPC manufacturing. Impacts resulting from the manufacture of the DOE-ID hardware components listed in Table 2.1 were estimated by applying a scaling factor of 0.95 to the impacts estimated in the Navy Container System EIS for Navy hardware components.

The scaling factor of 0.95 is based upon the ratio of DOE-ID hardware components to naval hardware components plus an additional factor to account for the manufacture of the DOE-ID standard canisters. In Table 2.1, the naval hardware components sum to a total of 896 units; the DOE-ID hardware components (excluding standard canisters) sum to a total of 693 units. In Appendix A it is shown that the volume for the materials of construction for the 1,485 standard canisters is 70% of the volume for the 227 DPCs. Therefore, from a materials standpoint, the

1,485 standard canisters are equivalent to about 159 DPCs (0.7 x 227). Adding these 159 equivalent DPC units to the previous sum of 693 units for DOE-ID hardware results in 852 units when standard canisters are included. The ratio of DOE-ID hardware components to naval hardware components is 852/896, or 0.95.

2.1.1 Findings

The results of the impact analysis for manufacture of the DPC system are summarized in Table 2.2. Overall impacts for manufacture of the DOE-ID hardware components are approximately the same as those for the Navy DPC system. The environmental impacts of manufacturing the required hardware components would be small for both the Navy and DOE-ID DPC systems.

The estimated air emissions in Table 2.2 are typical of the small environmental impacts that would be involved in the manufacturing of these DPC systems. For example, volatile organic compounds and nitrogen oxides are released from these manufacturing processes into the local atmosphere. Volatile organic compounds and nitrogen oxides are also released to the atmosphere by other manufacturers in the same locality. Based on data contained in the Navy Container System EIS, the maximum contribution of the DPC system manufacturer in a peak year to the total contributions of all manufacturers in an average year is estimated to be only 0.003% for the volatile organic compounds and 0.0003% for nitrogen oxides. This indicates that the air emissions from manufacturing DPC system components would be a small part of the prevailing totals. The impacts on air quality, health and safety, material use, waste generation, and socioeconomics are similarly small for both the Navy DPC system and the DOE-ID DPC system.

The impacts from manufacture of the DOE-ID DPC system components are in addition to the impacts from manufacture of the Navy DPC system components. Therefore, the total impacts for the manufacturing of both the Navy and DOE-ID DPC systems are about two times greater than the impacts analyzed in the Navy Container System EIS. Even considering this doubling effect, the impacts on air quality, health and safety, material use, waste generation, and socioeconomics are small for the combined Navy and DOE-ID DPC systems.

2.2 Loading and Storage at INEEL

The baseline for assessment of impacts from loading and storage of DOE-ID SNF at the INEEL is established by the analyses for the Dry Fuel Storage Facility; Fuel Receiving, Canning/Characterization, and Shipping project in the SNF & INEL EIS (Volume 2, Appendix C). To assess impacts from loading and storage of DOE-ID SNF under the Proposed Action, this SA compares the loading and storage activities required for the Proposed Action to the activities evaluated in the SNF & INEL EIS to determine if the Proposed Action is within the envelope evaluated by the SNF & INEL EIS.

Table 2.2. Comparative Analysis of Manufacturing Potential Impacts for Use of a Dual-Purpose Canister System

Parameter	Potential Impacts from Manufacturing		
	Naval SNF[a]	**DOE-ID SNF**[b]	**Total Naval and DOE-ID SNF**
Air emissions (total, tons)			
Volatile organic compounds	2.6	2.5	5.1
Nitrogen oxides	3.4	3.2	6.6
Industrial accident fatalities			
(total numbers)	0.022	0.021	0.043
Material use (total as % U.S. annual production)			
Steel	0.019	0.018	0.037
Chromium[c]	0.18	0.17	0.35
Nickel	0.052	0.049	0.101
Lead	0.15	0.14	0.29
Waste generated (Annual average, tons)			
Liquid	0.16	0.15	0.31
Solid	0.022	0.021	0.043
Socioeconomics (% change over local baseline)			
Annual average output	0.04	0.038	0.078
Annual average income	0.04	0.038	0.078
Annual average employment	0.03	0.029	0.059

a. Source: Dept. of Navy, 1996. Includes naval SNF and special case waste.
b. Impacts derived from Navy-estimated impacts using scaling factor of 0.95.
c. Compared with the Federal Strategic and Critical Inventory.

The Dry Fuel Storage Facility; Fuel Receiving, Canning/Characterization, and Shipping project was one of the INEEL SNF Program activities implemented by the ROD for the SNF & INEL EIS. This multi-functional project will accommodate receipt and storage of the various SNF types currently in inventory at the INEEL and the fuels projected to be received at the INEEL under terms of the Amended ROD. The project consists of two major facilities that will be integrated but that can be constructed in phases. One facility is the Fuel Receiving, Canning/Characterization, and Shipping Facility. The second facility is the Dry Fuel Storage Facility consisting of a modular aboveground dry storage system. A complete description of the project is contained in Volume 2, Appendix C, of the SNF & INEL EIS.

Both facilities were proposed to be located at INTEC. The two facilities of this project would perform the following functions:

- Receive fuel shipping casks from various INEEL and offsite locations;
- Unload fuel casks into a dry hot cell;
- Inspect, dry, characterize, can, seal and test canisters of fuel;
- Load canned fuel into dry storage canisters;
- Transport dry storage canisters to the Dry Fuel Storage Facility;
- Retrieve dry storage canisters from the Dry Fuel Storage Facility;
- After interim storage, prepare the fuel canisters for transport from the facility to a permanent disposal facility or to another facility for additional conditioning prior to disposal in a repository; and
- Monitor storage conditions as required.

Volume 2, Appendix C, of the SNF & INEL EIS summarized the potential environmental impacts of the construction and operation of the project. The environmental impacts for the Dry Fuel Storage Facility were based on a facility sized to accommodate 1,500 dry storage canisters of similar size to the dual-purpose canisters evaluated in this SA (Hale 1994). Therefore, the potential environmental impacts of the construction and operation of facilities to load and store SNF in dual-purpose canisters can be estimated from the impact analysis performed in the SNF & INEL EIS.

Table 2.1 shows that 227 dual-purpose canisters would be needed to store the DOE-ID spent fuel inventory located at the INEEL. This number of canisters would be required for either the rail or truck transportation models and is only 15% (227/1500) of the number of dry storage canisters estimated for sizing of the Dry Fuel Storage Facility in the SNF & INEL EIS. Therefore, the storage facility needed to store 227 DPCs would be expected to be only about 15% of the size of the facility evaluated in the SNF & INEL EIS. However, the Fuel Receiving, Canning/Characterization, and Shipping facility is an operational facility as opposed to a storage facility, so it is anticipated that this portion of the project would be of comparable size to the facility evaluated in the SNF & INEL EIS.

2.2.1 Findings

Table 2.3 summarizes the analysis of spent fuel loading activities for the SNF & INEL EIS and the Proposed Action. The spent fuel loading facility required to implement the Proposed Action would be no larger than, and likely smaller than, the facility proposed in the SNF & INEL EIS; therefore, the impacts of the Proposed Action are bounded by the SNF & INEL EIS.

Table 2.4 summarizes the analysis of spent fuel storage activities for the SNF & INEL EIS and the Proposed Action. The environmental impacts estimated in Volume 2, Appendix C, of the SNF & INEL EIS for the Dry Storage Facility are not directly scalable, but it can be concluded that these impacts, based on a facility designed to store 1,500 dry storage canisters, establish an upper bound on the impacts that would be expected from the storing of 227 DPCs under the Proposed Action.

Based on the results shown in Tables 2.3 and 2.4, the overall environmental impacts associated with the loading and storage of DOE-ID SNF in DPCs at the INEEL are bounded by the analyses performed in the SNF & INEL EIS.

2.3 Transportation of DOE-ID SNF

In this section, the transportation impacts evaluated in the SNF & INEL EIS (referred to as the baseline) are compared to the transportation impacts of the Proposed Action. As in the SNF & INEL EIS, transportation impacts are composed of incident-free impacts and the impacts from transportation accidents. The impacts of both radiological accidents and nonradiological accidents (traffic fatalities) are evaluated. The baseline used in this SA consisted of shipments to the INEEL for SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type, and the shipments from the INEEL for SNF & INEL EIS Alternative 5E, Centralization in Nevada. Alternative 4A served as the basis for the ROD for the SNF & INEL EIS. Alternative 5E is the alternative evaluated in the SNF & INEL EIS that provides a suitable baseline for evaluating the transport of DOE-ID SNF to a geologic repository located in Nevada.

The shipments for the Proposed Action are the SNF shipments to the INEEL outlined in the Amended ROD for the SNF & INEL EIS, and the number of canisterized SNF shipments necessary to move all DOE-ID SNF out of Idaho. The canisterized SNF shipments are based on the shipments of existing SNF at the INEEL and shipments of SNF scheduled to be shipped to the INEEL based on the Amended ROD, and represent removing all SNF from the INEEL. It should be noted that the shipments for the baseline and the Proposed Action consisted only of shipments to or from the INEEL; shipments that did not originate or terminate at the INEEL were not included in either the baseline or the Proposed Action. Appendix A provides the details on how the canisterized SNF shipments were estimated. Appendix B provides details on how the remainder of the shipments were estimated. As in the SNF & INEL EIS, shipments by both rail and truck were analyzed and it was assumed that a single transportation overpack was equivalent to a shipment.

