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Supplement Analysis for the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program

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ACRONYMS

BR-2	Belgian Reactor-2
CFR	*Code of Federal Regulations*
DOE	Department of Energy
DOS	Department of State
DOT	Department of Transportation
FCA	Fast Critical Assembly
FR	*Federal Register*
FRR SNF	foreign research reactor spent nuclear fuel
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INL	Idaho National Laboratory
ISO	International Organization for Standardization
JBC	Joint Base Charleston – Weapons Station
JMTR	Japan Materials Testing Reactor
JMTRC	Japan Materials Testing Reactor Critical Facility
JRR-3	Japan Research Reactor 3
JRR-4	Japan Research Reactor 4
KUR	Kyoto University Reactor
LCF	latent cancer fatality
LEU	low-enriched uranium
MEI	maximally exposed individual
MTHM	metric tons of heavy metal
MTR	Materials Test Reactor
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
ROD	Record of Decision
SA	Supplement Analysis
SOI	Statement of Intent
SRS	Savannah River Site
TRIGA	Training, Research, Isotope, General Atomics
Y-12	Y-12 National Security Complex

SUPPLEMENT ANALYSIS FOR THE FOREIGN RESEARCH REACTOR SPENT NUCLEAR FUEL ACCEPTANCE PROGRAM

1.0 INTRODUCTION AND BACKGROUND

The Foreign Research Reactor Spent Nuclear Fuel (FRR SNF) Acceptance Program (hereinafter, the Acceptance Program) was begun by the Department of Energy (DOE) and the Department of State (DOS) in 1996 with the announcement of the Record of Decision (ROD) for the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (61 *Federal Register* [FR] 25092). Under the Acceptance Program, the United States accepts eligible[1] spent fuel and target[2] material containing uranium of U.S. origin. DOE and DOS detailed the types of material accepted in the ROD published on May 19, 1996 (61 FR 25092). (Prior to the decision to implement the Acceptance Program, DOE prepared the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS)* (DOE 1996). The original Acceptance Program was valid for 10 years for irradiation of material in eligible reactors and 13 years for receipt of material from eligible reactors. In 2004 (69 FR 18006) DOE and DOS decided to extend the Acceptance Program for 10 years for both irradiation and receipt. In 2009 the Acceptance Program was expanded (74 FR 4173) to include non-U.S. origin uranium, and FRR SNF that DOE had not previously included.

The first extension of the Acceptance Program officially concluded on May 12, 2016. Under the current program, fuel irradiation must have ended by that date for fuel to be eligible for return to the United States. The Acceptance Program allows an additional 3-year window for fuel cool down and transportation of SNF elements. The end of this shipping window is May 12, 2019.

The Acceptance Program is managed by the National Nuclear Security Administration's (NNSA) Office of Material Management and Minimization.[3] It has been successful in meeting the goal of reducing the amount of highly enriched uranium (HEU) in civil commerce by returning U.S. origin HEU to the United States for secure storage, management, and disposition. Now, NNSA is proposing that the Acceptance Program be extended through May 12, 2029. However, permission to continue to return Acceptance Program material is being severely restricted and exemptions to the May 12, 2019 end date will be only be granted where there is clear justification to do so. NNSA would determine the date by which fuel irradiation must end based on a variety of factors including, but not limited to, characteristics of the fuel; extent to which the fuel was irradiated; necessary cooldown times; and time requirements for preparation, packaging, transport, and receipt at the Savannah River Site (SRS) or the Idaho National Laboratory (INL). If exemptions are granted, the United States would still receive substantially less spent

[1] Eligible FRR SNF is fuel and target material listed in Tables 2-1 and 2-2 of the *FRR SNF EIS* (DOE 1996), and a relatively small amount of material included in DOE 2009.

[2] FRR SNF is defined in DOE's 1996 ROD (61 FR 25092) to include HEU and low-enriched uranium (LEU) SNF, both aluminum-based and Training Research Isotope General Atomics (TRIGA) of United States origin, unirradiated HEU and LEU from eligible reactors, and target materials. Hereinafter these materials are referred to as FRR SNF. Targets are solid elements containing uranium that, when irradiated in a nuclear reactor, are converted to desirable radioisotopes, such as molybdenum-99, used for medical applications.

[3] NNSA is a separately organized agency within DOE. NNSA prepared this Supplement Analysis (SA). The *Environmental Impact Statement on a Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS)* was prepared prior to the formation of NNSA; the *FRR SNF EIS* and all other references in this SA are cited as DOE documents.

fuel than DOE estimated at the inception of the Acceptance Program in 1996 (see Section 4.1, Table 1, of this Supplement Analysis [SA]).

In the *FRR SNF EIS*, DOE evaluated the environmental impacts of acceptance of approximately 19.2 metric tons of heavy metal (MTHM) of FRR SNF and approximately 0.6 MTHM of target material into the United States over a 13-year period, beginning on the effective date of the policy, May 12, 1996. Subsequent National Environmental Policy Act (NEPA) reviews and DOE decisions have added types of material and small quantities of fuel and extended the length of the Acceptance Program. DOE addressed the FRR SNF that could be received under the proposed action evaluated in this SA in the *FRR SNF EIS* or subsequent NEPA reviews. Implementation of the proposed action would not increase the total quantity of FRR SNF included in the Acceptance Program in 1996. Only eligible fuel would be considered for an exemption to the May 12, 2019 end date.

1.1 Policy on Exemptions

The NNSA Administrator signed the Policy on Exemptions to the FRR SNF Acceptance Program (hereinafter referred to as the "Policy on Exemptions") on December 22, 2016. NNSA is proposing to extend the FRR SNF Acceptance Program, subject to the Policy on Exemptions, through May 12, 2029. Proposed receipts through that date will be considered on a case by case basis. NNSA will grant exemptions from the shipping and receiving deadline only for cases where there is clear justification to do so. All other previously established requirements would continue to apply.

The Policy on Exemptions provides three examples of factors NNSA would consider when deciding whether to grant an exemption:

1. An HEU research reactor is shutdown or converted to operate with low-enriched uranium (LEU);
2. A clear nonproliferation justification exists, including the removal of a significant amount of HEU and/or separated plutonium[4] from a nuclear facility; or
3. A facility meets the criteria of the Acceptance Program prior to the deadline in 2019, but is unable to complete the shipping campaign for reasons outside of its control.

NNSA would base the length of an exemption, if granted, on the timely commitment of the country involved to the goals of the Acceptance Program, technical issues related to any reactor conversion to LEU fuel or shutdown, and logistical issues such as transportation and U.S. storage availability. The exemption would be commensurate with the amount, purity, and vulnerability of the material involved. Plans for ultimate disposition of the material would also be a factor in determining whether to grant an exemption to a particular country. NNSA would consult closely with DOE's Office of Environmental Management, which manages FRR SNF storage facilities and other disposition capabilities at SRS and INL, when deciding whether to grant an exemption.

NNSA would only grant exemptions for FRR SNF eligible for return under the Acceptance Program, including material described in the ROD for the *FRR SNF EIS* (61 FR 25092) and the 2009 amended ROD for Gap Material – Spent Nuclear Fuel (74 FR 4173).

The Policy on Exemptions states that any exemption would be subject to completion of the appropriate NEPA analysis. This SA is the required NEPA review. It provides an assessment of the potential

[4] The exemption policy mentions separated plutonium. NNSA prepared the *Environmental Assessment for GAP Material Plutonium – Transport, Receipt, and Processing* (DOE 2015b) to evaluate management of separated weapons-usable plutonium from foreign nations. NNSA issued a Finding of No Significant Impact on December 28, 2015. NNSA does not address separated weapons-usable plutonium from foreign nations in this SA.

environmental impacts of implementing the Policy on Exemptions. NNSA would review proposed individual exemptions to ensure that impacts are addressed in the *FRR SNF EIS* and this SA.

1.2 Statement of Intent Between the United States and Japan

In advance of the 2014 Nuclear Security Summit in The Hague, the Netherlands, the United States and Japan signed a Statement of Intent (SOI) Concerning Cooperation on Nuclear Security and Spent Nuclear Fuel Management (see Appendix A). This SOI included a commitment by Japan to remove all HEU and plutonium from the Japan Atomic Energy Agency's Fast Critical Assembly (FCA) to the United States. This material is eligible for transfer to the United States under the Acceptance Program. The removal of nuclear material from FCA, completed in 2016, is a key example of a significant nonproliferation objective meriting an exemption to the program end date, as outlined in the Policy on Exemptions.

Under the SOI, the United States and Japan agreed to cooperate to remove Materials Test Reactor (MTR) spent fuel elements from the:

- Japan Materials Testing Reactor (JMTR)
- Japan Materials Testing Reactor Critical Facility (JMTRC)
- Japan Research Reactor 3 (JRR-3)
- Japan Research Reactor 4 (JRR-4)
- Kyoto University Reactor (KUR)

All MTR spent fuel elements included in the SOI meet the Acceptance Program criteria. *Section II item 3* of the 2014 SOI says that implementation of activities in the SOI is subject to completion of appropriate documentation pursuant to NEPA. This SA constitutes that documentation.

Under the proposed Policy on Exemptions, eligible MTR spent fuel elements would be accepted by the United States through May 2029, with a limit of 2,100 MTR fuel elements in addition to those already transferred (through the Acceptance Program) as of the commencement date of the SOI.

As discussed in Section 1.3, in addition to the MTR fuel, the United States may also remove some unirradiated HEU material from JRR-3 and JRR-4.

1.3 HEU Shipments

The United States takes back other unirradiated, or fresh, HEU materials and transports it to the Y-12 National Security Complex (Y-12) at Oak Ridge, Tennessee. NNSA has evaluated the impacts of transport of unirradiated HEU from foreign countries by sea and air in the *Supplement Analysis for the Air and Ocean Transport of Enriched Uranium between Foreign Nations and the United States* (DOE 2006). NNSA discussed the impacts of overland transport of HEU to Y-12 in the *Final Site-Wide Environmental Impact Statements for the Y-12 National Security Complex* (DOE 2001, 2011). NNSA provides more information on the NEPA reviews in Appendix B of this SA. While the HEU return program is not the subject of this SA, Japan or another country eligible for an exemption may ship HEU materials or other materials with FRR SNF. Such materials are not associated with the Acceptance Program; however, NNSA considers these ancillary shipments in this SA only for the potential contribution to cumulative crew doses and accident consequences.

1.4 Training Research Isotope General Atomics (TRIGA) Fuel

The Acceptance Program applies to aluminum-based fuel and to TRIGA fuel, which may be clad with Incoloy, aluminum, or stainless steel. In accordance with DOE's decision to consolidate SNF (from both foreign and domestic research reactors) by fuel type (60 FR 28680, June 1, 1995), NNSA ships spent aluminum fuel to SRS and all spent TRIGA fuel, including aluminum-clad TRIGA, to INL. Any fuel NNSA would receive because of an exemption, other than Canadian fuels, would be shipped to Joint Base Charleston-Weapons Station (JBC). NNSA expects that the majority would be aluminum fuel, which NNSA would ship from JBC to SRS. However, reactors using TRIGA fuel may meet the exemption criteria and be granted exemptions, and NNSA would ship the TRIGA fuel to INL. In accordance with the Policy on Exemptions, NNSA, in consultation with DOE's Office of Environmental Management, would assess the availability of storage space for TRIGA fuel at INL prior to granting an exemption.

