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

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ACRONYMS

ANSTO	Australian Nuclear Science & Technology Organisation
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
DOE	U.S. Department of Energy
EIS	environmental impact statement
FRR SNF	foreign research reactor spent nuclear fuel
GTRI	Global Threat Reduction Initiative
HEU	high-enriched uranium
HIFAR	High Flux Australian Reactor
INEEL	Idaho National Engineering and Environmental Laboratory
LCF	latent cancer fatality/fatalities
LEU	low-enriched uranium
MACCS	MELCOR Accident Consequences Code System
MEI	maximally exposed individual
MTHM	metric tonnes of heavy metal
MTR	Materials Test Reactor
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
NWS	Naval Weapons Station
RERTR	Reduced Enrichment for Research and Test Reactors
RHF	Réacteur Á Haut Flux
ROD	Record of Decision
RRR	Replacement Research Reactor
SRS	Savannah River Site
TRIGA	Training, Research, Isotope, General Atomics

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

1. Introduction

Reducing the threat posed by the proliferation of nuclear weapons is a foremost goal of the United States. On May 26, 2004, in Vienna, Austria, U.S. Secretary of Energy Spencer Abraham announced the establishment of the Global Threat Reduction Initiative (GTRI) under the U.S. Department of Energy's (DOE's) National Nuclear Security Administration (NNSA). The goal of the GTRI is to rapidly identify, secure, remove, or facilitate the disposal of vulnerable nuclear and radioactive materials and equipment that pose a threat to the international community. A major element of the GTRI is the U.S. Foreign Research Reactor Spent Nuclear Fuel (FRR SNF) Acceptance Program. The FRR SNF Acceptance Program has been underway since 1996 and is now being managed by DOE as part of the GTRI. Under the Acceptance Program, the United States will repatriate FRR SNF containing U.S. origin high-enriched uranium (HEU) and low-enriched uranium (LEU) fuel [about 20 metric tonnes of heavy metal (MTHM)].

The Acceptance Program plays an integral role in U.S. efforts to prevent the spread of nuclear weapons. The primary objective of this program is to reduce, and eventually eliminate, HEU of U.S. origin from civil commerce worldwide. To this end, DOE accepts spent fuel containing uranium that was enriched in the United States from research reactors located in 41 countries. The Acceptance Program was evaluated in the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (FRR SNF EIS,* DOE/EIS-0218F) (DOE 1996a).

The objective of this analysis is to determine whether a supplement to the *FRR SNF EIS* is needed. Under the initial Record of Decision (ROD) signed May 13, 1996 and published in the *Federal Register* on May 17, 1996 (61 FR 25092), only spent fuel of U.S. origin that is irradiated and discharged from foreign research reactors in the eligible nations before May 13, 2006, can be accepted. Eligible spent fuel can be accepted through May 12, 2009. This Supplement Analysis evaluates a proposal to extend the expiration date for irradiation and return of a limited amount of FRR SNF (not to exceed the originally eligible 20 MTHM), and to include SNF from the Replacement Research Reactor (RRR) in Australia, which will not be commissioned before 2005.

2. Background

Twenty-nine shipments of SNF were received in the United States from May 1996 through April 2004. Of these 29 shipments, 1 shipment arrived at the Concord Naval Weapons Station at California, and was transported to INEEL. Two shipments entered overland through Canada and were sent to SRS. The remaining 26 shipments arrived at Charleston NWS at South Carolina. Five of these shipments went to INEEL, and 21 went to SRS.

This supplement analysis is based on data compiled for the period May 1996 through April 2004, i.e., 29 shipments, in which 160 casks of FRR SNF were shipped from 27 countries and accepted for management in the United States under the Acceptance Program. (Although it would not change the calculations contained herein, 1 shipment of 3 casks covered under the existing Acceptance Policy has been received since April 2004 bringing the total shipments as of November 2004 to 30. The 3 casks were sent to SRS.) Of the 160 casks, 157 were shipped by sea and 3 overland. The accepted SNF includes approximately 0.7 metric tonnes of uranium-235. Most of the accepted SNF elements were aluminum-based spent fuel transported to the Savannah River Site (SRS) in 145 casks. The remaining Training, Research, Isotope, General Atomics (TRIGA) spent fuel was transported to the Idaho National Engineering and Environmental Laboratory (INEEL) in 15 casks. No accidents involving FRR SNF have occurred, and no shipment received under the Acceptance Program has resulted in a release of radioactive material from a cask containing FRR SNF. All fuel is being stored at DOE sites until a geologic repository becomes available for disposal.

With approximately 2 years remaining until the cutoff date for irradiation of eligible fuel and 5 years remaining until the cutoff date for acceptance of eligible FRR SNF, DOE has received only about 35 percent of the eligible spent fuel elements estimated in 1996 (DOE 1996a) to be available. This is because some reactors with eligible spent fuel have elected to have their FRR SNF processed[1], and because others have not burned their nuclear fuel at the rate projected in 1996. In addition, attempts to develop suitable LEU fuel to replace HEU have encountered unexpected administrative and technical delays.

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3. The Proposed Action

DOE and the U.S. Department of State propose to modify the FRR SNF Acceptance Program by:

- Extending the expiration date for irradiation of eligible spent fuel either 5 or 10 years, from May 12, 2006, to May 12, 2011, or to May 12, 2016;
- Extending the acceptance date for eligible spent fuel either 5 or 10 years, from May 12, 2009, to May 12, 2014, or to May 12, 2019; and
- Extending eligibility to Australia's RRR for participation in the SNF Acceptance Program.

The amount of potentially eligible SNF would remain the same as identified in the original EIS, about 22,700 elements or about 20 MTHM total.

Target material (fuel for isotope production, such as technetium-99) and damaged spent fuel received under the Acceptance Program currently can be treated in H-Canyon at SRS (none has been received to date). Current plans call for H-Canyon facilities to be maintained in operable condition through 2010 pending a review of the facility. While the coverage of target material and damaged SNF under the current Acceptance Policy remains in effect until 2009, the material will not be accepted under the proposed extension if H-Canyon is not available after 2010 to prepare the target material and damaged fuel for disposal. In the unlikely event that fuel were damaged during shipment or after receipt in the United States, and H-Canyon were not available, the fuel would be repackaged into a sealed canister to maintain its confinement boundary until appropriate arrangements could be made to prepare the fuel for disposal. Prior to disposal, the fuel would be safely stored at either SRS or INEEL. To date, no FRR shipments have been received with any damaged fuel. It should also be noted that all licensed transportation casks are designed to preclude any fuel damage during both normal and accident conditions.