Table 2.3. Comparative Analysis of Spent Fuel Loading Impacts

Impact Area	Potential impact: SNF & INEL EIS[a]	Potential impact: Proposed Action
Geology and soil	None (no disturbed acreage)	See footnote e
Water resources	Construction: minimal water usage Operation: no information Effluent: construction water	
Wildlife and habitat	None	
Historic, archaeological, or cultural resources	None	
Air resources	Radiological operational emissions: 3.2×10^{-3} % of NESHAP[b] dose limit[c,d] Toxic Air Pollutants: None Prevention of Significant Deterioration: None	
Human health	Radiation exposures and cancer risk Maximally exposed individual: 3.2×10^{-4} mrem/yr 1.6×10^{-10} latent cancer fatalities/yr 80-km (50-mile) population: 2.0×10^{-3} person-rem/yr[d] 1.0×10^{-6} latent cancer fatalities/yr Nonradiological effects: No emissions	
Transportation	Construction (onsite truck trips): Nonradiological – 1 Operation (truck trips per year) Nonradiological – 13.3 onsite Radiological – 6.0 onsite SNF – 272 onsite – 272 offsite	
Waste management	Construction (m^3): Industrial waste – 37.5 Operation (m^3/yr): Low-level waste – 220 Industrial – 490	
Socioeconomic conditions	Construction: 100 subcontract workers Operation: 20 existing workers	

a. Impacts from Table C-4.1.4-2, Volume 2, Appendix C, SNF & INEL EIS.
b. NESHAP – National Emission Standards for Hazardous Air Pollutants.
c. NESHAP dose limit is 10 mrem per year to any member of the public located offsite of INEEL.
d. Includes dose associated with the storage segment of this project specified in Table 2.4.
e. The spent fuel loading facility required to implement the Proposed Action would be no larger than, and likely smaller than, the facility proposed in the SNF & INEL EIS; therefore, the impacts analyzed within this Supplement Analysis are bounded by the SNF & INEL EIS.

Table 2.4. Comparative Analysis of Spent Fuel Storage Impacts

Impact Area	Potential Impact: SNF & INEL EIS[a]	Potential Impact: Proposed Action
Geology and soil	Disturbs 18.5 acres of previously disturbed soil	See footnote e
Water resources	Construction: water usage Effluent: construction water	See footnote e
Wildlife and habitat	Minimal short-term impact on biodiversity, productivity, and animal displacement and mortality within major facility area	See footnote e
Historic, archaeological, or cultural resources	Unknown number of sites	See footnote e
Air resources	Radiological operational emissions: 3.2×10^{-3} % of NESHAP[b] dose limit[c,d] Toxic Air Pollutants: None Prevention of Significant Deterioration: None	See footnote e
Human health	Radiation exposures and cancer risk Maximally exposed individual: 3.2×10^{-4} mrem/yr 1.6×10^{-10} latent cancer fatalities/yr 80-km (50-mile) population: 2.0×10^{-3} person-rem/yr[d] 1.0×10^{-6} latent cancer fatalities/yr Nonradiological effects: No emissions	See footnote e
Transportation	Construction (onsite truck trips): Nonradiological – 1 Operation (truck trips per year) Nonradiological – 1 onsite Radiological – 1 onsite	See footnote e
Waste management	Construction (m^3): Industrial waste – 37.5 Operation (m^3/yr): Low-level waste – 5 Industrial – 10	See footnote e
Socioeconomic conditions	Construction: 50 subcontract workers Operation: 15 existing workers	See footnote e

a. Impacts from Table C-4.1.4-1, Volume 2, Appendix C, SNF & INEL EIS, based on 1,500 dry storage canisters.
b. NESHAP – National Emission Standards for Hazardous Air Pollutants.
c. NESHAP dose limit is 10 millirem per year to any individual member of the public located offsite of INEEL.
d. Includes dose associated with loading activities specified in Table 2.3.
e. Dry storage container requirements 15% of those estimated in SNF & INEL EIS; therefore, the impacts analyzed within this Supplement Analysis are bounded by the SNF & INEL EIS.

For the analysis of transportation impacts, there are incident-free impacts and accident impacts. Incident-free impacts are primarily a function of the external dose rate from the shipping container (Transportation Index), routing (which includes distances and population densities), and the number of shipments. The transportation analyses performed for the DOE SNF & INEL EIS assumed an external dose rate at the regulatory maximum (10 mrem/hr @ 2 meters); for the Proposed Action the external dose rate would be no greater than the regulatory maximum. However, there could be small differences between the doses calculated in the SNF & INEL EIS and the doses for the Proposed Action due to slightly different container sizes. It is also assumed that the routing of shipments and the population densities along the routes would be similar to that analyzed in the SNF & INEL EIS. Therefore, the key factor for assessing whether impacts from the Proposed Action are bounded by existing analyses is the number of shipments. To determine if the impacts of incident-free transportation for the Proposed Action are bounded by existing analyses, it is necessary only to estimate the number of shipments and compare that number to the shipments analyzed in the SNF & INEL EIS.

Transportation accident impacts can be radiological (involving release of radioactive material) or nonradiological (physical impacts resulting in injuries or fatalities). Nonradiological impacts are independent of the cargo and depend primarily on routing, accident rates for the selected routes, and number of shipments. The SA assumes that routing and accident rates are similar to those analyzed in the SNF & INEL EIS, so the key factor for assessing nonradiological transportation accident impacts is the number of shipments. Therefore, to determine the impacts of non-radiological traffic accidents, the SA needs only to estimate the number of shipments for the Proposed Action and compare that number to the shipments analyzed in the SNF & INEL EIS.

Radiological impacts from transportation accidents are more complicated because the impacts depend on the physical/chemical/radiological characteristics of the cargo, routing, number of shipments, accident severity, release fractions, atmospheric dispersion, population densities, and other pathway factors. The SA makes a number of simplifying assumptions to minimize the amount of new analysis. The cargo is the same SNF that was analyzed in the SNF & INEL EIS, with two principal differences: (1) the radioactivity of SNF already in storage is lower as a result of an additional 20 years of decay (1995-2015), and (2) the quantity of SNF per shipment is different because of different container types. All other factors affecting transportation accidents, with the exception of shipment counts, are assumed to be similar to those used in the SNF & INEL EIS. For example, the atmospheric dispersion characteristics, release fractions, routing, accident rates, population densities, and exposure pathways were assumed to be the same for the Proposed Action and the baseline shipments.

Transportation accident risk is the product of probability and consequences. The probability of a transportation accident is a function of the accident rate for the selected routes, the conditional probability associated with accident severity, and the number of shipments. The SA assumes the same routes, accident rates, and conditional probabilities as used in the SNF & INEL EIS. Therefore, the number of shipments is the only variable affecting accident probability. If the number of shipments for the Proposed Action is less than, or approximately equal to, the number of shipments analyzed in the SNF & INEL EIS, then the transportation accident probability for the Proposed Action will be less than, or approximately equal to, the transportation accident probability analyzed in the SNF & INEL EIS.

Transportation accident consequences are a function of the amount and type of radioactivity being shipped, the release fraction (which varies by nuclide and accident severity), atmospheric dispersion conditions, population density, and other pathway factors. The SA assumes all these factors are the same as in the SNF & INEL EIS with the exception of the amount and type of radioactivity being shipped. As discussed earlier, the radioactivity content of the shipments for the Proposed Action has changed compared to the SNF & INEL EIS as a result of radioactive decay and use of different container types. To determine if accident consequences are bounded by existing analysis, an analytical tool known as the hazard index was used. The hazard index is simply a screening tool to compare the relative hazard of two radionuclide distributions. The higher the value of the hazard index, the higher is the relative hazard. Therefore, if the hazard index for SNF shipped under the Proposed Action is less than, or approximately equal to, the hazard index for the same SNF type evaluated in the SNF & INEL EIS, then the consequences of a transportation accident for the Proposed Action are bounded by the consequences evaluated in the SNF & INEL EIS. This methodology was selected because it is an effective method for relative comparison of accident risk and requires less time than a detailed transportation accident risk analysis.

Appendix B provides a detailed description of the determination of shipment counts and the calculations of shipment radioactivity inventories and hazard indixes.

2.3.1 Findings for Incident-Free Transportation

Radiation doses during normal, incident-free transportation of SNF result from exposures to the external radiation field surrounding the shipping containers. The radiation dose is a function of the number of shipments, the intensity of the radiation field, the number of people exposed, and duration of their exposure. The SNF & INEL EIS conservatively assumed that the intensity of the radiation field surrounding the SNF shipping containers would be the regulatory maximum, 10 mrem/hr at 2 meters from the container.

In this SA, it was also assumed that the radiation field was at the regulatory maximum, because several of the shipping containers that would be used to transport the SNF have not yet been designed. However, there could be small differences between the doses calculated in the SNF & INEL EIS and the doses for the Proposed Action due to slightly different container sizes. Therefore, the comparison for incident-free transportation will be based on the number of shipments, because the total impact to the population from incident-free transportation is directly proportional to the number of shipments.

The shipments for the baseline and the Proposed Action are listed in Table 2.5.a. It can be seen that the number of SNF shipments to the INEEL for the baseline ranged from 437 to 1363 while the number of shipments to INEEL for the Proposed Action ranged from 353 to 558. In addition, the number of shipments from the INEEL for the baseline ranged from 263 to 1536 while the number of canisterized SNF shipments from the INEEL to a geologic repository for the Proposed Action ranged from 227 to 1597.

To facilitate presentation of the results, Table 2.5.b shows the shipment ratios for the baseline and the Proposed Action with the baseline shipment counts normalized to 1.00. If the shipment ratio for the Proposed Action is less than 1.00, it may be concluded that the number of shipments and the incident-free impacts evaluated in the SNF & INEL EIS bound the shipments and impacts of the Proposed Action. This is seen to be the case for truck and rail shipments to the INEEL with shipment ratios of 0.41 and 0.81, respectively, and for rail shipments from the INEEL with a shipment ratio of 0.86.

Table 2.5.a. Shipments for the Baseline and the Proposed Action

	Baseline[a]		**Proposed Action[b]**	
Scenario	**Truck Shipments**	**Rail Shipments**	**Truck Shipments**	**Rail Shipments**
Shipments to the INEEL	1363	437	558	353
Shipments from the INEEL	1536	263	1597	227

a. The baseline used in this SA consisted of shipments to the INEEL for SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type, and the shipments from the INEEL for SNF & INEL EIS Alternative 5E, Centralization in Nevada.
b. The shipments for the Proposed Action are the shipments outlined in the Amended ROD for the SNF & INEL EIS and the number of canisterized SNF shipments necessary to move all DOE-ID SNF to a geologic repository.