2.0 PURPOSE AND NEED, AND PROPOSED ACTION

2.1 Purpose and Need

Reducing the threat posed by the proliferation of nuclear weapons and nuclear materials is a foremost goal of the United States. NNSA's objective is to reduce, and to the extent possible, eliminate, HEU from civil commerce worldwide. The last date for receipt of fuel under the Acceptance Program is May 12, 2019 (69 FR 69901). The Acceptance Program has removed approximately five metric tons of HEU and LEU[5] from 35 countries worldwide. Building on this success, NNSA proposes to extend the Acceptance Program beyond May 2019 and apply the Policy on Exemptions to permit return of eligible fuel on a case by case basis. Opportunities remain to remove HEU materials from civil commerce and therefore NNSA needs the ability to continue to remove FRR SNF from international commerce when the proper circumstances arise.

2.2 Proposed Action

NNSA proposes to extend the Acceptance Program through May 12, 2029 and implement the Policy on Exemptions. Exemptions for the return of eligible FRR SNF could be granted to allow receipt of FRR SNF until May 12, 2029. If NNSA decides to implement the Policy on Exemptions, any FRR SNF received by the United States would be eligible (see DOE 1996: Tables 2-1 and 2-2, and 2009). The amount of FRR SNF and the number of shipments received under exemptions, when added to the quantity received to date, would remain very substantially less than the amount analyzed in the *FRR SNF EIS*.[6] Any FRR SNF received by the United States because of an exemption would be safely stored pending disposition.

2.3 Description of Activities

NNSA would ship FRR SNF to the United States after May 2019 in Type B packaging in compliance with U.S. and international standards for safe transport of radioactive materials. These standards include International Atomic Energy Agency (IAEA) Safety Standard Series Number SSR-6, *Regulations for the Safe Transport of Radioactive Material* (IAEA 2012), and Title 10 of the *Code of Federal Regulations* (CFR), Part 71 (10 CFR Part 71, *Nuclear Regulatory Commission Regulations for Packaging and Transportation of Radioactive Materials*).

[5] See Section 4.1 of this SA for details.

[6] See Table 1, Section 4.1.1 of this SA for details.

DOE evaluated a variety of Type B packages for transporting FRR SNF in the *FRR SNF EIS* (DOE 1996). While the various Type B packages differ in terms of characteristics (for example, dimensions, weight, the type and quantity of SNF accommodated, the minimum SNF cooling time before shipment, the maximum activity, and the maximum uranium-235 content), they meet the same regulatory requirements, and the impacts associated with the use of any given Type B package would be essentially the same as those resulting from the use of any Type B package. NNSA projects, contingent upon completing this NEPA evaluation, the shipment of 26 Type B packages of FRR SNF from Japan after May 2019 in nine JRC-90Y-20T (JRC-90Y) Type B packages and 17 JMS-87Y-18.5T (JMS-87Y) Type B packages, in up to six ocean voyages. The Type B packages would be secured for transport on skids in open International Organization for Standardization (ISO) racks (Dunsmuir 2017a). The largest shipment is projected to consist of two JRC-80Y Type B packages and four JMS-87Y Type B packages (Dunsmuir 2017a). All packages would be Type B packages. NNSA assumes, for purposes of analysis only, that NAC-LWT Type B packages in 20-foot ISO containers would be used for transport of potential exemption shipments.

Implementation of the Policy on Exemptions would not result in any change in the processes of preparing materials for transport; the types of ships used or routes taken for open-ocean transportation; port activities at either end of the transportation process in terms of loading and unloading packages; the modes of overland transport (for example, truck or rail) used between the port and the final destination (for example, SRS or INL) or for associated waste disposition; materials handling, storage, and processing at the destination facility; or final disposition.

3.0 AFFECTED ENVIRONMENT

3.1 Elements of the Affected Environment Considered But Not Analyzed in Detail

Implementation of the Policy on Exemptions would result in no or negligible impacts upon the following elements of the affected environment:

- Global Commons/Marine Resources – The global commons include the world's oceans as described in the *FRR SNF EIS* (DOE 1996) and the SA for Gap Material-Spent Nuclear Fuel (DOE 2009). The proposed Policy on Exemptions would not result in any increase in shipments or changes in routes associated with the Acceptance Program, increases in probability or severity of accidents, or substantial increases in radiological impacts on workers or the public.
- Cultural, Biological, and Visual Resources – The Policy on Exemptions involves no land-disturbing activities, new construction, or changes to existing structures. Because the number of shipments will be fewer than analyzed in the *FRR SNF EIS* (DOE 1996), no increase in impacts on marine environments is anticipated.
- Geology and Soils – The Policy on Exemptions involves no land-disturbing activities or new construction.
- Air Quality – The Policy on Exemptions would not involve any substantial increase in material received or operational activities that would increase or change air emissions.
- Water Resources – The Policy on Exemptions would not substantially increase water or decrease use or effluent generation, or result in increased discharges to surface water or groundwater.
- Socioeconomics – The Policy on Exemptions would not substantially increase or decrease local or regional expenditures or result in the loss or creation of employment opportunities.

- Environmental Justice – The Policy on Exemptions would not result in the placement of new facilities or increases in emissions that would affect any population, including minority or low-income populations.

3.2 U.S. Sites for Receipt and Storage of FRR SNF

3.2.1 Joint Base Charleston – Weapons Station

JBC, a military installation located approximately 25 miles (40 kilometers) north of metropolitan Charleston, South Carolina, offers a secure site that is conducive to receiving and transferring FRR SNF from ships to overland transport vehicles. In addition to the restricted access, there are secure parking areas where the transporters can be staged prior to driving to the wharf for cargo loading (DOE 2015a). JBC routinely receives marine shipments of SNF and other nuclear materials.

The greater Charleston area is a major seaport on the east coast of the United States. The principal shipping terminals are along the west bank of the Cooper River, north of the city of North Charleston and about 19 miles (31 kilometers) upriver from the Atlantic Ocean. The highway system in the area includes Interstates 26 and 526 and U.S. Routes 17 and 52. These major highways are supplemented by interconnecting primary state highways that provide access to JBC (DOE 2015a).

JBC encompasses more than 17,000 acres (6,900 hectares), including 10,000 acres (4,000 hectares) of forest and wetlands, 16 miles (26 kilometers) of waterfront, four deep-water piers (including piers capable of unloading transport containers directly from ships), 38 miles (61 kilometers) of railroad, and 292 miles (470 kilometers) of road. The base provides ordnance storage capability and other material supply and support functions and can load and unload cargo directly between vehicles and ships (MARCOA Publishing, Inc. 2015).

According to the 2010 census, approximately 773,000 people lived within 50 miles (80 kilometers) of the docks at JBC; and approximately 737,000 people lived within 50 miles (80 kilometers) of the Charleston harbor, through which vessels pass to enter the Cooper River. For the analyses in this SA, NNSA has projected these populations to 2030, at which time it is estimated that these figures would be 1.4 million and 1.3 million, respectively NNSA assumes that natural background radiation dose to an average individual in the population near JBC is the same as that to an average individual in the United States (approximately 311 millirem per year) (NCRP 2009).

3.2.2 Savannah River Site

SRS occupies 80,270 hectares (198,344 acres) in south-central South Carolina adjacent to the Savannah River, about 12 miles (19 kilometers) south of Aiken, South Carolina, and 25 miles (40 kilometers) southeast of Augusta, Georgia. Vehicular access to SRS is provided by South Carolina State Highways 19, 64, 125, and 781; and U.S. Highway 278. Interstate 20 is about 20 miles north of the site. Major nuclear facilities at SRS have included fuel and target fabrication and storage facilities, nuclear material production reactors, chemical separations and tritium processing facilities, and radioactive waste management facilities (DOE 2009). Additional information about SRS may be found in Section 3.3.1 of the *FRR SNF EIS* (DOE 1996) and Chapter 3 of the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE/EIS-0283-S2) (DOE 2015a).

The majority of the FRR SNF that is the subject of this SA would be shipped to SRS. Receipt and storage operations and practices would not change as a result of implementing the Policy on Exemptions, and the quantity of material received and stored would be less than that analyzed in the *FRR SNF EIS* (DOE 1996). NNSA would consult with DOE's Office of Environmental Management, as required by the Policy on Exemptions, regarding appropriate storage of materials. The facility recommended for storage would be evaluated against the characteristics of the SNF, the documented safety analysis would be reviewed and revised as appropriate, and any issues concerning available space and scheduling would be resolved. NNSA expects that any necessary acceptance conditioning (i.e., cladding removal, size reduction, placement in a sealed canister) of the FRR SNF would be completed in the country of origin prior to shipment to the United States.

3.2.3 Idaho National Laboratory

INL is located in southeastern Idaho and consists of several facilities, each occupying less than 2 square miles with an 890-square mile expanse of otherwise undeveloped, high-desert terrain (DOE 2014) about 34 miles (55 kilometers) west of Idaho Falls, Idaho. U.S. Highways 20 and 26 are the main access routes to the southern portion of INL, while State Route 33 provides access to the northern INL facilities. The site was founded in 1949 as the National Reactor Testing Station. DOE and its predecessor agencies have conducted basic and applied nuclear and radiological science research at INL since its founding (DOE 2014). One of INL's primary missions is management of naval nuclear fuel. Additional information about the INL affected environment is available in Section 3.3.2 of the *FRR SNF EIS* (DOE 1996) and in Chapter 3 of the *Final Environmental Impact Statement for the Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling*, DOE/EIS-0453F (DOE 2016).

In accordance with DOE's decision to consolidate SNF (from both foreign and domestic research reactors) by fuel type (60 FR 28680, June 1, 1995), DOE ships spent aluminum-based fuel to SRS and spent TRIGA fuel to INL. This decision would apply to any exemption shipments.

4.0 FOREIGN RESEARCH REACTOR SPENT FUEL ACCEPTANCE PROGRAM 1996-2017

This section summarizes actual and projected receipts of FRR SNF since the inception of the Acceptance Program. It describes the assumptions DOE used for the impact analysis in the *FRR SNF EIS* (DOE 1996) and compares the assumptions to data from actual experience in implementing the Acceptance Program since 1996. Section 5.0 of this SA describes the revised assumptions used for analysis; more detail is found in the *Transportation Analysis Report for Exemptions to the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program* (Transportation Analysis Report) (Leidos 2018).

This SA examines only those aspects of the proposed Policy on Exemptions that may have changed since prior analyses were conducted. As discussed in Section 3.0, some elements of the Acceptance Program are not subject to re-evaluation in this SA because they are substantially unaffected by the proposed change in the deadline for receipt. For other purposes, however, some of these elements were reviewed in the transportation analysis and, since some minor changes in assumptions were made, a brief discussion of these elements is included in the following sections.

4.1 Projected and Actual Receipts

Table 1 compares the total number of fuel elements, the uranium mass before irradiation in nuclear reactors, and the number of Type B packages containing FRR SNF projected in the *FRR SNF EIS* (DOE 1996) and subsequent NEPA documents (DOE 2009, 2012) with the number of fuel elements, uranium mass, and number of Type B packages actually received and projected through 2029 (Dunsmuir 2017a, 2017b) and shows the differences. This table includes shipments that could be received from Japan in accordance with the SOI and potential shipments from Canada. A detailed breakdown of FRR SNF receipts and projected receipts is found in Leidos 2018.

The quantity of FRR SNF that NNSA could receive by May 2029, including fuel already received, is far less than that projected in the *FRR SNF EIS* (about 7.0 MTHM versus the originally projected 19.2 MTHM). The number of Type B packages of FRR SNF received to date and projected through May 2029 is much less than originally projected: 355 total Type B packages rather than the 958 Type B packages projected in the *FRR SNF EIS* and subsequent NEPA documents, including 286 Type B packages rather than 792 Type B packages transported to the United States by ocean vessel. These projections include Japanese and Canadian fuel. If the Policy on Exemptions is implemented, additional FRR SNF could be received, but NNSA expects the quantities would be small relative to the projected receipts from Japan.