4. Rationale for the Proposed Action

With less than 2 years to the cut-off date for irradiation, DOE has received approximately 35 percent of the total estimated in 1996 for the duration of the program. Meanwhile, Australia is nearing completion of a reactor that will use high density LEU fuel that is not expected to be available until 2010. This fuel is under development, partially sponsored by DOE. Given these circumstances, it has become necessary to consider extending the Acceptance Program's expiration date and including fuel from the RRR.

[1] *Processing SNF is defined as the chemical separation of radioactive fission products and activation products from SNF.*

4.1 Existing Policy and Program

Under the current Acceptance Policy, the United States decided to accept target materials and the following types of materials containing uranium of U.S. origin (61 FR 25092):

- SNF from research reactors operating on LEU fuel or in the process of converting from HEU fuel to LEU fuel when the policy became effective (May 13, 1996);
- SNF from reactors operating on HEU fuel when the policy became effective, but that agreed to convert to LEU fuel (SNF is not accepted from research reactors that could convert from HEU fuel to LEU fuel but have not agreed to do so);
- HEU SNF from research reactors having lifetime cores, research reactors planning to shut down while the policy is in effect, and research reactors for which no suitable LEU is available;
- SNF from research reactors that had already shut down before May 1996; and
- Unirradiated HEU fuel or LEU fuel from eligible research reactors.

For eligible research reactors with both LEU and HEU SNF, LEU SNF is not accepted until all HEU SNF has been accepted, except under extenuating circumstances such as health or safety concerns caused by deterioration of LEU SNF.

As discussed later in this section, changed circumstances warrant a re-evaluation of the policy of accepting SNF from research reactors that began operating after May 1996, as it pertains to the Australian RRR.

4.2 Shipments Received as of April 2004

The FRR SNF Acceptance Policy adopted in 1996 was based on the best available information at that time. **Tables 1 and 2** show estimates of aluminum-based and TRIGA FRR SNF elements projected for acceptance, respectively, from eligible countries in 1996, and actual cask shipments received from those countries as of April 2004. For operational purposes, SRS and INEEL define FRR SNF shipments differently than in the *FRR SNF EIS*. SRS and INEEL define a shipment as one or more casks, either on the same cargo ship or on the same truck. The *FRR SNF EIS* defined a shipment as the transportation of a single cask. Therefore, for ease of comparison, shipments in Tables 1 and 2 are compared in terms of numbers of individual casks shipped. Overall, approximately 37 percent of the eligible aluminum-based SNF elements and 30 percent of eligible TRIGA elements (or 35 percent of the total of both types) have actually been received as of April 2004. Under the current Acceptance Policy, eligible spent fuel must be irradiated and discharged from candidate FRRs within the next 2 years. However, FRRs in several countries have burned their fuel less rapidly than was anticipated in 1996.

Experience gained from the actual shipments as of April 2004 indicates that the assumptions made in the *FRR SNF EIS* to analyze radiological impacts to the health and safety of workers and the general public were very conservative. For example, measured cask surface dose data obtained from shipped casks indicate much lower rates than the regulatory limit of 10 millirem per hour at 2 meters assumed in the EIS. The environmental analysis contained in the *FRR SNF EIS* assumed 65 minutes would be required to unload each cask from the ship to the dock. Operational experience shows average unloading times are closer to 20 minutes per cask. Inspection personnel who perform daily inspection of the casks during ocean voyages, and who are wearing radiation dosimetry badges, report that no measurable dose has yet been observed. Section 6.2 of this Supplement Analysis attempts to quantify the conservatism in the *FRR SNF EIS* analysis, based on the experience gained from actual shipments.

Table 1. Comparison of Projected and Actual Shipments of Aluminum-Based SNF Accepted from FRRs by the United States as of April 2004

Country	*FRR SNF EIS Fuel Elements Projected for Acceptance by May 2009* [(a)]	*Number of SNF Elements Actually Accepted through April 2004* [(b)]	*Initial* [(c)] *Mass of Uranium Projected for Acceptance by May 2009* [(a)] *(MTHM)*	*Initial* [(c)] *Mass of Uranium Actually Accepted through April 2004 (MTHM)*	*Number of Casks Projected to be Accepted by May 2009* [(b)]	*Actual Number of Casks Shipped through April 2004*
Argentina	283	207	0.071	0.038	9	5
Australia	975	240	0.427	0.045	9	3
Austria	157	80	0.191	0.090	5	2
Belgium	1,766	0	0.730	0.000	59	0
Brazil	155	127	0.099	0.071	5	4
Canada	2,831	84	4.478	0.016	116	3
Chile	58	58	0.012	0.012	2	2
Colombia	16	21	0.002	0.003	1	1
Denmark	660	466	0.529	0.359	22	10
France	1,962	0	3.442	0.000	149	0
Germany [d]	1,504	750	0.909	0.301	49	29
Greece	239	108	0.113	0.013	8	1
Indonesia	198	159	0.236	0.189	6	5
Iran	29	0	0.006	0.000	1	0
Israel	192	0	0.111	0.000	6	0
Italy	150	160	0.043	0.030	5	3
Jamaica	2	0	0.001	0.000	1	0
Japan	2,981	1,530	3.134	0.907	99	50
Republic of Korea	168	0	0.321	0.000	7	0
Netherlands	1,488	150	1.404	0.045	49	3
Pakistan	82	0	0.016	0.000	3	0
Peru	29	0	0.039	0.000	1	0
Philippines	50	51	0.024	0.024	2	2
Portugal	88	39	0.054	0.030	3	1
South Africa	50	0	0.010	0.000	2	0
Spain	40	41	0.016	0.017	1	3
Sweden	1,113	633	1.374	0.447	37	10
Switzerland	159	167	0.128	0.127	5	3
Taiwan	127	54	0.066	0.029	4	2
Thailand	31	31	0.005	0.005	1	1
Turkey	69	0	0.089	0.000	2	0
United Kingdom	12	0	0.004	0.000	1	0
Uruguay	19	19	0.018	0.016	1	1
Venezuela	120	56	0.082	0.040	3	1
Total	**17,803**	**5,231**	**18.184**	**2.797**	**674**	**145**

MTHM = metric tonnes of heavy metal.
[(a)] Extracted from Table 2-1 of the *FRR SNF EIS* (DOE 1996a).
[(b)] Includes parts of fuel elements.
[(c)] This is a mass prior to irradiation.
[(d)] Includes fuel received since April 2004 that is covered under the existing Acceptance Policy. These receipts do not change the impact calculations in this analysis.