Table 2.5.b. Shipment Ratios for the Baseline and the Proposed Action

	Baseline[a]		**Proposed Action[b]**	
Scenario	**Truck Shipments**	**Rail Shipments**	**Truck Shipments**	**Rail Shipments**
Shipments to the INEEL	1.00	1.00	0.41	0.81
Shipments from the INEEL	1.00	1.00	1.04	0.86

a. The baseline used in this SA consisted of shipments to the INEEL for SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type, and the shipments from the INEEL for SNF & INEL EIS Alternative 5E, Centralization in Nevada.
b. The shipments for the Proposed Action are the shipments outlined in the Amended ROD for the SNF & INEL EIS and the number of canisterized SNF shipments necessary to move all DOE-ID SNF to a geologic repository.

However, for truck shipments from the INEEL, the shipment ratio for the Proposed Action is 1.04, or 4 percent larger than the number of truck shipments evaluated in the SNF & INEL EIS. A 4 percent increase in the number of shipments or impacts is extremely small and would not appreciably increase the overall risk to public health and safety. In addition, if a mixture of truck and rail shipments were used to move canisterized SNF to a geologic repository, a relatively small number of rail shipments (less than 20) would be required to offset the 4 percent increase in truck shipments.

Based on these analyses, the number of incident-free cancer fatalities estimated for the baseline would be greater than or approximately equal to the number of incident-free cancer fatalities estimated for the Proposed Action.

2.3.2 Findings for Traffic Fatalities

Traffic fatalities during transportation are dependent on the number of shipments, the routes traveled, and the accident rate. For this SA, the routes traveled and accident rates for the baseline and the Proposed Action would be the same but not additive, so the number of shipments was used as the measure of impact for the number of traffic fatalities.

The shipments for the baseline and the Proposed Action are listed in Table 2.5.a, and the shipment ratios are shown in Table 2.5.b. As with the incident-free impacts discussed in Section 2.3.1, the shipment ratios for the Proposed Action are less than 1.00, except for truck shipments from the INEEL with a ratio of 1.04. Based on these analyses, the number of traffic fatalities estimated for the baseline would be greater than or approximately equal to the number of traffic fatalities estimated for the Proposed Action.

2.3.3 Findings for Radiological Accident Risk

Radiological accident risk is the product of probability and consequence. Accident consequences associated with shipping of SNF are dependent on the total radiological hazard of the SNF. The total radiological hazard of the SNF is in turn dependent on the amount and radiotoxicity of the radioactivity contained in the SNF. In order to quantify the total radiological hazard, a hazard index was developed that was based on the total radioactivity and radiotoxicity of the SNF to be shipped. The hazard index was used to compare impacts because radiological accident consequences are directly proportional to the radiological hazard associated with the SNF. Hazard indices were calculated for the baseline shipments and the shipments associated with the Proposed Action.

Table 2.6 contains the results of the total hazard index analyses. To facilitate presentation of the results, the total hazard index for the baseline case has been normalized to 1.00, and the hazard index results for the Proposed Action are shown in ratio to the baseline case. The total hazard index does not depend on shipment mode, because the total inventory shipped over the entire campaign is the same, regardless of the shipment mode. For SNF shipments to the INEEL, Table 2.6 shows that the total hazard index for the Proposed Action is 25% of the total hazard index for the baseline. For SNF shipments from the INEEL, the total hazard index for the Proposed Action is 40% of the total hazard index for the baseline. Since the hazard index of the baseline shipments is greater than the total hazard index of the shipments associated with the Proposed

Action, the radiological hazard of the baseline shipments is also greater than the radiological hazard of the shipments associated with the Proposed Action.

Previous discussion of methodology established that a relative comparison of transportation accident probability can be made based on a comparison of the number of shipments, given that all other relevant factors are approximately the same. Based on the shipment ratios presented in Table 2.5.b, it can be concluded that the probability of transportation accidents for the baseline would be greater than, or approximately equal to, the probability for the Proposed Action. An estimate of radiological accident risk, i.e., the product of probability and consequence, can be made by multiplying the shipment ratios in Table 2.5.b by the hazard indices in Table 2.6.

The resulting estimates of radiological accident risk are shown in Table 2.7. For SNF shipments to the INEEL, Table 2.7 shows that the radiological accident risk for the Proposed Action is 10% of the baseline risk for truck shipments and 20% of the baseline risk for rail shipments. For SNF shipments from the INEEL, the radiological accident risk for the Proposed Action is 42% of the baseline risk for truck shipments and 34% of the baseline risk for rail shipments. From these results, it is concluded that the radiological impacts of transportation accidents evaluated in the SNF & INEL EIS bound the impacts of the Proposed Action.

Table 2.6. Radiological Hazard for the Baseline and the Proposed Action

	Baseline[a]		**Proposed Action[b]**	
	Total Radiological Hazard Index		**Total Radiological Hazard Index**	
Scenario	**(Truck)**	**(Rail)**	**(Truck)**	**(Rail)**
Shipments to the INEEL	1.00	1.00	0.25	0.25
Shipments from the INEEL	1.00	1.00	0.40	0.40

a. The baseline used in this SA consisted of shipments to the INEEL for SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type, and the shipments from the INEEL for SNF & INEL EIS Alternative 5E, Centralization in Nevada.

b. The shipments for the Proposed Action are the shipments outlined in the Amended ROD for the SNF & INEL EIS and the number of canisterized SNF shipments necessary to move all DOE-ID SNF to a geologic repository.

Table 2.7. Radiological Accident Risk for the Baseline and the Proposed Action

Scenario	Baseline[a] Radiological Accident Risk (Truck)	Baseline[a] Radiological Accident Risk (Rail)	Proposed Action[b] Radiological Accident Risk (Truck)	Proposed Action[b] Radiological Accident Risk (Rail)
Shipments to the INEEL	1.00	1.00	0.10	0.20
Shipments from the INEEL	1.00	1.00	0.42	0.34

a. The baseline used in this SA consisted of shipments to the INEEL for SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type, and the shipments from the INEEL for SNF & INEL EIS Alternative 5E, Centralization in Nevada.

b. The shipments for the Proposed Action are the shipments outlined in the Amended ROD for the SNF & INEL EIS and the number of canisterized SNF shipments necessary to move all DOE-ID SNF to a geologic repository.

2.4 Cumulative Impacts

The manufacturing impacts associated with the Proposed Action were shown to be 95 percent of the impacts associated with manufacturing alternative container systems for naval SNF and special case waste. Even if the impacts presented in the Navy Container System EIS were doubled to account for manufacturing containers for both naval SNF and special case waste and DOE-ID SNF, the cumulative environmental impacts resulting from the manufacturing of container systems would still be small and would not result in discernible environmental consequences.

The cumulative impacts analysis presented in the SNF & INEL EIS (Volume 2, Section 5.15) included the impacts of loading and storage activities at the Dry Storage Facility and the Fuel Receiving, Canning/Characterization, and Shipping Facility. The impacts of loading and storage activities associated with the Proposed Action were shown to be bounded by the impacts from the Dry Storage Facility and the Fuel Receiving, Canning/Characterization, and Shipping Facility. Therefore, the cumulative impacts analysis presented in the SNF & INEL EIS bounds the cumulative impacts of loading and storage activities associated with the Proposed Action.

The cumulative impacts of radioactive materials transportation were analyzed in the SNF & INEL EIS. The cumulative impacts of radioactive materials transportation were estimated to be 290 cancer fatalities over the time period 1943 through 2035. These impacts included the impacts of the baseline evaluated in this SA, Alternative 4A, Regionalization by Fuel Type, and Alternative 5E, Centralization in Nevada. If the impacts from these two alternatives are added, the resulting cumulative transportation impacts are still estimated to be 290 cancer fatalities. In Section 2.3, the transportation impacts of Alternatives 4A and 5E (as measured by the number of shipments and radiological hazard index) were shown to bound or be approximately equal to the transportation impacts of the Proposed Action, and the cancer fatalities associated with Alternatives 4A and 5E will bound or be approximately equal to the cancer fatalities for the

Proposed Action. Therefore, the results of the cumulative impacts of transportation analyzed in the SNF & INEL EIS are bound or are approximately equal to the cumulative impacts of transportation for the Proposed Action.

3.0 Summary of Findings and Conclusion

This SA considers the potential environmental impacts associated with the use of a dual-purpose canister system, or comparable multi-purpose canister system, designed to accommodate most DOE-ID SNF for both storage at the INEEL and ultimate shipment to a geologic repository or centralized interim storage site outside the State of Idaho. Potential environmental impacts are evaluated for (a) the manufacturing of canister systems, (b) loading and storage of SNF at the INEEL, (c) transportation of DOE-ID SNF for ultimate disposition outside Idaho, and (d) cumulative impacts.

The results of the supplement analysis indicate that the potential environmental impacts for loading and storage of SNF at the INEEL, and transportation of DOE-ID SNF for ultimate disposition outside Idaho, are bounded by, or are approximately equal to, the impacts analyzed in the SNF & INEL EIS. Likewise, the cumulative impacts associated with these activities are also bounded by or are approximately equal to the cumulative impacts analyzed in the SNF & INEL EIS.

The potential environmental impacts associated with the manufacturing of container systems are not bounded by previous DOE NEPA analyses because the Proposed Action would result in the manufacture of additional containers above what was analyzed in the Navy Container System EIS. The incremental increase in environmental impacts would be approximately 95% of the impacts analyzed in the Navy Container System EIS. However, the cumulative impacts resulting from the manufacturing of container systems would still be small and would not result in discernible environmental consequences.

In conclusion, the results of this Supplement Analysis indicate that the potential environmental impacts of using a dual-purpose canister system, or comparable multi-purpose canister system, to store and transport DOE-ID SNF are bounded by, or are reasonably comparable to, the impacts analyzed in the DOE SNF & INEL EIS and the Navy Container System EIS.

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Organizations Consulted

Department of the Navy, Naval Nuclear Propulsion Program

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APPENDIX A

ESTIMATES OF THE NUMBERS OF STANDARD CANISTERS AND DPCS

Appendix A: Estimates of the Numbers of Standard Canisters and DPCs

In order to perform the Supplement Analysis (SA) evaluating the impact of employing dual purpose canisters (DPCs) to prepare Department of Energy (DOE) Spent Nuclear Fuel (SNF) located at the Idaho National Engineering and Environmental Laboratory (INEEL) for storage and transport out of the State of Idaho, it is essential to have some concept of the system and an estimate of the number of standard canisters and DPCs required for DOE-ID SNF. This appendix provides the basis for this estimate of the number of standard canisters and DPCs. Data developed by the DOE National SNF Program was utilized to derive these estimates.