Table 1. Summary of FRR SNF Fuel Elements, Uranium Mass, and Number of Type B Packages Under the Acceptance Program

Parameter	*Ocean Transport to United States, Aluminum-based SNF*	*Overland Transport from Canada to United States, Aluminum-based SNF*	*Ocean Transport to United States, TRIGA SNF*	*Total*
Material Originally Projected for Acceptance [a]				
Fuel elements	15,068	2,831	4,940	22,839
Uranium mass (MTHM) [b]	13.706	4.478	1.033	19.217
Type B packages	629	166	163	958
Material Accepted and Projected for Acceptance by May 2029 [c]				
Fuel elements	8,859	1,201	2,502	12,562
Uranium mass (MTHM) [b]	6.308	0.244	0.439	6.991
Type B packages	258	69	28	355
Difference Between Material Originally Projected and Accepted and Currently Projected				
Fuel elements	-6,209	-1,630	-2,438	-10,277
Uranium mass (MTHM) [b]	-7.398	-4.234	-0.594	-12.22
Type B packages	-371	-97	-135	-603

FRR = foreign research reactor; MTHM = metric tons of heavy metal; SNF = spent nuclear fuel; TRIGA = Training, Research, Isotopes, General Atomics.

[a] Source: DOE 1996, 2009, 2012.

[b] Uranium mass in nuclear fuel before irradiation in foreign research reactors.

[c] Dunsmuir 2017a, 2017b. Includes potential receipts from Japan and Canada.

4.2 Changes in Assumptions and Conditions

DOE made certain assumptions for analysis purposes when it prepared the *FRR SNF EIS*. In the 20 years since that time, DOE and NNSA have accumulated data relative to those assumptions. The following sections describe what the data reveal about those assumptions.

4.2.1 External Radiation Levels

In the *FRR SNF EIS*, DOE evaluated impacts using two external radiation levels for the FRR SNF shipping Type B packages: (1) a dose rate equivalent to the regulatory limit for shipment (10 millirem per hour at 2 meters [6.6 feet] from the cask surface); and (2) a dose rate one-tenth of the regulatory limit based on experience with shipping FRR SNF at the time of preparation of the *FRR SNF EIS*. The analysis in this SA also considers these two radiation levels. As described in the following paragraphs, radiation surveys performed on shipments received since issuance of the *FRR SNF EIS* show that for more than 2 decades, average external radiation levels have been at most one tenth of the regulatory limit, and often substantially less than that.

NNSA's analysis of FRR SNF Type B packages received from 1996 through April 2004 (DOE 2004) showed that the doses from exposure to external radiation from these Type B packages were about 40 times less than the doses determined using the assumptions for analysis in the *FRR SNF EIS*.

In the *2009 Gap Material SNF SA* (DOE 2009), NNSA reported surface radiation levels for FRR SNF Type B packages received from August 2004 through September 2008. The peak surface total dose rate for these Type B packages ranged from 0.02 to 65.5 millirem per hour, with an average peak surface total dose rate of 10.2 millirem per hour. The average surface dose rate was 4.1 millirem per hour, or a factor of about 17 less than the surface dose rate assumed for the *FRR SNF EIS* analysis.

NNSA evaluated radiological survey data from FRR SNF shipments received from 2004 through July 2017 for preparation of this SA. These data consist of documentation prepared at the foreign reactor or seaport, as well as surveys of shipments received at JBC (Leidos 2018). The average dose rate at 2 meters from the surfaces of the ISO containers was about 1 millirem per hour, a factor of about 10 less than the regulatory limit of 10 millirem per hour at 2 meters from a conveyance surface.

4.2.2 Type B Packages Used for Ocean Transit

In the *FRR SNF EIS,* DOE postulated that FRR SNF would be shipped using a variety of Type B packages. Shipment documentation from 2004 through July 2017 shows that 93 Type B packages were received during this period, of which 71 were from countries other than Japan. Of these 71 Type B packages, 45 (63 percent) were NAC-LWT Type B packages, 14 (20 percent) were GNS16 Type B packages, and 12 (17 percent) were TN-7/2 or TN-MTR Type B packages. NNSA would continue to use a variety of Type B packages.

4.2.3 Ocean Transit Time

The radiation doses that a ship's crew could receive while transporting FRR SNF depend on the ocean transit time. In the *FRR SNF EIS,* DOE estimated an average travel time, from all 40 countries evaluated, of about 21 days, accounting for the potential use of ports on either the east or west coast of the United States, and assuming unrestricted passage through the Suez or Panama Canals (DOE 1996). This average travel time was based on an average vessel speed of 15 knots and included a 3-day contingency to account for possible additional port stops. The *FRR SNF EIS* also considered a second average voyage of about 18 days, a voyage with no stops between the port of origin and the United States. A subsequent NEPA document, the *Supplement Analysis of Acceptance of Foreign Research Reactor Spent Nuclear Fuel Under Scenarios Not Specifically Mentioned in the EIS* (DOE 1998), reported that a more reasonable average vessel speed was 12 knots; using this assumption the average length of a voyage would increase by about 25 percent.

For the transportation analysis developed for this SA, NNSA determined the travel time from Japan to JBC. Assuming an average cruising speed of 12 knots (DOE 1998), and departure from Yokohama as a representative port, NNSA estimated a travel time of about 33 days, assuming travel through the Panama Canal. NNSA does not anticipate additional travel time due to stops at another seaport for additional cargo. If the Panama Canal were not transited, a voyage around the Cape of Good Hope would require about 53 days.

For the potential exemption ocean shipments, NNSA evaluated voyages of 25 and 60 days. The 25-day voyage, assuming a 12-knot average vessel speed and a possible 3-day stop at a secondary port, would envelope the time for shipment from countries in Europe, the Mediterranean region, the Caribbean, the east coast of South America, and, except for South Africa,[7] the west coast of Africa. All South American countries would be enveloped if passage through the Panama Canal were assumed. This 25-day travel time would envelope travel from about three-quarters of all the countries identified in the *FRR SNF EIS* (DOE 1996) and subsequent NEPA documents (DOE 2009, 2012). The 60-day voyage would envelope the travel time from anywhere in the world. The 60-day voyage assumes an average cruising speed of 12 knots and travel from a representative port in the Far East without passage through the Suez or Panama Canal (DOE 2010).[8]

4.2.4 Seaport Activities

In the *FRR SNF EIS*, DOE estimated projected radiation doses during seaport activities in two ways. First, DOE assumed that five members of the ship's crew would assist in unloading operations, and that 65 minutes would be required to unload a Type B package at a U.S. seaport. Assuming the external radiation levels of the Type B packages were at the regulatory limit and considering radiation exposures from another Type B package in the work vicinity, DOE estimated that the total crew dose from unloading two Type B packages would be about 0.041 person-rem (DOE 1996).[9]

Second, in Appendix D of the *FRR SNF EIS*, DOE assessed the doses to a variety of persons at the dock by: (1) assuming tasks; (2) estimating the exposure distances, dose rates, and exposure times; and (3) projecting the total worker dose as well as the maximum individual dose (DOE 1996). **Table 2** summarizes the per-Type B package collective dose among dock workers, where about 96 percent of the collective dose would be received by port handlers (longshoremen), observers, and inspectors. DOE assumed that the maximally exposed dock worker would be an inspector who would receive an estimated dose of 1.3 millirem. These doses are for transfer of Type B packages assuming the external radiation levels at 2 meters (6.6 feet) from the Type B package surfaces were at the regulatory limit.

Table 2. Per-Type B Package Port Worker Collective Doses from the *FRR SNF EIS*

Exposed Workers	*Number of Workers*	*Collective Dose (person-rem)* [a]
Port Handlers (Longshoremen)	9	0.0015
Crane Operators	2	0.00011
Truck Driver	1	0.00038
Observers	54	0.0041
Inspectors [b]	6	0.0053
Total Collective Dose per Cask (person-rem)		**0.011**

[a] DOE assumed for analysis that the radiation levels at the surfaces of the Type B packages would be at regulatory limits (10 millirem/hour at 2 meters from the Type B package surface), and that the workers would be exposed to one or more additional sources of radiation while handling a Type B package.

[b] Includes U.S. Coast Guard, DOE, Nuclear Regulatory Commission, State, and local/port Inspectors, and the representative receiving the FRR SNF at the seaport.

Source: DOE 1996.

[7] The travel time from Cape Town, South Africa, to Charleston, South Carolina, is about 27 days assuming a 3-day stop at another port, or about 24 days assuming a direct voyage.

[8] NNSA determined the 60-day voyage by selecting the port of Kushiro on the northern Japanese island of Hokkaido as a hypothetical starting point for all shipments from the Far East. The analysis resulted in a voyage of 58.1 days including a 3-day contingency, which was rounded to 60 days (DOE 2010).

[9] For the *FRR SNF EIS* analysis DOE assumed that 5 members of a ship's crew would require 65 minutes to load a cask onto a ship.

NNSA obtained information on the numbers and types of personnel and the time required for performing various tasks during Type B package unloading and transfer operations from two recent shipments of FRR SNF from foreign countries (Jackson 2017a, 2017b). This limited documentation indicates personnel requirements and time required to perform certain operations differed somewhat from those DOE assumed for the *FRR SNF EIS*. Those differences, discussed in detail in the Transportation Analysis Report (Leidos 2018) are summarized in **Table 3.**

Table 3. Summary of Changed Port Operations Assumptions for Radiation Exposure Analysis

Assumption	*FRR SNF EIS*	*Current Analysis*
Time to remove packages from ship (minutes)	60	25
Crew members assisting in removing packages from ship	5	2-3
Personnel unlatching packages and attaching to crane	2-4	3-4
Personnel securing cargo to transport vehicles	2-4	3-4
Inspectors and receiving official	5 Inspectors + 1 receiving official	8-11 inspectors + 1 receiving official
Individual receiving largest exposure	Inspector	Worker preparing package for removal from ship

Considering this limited information, NNSA updated the analysis of dock worker doses to reflect the potential for additional cumulative dose among inspectors because more of them may be present at JBC than DOE assumed for the *FRR SNF EIS* analysis. Because the data from the recent shipments indicated that the maximally exposed worker might not be an inspector, NNSA also performed a calculation for the potential dose to a worker (port handler) rigging the Type B package for hoisting (the recipient in one documented shipment of the largest radiation dose from Type B package unloading operations).

4.2.5 Population Density

For the *FRR SNF EIS*, DOE determined the populations near the evaluated seaports using U.S. census data for 1990 projected to 2010 levels. DOE determined the populations along the overland transport routes between the ports of entry and the DOE management sites using 1990 census data. For this SA, NNSA determined the affected populations at JBC and along the overland transport routes using U.S. census data for 2010 projected to 2030 levels.

4.2.6 Revised Transportation Impact Analytical Tools

DOE identified truck and rail routes for the *FRR SNF EIS* analysis using the computer models HIGHWAY and INTERLINE, and available route population data. DOE used the RADTRAN 4 program to determine radiation doses and risks to transport crews and members of the public for incident-free and accident impacts. NNSA used updated versions or newer transportation impact computer models for the analyses presented in this SA (Leidos 2018).

NNSA calculated risk factors using the RADTRAN 6.02 computer code (SNL 2013), in conjunction with the Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003). DOE also updated some of the analytical assumptions for transport for this SA (Leidos 2018).