Table 2. Comparison of Projected and Actual Shipments of TRIGA[(a)] SNF Accepted from FRRs by the United States as of April 2004

Country	*FRR SNF EIS Fuel Elements Projected for Acceptance by May 2009* [(b)]	*Number of SNF Elements Actually Accepted through April 2004* [(c)]	*Initial* [(d)] *Mass of Uranium Projected for Acceptance by May 2009* [(b)] *(MTHM)*	*Initial* [(d)] *Mass of Uranium Actually Accepted through April 2004 (MTHM)* [(c)]	*Number of Casks Projected to be Accepted by May 2009* [(b)]	*Actual Number of Casks Shipped through April 2004* [(c)]
Austria	106	0	0.020	0	3	0
Bangladesh	100	0	0.049	0	3	0
Brazil	75	0	0.014	0	3	0
Finland	171	0	0.033	0	6	0
Germany	358	202	0.068	0.037	12	4
Indonesia	245	181	0.047	0.036	8	2
Italy	386	140	0.072	0.026	13	1
Japan	326	71	0.062	0.013	11	1
Republic of Korea	336	299	0.064	0.054	11	3
Malaysia	94	0	0.047	0	3	0
Mexico	186	0	0.035	0	6	0
Philippines	128	0	0.079	0	4	0
Romania	1451	267	0.189	0.006	48	1
Slovenia	393	219	0.075	0.041	13	2
Taiwan	144	0	0.086	0	5	0
Thailand	136	0	0.035	0	4	0
Turkey	79	0	0.015	0	2	0
United Kingdom	90	90	0.017	0.017	3	1
Democratic Republic of Congo	136	0	0.026	0	4	0
Total	**4,940**	**1,469**	**1.033**	**0.230**	**162**	**15**

MTHM = metric tonnes of heavy metal.
(a) TRIGA is an acronym for Training, Research, Isotope, General Atomic reactors.
(b) Extracted from Table 2-2 of the *FRR SNF EIS* (DOE 1996a).
(c) INEEL 2004.
(d) This is a mass prior to irradiation.

4.3 Development of LEU Fuels

HEU fuel contains fissile material at an enrichment level that could allow the material to be used to construct nuclear weapons. Research reactors have used HEU since the 1950s; however, all but a few can be operated with appropriately designed LEU fuel. The replacement of HEU fuel in research reactors with LEU fuel would reduce the potential availability of nuclear weapons-grade fissile material in the world, and is a key nonproliferation objective of the United States.

Under the Reduced Enrichment for Research and Test Reactors (RERTR) program that began in 1978, DOE developed LEU fuel suitable for replacing HEU in civilian applications. In the 1980s, uranium-silicide LEU fuel was developed and eligible as a replacement for HEU fuel in research reactors (Travelli 2003). Processing studies at SRS concluded in 1983 that uranium-silicide fuel could be successfully processed there. However, the results were rendered moot by the suspension of processing operations at SRS in the early 1990s. The United Kingdom Atomic Energy Agency demonstrated in laboratory scale trials (Cartwright 1996) that LEU silicide could be processed at its facility in Dounreay, Scotland. However, new equipment that would need to be installed for a larger scale LEU processing campaign was determined to be uneconomical before the plant was shut down in 1998 for other reasons. The only other major alternative processing facility, COGEMA in La Hague, France, did not process uranium-silicide spent fuel at that time. The primary reason was that significant process changes would be required for the removal of the silicide constituent; the higher uranium densities did not present a problem. Since no processing facility was available for uranium-silicide spent fuel, nations who had planned to use uranium-silicide LEU fuel in their research reactors were left with no feasible way to dispose of SNF from their research reactors, and could be forced to halt important ongoing medical and research work. Thus, DOE is seeking to develop and qualify medium and high-density LEU fuels that can be processed at COGEMA. [COGEMA is now accepting a limited quantity of silicide SNF for processing and is investigating the possibility of increasing the quantity that could be accepted (Auziere 2004).]

In the 1990s, uranium-molybdenum LEU fuel was shown to be a potential replacement for HEU (Travelli 2003). Two uranium-molybdenum LEU fuels, dispersion and monolithic fuels, are now being pursued for further testing and development. Both fuels use an alloy of uranium and molybdenum. The two fuels are manufactured differently. Dispersion uranium-molybdenum fuel consists of spherical particles of uranium-molybdenum alloy randomly dispersed in a thin layer of metal. In contrast, monolithic uranium-molybdenum fuel consists of a thin sheet of solid uranium-molybdenum alloy. Furthermore, uranium-molybdenum LEU spent fuel would be processable at COGEMA. The United States and other nations such as Australia, France, and Russia have therefore sponsored research directed at medium- and high-density uranium-molybdenum LEU fuels. Qualification of medium-density uranium-molybdenum fuel in reactor trials was initially planned for 2001 at the Petten Reactor in the Netherlands. However, qualification tests of the medium density uranium-molybdenum dispersion fuel in the Petten Reactor and in the Osiris Reactor in France have been postponed due first to patent issues in 2000 and then to the need to investigate the causes of failures that occurred during irradiation tests of such fuel in Russia, Belgium, and France during 2003 (Lemoine et al. 2004). Qualification of the dispersion fuel will be delayed at least until the end of 2010. Development and qualification of a high-density, monolithic uranium-molybdenum LEU fuel is expected to be completed by the end of 2010.

4.4 Effects of Uranium-Molybdenum LEU Fuel Development on the Australian RRR Program

In addition to extending the timeframe for acceptance of currently eligible FRR SNF, DOE proposes extending eligibility to one research reactor that will come online in 2005. This represents a change in the Acceptance Policy established in 1996, because new reactors coming online after May 1996 were specifically excluded from eligibility. The United States included this provision because it never intended the Acceptance Program to serve as a fuel management solution for all research reactors in perpetuity. Under international law, all nations that enjoy the benefits of nuclear technology are ultimately responsible for their own SNF management. However, the unique geographic circumstances associated with the Australian RRR, along with the critical role Australia has played in cooperatively supporting international nonproliferation policies, and specifically in the development of new LEU fuels by contributing staff and funding, justifies an exception in this instance.

Since becoming operational in January 1958, the High Flux Australian Reactor (HIFAR) has served as Australia's national research reactor. Operated by the Australian Nuclear Science & Technology Organisation (ANSTO), it has served as the centerpiece for Australia's production of medical and industrial radioisotopes, materials research, and other peaceful applications of nuclear technology. In 1997, the Australian government announced its intention to replace the HIFAR with a new replacement research reactor, the RRR. Commissioning of the RRR is scheduled for 2005, while the HIFAR is scheduled for decommissioning in 2006. ANSTO anticipates operating the HIFAR and the RRR simultaneously for approximately 6 months, in order to demonstrate to Australian health authorities that medical isotopes produced in the RRR are clinically equivalent to those produced in the HIFAR.