The SNF considered in this analysis includes all SNF designated for management by DOE-ID at INEEL under the Amended ROD (61 FR 9441), with the exception of the sodium-bonded SNF. The sodium-bonded SNF is expected to require treatment prior to disposal due to the potential Resource Conservation and Recovery Act (RCRA) characteristic reactivity of the metallic sodium. After treatment, the material originating from this sodium-bonded SNF is expected to be managed as high-level radioactive waste (HLW) or other waste forms rather than SNF and, therefore, is excluded from consideration here. While it is possible that some of the SNF designated for management at INEEL may not ultimately come to INEEL, this is a small portion of the total SNF considered here and retaining all except sodium-bonded SNF provides a slightly conservative analysis.

This appendix utilizes existing concepts being considered by DOE and combines it with the DPC concept in order to develop estimates of the number of standard canisters and DPCs required. DOE is considering use of standard canisters that contain quantities of SNF that do not present undue criticality risks (see RW-0017) for transportation, storage, and disposal. These standard canisters, nominally 18 and 24 inches in diameter with nominal lengths of 10 and 15 feet, may ultimately be combined with 24 inch diameter HLW canisters into waste packages for co-disposal in a repository. DOE also has some SNF that would could be placed into standard 21-assembly Pressurized Water Reactor (PWR) canisters. This analysis assumes that these standard canisters are placed into larger DPCs for storage and transportation as shown in Figure A-1. While DOE may

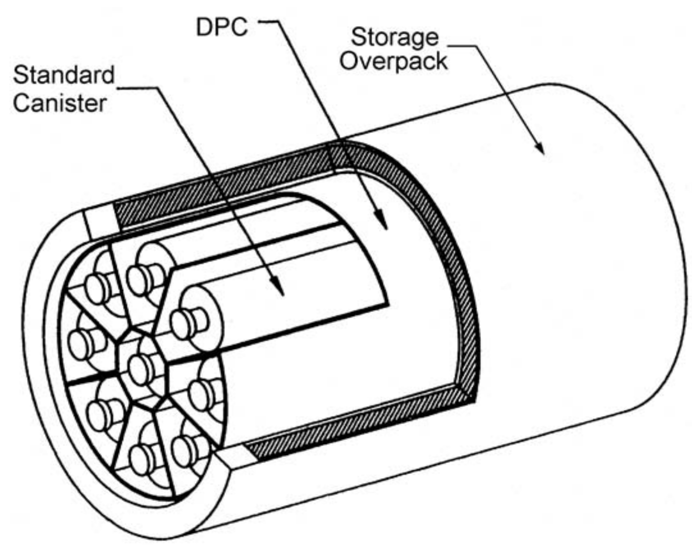

Figure A-1. Overview of Standard Canister and DPC Configuration

actually store and transport the standard canisters without use of the DPCs, this assumed nesting configuration provides an enveloping estimate of fabrication impacts. No credit is taken in this analysis for the double confinement of the SNF.

Table A-1 summarizes the most recent estimate of each of these standard canister types based on data developed by the National SNF Program (Stroupe 1998; Hill 1998). The SNF considered by Stroupe (1998) is the same as that considered in this analysis.

Table A-1. Estimated Number of Canisters for DOE-ID SNF

Standard Canister Type	Number of Standard Canisters
18” diameter 10’ long	331
18” diameter 15’ long	1,107
24” diameter 10’ long	0
24” diameter 15’ long	47
21-assembly PWR[a] canister	16
Total	1,501

a. PWR-Pressurized Water Reactor

These standard canisters could be used directly with storage systems or they could be placed into DPCs for storage. Use of DPCs would be the most impacting approach from a fabrication and handling perspective, and will be used as the basis here for storage. These standard canisters are allocated among the SNF categories used for this SA. These SNF categories are the same as those used in the SNF & INEL EIS. This grouping was accomplished by relating the proper categories from Stroupe (1998) with the categories used in this analysis, specifically:

- the commercial categories align directly,
- the graphite categories align directly,
- the TRIGA (Training, Research, and Isotope Reactors built by General Atomics) category corresponds to the domestic research reactor (DRR), foreign research reactor (FRR), and university research reactor (URR) categories (the standard canister count was allocated on the basis of metric tons of heavy metal, MTHM), and
- all other categories correspond to the DOE research reactor category below.

Table A-2 provides a summary of the number of standard canisters required for each SNF category as defined for this SA. There is still considerable uncertainty in the number of standard canisters and DPCs required for storage. The number of standard canisters may vary depending upon the fissile loading limits imposed as a result of criticality concerns. There is an indication that highly enriched uranium (HEU) aluminum SNF may be limited to 14.4 kg of U-235 equivalent fissile mass [RW-0017]. There are some preliminary indications that criticality analyses on specific SNF types may have limits below 14.4 kg of U-235 equivalent fissile mass. On the other hand, addition of neutron poisons may increase the limits.

Table A-2. Estimated Number of Standard Canisters for DOE-ID SNF

	Standard canister Type					
SNF Category	**18”x10’**	**18”x15’**	**24”x10’**	**24”x15’**	**21 PWR**	**Total**
Commercial	-	-	-	-	16	16
Graphite	-	563	-	-	-	563
DOE Research	239	539	-	47	-	825
DRR[a]	6	<1	-	-	-	7
FRR[b]	52	3	-	-	-	55
URR[c]	34	<2	-	-	-	35
Total	331	1,107	-	47	16	1,501

a. DRR-Domestic Research Reactor
b. FRR-Foreign Research Reactor
c. URR-University Research Reactor

Table A-3 summarizes the number of standard canisters of each type that could be placed into a DPC.

Table A-3. Estimated Standard Canisters Per DPC

Standard Canister Type	**Number of Standard Canisters Per DPC**
18” diameter 10’ long	9
18” diameter 15’ long	7[a]
24” diameter 10’ long	4
24” diameter 15’ long	3[a]
21-assembly PWR[b] canister	1[c]

a. Fewer of the longer standard canisters can be placed in each DPC due to weight restrictions
b. PWR-Pressurized Water Reactor
c. The 21-assembly PWR canister is a DPC. The standard canister and DPC are synonymous and only one canister is used.

Based on the standard canister count in Table A-2 and the potential loading configuration indicated in Table A-3, the total number of DPCs for each SNF category is presented in Table A-4.

Table A-4. Estimated Number of DPCs for DOE-ID SNF

SNF Category	Number of DPCs (by Standard Canister Type)					
	18"x10'	**18"x15'**	**24"x10'**	**24"x15'**	**21 PWR**	**Total**
Commercial	-	-	-	-	16	16
Graphite	-	80	-	-	-	80
DOE Research	27	77	-	16	-	120
DRR[a]	≤1	-	-	-	-	1
FRR[b]	6	<1	-	-	-	6
URR[c]	≤4	<1	-	-	-	4
Total	37	158	-	16	16	227

a. DRR-Domestic Research Reactor
b. FRR-Foreign Research Reactor
c. URR-University Research Reactor

The SA includes consideration of impacts associated with the manufacture of standard canisters and DPCs. The manufacturing impacts associated with standard canisters will be estimated by scaling from the impacts of DPC manufacturing on the basis of the materials of construction. Table A-5 presents a summary of the quantity, nominal dimensions, and materials of construction for the standard canister and DPCs.

Table A-5. Cumulative Volume of Materials of Construction Comparison

Std. Canister	I.D. (in)	O.D. (in)	Length (in)	Unit Vol. (in^3)	Quantity	Total Vol. (in^3)
18" x 10'	17.25	18.00	101.00	2,479	331	8.E+05
18" x 15'	17.25	18.00	163.00	3,766	1,107	4.E+06
24" x 10'	23.00	24.00	98.25	4,532	-	-
24" x 15'	23.00	24.00	160.00	6,811	47	3.E+05
Total for Standard Canisters[a]					1,485	5.E+06
DPCs	67.25	68.5	186	32,159	227	7.E+06

a. The 21-assembly PWR canister listed in Table A-3 is not included in the standard canisters for this table because it is a DPC. Material quantities for the PWR canister are included in the DPCs listed in Table 2.1.

The volume for the materials of construction for the standard canisters is 70% of the volume for the DPC's. The internal material volumes are not estimated directly but are assumed to scale from the DPC values on the basis of the outer surface material volumes.

In the event of transportation by rail, each DPC will be shipped in a transportation overpack, resulting in 227 rail shipments. In the event of transportation by truck, each of the standard canisters will be shipped individually in a transportation overpack. The number of truck shipments is estimated to be as follows:

- The 331 standard canisters 10-foot long are expected to be shipped by legal weight truck shipments.
- The 1,154 standard canisters 15-foot long are expected to be shipped by overweight truck shipments.
- The SNF in the sixteen 21-PWR DPC would likely be removed from the canisters and shipped as bare SNF in a transportation cask. Legal weight transportation casks can typically hold 3 PWR assemblies, which results in 112 legal weight shipments.

Therefore, the total number of legal weight truck shipments is 443 and the total number of overweight truck shipments is 1,154.

References

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APPENDIX B

OFFSITE TRANSPORTATION IMPACTS

Appendix B: Offsite Transportation Impacts

This appendix analyzes the impacts of transportation of Department of Energy-Idaho (DOE-ID) Spent Nuclear Fuel (SNF) located at the Idaho National Engineering and Environmental Laboratory (INEEL) using dual-purpose canisters (DPCs). This analysis is based on information presented in the Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration & Waste Management Programs Final Environmental Impact Statement (SNF & INEL EIS) (DOE 1995), the Amended Record of Decision (ROD) for the SNF & INEL EIS (61 FR 9441) and Heiselmann (1995). Supplemental information about radionuclide inventories can be found in Anderson (1998).