NNSA used revised traffic densities on the transport routes (SNL 2014), as well as revised stop rates for rest and refueling during transport, for the analyses in this SA. Revised security requirements implemented since the issuance of the *FRR SNF EIS* add measures (e.g., avoidance of populated truck stops) to reduce potential exposures to members of the public, which result in lower doses to populations during rest stops than those assumed for the *FRR SNF EIS*. The analyses of incident-free impacts in the *FRR SNF EIS* and this SA are based on one Type B package per truck. The analysis of rail transport in the *FRR SNF EIS* was based on 1 Type B package per railcar and 1 railcar per shipment. For this SA, to be consistent with NNSA's expectations for shipments from Japan, rail shipments of SNF are based on based on 2 Type B packages per railcar, and up to 3 railcars per rail shipment (6 Type B packages per shipment). Analysis of potential exemption shipments of SNF is based on 2 Type B packages per railcar and 1 railcar per shipment (2 Type B packages per shipment). This minimum configuration allows scaling to multiple rail cars and NNSA uses it here because the configuration of exemption shipments is not known at this time.

For postulated accidents during truck or rail transport, DOE assumed a neutral weather condition for the *FRR SNF EIS* analyses, with a wind speed of 4 meters per second (9 miles per hour); for this SA NNSA assumed the RADTRAN default weather condition, which is the average U.S. weather condition.[10] Radiological analyses for this SA were performed using dose factors in accordance with the International Commission on Radiological Protection (ICRP) Report ICRP-72 (SNL 2013), whereas the radiological analyses for the *FRR SNF EIS* were performed based on earlier ICRP reports and Federal Guidance Report Number 11 (EPA 1988).

4.2.7 Revised Radiological Risk Factor

For the *FRR SNF EIS*, DOE used risk factors of 0.0004 latent cancer fatalities (LCFs) per rem or person-rem for workers and 0.0005 LCFs per rem or person-rem for members of the public. In 2003, DOE updated the risk factors (DOE 2003), and consistent with NEPA documents since that time, NNSA used that risk factor, 0.0006 LCF per rem or person-rem, in this SA for workers as well as members of the public.

5.0 ANALYSIS AND DISCUSSION

5.1 Basis for Analysis

This section provides the basis for the analysis of impacts from transporting FRR SNF as described for the Proposed Action in Section 2.2. In particular, this section describes the differences between the assumptions used for the *FRR SNF EIS* (DOE 1996), as described in Section 4.0, and the assumptions used in the analyses for this SA. This section summarizes the transportation analysis performed for this SA (Leidos 2018).

This section focuses primarily on impacts to human health from shipments of FRR SNF by overland routes. Impacts from storage of FRR SNF, pending disposition, are briefly compared to the *FRR SNF EIS* analysis. Any changes in impacts to human health are the result of changes in the assumptions used for analysis, including changes in population along transportation routes and the number of workers on board ships and at JBC. In general, because the *FRR SNF EIS* evaluated transport and storage of a much greater number of shipments and fuel elements, and storage of a much larger number of fuel elements, and no new construction is needed to implement the proposed action, impacts in other areas, such as air and water quality, would be less than those DOE estimated in the *FRR SNF EIS*.

[10] When DOE prepared the *FRR SNF EIS*, the RADTRAN code used conservative assumptions. Code revisions over the intervening years have been made to make the analysis more accurate. Average U.S. meteorology is hardwired in the RADTRAN code. Because of the many changes to the code since the mid-1990s, it is impossible to determine the overall impact of individual changes such as neutral versus average wind conditions.

5.1.1 Spent Nuclear Fuel Receipts

Table 4 compares the number of Type B packages of FRR SNF originally projected (and analyzed in the *FRR SNF EIS* and associated NEPA documents) to be transported to the United States by ocean vessel or direct overland transport from Canada, with the number of Type B packages actually received or currently projected to be transported. DOE originally projected a total of 792 Type B packages of SNF would be shipped by ocean vessel; 286 have been received or are currently projected to be received, including 26 after May 2019. DOE originally projected a total of 166 Type B packages would be delivered by truck from Canada; a total of 69 have been or are currently projected to be received, including 43 after May 2019. Although many of these 43 Type B packages of SNF will likely be shipped before May 2019, NNSA assumed, to ensure a conservative analysis that all 43 Type B packages would be delivered after May 2019. Any potential additional shipments of SNF would be from the countries considered in the *FRR SNF EIS* and associated NEPA documents and would be in addition to the actual receipts and current projections shown in Table 4.

DOE assumed for the *FRR SNF EIS* (DOE 1996) analysis and associated NEPA documents (DOE 2009, 2012) that FRR SNF would be transported to the United States in 381 ocean voyages. NNSA conservatively estimates that actual and currently projected number of ocean voyages is no more than about 70 voyages, not including any potential exemption shipments (Leidos 2018). Because NNSA has not implemented the Policy on Exemptions, and it would not be implemented until May 2019, the number of exemption shipments is unknown. FRR SNF could be received as a result of exemptions, and NNSA expects the quantities would be small compared to the projected receipts from Japan.

Table 4. Originally Projected, Actual, and Currently Projected Numbers of Type B Packages of FRR SNF

	Originally Projected			*Actual and Currently Projected* [c]			
Country	*FRR SNF EIS* [a]	*Additional NEPA* [b]	*Total*	*As of May 2017*	*To May 2019*	*Through May 2029*	*Total*
Ocean Shipments							
All countries	721	71	792	251	9	26	286
Overland Shipments							
Canada	116	50 [d]	166	26	0 [e]	43 [e]	69

FRR = foreign research reactor; NEPA = National Environmental Policy Act; SNF = spent nuclear fuel.

[a] DOE 1996.

[b] DOE 2009, 2012. The *2009 Gap Material SNF SA* identified 36 Type B packages from specific countries other than Canada and evaluated the impacts from shipping an additional 34 Type B packages if additional countries and nuclear facilities were identified at a later date (DOE 2009). The *2012 SA for Austrian Fuel* evaluated impacts from shipping a single Type B package from Austria (DOE 2012).

[c] Dunsmuir 2017a, 2017b. This table includes shipments projected to be received through May 2029 from Japan and potentially from Canada.

[d] The *2009 Gap Material SNF SA* forecast the potential shipment of 41 Type B packages of SNF from Canada, but evaluated the impacts from shipping 50 Type B packages if shipping additional FRR SNF to the United States would be required.

[e] Although many of the projected 43 shipments of SNF from Canada will occur before May 2019, NNSA assumed to ensure conservative analysis that all of these shipments would occur after May 2019.

5.1.2 Updates to *FRR SNF EIS* Assumptions

In this SA the analyses of incident-free impacts are based on the assumption that the external radiation levels of the shipments would be at the regulatory limit. However, NNSA also provides a comparison with impacts based on external radiation levels of one-tenth of the regulatory limit. That value is based on two decades of experience with receipt of FRR SNF.

Principal additional analytical assumptions used for the analyses in this SA are as follows:

- The ocean travel time is based on an average vessel speed of 12 knots.
- NNSA assumes that shipments from Japan to JBC would require 33 or 53 days, depending on the route used; potential additional exemption shipments (i.e., not from Japan) would require 25 or 60 days.
- The ships' crew members potentially exposed to radiation are the same as those identified in the *FRR SNF EIS*.
- Japanese SNF would be shipped in Type B packages, such as JRC-80Y and JMS-87Y; potential additional exemption shipments (I.e., not from Japan) would be made in NAC-LWT or similar Type B packages.
- The 26 Type B packages of Japanese SNF would be shipped to the United States in six ocean voyages; the number of Type B packages per ocean voyage would vary from two to six.
- Overland shipment of Japanese SNF from JBC to SRS would be made in 26 truck shipments, with one Type B package per truck, or in six rail shipments. The number of Type B packages per rail shipment would range from two to six, matching the number of Type B packages in each ocean transport. The largest shipment of six Type B packages would be made using three railcars with two Type B packages per railcar.
- All shipments of Canadian SNF to SRS would be by truck, with one Type B package per truck.
- Any potential additional exemption shipments of aluminum-based SNF from JBC to SRS may be made by truck or rail; any potential additional exemption shipments of TRIGA SNF from JBC to INL would be made by truck only. For truck transport, there would be one Type B package per truck. For rail transport, there would be one railcar per shipment with two Type B packages per railcar.
- NNSA used updated analytical assumptions such as updated computer codes, stop times during transport, and radiation dose conversion factors for analysis of overland transport of SNF.

5.1.3 Population Changes at JBC and along Overland Transportation Routes

The *FRR SNF EIS* estimated population impacts for 2010 based on the 1990 population of 423,815 and a projected 2010 population of 592,200, an annual 1.7 percent growth rate (DOE 1996). The actual 2010 population within 50 miles (80 kilometers) of JBC was about 773,460, reflecting about an annual 3 percent growth rate since 1990 (Census 2010). Using an annual growth rate of 3 percent, NNSA determined potential radiological impacts on the population within 50 miles of JBC assuming a population projected to 2030 levels, or about 1.4 million people. NNSA evaluated potential radiological impacts along projected routes for overland transport assuming projected 2030 populations.

5.1.4 Dose-to-Risk Factor

NNSA estimated radiologically induced LCFs assuming a risk factor of 0.0006 LCF per rem or person-rem (DOE 2003).

5.2 Transportation Impacts on Human Health

5.2.1 Ship Transportation

5.2.1.1 Human Health Impacts from Incident-Free Transport

The Transportation Analysis Report (Leidos 2018: Section 3.1) provides an in-depth analysis of human health effects associated with ship transportation, including under incident-free (Section 3.1.1) and accident (Section 3.1.2) conditions, and discusses potential changes in doses received by workers during transport. The general public would not be exposed to radiation from incident-free transport of FRR SNF by ocean vessel. Some crew members on ships transporting the FRR SNF, however, could be exposed to radiation. No increase in human health impacts is anticipated, and no LCFs are projected.

5.2.1.2 Impacts at Joint Base Charleston-Weapons Station

The Transportation Analysis Report (Leidos 2018; Section 3.2) provides a detailed discussion of human health effects associated with operations at JBC under both incident-free (Section 3.2.1) and accident (Section 3.2.2) conditions. NNSA does not expect that members of the public would receive radiation doses during port operations. JBC is a secure military base; access by the general public is restricted and unauthorized personnel would be excluded from the vicinity of the unloading and transfer operations. Port workers transferring FRR SNF from ships to overland transport vehicles could, however, receive radiation doses. Based on the transportation analysis, no increase in impacts is anticipated, and no LCFS would result from implementation of the Policy on Exemptions.

5.2.2 Overland Transportation

This section presents the potential transportation risks associated with incident-free and accident conditions for overland transport of FRR SNF from the port of entry into the United States to its designated DOE site. Japanese FRR SNF would be transported to SRS from JBC by truck or rail; SNF from Canada would be shipped by truck to SRS. Any potential exemption shipments of aluminum-based SNF would be transported to SRS from JBC by truck or rail. Any exemption shipments of TRIGA SNF would be shipped by truck from JBC to INL. Potential risks from transporting any unirradiated HEU that may accompany the SNF shipments to Y-12 are discussed in the 2001 and 2011 Y-12 Site-Wide EISs (DOE 2001, 2011).

5.2.2.1 Background

Incident-free overland transportation of radiological materials has the potential for radiological impacts for both the transportation crew and the exposed population along the transportation route, while transportation accidents involving radioactive materials have the potential for both radiological and nonradiological risks. For incident-free transportation, risk factors are given for radiological impacts in terms of potential LCFs. For transportation accidents, risk factors are given for radiological impacts in terms of potential LCFs; and for nonradiological impacts, in terms of the number of immediate (traffic accident) fatalities that would result from the physical impact of a traffic accident. LCFs represent the number of additional latent fatal cancers among the exposed population in the event of an accident. Under accident conditions, the population would be exposed to radiation from released radioactivity if a package were breached. If the package were not breached, the population near the package could receive a direct dose, since shielding never completely contains all radiation; however, only a miniscule amount of radiation passes through shielding, and regulations apply strict limits to the dose rate from the surface of the package (10 millirem per hour at a distance of 2 meters [6.6 feet]) to limit the potential dose.