In accordance with nonproliferation objectives shared by the governments of Australia and the United States, the RRR was designed to operate with high-density uranium-molybdenum LEU fuel rather than the HEU fuel used in the HIFAR. High-density uranium-molybdenum LEU fuel, when it becomes available, will be processable, and ANSTO initially planned to process its high-density spent fuel from the RRR at COGEMA. However, as discussed above, uranium-molybdenum LEU fuel under development in the RERTR program will not be available in time for the commissioning of the RRR. It is expected that the RRR will have to be operated until about 2012 using uranium-silicide LEU fuel, all of which may not be accepted by COGEMA. The HIFAR cannot operate beyond the fall of 2006 because it is projected to run out of fuel at that time, and running the HIFAR at reduced power to conserve fuel would not allow ANSTO to meet its commitments to supply medical and industrial radioisotopes. In addition, while the HIFAR is safe for continued operation to the end of 2006, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has indicated operating the HIFAR beyond 2006 would require major upgrades to meet modern safety standards. In effect, the RRR is a replacement for the HIFAR and is the functional equivalent of a reactor conversion.

In the fall of 2004, ANSTO plans to apply to ARPANSA for an operating license for the RRR. However, unless ANSTO has established a firm path for disposition of all SNF from the RRR, it is unlikely ARPANSA will grant the operating license. If the operating license for the RRR is denied, then after decommissioning of the HIFAR in 2006, Australia will have no operational research reactor. Australia's production of medical and industrial radioisotopes will be disrupted, and Australia's materials research programs scheduled for the RRR will be delayed or terminated. Unlike other reactors in areas such as Europe, Australia's reactor is a continent away from other reactors that could provide certain radioisotopes with short half-lives that cannot be transported to Australia in time to be effective. Patients could then either be required to travel far from their homes for treatment, or to resort to possibly less effective therapies.

Due to the compelling circumstances attendant to operation of the HIFAR and the RRR, the government of Australia has formally requested that uranium-silicide LEU SNF from the RRR be accepted under DOE's FRR SNF Acceptance Program until processable uranium-molybdenum fuel becomes available for use in the RRR. As noted earlier, Australia has been an active and committed partner in the U.S.-led effort to develop new LEU fuels.

The inclusion of the RRR in the program will introduce approximately 96 additional fuel elements to the total projected for acceptance from Australia in the *FRR SNF EIS*. The Australian government now estimates that the number of non-RRR fuel elements that have already been received and those yet to be received from HIFAR would be 723, rather than the 975 elements estimated in 1996 (see Table 1). The FRR program therefore would have received 252 fewer elements from HIFAR than originally planned. The maximum number of spent fuel elements projected for the RRR is 348, for a total of 1,071, or 96 more than the 975 analyzed in the *FRR SNF EIS*. All eligible spent nuclear fuel from Australia under the proposed action will be managed at SRS. In order for the United States to accept RRR SNF, the government of Australia has formally committed that all FRR SNF shipments to the United States under the proposed action will meet the assumptions used in the *FRR SNF EIS* (i.e., no more than 1.26 million curie cask activity and 10 millirem per hour at 2 meters dose rate from each cask) (Hart 2004). The limitation on the cask curie activity would ensure that the upper limit estimate for the source term assumed in the *FRR SNF EIS* accident analysis would not be exceeded.

5. Related National Environmental Policy Act (NEPA) Documentation

DOE and the Department of State jointly issued the Final *FRR SNF EIS* on February 16, 1996 (DOE 1996a). In the Final EIS, DOE and the Department of State considered the potential environmental impacts of a proposed policy that would apply only to aluminum-based and TRIGA FRR SNF and target material containing uranium enriched in the United States. The potential environmental impacts addressed in the EIS included those from marine transportation of the SNF from overseas points-of-origin to U.S. ports, overland transportation of some SNF from Canada, overland transportation of SNF from various U.S. ports to SNF management sites, and management of the SNF at these sites until ultimate disposition in a geologic repository.

DOE subsequently announced the decision to implement the proposed policy as identified in the Preferred Alternative contained in the Final EIS. As stated in the ROD (61 FR 25092; May 17, 1996), implementation of the policy would involve acceptance of approximately 19.2 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 13, 1996. The FRR SNF would be shipped by either chartered or regularly scheduled commercial ships. The majority of the spent fuel would be received from abroad through the Charleston NWS in South Carolina and the Concord NWS in California. Most of the target material and some of the spent fuel would be received overland from Canada. In accordance with the ROD for the *DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement (Programmatic SNF&INEL Final EIS)* issued in April 1995 (DOE/EIS-0203F) (DOE 1995), the aluminum-based FRR SNF accepted by DOE (about 18.2 MTHM) would be managed at SRS in South Carolina, and the TRIGA elements (about 1 MTHM) would be managed at INEEL. After a limited period of interim storage, the spent fuel would be treated and packaged at SRS and INEEL as necessary to prepare it for transportation to a repository for disposal.

Although a number of options for interim storage, treatment, and packaging prior to ultimate disposition were considered and analyzed in the *FRR SNF EIS*, no specific decisions were included as part of that ROD. Since May 1996, two revisions to the ROD and two fee policy announcements[2] have been issued regarding taking title of the FRR SNF at locations other than the U.S. port-of-entry for countries with other-than-high-income economies: the fee policy for acceptance of FRR SNF and the increase of the maximum number of casks allowed in a single oceangoing vessel from 8 to 16 (61 FR 38720, July 25, 1996; 61 FR 26507, May 28 1996; 64 FR 18006, April 13, 1999; and 65 FR 44767, July 19, 2000, respectively).

Management of TRIGA elements at INEEL until ultimate disposition was analyzed in the *Programmatic SNF&INEL Final EIS*, Volume 2 (DOE/EIS-0203-F) (DOE 1995). Management of the aluminum-based FRR SNF at SRS until ultimate disposition was analyzed in the *Savannah River Site Spent Fuel Management Final Environmental Impact Statement (SRS SNF Management EIS)*, issued in March 2000 (DOE/EIS-0279) (DOE 2000). The *SRS SNF Management EIS* evaluates potential environmental impacts from managing SNF that is located or expected to be located at SRS. The SNF includes the 18 MTHM of aluminum-based FRR SNF that was projected to be stored at SRS. The *SRS SNF Management EIS* also evaluates the management of non-aluminum-clad SNF, which includes TRIGA FRR SNF currently stored or expected to be stored at SRS and expected to be transferred to INEEL in accordance with the ROD for the *Programmatic SNF&INEL Final EIS* (DOE 1995). The transportation of TRIGA FRR SNF from SRS to INEEL is analyzed in the *FRR SNF EIS* (DOE 1996a).