PURPOSE

The purpose of the Supplement Analysis (SA) is to determine whether or not existing NEPA analyses envelop, or bound, the impacts of the Proposed Action. Consequently, instead of performing a traditional NEPA impacts analysis, the SA performs comparative analyses for the purpose of determining if the impacts of the Proposed Action have been bounded by previous NEPA analyses. The analyses performed for the SA are screening level analyses designed to give a “YES/NO” result. The YES/NO criteria is simply: Is the impact less than, or approximately equal to, the impact analyzed in existing NEPA documentation? If the answer is NO for any of the impact areas addressed, then further detailed analysis may be necessary in the form of a Supplemental EIS or a new EIS.

The purpose of this appendix is to compare the impacts of offsite transportation for the Proposed Action of this SA with an appropriate baseline. For this analysis, the appropriate baseline for shipments to the INEEL is the SNF & INEL EIS Alternative 4A, Regionalization by Fuel Type; for shipments from the INEEL, the appropriate baseline is the SNF & INEL EIS Alternative 5E, Centralization in Nevada. Alternative 4A served as the basis for the original ROD for the SNF & INEL EIS (60 FR 28680). Alternative 5E is the alternative evaluated in the SNF & INEL EIS that provides a suitable baseline for evaluating the transport of DOE-ID SNF to a geologic repository located in Nevada.

The shipments for the Proposed Action are the SNF shipments coming to the INEEL as outlined in the Amended ROD for the SNF & INEL EIS, and the number of canisterized SNF shipments necessary to move all DOE-ID SNF from the INEEL to a geologic repository. The canisterized SNF shipments for the Proposed Action are based on the shipments of existing SNF at the INEEL and shipments of SNF scheduled to be shipped to the INEEL based on the Amended ROD, and represent removing all SNF from the INEEL. It should be noted that the shipments for the baseline and the Proposed Action consisted only of shipments to or from the INEEL; shipments that did not originate or terminate at the INEEL were not included in either the baseline or the Proposed Action. Appendix A provides the details on how the canisterized SNF shipments from the INEEL were estimated for the Proposed Action.

METHODOLOGY

For the analysis of transportation impacts, there are incident-free impacts and accident impacts. Incident-free impacts are primarily a function of the external dose rate from the shipping container (Transportation Index), routing (which includes distances and population densities), and the number of shipments. The transportation analyses performed for the DOE SNF & INEL EIS assumed an external dose rate at the regulatory maximum (10 mrem/hr @ 2 meters); for the Proposed Action the external dose rate would be no greater than the regulatory maximum. However, there could be small differences between the doses calculated in the SNF & INEL EIS and the doses for the Proposed Action due to slightly different container sizes. It is also assumed that the routing of shipments and the population densities along the routes would be similar to that analyzed in the SNF & INEL EIS. Therefore, the key factor for assessing whether impacts from the Proposed Action are bounded by existing analyses is the number of shipments. To determine if the impacts of incident-free transportation for the Proposed Action are bounded by existing analyses, it is necessary only to estimate the number of shipments and compare that number to the shipments analyzed in the SNF & INEL EIS.

Transportation accident impacts can be radiological (involving release of radioactive material) or nonradiological (physical impacts resulting in injuries or fatalities). Nonradiological impacts are independent of the cargo and depend primarily on routing, accident rates for the selected routes, and number of shipments. The SA assumes that routing and accident rates are similar to those analyzed in the SNF & INEL EIS, so the key factor for assessing nonradiological transportation accident impacts is the number of shipments. Therefore, to determine the impacts of non-radiological traffic accidents, the SA needs only to estimate the number of shipments for the Proposed Action and compare that number to the shipments analyzed in the SNF & INEL EIS.

Radiological impacts from transportation accidents are more complicated because the impacts depend on the physical/chemical/radiological characteristics of the cargo, routing, number of shipments, accident severity, release fractions, atmospheric dispersion, population densities, and other pathway factors. The SA makes a number of simplifying assumptions to minimize the amount of new analysis. The cargo is the same SNF that was analyzed in the SNF & INEL EIS, with two principal differences: (1) the radioactivity of SNF already in storage is lower as a result of an additional 20 years of decay (1995-2015), and (2) the quantity of SNF per shipment is different because of different container types. All other factors affecting transportation accidents, with the exception of shipment counts, are assumed to be similar to those used in the SNF & INEL EIS. For example, the atmospheric dispersion characteristics, release fractions, routing, accident rates, population densities, and exposure pathways were assumed to be the same for the Proposed Action and the baseline shipments.

Transportation accident risk is the product of probability and consequences. The probability of a transportation accident is a function of the accident rate for the selected routes, the conditional probability associated with accident severity, and the number of shipments. The SA assumes the same routes, accident rates, and conditional probabilities as used in the SNF & INEL EIS. Therefore, the number of shipments is the only variable affecting accident probability. If the number of shipments for the Proposed Action is less than, or approximately equal to, the number of shipments analyzed in the SNF & INEL EIS, then the transportation accident probability for the Proposed Action will be less than, or approximately equal to, the transportation accident probability analyzed in the SNF & INEL EIS.

Transportation accident consequences are a function of the amount and type of radioactivity being shipped, the release fraction (which varies by nuclide and accident severity), atmospheric dispersion conditions, population density, and other pathway factors. The SA assumes all these factors are the same as in the SNF & INEL EIS with the exception of the amount and type of radioactivity being shipped. As discussed earlier, the radioactivity content of the shipments for the Proposed Action has changed compared to the SNF & INEL EIS as a result of radioactive decay and use of different container types. To determine if accident consequences are bounded by existing analysis, an analytical tool known as the hazard index was used. The hazard index is simply a screening tool to compare the relative hazard of two radionuclide distributions. The higher the value of the hazard index, the higher is the relative hazard. Therefore, if the hazard index for SNF shipped under the Proposed Action is less than, or approximately equal to, the hazard index for the same SNF type evaluated in the SNF & INEL EIS, then the consequences of a transportation accident for the Proposed Action are bounded by the consequences evaluated in the SNF & INEL EIS. This methodology was selected because it is an effective method for relative comparison of accident risk and requires less time than a detailed transportation accident risk analysis.

Table B-1 summarizes the basic assumptions regarding shipment counts and shipment inventories that are used in this SA.

Shipment Counts

The total number of shipments of SNF analyzed for the baseline case is the number of shipments under Alternative 4A (shipments entering INEEL) plus those under Alternative 5E (shipments leaving INEEL for Nevada), as they appear in Heiselmann (1995). The only modification is the number of graphite shipments from Ft. St. Vrain to INEL under Alternative 4A. The number used in this analysis is 244 truck shipments, based on Appendix I of the SNF & INEL EIS (DOE 1995). These shipment numbers are presented in Tables B-2 and B-3 below.

As stated in Table B-1, the Proposed Action includes the shipments to INEEL under Alternative 4A as amended by the Amended ROD plus the shipments leaving INEEL as estimated in Appendix A. Sodium-bonded fuels owned by the Department of Energy are not likely to be shipped to a geologic repository due to the restrictions against reactive materials that are documented in 10CFR60. The final determination has not been made pending appropriate NEPA evaluation; however, it is the likely scenario adopted for this analysis (Chacey 1998). Therefore, sodium-bonded fuels have been excluded from the shipments leaving the INEEL under the Proposed Action. The shipments estimated in Appendix A for shipments leaving the INEEL by truck or rail are presented in Table B-4. The number of shipments presented in Tables B-2 through B-4 were used as input values in Equation B-2.

Table B-1. Assumptions for Comparison of Transportation Impacts

Assumption	Baseline Case	Proposed Action
Radionuclide Inventory	Taken from SNF & INEL EIS (DOE 1995) Tables I-22 through I-26. No decay is assumed	Taken from SNF & INEL EIS (DOE 1995) Tables I-22 through I-26. Decay of 20 years is assumed for commercial, Hanford production, graphite, and DOE research reactor fuel. No decay assumed for university, foreign, and domestic non-DOE research reactors.
Shipment Counts	Taken directly from Heiselmann (1995) with the only modification being to the graphite shipment counts. This shipment count was changed to correspond to DOE (1995).	Incoming and outgoing DOE-ID SNF shipments from Heiselmann (1995) were amended according to the Amended ROD (61 FR 9441). Outgoing shipments were also modified to eliminate shipments of sodium-bonded SNF from the INEEL because this SNF will be treated at the INEEL and shipped as high-level waste (Dirkmaat 1998). Appendix A provides the basis for estimating outgoing shipments for the rail and truck transportation models.
Overall Transportation Options		
Incoming	Alternative 4A	Amended ROD 4A
Outgoing	Alternative 5E	Appendix A

Table B-2. Shipment Counts for Alternative 4A (Baseline and Proposed Action)[a]

Fuel Type	Origin	Estimated number of shipments: Baseline Alternative 4A		Amended ROD 4A (Proposed Action)	
		Truck	Rail	Truck	Rail
Graphite Fuels	Ft. St. Vrain	244	35	0[b]	0[b]
Commercial Type	West Valley	83	4	83	4
Commercial Type	ORNL	7	2	1	1
Commercial Type	SRS	27	5	27	5
Commercial Type	Lynchburg	2	2	5	5
Commercial Type	Hanford	6	2	0[b]	0[b]
Commercial Type	ANL-E	1	1	1	1
Subtotal		**126**	**16**	**117**	**16**
Hanford Production	ORNL	1	1	1	1
DOE T&E Research	ANL-E	10	2	5	1
DOE T&E Research	Sandia	12	3	11	3
DOE T&E Research	Hanford	341	17	12	3
DOE T&E Research	Hanford	64	12	0[b]	0[b]
DOE T&E Research	Hanford	5	1	0[b]	0[b]
DOE T&E Research	Hanford	14	3	0[b]	0[b]
DOE T&E Research	SRS	25	5	25	5
DOE T&E Research	ORNL	43	9	11	3
DOE T&E Research	Hanford	94	6	0[b]	0[b]
DOE T&E Research	SRS	69	14	69	14
DOE T&E Research	ORNL	3	1	1	1
Subtotal		**681**	**74**	**135**	**31**
Domestic NonDOE	San Ramon	3	3	3[c]	3[c]
Domestic NonDOE	Bethesda	3	3	3[c]	3[c]
Domestic NonDOE	Midland	3	3	3[c]	3[c]
Domestic NonDOE	San Diego	8	8	8[c]	8[c]
Domestic NonDOE	Denver	6	6	6[c]	6[c]
Domestic NonDOE	McClellan	3	3	3[c]	3[c]
Domestic NonDOE	Nebraska	0	0	2[c]	2[c]
Subtotal		**26**	**26**	**28**	**28**

University Research	Stainless Clad	104	104	104	104
University Research	Zirc. Clad	12	12	12	12
Subtotal		**116**	**116**	**116**	**116**
Foreign Research	East Ports	121	121	115	115
Foreign Research	West Ports	49	49	47	47
Subtotal		**170**	**170**	**162**	**162**

a. Information taken from the Heiselmann (1995), the SNF & INEL EIS (DOE 1995), and the Amended ROD for the SNF & INEL EIS (61 FR 9441) .

b. This fuel will not be shipped under the Proposed Action (61 FR 9441) and (Chacey 1998).

c. Some Domestic Research Reactor SNF may not be coming to INEEL but are included in the analyses performed for this SA.