For incident-free transportation, NNSA estimated the potential human health impacts of the radiation fields surrounding the transportation packages for transportation workers and the population along the route, as well as for people sharing the route (car occupants along the route) and at rest areas and other stops. Under incident-free and accident conditions, the affected population includes individuals living within 0.5 miles (0.8 kilometers) and 50 miles (80 kilometers) of each side of the road or railroad. The analysis also assumes a doubling of traffic densities on the urban and suburban segments of the routes, to account for the potential for traffic congestion in these areas.

All the materials evaluated in this SA would be transported in accordance with Department of Transportation (DOT) (49 CFR Part 173) and Nuclear Regulatory Commission (10 CFR Part 71) regulations. The materials would be transported in Type B packages, which are designed and tested to withstand postulated severe accidents with minimal release of the contents. Only a long-duration severe fire or a powerful collision, both of extremely low probability, could damage a Type B package so that radioactivity could be released to the environment. The population would be exposed to radiation from released radioactivity if a package were breached or receive a direct radiation dose if in close proximity to a package that had not been breached, since shielding never completely contains all radiation; however, only a miniscule amount of radiation passes through the shielding, and regulations apply strict limits to the dose rate from the surface of the package (10 millirem per hour at a distance of 2 meters [6.6 feet]) to limit the potential dose.

NNSA assumed the characteristics of a generic Type B package for the *FRR SNF EIS* analyses. For this SA, NNSA assumed specific Type B packages (JMS-87Y and JRC-80Y) for shipments from Japan, and NAC-LWT Type B packages for overland transport from Canada and for any potential exemption shipments; however, these are used as representative packages, and other Type B packages may be used in the future. NNSA conservatively assumed that the radioactive inventories of each Type B package would be same as those considered in the *FRR SNF EIS* (DOE 1996: Table B-8) for aluminum-based and TRIGA SNF. NNSA assumed the Belgian Reactor-2 (BR-2) inventory for the Japanese FRR SNF, the National Research Universal inventory for the Canadian FRR SNF, and the TRIGA inventory for the TRIGA SNF. The accident severity probabilities and release fractions used in this SA are the same as those in Appendix E, Figure E–15 and Table E-6 of the *FRR SNF EIS*, respectively.

The radiological impact of an accident is expressed in terms of probabilistic risk (i.e., dose-risk), which is the accident probability (accident frequency) multiplied by the accident consequence (dose). The overall radiological risk is the sum of the individual radiological risks from all reasonably conceivable accidents. The analysis takes into account a spectrum of accident severities ranging from high-probably accidents of low severity (e.g., fender benders) to hypothetical high-severity accidents having low probabilities of occurrence. For this analysis, NNSA assumed that a high-severity, low-probability accident could result in the release of radioactive materials.

5.2.2.2 Human Health Impacts from Incident-Free Transport and Under Potential Accident Conditions

Table 5 summarizes the potential transportation impacts for shipments of Japanese FRR SNF by truck or rail to SRS from JBC, and for shipments of Canadian FRR SNF to SRS by truck through Alexandria Bay or Buffalo, New York. Impacts are evaluated for external radiation levels at both the regulatory limit and at historical average levels. The impacts reflect the assumption of 26 truck shipments or 6 rail shipments from JBC, for a total of 15 rail cars (11 rail cars would carry 2 Type B packages, and 4 rail cars would carry 1 Type B package, for a total of 26 Type B packages). In addition, NNSA assumes that there would be 43 truck shipments through Alexandria Bay or Buffalo, New York. No LCFs are expected among the transport crew or members of the public under incident-free or accident conditions.

Table 5. Total Transportation Impacts for Known-Origin and Potentially Identified Exemption Shipments

Shipment	*Incident-Free Impacts*				*Accident Impacts*	
	Crew Dose (person-rem)	*Crew LCFs* [a]	*Population Dose (person-rem)*	*Population LCFs* [a]	*Radiological Impacts (LCFs)* [a, b]	*Nonradiological Impacts (traffic fatalities)* [a]
External Radiation Dose Rates at the Regulatory Limit [c]						
Japanese SNF by truck	4.6×10^{-1}	3×10^{-4}	1.6×10^{-1}	1×10^{-4}	5×10^{-10}	5×10^{-4}
Japanese SNF by rail	2.8×10^{-3}	2×10^{-6}	3.2×10^{-1}	2×10^{-4}	3×10^{-11}	8×10^{-4}
Canadian SNF by truck (through Alexandria Bay, New York) [d]	8.0	5×10^{-3}	5.9	4×10^{-3}	5×10^{-9}	4×10^{-3}
Canadian SNF by truck (through Buffalo, New York) [d]	7.0	4×10^{-3}	5.2	3×10^{-3}	3×10^{-9}	4×10^{-3}
External Radiation Dose Rates at Historical Levels [c]						
Japanese SNF by truck	4.6×10^{-2}	3×10^{-5}	1.6×10^{-2}	1×10^{-5}	5×10^{-11}	5×10^{-4}
Japanese SNF by rail	2.8×10^{-4}	2×10^{-7}	3.2×10^{-2}	2×10^{-5}	3×10^{-12}	8×10^{-4}
Canadian SNF by truck (through Alexandria Bay, New York) [d]	8.0×10^{-1}	5×10^{-4}	5.9×10^{-1}	4×10^{-4}	5×10^{-10}	4×10^{-3}
Canadian SNF by truck (through Buffalo, New York) [d]	7.0×10^{-1}	4×10^{-4}	5.9×10^{-2}	3×10^{-4}	3×10^{-10}	4×10^{-3}

LCF = latent cancer fatality; SNF = spent nuclear fuel.

[a] Risk is expressed in terms of LCFs, except for the nonradiological risk, which is risk of a traffic accident fatality irrespective of the type of cargo. Radiological risk is calculated for one-way travel while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing radiological risk values by 0.0006 (DOE 2003). The values are rounded to one non-zero digit.

[b] The dose-risk for a population is determined as the sum of the range of probabilities of an accident of a particular severity multiplied by the radiation dose that could be received because of that accident.

[c] Regulatory Limit refers to the assumption that Type B package external radiation levels are at 10 millirem per hour at 2 meters (6.6 feet) from all Type B package surfaces. Historical Levels refers to the assumption based on measurements of FRR SNF shipments that Type B package external radiation levels are at 1 millirem per hour at 2 meters (6.6 feet) from all Type B package surfaces.

[d] Alexandria Bay and Buffalo are used for analysis as representative U.S. ports of entry.

To further assess the potential impacts from overland transport of Japanese and Canadian FRR SNF and from an uncertain number of potential additional exemption shipments, NNSA prepared a per-shipment analysis of potential radiological impacts (Leidos 2018), which is summarized in **Table 6**. For any single shipment of FRR SNF, no LCFs would be expected among the transport crew or populations along the transportation routes. This analysis was performed for incident-free radiation doses to transport crews, and for radiation doses to populations along the transport routes under incident-free and postulated accident conditions. The analysis was performed using the updated analytical assumptions summarized in Section 4.2.6, and the results of the analysis are compared with the per-shipment doses reported for transport crews and population in the *FRR SNF EIS*.

Table 6. Comparisons of the Per-Shipment Impacts from Truck or Rail Shipments with those Evaluated in the *FRR SNF EIS*

Material	*Origin*	*Transport Destination (mode of transport)*	*Shipping Type B Package*	*Incident-Free Dose (person-rem)*				*Accident Dose-Risk (person-rem)*	
				Crew	*Crew/ FRR SNF EIS*	*Population*	*Population/ FRR SNF EIS*	*Population* [a]	*Population/ FRR SNF EIS* [b]
Known-Origin and Potentially Identified Exemption Shipments									
Japanese SNF	JBC	SRS (Rail) [c]	JMS-87Y/ JRC-80Y	4.7×10^{-4}	1.4×10^{-2}	7.4×10^{-2}	6.6×10^{-3}	9×10^{-9}	9×10^{-7}
Japanese SNF	JBC	SRS (Truck)	JMS-87Y/ JRC-80Y	1.8×10^{-2}	1.8×10^{-2}	6.2×10^{-3}	4.3×10^{-2}	3×10^{-8}	8×10^{-6}
Canadian SNF	Alexandria Bay, New York [d]	SRS (Truck)	NAC-LWT	1.9×10^{-1}	1.0×10^{-1}	1.4×10^{-1}	2.3×10^{-1}	2×10^{-7}	9×10^{-5}
Canadian SNF	Buffalo, New York [d]	SRS (Truck)	NAC-LWT	1.6×10^{-1}	NA	1.2×10^{-1}	NA	1×10^{-7}	NA
Potential Additional Exemption Shipments									
Aluminum-based SNF	JBC	SRS (Rail) [e]	NAC-LWT	1.6×10^{-3}	1.4×10^{-2}	6.2×10^{-2}	6.6×10^{-3}	5×10^{-9}	9×10^{-7}
Aluminum-based SNF	JBC	SRS (Truck)	NAC-LWT	2.5×10^{-2}	1.8×10^{-2}	2.1×10^{-2}	4.3×10^{-2}	3×10^{-8}	2×10^{-5}
TRIGA SNF	JBC	INL Direct (Truck)	NAC-LWT	4.4×10^{-1}	2.2×10^{-1}	3.0×10^{-1}	5.5×10^{-1}	2×10^{-6}	4×10^{-4}

INL = Idaho National Laboratory; JBC = Joint Base Charleston – Weapons Station; NA = not analyzed; SNF = spent nuclear fuel; SRS = Savannah River Site; TRIGA = Training, Research, Isotope, General Atomics.

[a] The dose calculations are performed using the default average U.S. weather data in the RADTRAN code.

[b] The dose calculations were performed using a neutral weather condition with a wind speed of 4 meters per second (9 miles per hour), as indicated in Section E.6.5 of Appendix E to *FRR SNF EIS* (DOE 1996).

[c] The Japanese SNF would arrive in 26 Type B packages, with a maximum of 6 Type B packages in 3 railcars. The *FRR SNF EIS* incident-free dose is based on one railcar and one Type B package per shipment.

[d] Alexandria Bay and Buffalo are used for analysis as representative U.S. ports of entry.

[e] Each shipment consists of two Type B packages per railcar. The *FRR SNF EIS* analysis is based on one railcar and one Type B package per shipment.