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[2] *The fee policy announcements set per kilogram rates for high-income economy countries to help offset fuel acceptance and management costs.*

The transportation of FRR SNF from SRS and INEEL for disposal was analyzed in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, (DOE/EIS-0250), issued in February 2002 (DOE 2002). This EIS evaluates not only the impacts associated with constructing, operating, and closing a repository, but also those associated with transporting the materials to the Yucca Mountain Repository site from the various interim storage locations, including SRS and INEEL.

6. Analysis and Discussion

This Supplement Analysis discusses the impact of the proposed action on the shipment schedule projected and analyzed in the *FRR SNF EIS*, and compares likely effects that the proposed action would have on environmental resources to those analyzed in the EIS. The comparison focuses primarily on radiological effects on human health and safety because they are the most likely to be affected by the proposed action. Section 6.2 discusses the most significant assumptions used in the *FRR SNF EIS* to analyze the radiological effects on human health and safety and describes the conservatism of these assumptions based on experience gained from actual shipments to date. Section 6.2 also discusses assumptions that need to be changed because of the proposed action or because of new information made available since the publication of the *FRR SNF EIS*. This Supplement Analysis addresses impacts associated with marine transportation, port activities, ground transportation, and management sites as addressed in the *FRR SNF EIS*.

6.1 Shipment Schedule

DOE evaluated the impact of the proposed action on cask shipments. **Figures 1 and 2** present a comparison of annual and cumulative numbers of casks shipped between 1996 and 2003, as assumed by the *FRR SNF EIS*, and the actual numbers of casks that were shipped during this time period. This includes both marine shipments and overland shipments. The EIS assumed a constant annual number of 65 casks shipped whereas, in reality, the annual and cumulative number of casks shipped from 1996 to 2003 was significantly lower than assumed in the EIS, and ranged from a low of 8 (for May through December 1996) to a high of 35 in 1999.

When Energy Secretary Abraham established the U.S. GTRI to accelerate the return of nuclear materials from overseas that could pose a proliferation risk, the FRR SNF Acceptance Program was realigned to complement other GTRI programs as part of this initiative. Efforts are being made to accelerate shipments from potentially sensitive areas. Determining which specific shipments may be expected to occur, and the specific schedule for those shipments, is difficult since many factors are involved in preparing for a fuel return. Further, “acceleration” in the near-term acceptance rate from a proliferation standpoint does not necessarily translate into substantially more shipments. For example, between May 1996 and May 2004 the Acceptance Program averaged about four shipments per year. “Accelerating” this rate may result in an additional two or three shipments over the next several years. The material that would be shipped has already been included in the total inventories identified in the *FRR SNF EIS*, so its impact has been assessed. For these reasons, the potential impact of the acceptance rate as it actually occurs is expected to remain substantially lower than the constant acceptance rate assumed in the EIS.

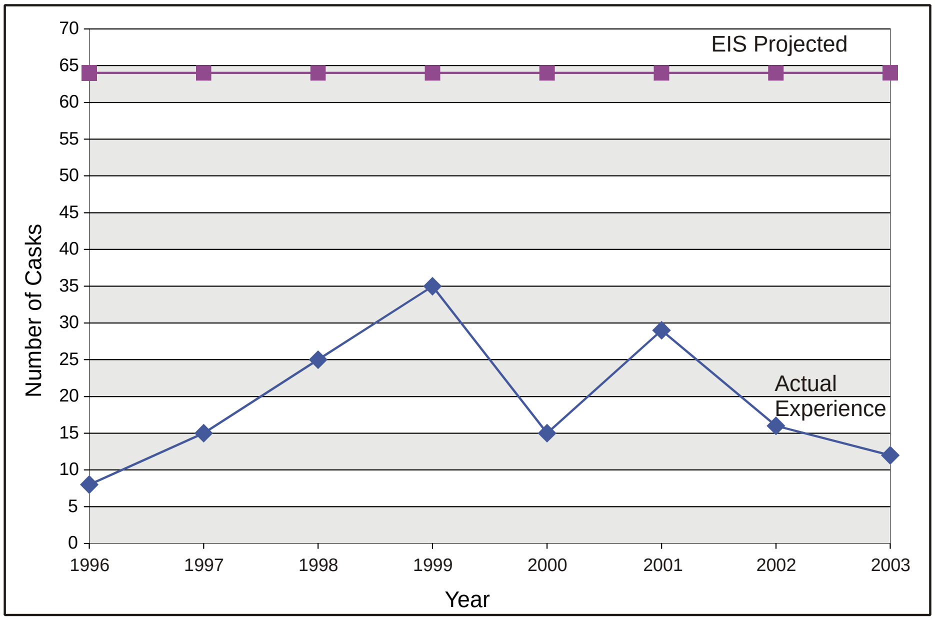

Figure 1. Comparison of EIS Assumed and Actual Number of Casks Shipped Annually from 1996 to 2003

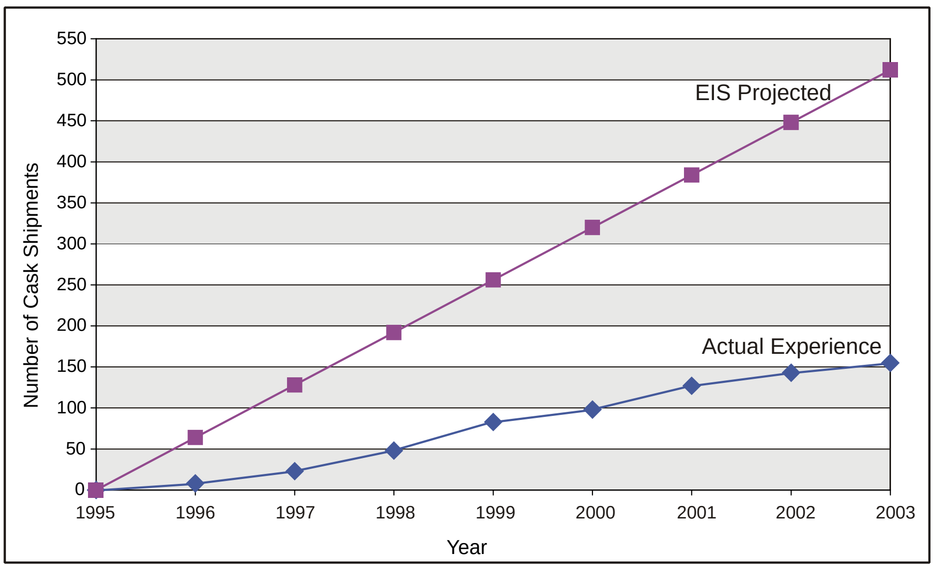

Figure 2. Comparison of EIS Assumed and Actual Cumulative Number of Casks Shipped from 1996 to 2003

6.2 Normal and Accident Radiological Consequences

Radiation can cause a variety of adverse health effects in people. Whether from external or internal sources, health impacts of radiation exposure can be “somatic” (affecting the exposed individual) or “genetic” (affecting descendants of the exposed individual). Somatic effects include the inducement of both fatal and nonfatal cancers. It may take years after the radiation exposure for a fatal cancer to develop, so these are referred to as “latent” cancers.