Table B-3. Shipment Counts for Alternative 5E (Baseline)[a]

Fuel Type	Origin	Estimated number of shipments	
		Truck	**Rail**
Graphite Fuels	Peachbottom SNF	42	6
Graphite Fuels	Ft. St. Vrain SNF	120	17
	Subtotal	**162**	**23**
Commercial Type	TMI-2 Core Debris	245	49
Commercial Type	Dry rod Consolidation Tech. SNF	65	13
Commercial Type	Miscellaneous commercial	60	12
	Subtotal	**370**	**16**
DOE T&E Research	ATR, small amount of university SNF	114	23
DOE T&E Research	SST, Fermi Blanket, miscellaneous	212	43
DOE T&E Research	ANL-W SST, EBRII[b], NRAD, ZPPR, RSWF	394	79
DOE T&E Research	INEEL Zirc; Shippingport LWBR	272	18
DOE T&E Research	INEL Zirc; Shippingport Cores 1&2	10	1
DOE T&E Research	ANL-W Zirc; Treat	1	1
	Subtotal	**1,003**	**165**
University Research	ISU	1	1

a. Information taken from Heiselmann (1995) and the SNF & INEL EIS (DOE 1995).

b. EBR-II SNF shipments are included in the baseline. The assumption that EBR-II fuel will be treated and not shipped as SNF applies only to the Proposed Action and is reflected in the shipment counts presented in Table B-7.

Table B-4. Shipment Counts And Mass Per Shipment For All SNF Leaving INEEL Under The Proposed Action (See Appendix A)

Fuel Type	Number of Shipments		Mass per Shipment (MTHM/shipment)	
	Truck[a]	**Rail**[b]	**Truck**	**Rail**
Commercial	112[c]	16	1.40	9.78
Graphite	563	80	0.02	0.14
DOE Research	825	120	0.08	0.58
Domestic non-DOE Research Reactor (DRR)	7[d]	1[d]	0.02	0.19
Foreign Research Reactor (FRR)	55	6	0.02	0.19
University Research Reactor (URR)	35	4	0.05	0.47
Total	**1597**	**227**		

a. It is assumed that one standard canister is transported per truck shipment.
b. It is assumed that one DPC is transported per rail shipment.
c. It is assumed that commercial PWR spent fuel assemblies are shipped as bare SNF using existing truck transportation casks.
d. Some Domestic Research Reactor SNF may not be coming to INEEL but are included in the analyses performed for this SA.

Radionuclide Inventory

The radionuclide inventories used in this analysis were taken from the SNF & INEL EIS (DOE 1995) and are documented in Anderson (1998). It was determined that for the Proposed Action the radionuclide inventory for the SNF that is already in storage as of 1995, a decay time of 20 years would be applied. The earliest date that DOE SNF, other than naval SNF, could be shipped to a geologic repository is 2015. Therefore, an additional 20-year decay time (1995-2015) was assumed for that SNF that is already in storage (i.e., commercial, DOE research, Hanford production, and graphite SNF).

MicroShield 5 was used to calculate the decayed radionuclide inventory (Grove Engineering 1996). This includes commercial, graphite, Hanford production, and DOE research reactor fuel. The domestic non-DOE, university research reactor, and foreign research reactor SNF is still in the reactor, and therefore, has no decay applied. These radionuclide inventories are based on certain assumptions, such as burnup time and cooling time. They are also given in different units depending on the fuel type. For example Hanford SNF is given in curies per metric ton uranium while representative commercial SNF is given in curies per one pressurized water reactor fuel assembly. Table B-5 presents the pertinent assumptions for the radionuclide inventories.

In order to use the radionuclide inventories in equation B-1, the inventories must have consistent units (i.e., curies per metric ton heavy metal). For those fuel types where the radionuclide inventories are given in units other than curies per MTHM (e.g., graphite SNF, commercial, and domestic non-DOE SNF), the values presented in Table B-5, as well as the mass per shipment numbers in Tables B-6 and B-7, were used to convert the inventories to the required curies per MTHM. The mass per shipment numbers in Tables B-6 and B-7 were also used explicitly in equation B-1.

Table B-5. Assumptions for Radionuclide Inventories

Fuel Type	Assumption
Hanford N-reactor SNF	In units of Ci/MTU (note: 1 MTU = 1 MTHM)[a]. Mass per rail shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.
Representative graphite reactor SNF	Based on 6 Ft. St. Vrain fuel blocks[a]; 42 fuel blocks per rail shipment[b]. Mass per shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.
Representative Commercial SNF	Based on 1 pressurized water reactor (PWR) fuel assembly[a], 0.46 MTU per fuel assembly[b]. Mass per shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.
Representative university research and Domestic Non-DOE research SNF	Based on 19 TRIGA fuel rods[a], 38 TRIGA fuel rods per cask[b]. Mass per shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.
DOE research reactor SNF	Based on 1 fuel assembly[a], 4.25 KgHM per fuel assembly[b]. Mass per shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.
Foreign Research Reactor SNF	Based on 40 TRIGA fuel rods[a], 40 TRIGA fuel rods per cask[b]. Mass per shipment is dependent on the origin of the fuel and is presented in Tables B-3 and B-4.

a. DOE (1995)
b. Enyeart (1995)

Table B-6. Assumptions for Mass per Shipment for Alternative 4A (Baseline and Proposed Action)[a]

Fuel Type	Origin	Estimated KgHM/shipment			
		Baseline Alternative 4A		Amended ROD 4A (Proposed Action)	
		truck	rail	truck	rail
Graphite Fuels	Ft. St. Vrain	65.57	457.14	0.00[b]	0.00[b]
Commercial	West Valley	325.30	6750.00	325.30	6750.00
Commercial	ORNL	174.57	611.00	1222.00	1222.00
Commercial	SRS	168.37	909.20	168.37	909.20
Commercial	Lynchburg	22.00	22.00	8.80	8.80
Commercial	Hanford	380.33	1141.00	0.00[b]	0.00[b]
Commercial	ANL-E	19.00	19.00	19.00	19.00
Hanford Production[c]	ORNL	23.00	23.00	23.00	23.00
DOE T&E Research	ANL-E	6.00	30.00	12.00	60.00
DOE T&E Research	Sandia	6.25	25.00	6.82	25.00
DOE T&E Research	Hanford	38.12	764.71	19.17	76.67
DOE T&E Research	Hanford	1.25	6.67	0.00[b]	0.00[b]
DOE T&E Research	Hanford	8.70	43.50	0.00[b]	0.00[b]
DOE T&E Research	Hanford	8.50	39.67	0.00[b]	0.00[b]
DOE T&E Research	SRS	24.60	123.00	24.60	123.00
DOE T&E Research	ORNL	25.05	119.67	97.91	359.00
DOE T&E Research	Hanford	174.47	2733.33	0.00[b]	0.00[b]
DOE T&E Research	SRS	172.84	851.86	172.84	851.86
DOE T&E Research	ORNL	12.33	37.00	37.00	37.00
Domestic NonDOE	San Ramon	5.00	5.00	5.00[d]	5.00[d]
Domestic NonDOE	Bethesda	6.33	6.33	6.33[d]	6.33[d]
Domestic NonDOE	Midland	4.67	4.67	4.67[d]	4.67[d]
Domestic NonDOE	San Diego	6.00	6.00	6.00[d]	6.00[d]
Domestic NonDOE	Denver	4.17	4.17	4.17[d]	4.17[d]
Domestic NonDOE	McClellan	5.00	5.00	5.00[d]	5.00[d]
Domestic NonDOE	Nebraska	e	e	8.00[d]	8.00[d]
University Research	Stainless clad	12.48	12.48	12.48	12.48
University Research	Zirc. Clad	49.42	49.42	49.42	49.42
Foreign Research	East Ports	4.79	4.79	5.04	5.04
Foreign Research	West Ports	11.22	11.22	11.70	11.70

a. Information taken from the Heiselmann (1995) and the Amended ROD for the SNF & INEL EIS (61 FR 9441) .
b. This fuel will not be shipped under the Amended ROD (61 FR 9441).
c. Hanford production SNF is combined with the DOE research SNF in order to compare the Proposed Action with the baseline case.
d. Some Domestic Research Reactor SNF may not be coming to INEEL but are included in the analyses performed for this SA.
e. SNF shipments from Nebraska were not explicitly identified in the SNF & INEL EIS; however, these shipments were identified in the Amended ROD for the SNF & INEL EIS (61FR9441).

Table B-7. Assumptions for Mass per Shipment for Alternative 5E (Baseline Case)[a]

Fuel Type	Origin	Estimated KgHM/shipment	
		rail	truck
Graphite Fuels	Peachbottom SNF	500.00	71.43
Graphite Fuels	Ft. St. Vrain SNF	505.88	71.67
Commercial Type	TMI-2 Core Debris	1673.47	334.69
Commercial Type	Dry rod Consolidation Tech. SNF	1615.38	323.08
Commercial Type	Miscellaneous commercial	1721.17	344.23
DOE T&E Research	ATR, small amount of university SNF	123.07	24.83
DOE T&E Research	SST, Fermi Blanket miscellaneous	861.93	174.83
DOE T&E Research	ANL-W SST, EBRII, NRAD, ZPPR, RSWF	848.11	170.05
DOE T&E Research	INEEL Zirc; Shippingport LWBR	2649.28	175.32
DOE T&E Research	INEL Zirc; Shippingport Cores 1&2	1600.00	160.00
DOE T&E Research	ANL-W Zirc; Treat	10.00	10.00
University Research	ISU	11.00	11.00

a. Information taken from Heiselmann (1995) and the SNF & INEL EIS (DOE 1995).