For potential shipments of FRR SNF in NAC-LWT Type B packages, the per-shipment incident-free radiation doses to transport crews during truck transport of FRR SNF are higher (by factors less than 2) than the doses reported in the *FRR SNF EIS*. This higher dose for FRR SNF transported in NAC-LWT Type B packages is due to the different dimensions of the NAC-LWT Type B packages compared to the generic Type B package assumed for the *FRR SNF EIS* analysis. Doses to transport crews from truck transport of JRC-80Y and JMS-87Y Type B packages are comparable to those reported in the *FRR SNF EIS*. The per-shipment incident-free doses to populations during rail transport of FRR SNF from JBC to SRS are also higher than those reported in the *FRR SNF EIS*. In addition to the higher population density along the transport route, the higher rail transport population doses result from different assumptions about the numbers of Type B packages in a shipment, and the different dimensions of the NAC-LWT Type B packages assumed for transport of potential exemption shipments of FRR SNF. Also, the population dose for rail transport (as evaluated for this SA and the *FRR SNF EIS*) includes the dose to railyard workers during classification stops (stops in railyards where railcars are moved between trains or tracks to position them for travel to their destination), who are considered members of the public. The doses during these classification stops account for about 90 percent of the total per-shipment population dose. Because of the short distance between JBC and SRS, stops are generally not made, so classification stop doses would likely not occur. Furthermore, NNSA expects that incident-free doses for actual shipments of FRR SNF by both truck and rail would be reduced by a factor of about 10 compared to those in the *FRR SNF EIS* (DOE 1996) because the analysis shown in the *FRR SNF EIS* (DOE 1996) assumes external radiation levels at the regulatory limit. For both truck and rail transport, per-shipment doses to the population under postulated accident conditions are less than those reported in the *FRR SNF EIS*. Thus, NNSA expects transport crew and population impacts from overland transport of FRR SNF would be less than those determined in the *FRR SNF EIS*. No LCFs would be expected from overland transportation under incident-free or accident conditions as a result of implementing the Policy on Exemptions.

5.3 Impacts at Receipt and Storage Sites

5.3.1 Savannah River Site

NNSA would ship Japanese FRR SNF and any exemption shipments of aluminum-based FRR SNF by truck or rail to SRS. The Type B packages would be removed from the shipping containers, and the SNF would be removed from the Type B packages and placed in secure storage in L-Basin, or otherwise securely stored within the Type B packages. NNSA would ship any exemption shipments of TRIGA SNF by truck to INL. The facilities to conduct these operations as analyzed in the EIS are available through the end of the potential exemption period (2029). Routine operation and maintenance may be necessary, but no new or modified infrastructure is expected to be necessary. DOE will continue to evaluate future options for managing nuclear fuel and developing cost estimates, which could impact future SNF shipments. Any decisions regarding identifying alternative storage facilities, capacity needs, and SNF disposition would be contingent upon completing the appropriate NEPA analyses. In accordance with the Policy on Exemptions, NNSA, in consultation with DOE's Office of Environmental Management, would assess the availability of storage space and other activities at SRS before returning material under an exemption. Shipment and receipt would be scheduled so as not to interfere with other activities.

In the *FRR SNF EIS* (DOE 1996) DOE evaluated the impacts of implementing the preferred alternative at SRS. Under the preferred alternative, which DOE selected for implementation (60 FR 28680, June 1, 1995), DOE would receive and store up to approximately 18.2 MTHM of aluminum-based FRR SNF (approximately 17,900 elements) at SRS. DOE estimated the impacts to site workers and the public that could result from the incident-free receipt and storage of this quantity of FRR SNF at SRS. See Section 4.7.5.1 of the *FRR SNF EIS* (DOE 1996). DOE estimated that the impact to the maximally exposed individual (MEI) member of the public would be 4.3×10^{-6} LCF, and the risk to the population in the area surrounding SRS would be 0.18 LCF. DOE estimated that the risk to site workers would be 0.21 LCF. The estimated impacts are based on an assumed quantity of FRR SNF far greater than the quantity that has been received and stored at SRS. See Table 1 of this SA.

In the *FRR SNF EIS* (DOE 1996), DOE also estimated the impacts to the public that could result from accidents during receipt and storage of FRR SNF. DOE estimated that the risk of the highest consequence accident evaluated to the maximally exposed member of the public would be 4.7×10^{-5} LCF, and the risk to the population surrounding SRS would be 0.43 LCF.

5.3.2 Idaho National Laboratory

As described in Section 5.1.2, any TRIGA fuel that might be received under the terms of an exemption would be shipped by truck from JBC to INL. No TRIGA fuel would be repatriated unless it could be sent to INL. Shipments of FRR SNF to INL have not taken place since 2012, when a milestone under a Settlement Agreement with the State of Idaho was missed. Until compliance with the milestone is met or waived, DOE has agreed under the terms of the Settlement Agreement that it will not receive SNF such as FRR SNF at INL. The facilities to conduct these operations as analyzed in the EIS are available through the end of the potential exemption period (2029). Routine operation and maintenance may be necessary, but no new or modified infrastructure is expected to be necessary. DOE will continue to evaluate future options for managing nuclear fuel and developing cost estimates, which could impact future SNF shipments. If INL were to become available for receipt and storage of FRR SNF, NNSA, in consultation with DOE's Office of Environmental Management, would assess the availability of storage space and other activities at INL before returning material under an exemption. Shipment and receipt would be scheduled so as not to interfere with other activities.

In the *FRR SNF EIS* (DOE 1996) DOE evaluated the impacts of implementing the preferred alternative at INL. Under the preferred alternative, which DOE selected for implementation (60 FR 28680, June 1, 1995), DOE would receive and store up to approximately 1.033 MTHM of TRIGA FRR SNF (approximately 4,940 elements) at INL. DOE estimated the impacts to site workers and the public that could result from the incident-free receipt and storage of this quantity of TRIGA FRR SNF at INL. See Section 4.7.5.1 of the *FRR SNF EIS* (DOE 1996). DOE estimated that the risk to the MEI member of the public would be 7.8×10^{-10} LCF, and the risk to the population in the area surrounding INL would be 6.4×10^{-6} LCF. DOE estimated that the risk to site workers would be 0.021 LCF. The estimated impacts are based on an assumed quantity of TRIGA FRR SNF far greater than the quantity that has been received and stored at INL. See Table 1 of this SA.

In the *FRR SNF EIS* (DOE 1996), DOE also estimated the impacts on the public that could result from accidents during receipt and storage of FRR SNF. DOE estimated that the risk of the highest consequence accident evaluated to the maximally exposed member of the public would be 1.9×10^{-6} LCF, and the risk to the population surrounding INL would be 0.016 LCF.

5.4 Intentional Destructive Acts

Intentional destructive acts or other malevolent events such as piracy could occur during transport of the FRR SNF over the global commons, at JBC, or during overland truck or rail transport to SRS or INL. Implementation of the proposed action would not change the probability of such acts or their potential impacts.

5.4.1 Global Commons

NNSA would avoid, whenever possible, maritime areas where acts of terrorism or piracy are more likely. Ships that would have to pass through these areas would invoke additional security measures as necessary. The locations having the most incidents of piracy included waters near Nigeria, Somalia, and Southeast Asia (ICC 2016). Shipments of FRR SNF from Japan would not transit waters near these areas.

If an intentional destructive act were to occur, potential impacts on onboard personnel could range from fatalities associated with explosions or drowning to lesser impacts of radiation exposure to untrained or uninformed personnel in the immediate vicinity of the radioactive material. If the intentional destructive act occurred near a coastline and involved the release of radioactive material into the air or water, radiological impacts on people on land would be less than those for a severe accident at JBC (28,000 person-rem and 17 LCFs; see Section 5.4.2). Neither the nature nor the severity of maritime accidents would change from those analyzed in the *FRR SNF EIS* (DOE 1996).

5.4.2 Joint Base Charleston-Weapons Station

It is not possible to predict the occurrence of sabotage or terrorism events or the exact nature of such events if they were to occur. Nonetheless, the *FRR SNF EIS* (DOE 1996: Section D.5.9) examined three scenarios involving FRR SNF that would have comparable impacts if applied to the proposed FRR SNF shipments. Two scenarios involve explosive damage to Type B packages of SNF and one involves theft of a Type B package. None of these scenarios would lead to a criticality accident because the contents of the Type B packages are configured to avoid criticality; however, these scenarios could result in localized contamination.

In one scenario, DOE assumed that blast damage to a Type B package containing highly irradiated SNF would spread fuel elements on the ground, producing the highest possible direct dose rate. Based on this hypothetical, conservative analysis, DOE determined that an evacuation distance of about 900 meters (3,000 feet) would be sufficient to maintain a dose rate of less than 10 millirem per hour (DOE 1996). In a second scenario, DOE assumed that explosive penetration of a Type B package would damage the SNF inside the package, with release of all noble gases and one percent of the solid SNF as airborne aerosols. DOE estimated Impacts for the most populous port considered in the *FRR SNF EIS,* an east coast port with a population within a 50-mile (80-kilometer) of 16 million people. DOE estimated that a population dose of 208,000 person-rem would result in no acute fatalities or short-term adverse health effects. Up to 91 LCFs were projected among the population, with an average individual lifetime radiation dose of about 200 millirem among the 1 to 2 million people who could be exposed.

In the *2009 Gap Material SNF SA* (DOE 2009), NNSA adjusted the second scenario to reflect conditions for JBC. NNSA projected the population within a 50-mile (80-kilometer) radius around JBC would be approximately 1.1 million people as of 2020. NNSA assumed the same Type B package radionuclide inventory as that in the *FRR SNF EIS.* The population dose for this revised scenario was 28,600 person-rem, resulting in a projected 17 LCFs. The explosion would likely produce fatalities, injuries, and property damage in the immediate vicinity of the blast damage (DOE 2009). If the same scenario were applied to the JBC population as projected to 2030 (about 1.4 million), the impacts would be about 30 percent higher, or 22 LCFs.

Although DOE considered a scenario involving theft of a Type B package of FRR SNF in the *FRR SNF EIS,* the scenario was considered very unlikely due to the security measures that would be in place. In addition to the inherent radioactivity of the SNF, the large size and weight (20 to 30 metric tons) of a Type B containing Japanese SNF or SNF from an additional potential exemption shipment would deter most thefts. The Type B package could not be opened without great personal radiological risk. As discussed in the *FRR SNF EIS,* thieves would not be able to alter the fuel configuration inside the Type B package or have enough time or resources to change the moderating material to achieve criticality. If thieves were to remove the SNF, the resulting impacts on the public would be the same or less severe than other intentional destructive acts such as explosive damage to Type B packages. Impacts that could result from potential intentional destructive acts would not be expected to exceed those for postulated accidents analyzed in the *FRR SNF EIS* (DOE 1996).

5.4.3 Overland Transportation

In the *FRR SNF EIS*, Section D.5.9, DOE analyzed the spectrum of potential intentional destructive acts and impacts that could occur during FRR SNF transportation. In addition, Section 5.4.2 of this SA includes an analysis of the impacts from a potential intentional destructive act at a seaport with a large surrounding population performed for the *FRR SNF EIS*; an additional analysis was performed assuming the act occurred at JBC. If an intentional destructive act were to occur or be attempted during overland transport of FRR SNF to a DOE site, the potential impacts, given the range of population densities along the transportation routes, would likely be comparable to or less than those at the analyzed seaports. Impacts that could result from potential intentional destructive acts would not be expected to exceed those for postulated accidents analyzed in the *FRR SNF EIS* (DOE 1996).

6.0 CONCLUSIONS

The Acceptance Program has been successful in meeting the goal of reducing the amount of HEU in civil commerce by returning U.S. origin HEU to the United States[11] for safe and secure storage, management, and disposition. However, there may be continuing opportunities to return eligible FRR SNF to the United States. Therefore, NNSA is proposing to extend the Acceptance Program and implement the Policy on Exemptions (see Section 1.1 of this SA). While the Acceptance Program has been successful, only about 45 percent of the FRR SNF evaluated in the *FRR SNF EIS* has been returned to the United States. In addition to evaluating a much larger quantity of FRR SNF than foreign nations have returned to the United States, many of the assumptions used for impact analysis have been shown, because of experience implementing the Acceptance Program, to have been very conservative. For these two reasons, the potential impacts estimated in the *FRR SNF EIS* are greater than those that have occurred. None of the accidents analyzed in the *FRR SNF EIS* have occurred at all.