Radiological consequences [represented by estimated latent cancer fatalities (LCF)] of normal and postulated accident conditions in the *FRR SNF EIS* were estimated using a number of assumptions. Some of these assumptions are directly related to FRR SNF characteristics and properties. These assumptions are delineated below:

1) Cask and package dose rate at 2 meters would be at the 10 millirem per hour regulatory limit specified by 10 CFR 71.47, which would equal a cask surface dose rate of 71 millirem per hour.
2) Total fission product activity in a cask would be 1,260,000 curies if the BR-2 cask design shipped all Materials Test Reactor (MTR)-type concentric tube and plate aluminum-based SNF.
3) Total fission product activity in a cask would be 546,000 curies if the Réacteur Á Haut Flux (RHF) cask design shipped all MTR-type involute plate annular aluminum-based SNF.
4) Total fission product activity in any cask would be 110,000 curies for the TRIGA design representing all TRIGA-type stainless steel clad rod SNF.
5) Total fission product activity in any cask would be 833,000 curies for the National Research Universal design representing all pin cluster type aluminum-based SNF.

Assumption 1 is used in calculating dose rates to the ship crew; truck and rail operators; public along the transportation route; and workers at the docks, at SRS, and INEEL who are involved in handling the casks. Assumptions 2 through 5 are used in calculating doses to the public from incident-free operations and a spectrum of postulated accidents which would result in releases to the atmosphere of fission products from within the casks. Experience to date indicates that these assumptions are very conservative and a quantification of this conservatism, especially for Assumption 1, is presented below.

Since 1996, 160 casks of FRR SNF have been received (by sea or overland) in the United States at SRS, 12 of which were transported eventually from SRS to INEEL. Additionally, 3 casks have been received at INEEL from the NWS-Concord in California. No accidents or events occurred with these cask shipments either at sea, in port, or by truck or rail transportation modes. No workers received radiation doses in excess of their appropriate individual limits. All measured transportation cask surface and distance dose rates were within the licensing limits of that specific cask design.

Every FRR SNF cask shipped to the United States since 1996 was subject to detailed surface and distance gamma and neutron dose rate measurements at the reactor site after it was loaded with SNF, but prior to shipment. The accompanying shipping manifest also included the total activity of the enclosed SNF in a cask. The shipping manifest and summary data was obtained from SRS and INEEL, the final destinations for aluminum-clad and TRIGA FRR SNF. This data is useful in determining actual doses as compared to expected doses in the *FRR SNF EIS*.

All routine operational dose rates to workers and the public assumed in the EIS from both marine and overland transport were based on the assumption of 10 millirem per hour at 2 meters dose rate from each cask. This dose rate was analytically shown to be the equivalent of 71 millirem per hour at the cask surface in the EIS using the ZYLIND computer code. ZYLIND is a shielding computer code that calculates dose rates.

SNF typically has an inherent axial burnup and fission product distribution that is directly related to the gamma and neutron dose rate. The highest activity, and dose rate, comes from the central axial region of the SNF, with the dose rate dropping off at the upper and lower ends of the fuel elements. In addition, the cask shielding is usually not homogeneous over the entire radial and axial dimensions of the cask. Differences in cask shielding and fuel spatial fission product activity distribution will result in large variations in measured cask surface dose rate, although all dose rates must be below their appropriate licensing regulatory limits. These variations in cask surface dose rates directly affect the dose rate at a distance received by both workers and the public and are pictorially presented in **Figure 3**.

For purposes of analysis in the EIS and this Supplement Analysis this dose rate was assumed to be constant for all casks and independent of the spatial orientation of the person and cask. A person was assumed to receive 10 millirem per hour at 2 meters from the cask whether he or she were standing 2 meters from the axial centerline, axial end, top, or bottom of the cask. This is a conservative assumption because the actual cask surface dose rate usually varies significantly, and in many locations is typically lower than 10 millirem per hour at 2 meters. Under licensing regulations, a shipping cask would never exceed 10 millirem per hour at 2 meters for normal operations.

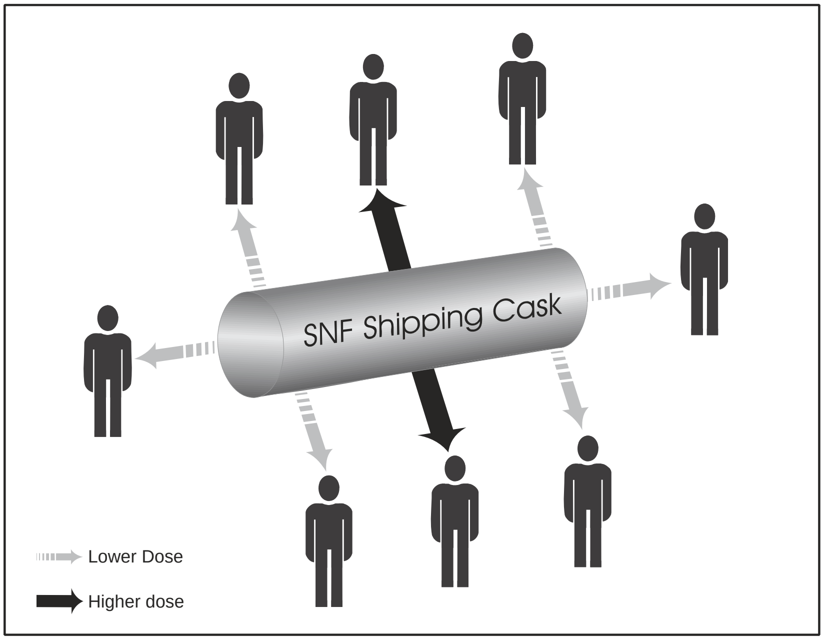

Figure 3. Pictorial Representation of Spatial Variations in SNF Shipping Cask Dose Rate

Measured total (i.e., gamma and neutron) cask surface dose rate data were obtained for 25 casks shipped to the United States (SRS 2004). Dose rate measurements were taken at 5 to 20 different surface locations on the cask. To quantify the effect of spatial cask dose rate distribution, the maximum-to-average surface measured dose rate was calculated and plotted for each of the 25 casks. This ratio varied from a low of 1.17 to a high of 5.08, with an average value of 3.04. This ratio provides an indication of the relationship between the maximum dose that could be received by an individual and the average dose that could be received by the same individual relative to their location around the cask. Therefore, depending on a person's position relative to a cask, the average individual would have likely received a dose rate about a factor of 3 lower than the average measured maximum value due to the cask surface dose rate variations.