Calculation of Hazard Index

To quantify the radiological hazard of individual shipments and the entire shipment campaign, hazard indices were developed which account for the total radioactivity and radiotoxicity of the SNF. Hazard indices were calculated for the baseline shipments and the shipments associated with the Proposed Action. In order to properly capture the differences between fuel types, separate hazard indices were calculated for commercial SNF, graphite SNF, DOE research reactor SNF, university research reactor SNF, foreign research reactor SNF, and domestic research reactor SNF.

In a transportation accident involving spent nuclear fuel, the primary radiological hazard is from atmospheric releases of radioactivity from the shipping cask. Therefore, the measure of radiotoxicity used in the hazard index is the atmospheric screening factors from NCRP Report No. 123, *Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground* (NCRP 1996). These screening factors are for atmospheric releases of radionuclides and include all exposure pathways (inhalation, ingestion, submersion, and external exposure to ground surfaces). These are also the same pathways evaluated in the SNF & INEL EIS. There are separate screening factors for each radionuclide and the units of the screening factors are dose per unit atmospheric concentration. This measure of radiotoxicity is appropriate because catastrophic transportation accidents in the SNF & INEL EIS were postulated to result in an atmospheric release of radioactive material and the screening factors account for all potential exposure pathways that might occur after such an accident.

The hazard index was calculated using a two step process. In the first step, the radionuclide inventory was determined for each fuel type. For the baseline shipments, the radionuclide inventories were estimated using conservative assumptions regarding cooling time (see Appendix I of the SNF & INEL EIS). For the shipments associated with the Proposed Action, more realistic assumptions were made regarding cooling time. The earliest date that DOE SNF, other than naval SNF, could be shipped to a geologic repository is 2015. Therefore, an additional 20-year decay time (1995 – 2015) was assumed for that SNF that is already in storage (i.e., commercial, DOE research, Hanford production, and graphite SNF). This tended to lower the radionuclide inventories associated with the shipments. No additional decay time was assumed for the university, domestic non-DOE, and foreign research reactors because much of the SNF is still being used and can be used up to 1 year prior to shipping.

In the second step, the inventory of each radionuclide was multiplied by the screening factor for each radionuclide. These products were then summed, which yielded the hazard index for one shipment of a particular fuel type. The hazard index was then multiplied by the number of shipments of a particular fuel type, which yielded the total hazard index for all the shipments of a fuel type. Finally, the gross hazard indices for all the shipments of each fuel type were summed, which yielded the total gross hazard index for the baseline shipments and the shipments associated with the Proposed Action. The total gross hazard index for the baseline shipments was then compared to the total gross hazard index for the shipments associated with the Proposed Action.

Since the hazard index is a measure of radiological hazard, if the total gross hazard index of the baseline shipments is greater than the total gross hazard index of the shipments associated with the Proposed Action, then the radiological hazard of the baseline shipments is also greater than the radiological hazard of the shipments associated with the Proposed Action. The hazard index is only useful as a relative comparison and the value of the hazard index is not meaningful in an absolute sense. As used in this SA, the hazard index (HI) is the hazard associated with a single shipment, while the gross hazard index (GHI) is the hazard associated with all shipments of a single fuel type. Both the HI and GHI have units of radiation dose (Sv).

The HI is calculated for a single shipment using Eq. B-1, summed over all the radionuclides. It should be noted that equation B-1 does not include a release fraction term. This is because the shipping container performance and resulting release fractions were assumed to be similar for the Proposed Action and the baseline shipments. Consequently, the release fractions would not serve to discriminate the radiological hazard of the shipments associated with the Proposed Action from the radiological hazard of the baseline shipments.

A HI is calculated for each fuel type and origin. The atmospheric screening factors, the measure of radiotoxicity, were taken from NCRP Report No. 123, *Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground* (NRCP 1996). These atmospheric screening factors (units of Sv-m^3/Bq) were multiplied by a unit atmospheric dispersion factor (1 m^{-3}) to yield the final atmospheric dispersion factors (ASF), with units of Sv/Bq. A unit atmospheric dispersion factor was used because the atmospheric dispersion characteristics for accidents involving baseline shipments and the shipments associated with the Proposed Action were assumed to be similar. Consequently, the atmospheric dispersion characteristics would not serve to discriminate the radiological hazard of the shipments associated with the Proposed Action from the radiological hazard of the baseline shipments. Equation B-2 is used to obtain the gross HI for each fuel type summed all over the fuel origins.

Eq. B- 1

$$HI = \sum_{all\ radionuclides} \left[\left(\frac{Ci}{MTHM} \right) \times \left(\frac{KgHM}{shipment} \right) \times \left(\frac{MTHM}{1000\,KgHM} \right) \times \left(ASF \right) \times \left(3.7E+10 \frac{Bq}{Ci} \right) \right]$$

Eq. B- 2

$$GHI = \sum_{fuel\ orgins} (HI \times number\ of\ shipments)$$

where:

HI = hazard index (Sv)
GHI = gross hazard index (Sv)
ASF = atmospheric screening factor (Sv/Bq)
KgHM = kilograms heavy metal
MTHM = metric tons heavy metal

RESULTS

Incident-Free Transportation and Traffic Fatalities

The comparison of incident-free transportation and traffic fatalities is based on the number of shipments under the baseline and the Proposed Action. This type of comparison is appropriate because the transportation routes considered for the Proposed Action are the same as those analyzed in the baseline with the following exceptions. As shown in Table B-2, certain types of SNF evaluated in the baseline would not be shipped to the INEEL under the Proposed Action (e.g., graphite fuel from Fort St. Vrain). This results in 427 fewer truck shipments, or 59 fewer rail shipments, coming to the INEEL for the Proposed Action compared to the baseline case.

Table B-2 shows one instance where shipments were not evaluated in the baseline but were included in the Proposed Action, i.e., Domestic Non-DOE research reactor SNF coming from Omaha, Nebraska. This represents only 2 truck shipments or 2 rail shipments. These shipments would take place over the same routes (I-80 and the Union Pacific Railroad) as many other shipments to the INEEL from the east coast. Therefore, including the Nebraska shipments will not significantly affect the results of the analysis. The shipment-miles for the Proposed Action were also compared to the shipment-miles for the baseline (Anderson 1998). This comparison showed that including the Nebraska shipments does not significantly affect the results of the analysis. In addition, the comparison of the shipment-miles showed the same pattern as the shipments (i.e., if the number of shipments was larger, then the shipment-miles were also larger). This provides additional support for using shipments as a way to compare incident-free and traffic fatalities. On balance, there are significantly fewer SNF shipments and shipment-miles coming to the INEEL under the Proposed Action as compared to the baseline, therefore, the baseline case is bounding.

Table B-8.a shows the comparison of SNF shipments coming to or going from the INEEL for the baseline case and the Proposed Action. It can be seen that the number of SNF shipments to the INEEL for the baseline ranged from 437 to 1363 while the number of shipments to the INEEL for the Proposed Action ranged from 353 to 558. In addition, the number of shipments from the INEEL for the baseline ranged from 263 to 1536 while the number of canisterized SNF shipments from the INEEL to a geologic repository for the Proposed Action ranged from 227 to 1597.

To facilitate presentation of the results, Table B-8.b shows the shipment ratios for the baseline and the Proposed Action with the baseline total shipment counts normalized to 1.00. If the total shipment ratio for the Proposed Action is less than 1.00, it may be concluded that the number of shipments evaluated in the SNF & INEL EIS bound the shipments of the Proposed Action. Based on this comparison of shipment ratios, for truck and rail shipments to the INEEL, the incident-free and traffic fatality impacts evaluated in the SNF & INEL EIS bound the impacts of the Proposed Action. For rail shipments from the INEEL, the incident-free and traffic fatality impacts evaluated in the SNF & INEL EIS also bound the impacts of the Proposed Action. However, for truck shipments from the INEEL, the shipment ratio for the Proposed Action is 1.04, or 4 percent larger than the truck shipments evaluated in the SNF & INEL EIS. A 4 percent increase in the number of shipments or impacts is extremely small and would not appreciably increase the overall risk to public health and safety. In addition, if a mixture of truck and rail shipments were used to move canisterized SNF to a geologic repository, a relatively small number of rail shipments (less than 20) would be required to offset the 4 percent increase in truck shipments.

Based on these analyses, the number of incident-free cancer fatalities and traffic fatalities estimated for the baseline would be greater than or approximately equal to the number of fatalities estimated for the Proposed Action.

Radiological Accident Risk

Table B-9 provides the results of the hazard index analysis which is used as the basis for comparing relative hazard from transportation accidents that result in a release of radioactivity. Table B-9 presents the gross hazard index results which apply to the total SNF inventory shipped over the entire campaign. To facilitate presentation of the results, the total hazard index for the baseline case has been normalized to 1.00, and the hazard index results for the Proposed Action are shown in ratio to the baseline case. Note that the gross hazard index does not depend on shipment mode because the total inventory shipped is the same, no matter the mode of shipment. For incoming SNF shipments to the INEEL, the total hazard index for the Proposed Action (Amended ROD 4A) is 25% of the total hazard index for the baseline case (Alternative 4A). For SNF shipments going from the INEEL to Nevada, the total hazard index for the Proposed Action (Shipments from INEEL) is 40% of the total hazard index for the baseline case (Alternative 5 E). Since the gross hazard index of the baseline shipments is greater than the gross hazard index of the shipments associated with the Proposed Action, the radiological hazard of the baseline shipments is greater than the radiological hazard of the shipments associated with the Proposed Action.

As discussed earlier, accident risk is the product of probability and consequence. The radiological hazard, as quantified by the gross hazard index, is a measure of consequences. Previous discussion of methodology established that a relative comparison of transportation accident probability can be made based on a comparison of the number of shipments, given that all other relevant factors are approximately the same. Based on the shipment ratios presented in Table B-8.b, it can be concluded that the probability of transportation accidents for the baseline would be greater than, or approximately equal to, the probability for the Proposed Action. An estimate of radiological accident risk, i.e., the product of probability and consequence, can be made by multiplying the total shipment ratios in Table B-8.b by the total hazard indices in Table B-9.