In this SA in the proposed action, NNSA evaluated the potential environmental impacts of transporting FRR SNF to the United States from Japan, Canada, and other countries, and to DOE sites for storage pending disposition. These proposed actions would take place after the current end date of the Acceptance Program and only if an exemption were granted. Consistent with the SOI between the United States and Japan (see Appendix A), NNSA based the analyses in this SA on the assumption that any exemption shipments would be completed by May 2029.

In this SA, NNSA has updated the analysis of environmental impacts in the *FRR SNF EIS* for changes in environmental conditions, calculation methods, and analytical assumptions. In addition, NNSA recognizes operational experiences from implementing the Acceptance Program from 1996 to the present. In more than two decades of receipt of FRR SNF the average external radiation levels for FRR SNF shipments to the United States have measured at most one-tenth of the regulatory limit that was used as a basis for the *FRR SNF EIS* analyses.

For known-origin ocean vessel shipments to JBC, assuming average external radiation levels based on FRR SNF shipments, the incident-free radiation doses received by workers during ocean transport would be less than the doses DOE estimated for these shipments in the *FRR SNF EIS*. For both known-origin and potential exemption shipments, NNSA expects that members of the public would receive no radiation doses during incident-free ocean transport and port operations.

[11] As shown in Table 1 of this SA, compared to the FRR SNF receipts projected and evaluated in the *FRR SNF EIS* (DOE 1996, 2009), approximately 36 percent in terms of uranium mass, 55 percent in terms of fuel elements, and 37 percent in terms of Type B packages of the eligible material has been or will be returned to the United States through 2029, including projected receipts from Canada and Japan. Any eligible fuel returned to the United States under an exemption would be in addition to these quantities. NNSA expects that, the number of exemption shipments, if any would be less than the number of shipments from Japan.

Because the population near JBC has increased since the DOE issued the *FRR SNF EIS*, the total population radiation dose due to a hypothetical very severe accident involving shipment of FRR SNF, such as a collision with another ship and a resulting fire, could be higher than what DOE estimated in the *FRR SNF EIS*. The risk of such an accident is very low, as is the risk of an LCF among the population in the JBC vicinity because of the low probability of the accident.

The analysis in this SA shows that per-shipment radiation doses to members of the public during incident-free overland transportation of FRR SNF would be less than those DOE estimated in the *FRR SNF EIS*. This is true assuming the external radiation levels are at the regulatory limit. Per shipment doses to transport crews could be as much as a factor of two higher than the doses DOE estimated in the *FRR SNF EIS* assuming external radiation levels at the regulatory limit. However, those doses would be less that those estimated in the *FRR SNF EIS* assuming external radiation doses are consistent with experience during the Acceptance Program. Per-shipment population doses from postulated accidents would be less than those DOE estimated in the *FRR SNF EIS*.

For rail transport of FRR SNF, assuming external radiation levels at the regulatory limit, per-shipment incident-free doses to members of the public would be higher than those DOE estimated in the *FRR SNF EIS*. This result is due to different analytical assumptions NNSA used for this SA than those used for the *FRR SNF EIS*, such as the higher population density along the transport routes and the increase in the number of Type B packages per shipment used for this SA. Given comparable analytical assumptions about the number of Type B packages per shipment and assuming external radiation levels consistent with experience during the Acceptance Program, NNSA expects that incident-free per-shipment population doses would be less than those DOE estimated in the *FRR SNF EIS*. Because DOE evaluated a much greater number of shipments in the *FRR SNF EIS*, the overall impacts of the proposed action would be less than those estimated in the *FRR SNF EIS*.

During postulated accidents, the per-shipment doses to rail transport crews would be less than the doses DOE estimated in the *FRR SNF EIS*, as would the per-shipment doses to populations along the transport routes. If packages of unirradiated HEU accompany some of the shipments of FRR SNF, NNSA expects that there would be only small incremental additions to the potential impacts resulting from shipment of FRR SNF alone.

In the *FRR SNF EIS*, DOE estimated the impacts of receipt and storage of FRR SNF at SRS and INL. DOE estimated incident-free and accident impacts based on the potential receipt of up to 17,500 fuel elements, consisting of both aluminum-based and TRIGA fuel, at both SRS and INL. Throughout the Acceptance Program and including projected shipments both sites have received only a fraction of that amount of fuel (see Table 1 and Leidos 2018). The proposed action would result in receipt of eligible fuel at SRS and INL, but the quantity would not approach that DOE used as the basis for the *FRR SNF EIS* impact analysis. Therefore, the incident-free and accident impacts of the proposed action would be well within the bounds of those estimated in the *FRR SNF EIS*.

7.0 DETERMINATION

In compliance with DOE NEPA Regulations at 10 CFR 1021. 14(c), DOE/NNSA has examined the circumstances relevant to the proposed action: extension of the Acceptance Program through May 12, 2029, consistent with the Policy on Exemptions and on a case by case basis. Any non-Canadian FRR SNF DOE/NNSA received as a result of granting an exemption would be transported by sea to Joint Base Charleston (JBC), and then transported to the Savannah River Site (SRS) where it would be placed in safe storage pending disposition. Training Research Isotope General Atomics FRR SNF would be transported from JBC to INL for safe storage pending disposition. Similarly, if an exemption were granted to Canada, FRR SNF would be transported to SRS by road through various U.S. ports of entry. NNSA expects that it may grant a limited number of other exemptions. Regardless the number of shipments and receipts of FRR SNF received in the United States by 2029 would be substantially less, likely less than half, of the quantities evaluated in the *FRR SNF EIS*. This examination was performed to determine if the proposed action would result in a substantial change to the environmental impacts reported in the *FRR SNF EIS* (DOE 1996), or if there are significant new circumstances or information relevant to environmental concerns related to the proposed action. Based on the analysis in this SA, DOE/NNSA finds that the impacts of the proposed action would be within the range of impacts analyzed in the *FRR SNF EIS*. Extending the Acceptance Program end date consistent with the Policy on Exemptions would not constitute a substantial change in the proposed action evaluated in the *FRR SNF EIS*. There are no new circumstances or information relevant to environmental concerns related to the proposed action or its impacts within the meaning of 40 CFR 1502.9(c) or 10 CFR 1021.314. Therefore, neither a supplement to the *FRR SNF EIS* nor a new EIS is required.

Issued in Washington, DC, this 6 day of May, 2019.

Brent K. Park
Deputy Administrator
National Nuclear Security Administration

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APPENDIX A
STATEMENT OF INTENT BETWEEN THE UNITED STATES AND JAPAN CONCERNING COOPERATION ON NUCLEAR SECURITY AND SPENT FUEL MANAGEMENT

STATEMENT OF INTENT

BETWEEN

THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA

AND

THE MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY OF JAPAN

CONCERNING
COOPERATION ON NUCLEAR SECURITY AND SPENT FUEL MANAGEMENT

The Department of Energy of the United States of America (DOE) and the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT), hereinafter collectively the "Participants":

SEEKING to further the shared goal of strengthening their long-term and productive cooperation;

SHARING a common commitment to the security of vulnerable nuclear materials;

SHARING a recognition of the importance of continued research and development conducted at Japan's materials testing reactors (MTRs); and

NOTING the explicit linkage between the minimization of highly enriched uranium (HEU) and plutonium and DOE's operation of the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program,

Hereby state their intentions as follows:

1

I. The Participants intend to cooperate to effect the following actions:

1. Removal of MTR spent fuel elements from the Japan Materials Testing Reactor (JMTR), Japan Materials Testing Reactor Critical Facility (JMTRC), Japan Research Reactor 3 (JRR-3), Japan Research Reactor 4 (JRR-4), and the Kyoto University Reactor (KUR), and transfer of this material to the United States through May 2029, with a maximum limit of 2,100 MTR elements in addition to those already transferred as of the commencement date of this Statement of Intent (Statement);

2. Removal of all HEU and plutonium from the Japan Atomic Energy Agency (JAEA)'s Fast Critical Assembly (FCA) to the United States by May 2019;

3. Completion of necessary internal procedures and approvals pertaining (a) to the shipment of MTR elements to the United States through May 2029, and (b) to the removal of all HEU and plutonium from the FCA by 2019;

4. Joint cooperation on the design of Japan's proposed Transmutation Physics Experimental Facility (TEF-P), including cooperation on establishing the feasibility of preparing minor actinide-bearing fuels necessary for transmutation experiments at the TEF-P;

5. Exploration of the possibility to cooperate on transmutation technology, including experimental study of reducing transuranic elements in Japan and the United States.

II. General Considerations

1. Cooperative activities under this Statement may commence upon signature by both Participants.

2. Each Participant should appoint one or more implementing agencies for implementation of cooperative activities under this Statement. For MEXT, the implementing agency is the JAEA for activities related to FCA, JMTR, JMTRC, JRR-3, and JRR-4; and Kyoto University for activities related to KUR. DOE plans to implement this Statement through one or more of its national laboratories.

2

3. Implementation of the activities contemplated in this Statement is subject to the completion of appropriate documentation, and the issuance of a DOE decision authorizing such activities, pursuant to the United States' National Environmental Policy Act.

4. Each Participant should conduct the activities contemplated by this Statement in accordance with all applicable laws and regulations to which it is subject and applicable international agreements to which its government is party.

5. Costs for MTR fuel removals through May 2029 are to be paid in accordance with the fee policy as stipulated under DOE's Foreign Research Reactor Spent Nuclear Fuel Acceptance Program as of the commencement date of this Statement.

6. The Participants are to assign costs for HEU and plutonium removal from the FCA on mutually acceptable terms, to be determined.

7. JAEA is to receive low enriched uranium (LEU) credits in return for any of the FCA HEU fuel shipped to the Y-12 National Security Complex, at a level commensurate with the practices of Y-12.

8. The Participants plan to jointly coordinate and mutually decide upon effective and efficient terms for the timely removal and disposition of the FCA material.

9. This Statement may be modified in writing by the Participants' mutual consent.

10. The Participants or their designated implementing agencies may make implementation plans in furtherance of this Statement to detail (a) technical cooperation on the TEF-P and transmutation technology, and (b) cooperation on the removal and disposition of the FCA HEU and plutonium, including relevant costs for activities described in paragraphs II. 4-7 of this Statement.

3

Signed in duplicate.

FOR THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA:

Date: MAR 14 2014
Place: Washington

FOR THE MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY OF JAPAN:

下村博文

Date: 03/19/2014
Place: Tokyo

4

APPENDIX B
RELATED NATIONAL ENVIRONMENTAL POLICY ACT REVIEWS

***Final Environmental Impact Statement on a Nuclear Weapons Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218, February 1996) (*FRR SNF EIS*)**

In 1996, DOE prepared the *FRR SNF EIS*. The *FRR SNF EIS* is tiered from the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203), April 2003.

In May 1996 (61 FR 25092, May 17, 1996) DOE, in consultation with the DOS decided to "Implement a new foreign research reactor spent nuclear fuel acceptance policy, as specified in the Final EIS ...." Implementation of the new FRR SNF acceptance policy would involve acceptance of aluminum-based spent fuel, TRIGA spent fuel, and target material containing uranium enriched in the United States. In the *FRR SNF EIS*, DOE analyzed the return of 22,700 individual spent fuel elements (17,800 aluminum and 4,900 TRIGA), comprising 19.2 MTHM (18.2 aluminum and 1.0 TRIGA) and requiring 837 Type B package shipments. These numbers included the fuel evaluated in the Urgent Relief EA (DOE/EA-0912, Urgent Relief Acceptance of Foreign Research Reactor Spent Nuclear Fuel, April 1994). DOE estimated that foreign research reactor operators could return this amount of fuel to the United States during the initial implementation of the Program. Environmental impacts addressed in the *FRR SNF EIS* included those from marine transport of FRR SNF from overseas points-of-origin to U.S. ports, overland transportation from U.S. ports to SNF management sites, overland transportation of some FRR SNF from Canada, and management of FRR SNF at DOE sites until its ultimate disposition.