Another way to verify the conservatism of the radiological consequence assumptions in the EIS is to examine the actual measured maximum cask surface dose rates for casks received under this program. **Figure 4** presents logarithmically plotted maximum cask dose rate as a function of total cask SNF activity for 45 casks (SRS 2004, Massey et al. 1999), including every received cask having an enclosed activity of 100,000 curies or greater as documented in shipping manifests. The values of maximum surface dose rate varied from 0.002 millirem per hour to 52 millirem per hour, and the total cask stored SNF activity varied from 9.5 to 466,938 curies. The mean maximum cask surface dose rate in this group of casks is 5.5 millirem per hour, only 8 percent of the 71 millirem per hour assumed in the EIS. Although casks shipped under the Acceptance Program could contain fuel with higher activity due to shorter SNF cooling times, approximately 35 percent of all the currently expected SNF elements have been received with no cask having a maximum surface dose rate near that assumed in the EIS.

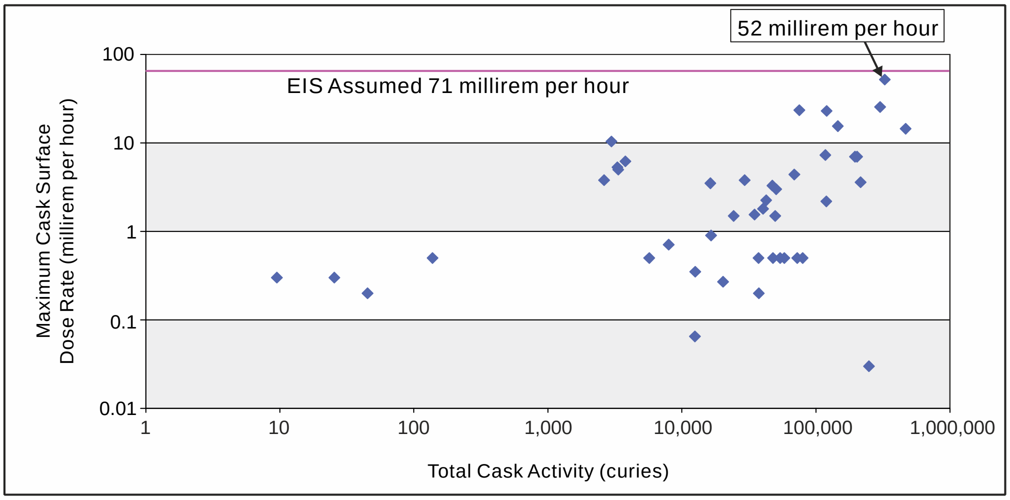

Figure 4. Measured Maximum Cask Surface Dose Rate

Another means of viewing the measured cask maximum surface dose rate data is to create a histogram, which in **Figure 5** presents a bar graph of the number of casks, from a sample of 45 received casks, with a maximum dose rate in discrete numerical value intervals. Figure 4 demonstrates that the vast majority of all casks received to date have a maximum surface total dose rate of 0 to 5 millirem per hour. Only one cask, at 52 millirem per hour, even approaches the EIS assumed 71 millirem per hour for all casks. To date, the average measured maximum cask dose rates of the received shipments of FRR SNF have exhibited a maximum surface dose rate that is about a factor of 13 lower (i.e., 5.5 versus 71 millirem per hour) than that assumed in the EIS (assuming measurement anywhere on the surface of the cask). Considering that the average measured maximum cask dose rate is a factor of 3 higher due to spatial variation, on average, the dose rate a person would receive would be lower by a factor of 40 as shown in the equation below.

$$\frac{\textit{EIS assumed cask dose rate}}{\textit{average measured maximum dose rate}} \times \frac{\textit{average measured maximum dose rate}}{\textit{average measured dose rate}} = 13 \times 3.04 \cong 40$$

Since it is not possible to predict with certainty the activity content of future cask shipments of FRR SNF to the United States, available data from shipments between 1996 and April 2004 were used to develop plots of maximum cask surface dose rate as a function of enclosed activity for specific cask designs. Sufficient data were only obtained for the NAC-LWT and GNS-11 cask designs, two designs frequently used for FRR shipments. For the same general mix of fission products, cask surface dose rate is expected to increase with increasing enclosed SNF activity. Such factors as preferential loading of the hottest fuel elements in the center of the cask basket can reduce surface dose rate. Upper limit estimate cask activities were identified as 1,260,000 curies for aluminum MTR tube and plate fuel, 546,000 curies for aluminum MTR involute annular fuel, 110,000 curies for TRIGA fuel, and 833,000 curies for aluminum pin cluster fuel. Most fuel has been shipped using NAC-LWT or GNS-11 casks. Measured maximum cask surface dose rates from FRR SNF shipments were plotted against cask enclosed SNF activity for the NAC-LWT and GNS-11 specific cask designs in **Figures 6 and 7.**