The resulting estimates of relative radiological accident risk are shown in Table B-10. For SNF shipments to the INEEL, Table B-10 shows that the radiological accident risk for the Proposed Action (Amended ROD 4A) is 10% of the baseline risk for truck shipments and 20% of the baseline risk for rail shipments. For SNF shipments from the INEEL, the radiological accident risk for the Proposed Action is 42% of the baseline risk for truck shipments and 34% of the baseline risk for rail shipments. From these results, it is concluded that the radiological impacts of transportation accidents evaluated in the SNF & INEL EIS bound the impacts of the Proposed Action.

The comparison of the maximum catastrophic accident for the baseline case and Proposed Action is based on the hazard index on a per shipment basis. The maximum reasonably foreseeable accident identified in the SNF & INEL EIS for shipments coming to and leaving the INEEL is a rail shipment of commercial SNF. The maximum hazard index for any SNF shipment under the Proposed Action was calculated to be 98% of the hazard index for a rail shipment of commercial SNF analyzed in the SNF & INEL EIS. Therefore, the consequences of a catastrophic accident for the Proposed Action are bounded by the consequences of the maximum reasonably foreseeable transportation accident analyzed in the SNF & INEL EIS.

Table B-8.a Comparison By Total Shipment Counts

	Baseline Case				Proposed Action			
	Alternative 4A (to INEEL)		Alternative 5E (from INEEL)		Amended ROD 4A (to INEEL)		Shipments from INEEL	
Fuel Type	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Commercial	126	16	370	74	117	16	112	16
Graphite	244	35	162	23	0	0	563	80
DOE Research	681	74	1003	165	135	31	825	120
University Research Reactor (URR)	116	116	1	1	116	116	35	4
Foreign Research Reactor (FRR)	170	170	0	0	162	162	55	6
Domestic non-DOE Research Reactor (DRR)	26	26	0	0	28	28	7	1
TOTAL	**1363**	**437**	**1536**	**263**	**558**	**353**	**1597**	**227**

Table B-8.b Comparison By Shipment Ratios

	Baseline Case				Proposed Action			
	Alternative 4A (to INEEL)		Alternative 5E (from INEEL)		Amended ROD 4A (to INEEL)		Shipments from INEEL	
Fuel Type	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Commercial	0.09	0.04	0.24	0.28	0.08	0.04	0.07	0.06
Graphite	0.18	0.08	0.11	0.09	0.00	0.00	0.37	0.30
DOE Research	0.50	0.17	0.65	0.63	0.10	0.07	0.54	0.46
University Research Reactor (URR)	0.09	0.26	<0.01	<0.01	0.09	0.27	0.02	0.02
Foreign Research Reactor (FRR)	0.12	0.39	0.00	0.00	0.12	0.37	0.04	0.02
Domestic non-DOE Research Reactor (DRR)	0.02	0.06	0.00	0.00	0.02	0.06	<0.01	<0.01
TOTAL	**1.00**	**1.00**	**1.00**	**1.00**	**0.41**	**0.81**	**1.04**	**0.86**

Table B-9. Comparison By Relative Hazard (Gross Hazard Index)

	Baseline Case				Proposed Action			
	Alternative 4A (to INEEL)		**Alternative 5E (from INEEL)**		**Amended ROD 4A (to INEEL)**		**Shipments from INEEL**	
Fuel Type	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Commercial	0.14	0.14	0.18	0.18	0.09	0.09	0.15	0.15
Graphite	0.21	0.21	0.05	0.05	0.00	0.00	0.03	0.036
DOE Research	0.61	0.61	0.77	0.77	0.12	0.12	0.20	0.20
University Research Reactor (URR)	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01
Foreign Research Reactor (FRR)	0.03	0.03	0.00	0.00	0.03	0.03	0.01	0.01
Domestic non-DOE Research Reactor (DRR)	<0.01	<0.01	0.00	0.00	<0.01	<0.01	<0.01	<0.01
TOTAL HAZARD INDEX	**1.00**	**1.00**	**1.00**	**1.00**	**0.25**	**0.25**	**0.40**	**0.40**

Table B-10. Comparison By Relative Radiological Accident Risk

	Baseline Case				Proposed Action			
	Alternative 4A (to INEEL)		**Alternative 5E (from INEEL)**		**Amended ROD 4A (to INEEL)**		**Shipments from INEEL**	
	Truck	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**	**Truck**	**Rail**
Radiological Accident Risk Relative to Baseline	**1.00**	**1.00**	**1.00**	**1.00**	**0.10**	**0.20**	**0.42**	**0.34**

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APPENDIX C

Glossary

Glossary

canister	A thin-walled, unshielded metal container used to hold fuel assemblies. Canisters are used in combination with specialized "overpacks" that provide shielding and structural support for transportation or storage purposes. (Overpacks are sometimes referred to as casks.)
can	The process of placing SNF in canisters to retard corrosion, contain radioactive releases, or control geometry.
cask	A heavily shielded, typically robust metal or concrete container for shipping or dry storage of SNF assemblies.
disposal canister	A cylindrical container constructed of highly corrosion-resistant metal alloys that will be loaded with SNF assemblies, sealed, and disposed of in an underground repository. Loaded and sealed disposal containers are called "waste packages." Synonymous with the term "disposal container" as used in the Navy Container EIS.
disposal overpack	An overpack whose primary purposes are to retard corrosion of the canisters and delay release of the radionuclides contained within.
dry storage canister	This term, used in the SNF & INEL EIS, is synonymous with the term dual-purpose canister. See dual-purpose canister.
dual-purpose canister system	A SNF container system can be designed for purposes of storage *or* transportation *or* disposal (single purpose); storage *and* transportation (dual purpose); or storage, transportation, *and* disposal (multi-purpose).
effective enrichment	The ratio of the fissile mass to the sum of the Total U plus Total Pu expressed as a percentage.
enrichment (uranium)	The ratio of the fissile uranium mass (i.e., U-233 and U-235) to the total uranium mass expressed as a percentage.
fissile	A material whose nucleus is capable of being split (fissioned) by thermal (slow) neutrons.
fuel assembly(ies)	Arrays of fuel rods (typically for light water reactors) that are spaced and held in place mechanically (e.g. PWR & BWR fuel assemblies). An assembly is usually made up of a group of rods, elements, or plates. The grouping of nuclear fuel rods remain together during the charging and discharging of a reactor core.

	Entire assemblies are replaced during refueling and handled as a unit until disassembled.
fuel element/rod	A component of nuclear fuel containing the fissile material. Comes in a variety of shapes and sizes. May or may not be made of rods. Several elements may make up an assembly. The fuel may be in a form (geometry) that can either alone or in an assembly can be or has been used in a reactor designed to use that form.
high-level waste	The highly radioactive waste material that results from the reprocessing of SNF, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.
heavy metal	Heavy metal is defined as all isotopes of plutonium, thorium, and uranium and is either measured in kilograms (kg HM) or metric tons (MTHM).
kilograms of heavy metal	Kilograms of Heavy Metal (KgHM) – 1 MTHM = 1000 KgHM (DOE-1995).
metric tons of heavy metal	Metric Tons of Heavy Metal (MTHM)-Quantities of unirradiated and spent nuclear fuel and targets are traditionally expressed in terms of metric tons of heavy metal (typically uranium), without the inclusion of other materials, such as cladding, alloy materials, and structural materials (DOE 1995).
metric tons of uranium	Metric Tons of Uranium (MTU)- 1MTHM = 1MTU (DOE 1995).
multi-purpose canister system	SNF container system can be designed for purposes of storage *or* transportation *or* disposal (single purpose); storage *and* transportation (dual purpose); or storage, transportation, *and* disposal (multi-purpose).
off-link doses	Doses to members of the public within 800 meters (2,625 feet) of a road or railway.
on-link doses	Doses to members of the public sharing a road or railway.
overpack	Specialized devices used in combination with canisters to provide shielding and structural support for transportation and storage purposes.

passivation	The process of making metals inactive or less chemically reactive. For example, to passivate the surface of steel by chemical treatment.
Record of Decision (ROD)	A public document that records the final decision(s) concerning a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process or the National Environmental Policy Act (NEPA) process, both of which take into consideration public comments and community concerns.
shipment	The transport of a single transportation cask or overpack and its contents. Several casks or overpacks may be transported on the same train, so the number of rail shipments will likely exceed the number of trips required by the train. For non-radiological impact assessment, the shipment includes an empty return trip.
shipping container	A specially designed large container used to transport SNF on a railcar. Shipping container designs are certified by the Nuclear Regulatory Commission and the Department of Transportation for the shipment of SNF.
spent nuclear fuel (SNF)	Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated. For the purposes of this document, SNF also includes uranium/neptunium target materials, blanket subassemblies, pieces of fuel, and debris.
stabilization (of SNF)	Actions taken to further confine or reduce the hazards associated with SNF, as necessary for safe management and environmentally responsible storage for extended periods of time. Activities that may be necessary to stabilize SNF include canning, processing, and passivation.
standard canister	A concept currently under consideration consisting of four standardized canister designs (18 or 24 inches in diameter and 10 or 15 feet long) potentially used for storage, transportation, and disposal of multiple DOE SNF assemblies. The standard canisters may generally be configured with 4 or 5 high-level radioactive waste (HLW) canisters for co-disposal as a single waste package. Disposal of each standard canister of DOE SNF along with HLW rather than additional DOE SNF reduces the fissile loading of each waste package and, thereby, enhances criticality prevention. This analysis assumes that the standard canisters are placed in a DPC for storage and transportation purposes.

storage overpack	An overpack used to house canisters during storage whose primary purpose is to provide radiation shielding.
transportation overpack	An overpack used to transport SNF canisters whose primary purpose is to provide radiation shielding and structural strength during transport. Synonymous with transportation cask for SNF in canisters.
truck trip	Synonymous with truck shipment. The transport by truck of a single transportation cask or overpack and its contents. For non-radiological impact assessment, the shipment includes an empty return trip.