In Table B-1 of the *FRR SNF EIS*, DOE gives estimates of the number of aluminum-based spent fuel elements that foreign research reactor operators would generate by January 2006 (the end date for irradiation of fuel eligible for acceptance). DOE estimated that Japan would have 2,981 such elements, totaling 3.134 MTHM and requiring 99 shipments.

The United States would accept material from the five Japanese research reactors listed in Section 1.2 of this SA, as follows (Table B-3, Foreign Research Reactor and Test Reactors that Possess Only Aluminum-Based Fuel Containing HEU and LEU of U.S.-Origin, of the *FRR SNF EIS*):

- Japan Materials Testing Reactor, a 50 MW reactor using plate-type fuel, an HEU reactor fully- or partially-converted to LEU Fuel
- Japan Materials Testing Reactor Critical Facility, a zero-power reactor using plate-type fuel, an HEU reactor that can be converted to LEU Fuel
- Japan Research Reactor 3, a 20 MW reactor using plate-type fuel, an LEU operating reactor possessing only LEU fuel
- Japan Research Reactor 4, a 3.5 MW reactor using plate-type fuel, an HEU reactor that can be converted to LEU fuel
- Kyoto University Reactor, a 5-MW reactor using plate-type fuel, an HEU reactor that can be converted to LEU fuel

Foreign Research Reactor EIS Supplement Analyses

Since May 1996, DOE/NNSA has prepared seven SAs for the *FRR SNF EIS* and has published announcements and revisions to the ROD in the *Federal Register*. The following sections describe each SA.

***Foreign Research Reactor Spent Nuclear Fuel Transportation Along Other Than the Representative Route from Concord Naval Weapons Station to the Idaho National Engineering and Environmental Laboratory* (DOE/EIS-0218-SA-1, January 1998)**

Based on the analysis in this SA, DOE/NNSA determined that no further NEPA review was required for using a different route from Concord, California, to the Idaho National Engineering and Environmental Laboratory (now the Idaho National Laboratory) than the reference route evaluated in the *FRR SNF EIS*. DOE/NNSA did not issue a revised ROD following this SA. This change did not extend or expand the Acceptance Program.

***Supplement Analysis of Acceptance of Foreign Research Reactor Spent Nuclear Fuel Under Scenarios Not Specifically mentioned in the EIS* (DOE/EIS-0218-SA-2, August 1998)**

This SA examined the impacts of accepting FRR SNF under scenarios not specifically mentioned in the *FRR SNF EIS*, including:

- Accepting FRR SNF from research reactors not specifically mentioned in the *FRR SNF EIS*, but within the set of countries identified in the EIS
- Accepting SNF from specific countries in quantities greater than those identified for that country, but within the overall numbers specified in the *FRR SNF EIS* and ROD
- Transporting more than 8 Type B packages of SNF on a single ocean-going vessel

In the SA, DOE noted that all shipments had been made on chartered vessels having a single hold containing two to eight casks. DOE determined that the risks from a possible accident would not increase, regardless of the possible transport of up to 16 Type B packages on a single vessel, because a severe accident could breach at most only a single Type B package. The SA concluded that accepting SNF under these scenarios would not constitute substantial changes or significant new circumstances or information relevant to environmental concerns. DOE/NNSA published a revised ROD on July 19, 2000 (65 FR 44767). DOE decided to allow up to 16 Type B packages of SNF on a single vessel transporting FRR SNF to the United States. This decision did not extend or expand the Acceptance Program in terms of the total quantity of fuel evaluated in the *FRR SNF EIS* or that the United States would accept under the Program, or the last date for receipt of FRR spent fuel.

***Supplement Analysis for the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program* (DOE/EIS-0218-SA-3, November 2004).**

In this SA, DOE evaluated the impacts of

- Extending the expiration date for irradiation of eligible spent fuel from May 12, 2006 to May 11, 2011 or May 12, 2016
- Extending the acceptance date for eligible spent fuel from May 12, 2009 to May 12, 2014 or May 12, 2019
- Extending eligibility to Australia's Replacement Research Reactor for participation in the SNF Acceptance Program and accepting an additional 96 fuel elements

DOE concluded that no additional NEPA review was required, and published a revision of the ROD (69 FR 69901, December 1, 2004). DOE, in consultation with the DOS, decided to extend the Acceptance Program for an additional 10 years, until May 12, 2016, for irradiation of eligible fuel, and until May 12, 2019, for fuel acceptance. DOE also decided to accept a small number of SNF elements (approximately 96) from Australia's Replacement Research Reactor that Australia would commission after 2005 to replace a reactor eligible for the acceptance program, which had been analyzed in the *FRR SNF EIS*.

DOE determined that extending the policy by up to 10 years (through May 12, 2019) and accepting an additional 96 elements from the Australian Replacement Research Reactor (compared to the 22,700 elements analyzed in the *FRR SNF EIS*) would not present a substantial change or significant new circumstances or information relevant to environmental concerns. DOE/NNSA published a revised ROD on December 1, 2004 (64 FR 18006). DOE/NNSA concluded that although there could be very small increases in health impacts from SNF transportation over the extended period, these impacts would not significantly change the results reported in the *FRR SNF EIS*. The analysis of impacts was based largely on the assumptions used for the *FRR SNF EIS*, even though the SA demonstrated, using operational data, that the assumptions were very conservative.

***Supplement Analysis for the U.S. Disposition of Gap Material – Spent Nuclear Fuel* (DOE/EIS-0218-SA-4, January 2009)**

NNSA proposed to expand efforts under the FRR SNF Acceptance Program to allow limited quantities – up to 1,000 kilograms of SNF containing non-U.S.-origin HEU and SNF containing U.S.-origin HEU that was not addressed in the *FRR SNF EIS* to be recovered from foreign countries and managed at DOE sites in the United States. SNF from Canada would enter the United States near Alexandria Bay, New York. SNF from other nations would enter the United States at the Charleston Naval Weapons Station. DOE issued a Revised ROD on January 23, 2009 (74 FR 4173). DOE decided to allow transport of up to one MTHM of spent nuclear fuel (Gap Material SNF) from foreign research reactor locations to the United States and safely store this Gap material at a DOE site pending disposition. The action would constitute neither substantial changes to the proposed action nor significant changes relevant to environmental concerns bearing on the proposed action evaluated in the *FRR SNF EIS*. Acceptance of Gap material SNF would not cause the total quantity of SNF that the United States would accept through the FRR SNF Acceptance Program to exceed the estimates analyzed in the *FRR SNF EIS*. This decision expanded the Program to include limited quantities of non-U.S.-origin HEU and SNF containing U.S.-origin HEU that DOE/NNSA did not address in the *FRR SNF EIS*. However, the total Program receipts would still be far less than analyzed in the *FRR SNF EIS*.

***Supplement Analysis on the Transfer and Return of Low-Enriched Uranium Fuel Elements from the Idaho National Laboratory to the Research Reactor in Vienna, Austria* (DOE/EIS-0218-SA-05 and DOE/EIS-0203-SA-05, May 2012)**

DOE evaluated the potential impacts of implementation of a Memorandum of Understanding between Austria and the United States. The United States would deliver previously irradiated but usable LEU TRIGA fuel elements to Austria and return to the United States the current inventory of fuel from the Vienna TRIGA Research Reactor, including all remaining HEU and LEU TRIGA fuel elements, as well as one plutonium source of U.S. origin. DOE also intends to remove the newly supplied LEU TRIGA fuel elements from the Vienna reactor before 2025 or later if DOE determines it can receive these fuel elements later. Accepting fuel currently at the Vienna reactor would be in accordance with the FRR Acceptance Program. In addition, DOE would ship up to 88 previously irradiated but usable LEU TRIGA fuel elements to the Vienna Reactor for use until Austria returns it to INL around 2025 for further storage for ultimate disposal. An additional 13 unirradiated and slightly irradiated fuel elements currently at the Austrian reactor that would be used simultaneously would also be returned. Implementing the MOU would result in two shipments, one to Austria and one returning to INL, not originally part of the Acceptance Program. DOE did not issue an amended ROD for this action.

***Supplement Analysis Savannah River Site Spent Nuclear Fuel Management* (DOE/EIS-0279-SA-01 and DOE-EIS/0218-SA-06, March 2013)**

In 2000, DOE decided to manage some SNF using the melt and dilute technology, but never fully developed or implemented that technology. In the SA for Savannah River Spent Nuclear Fuel Management, DOE evaluated the impacts of managing MTR SNF stored at the SRS using conventional processing. DOE also evaluated the impacts of transporting HEU residues (referred to as target residue material) from Canada to the SRS in liquid form, and processing the residues at the SRS to recover the HEU. This material was part of the Acceptance Program but the analysis in the *FRR SNF EIS* assumed it would be transported in oxide or calcine form rather than in a liquid solution. DOE decided (78 FR 20625, April 5, 2014), to manage approximately 3.3 MTHM, including approximately 1,000 bundles of SNF, up to 200 HFIR cores, and target residue material containing enriched uranium using conventional processing in H-Canyon, rather than the melt and dilute process. DOE/NNSA would make modifications to H-Canyon to receive the Canadian residues in liquid form. This decision neither extended nor expanded the Acceptance Program.

***Supplement Analysis for the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program Highly Enriched Uranium Target Residue Material Transportation* (DOE/EIS-0218-SA-07, November 2015)**

Since publication of DOE/EIS-0218-SA-06, DOE obtained additional information on the proposed shipment of target residue material from Canada. In summary, the new information consists of the fact that both U.S. and Canadian authorities certified the transport Type B packages, emergency management specialists held several training sessions for law enforcement and emergency responders along potential transport routes, and Canadian authorities have completed an environmental assessment of transport of liquid HEU solution within Canada. This action is evaluated in DOE/EIS-0218-SA-06, and neither expands nor extends the Acceptance Program.

DOE did not prepare an amended ROD for this action.

NEPA Reviews of Receipt and Management of Highly Enriched Uranium

***Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE/EIS-0309, September 2001)**

The *Y-12 Site-Wide EIS* evaluated alternatives for the continued operation of Y-12, and construction of new facilities. Included in the evaluation was continued operation and support of non-proliferation and national security missions, including receipt and storage of HEU from domestic and foreign sources. NNSA issued a ROD on March 13, 2002 (67 FR 11296) affirming the continued operation of non-proliferation and national security missions.

***Supplement Analysis for the Air and Ocean Transport of Enriched Uranium between Foreign Nations and the United States* (DOE/EIS-0309-SA-2, August 2006)**

NNSA prepared this SA to determine whether a supplement to the *Y-12 Site-Wide EIS* was required. NNSA evaluated the environmental impacts associated with the air and ocean transport of up to 5,000 kilograms of enriched uranium from foreign countries to Y-12. Transport modes evaluated included military and commercial air cargo and ocean vessel. NNSA assumed that all shipments would meet International Atomic Energy Agency specifications for unirradiated uranium and Y-12 acceptance criteria.

Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex **(DOE/EIS-0387, February 2011)**

NNSA evaluated a No Action Alternative that involved continued implementation of the 2002 ROD (67 FR 11296), which included non-proliferation and national security actions, and four action alternatives involving the Uranium Processing Facility. NNSA issued a ROD on July 20, 2011 (76 FR 43320) announcing its decision to select the No Action Alternative and the capability-sized Uranium Processing Facility alternative.