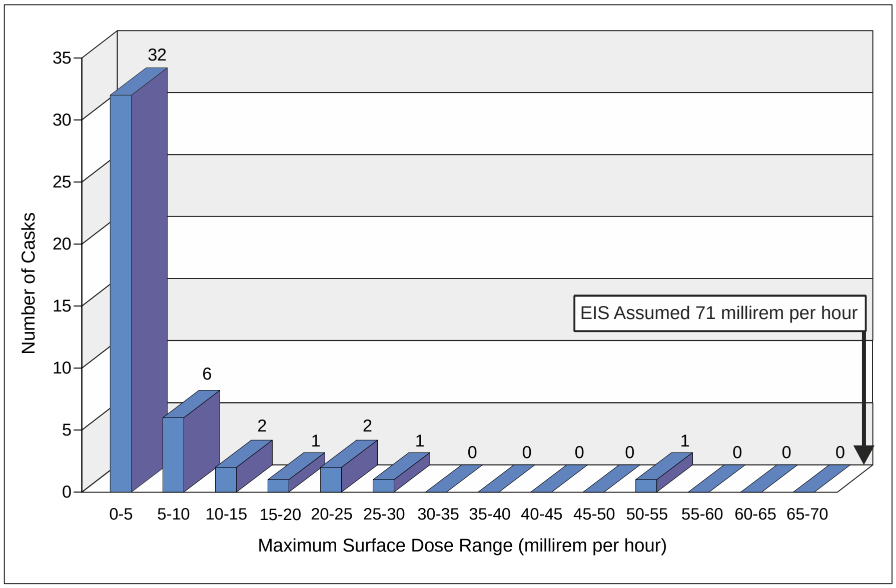

Figure 5. Maximum Shipping Cask Surface Dose Rate Distribution

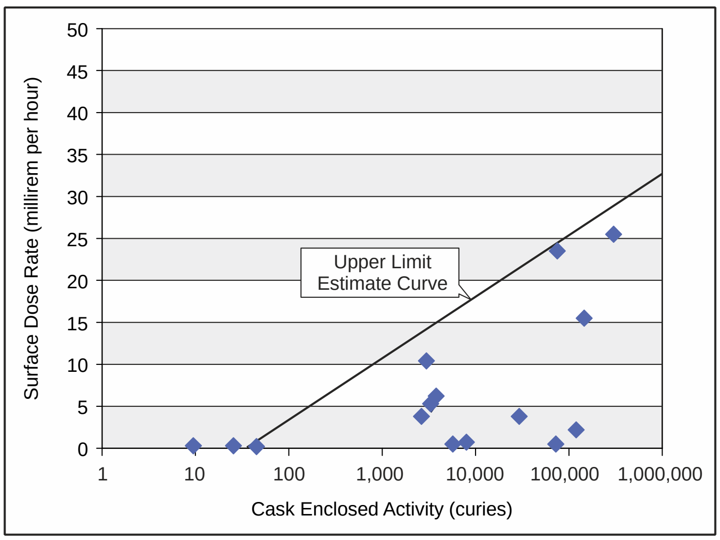

Figure 6. Measured NAC-LWT Cask Surface Dose Rate

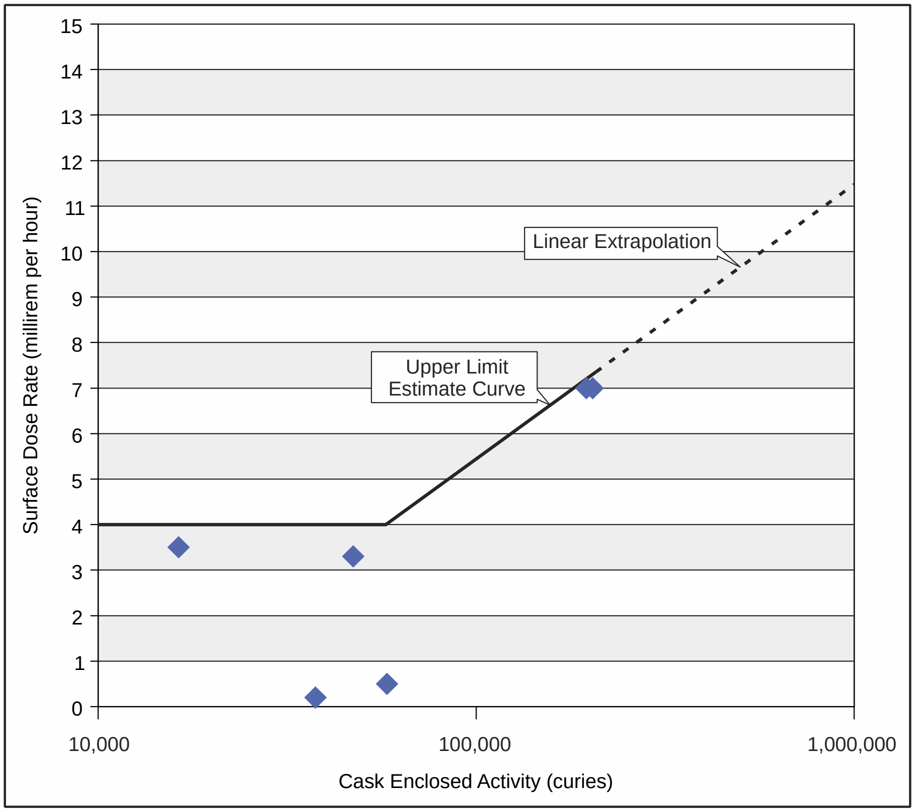

Figure 7. Measured GNS-11 Cask Surface Dose Rate

Both these figures show, by upper limit estimate curve fit to the measured data, that even at the highest EIS-assumed cask activity of 1.26 million curies, the cask surface dose rate would be well below the 71 millirem per hour assumed by the EIS. Use of the NAC-LWT cask extrapolates to a surface dose rate of about 34 millirem per hour and, use of the GNS-11 cask extrapolates to about 12 millirem per hour for 1.26 million curies. This would result in factors of 2 to 6 lower than the EIS-assumed value of cask surface dose rate. This empirical analysis does not preclude the possibility of higher dose rates (e.g., one cask had a maximum dose rate of 52 millirem per hour) because of the use of different cask designs, but it does show that frequently used cask designs have an inherent conservatism in dose rate as compared to the EIS assumption.

Analysts examined the conservatism and applicability of radiological consequence analyses in the *FRR SNF EIS* to a potential 5-year or 10-year extension in the time period for receipt of FRR SNF in the United States. This evaluation used empirical cask dose rate data, changes in expected FRR SNF, and changes in the analytical methodology to calculate LCFs from dose rate since the EIS was released in 1996. A summary of this evaluation follows:

- Two aluminum-based SNF cask designs, BR-2 and RHF, were used in the EIS for radioisotope inventory for accident calculations, but are no longer applicable because the countries have decided to process this SNF at COGEMA and not send it to the United States. The BR-2 cask was assumed to have 1.26 million curies, while the highest activity cask received to date had 0.47 million curies.

- The assumed maximum cask dose rate for all exposed workers and public does not account for spatial variations in cask surface dose rate around the cask, which can reduce the dose rate by a factor of about 3 based on cask dose rate measurements.

The mean maximum cask surface dose rate encountered for 45 casks (including every received casks having more than 100,000 curies enclosed activity), with about 35 percent of all SNF elements received, is about a factor of 13 lower than the EIS assumed 71 millirem per hour (equivalent to 10 millirem per hour at a distance of 2 meters).

Extrapolated cask surface dose rates from measured data for two of the most frequently used casks, the NAC-LWT and GNS-11, show at least a factor of 2 lower dose rates than assumed in the EIS for the assumed hottest inventory of 1.26 million curies.

Several changes have occurred that affect the assumptions used in the radiological consequence analysis of the *FRR SNF EIS* since its issuance in 1996. An important change is the fact that the Belgian and French research reactors have either formally decided to process their SNF at COGEMA or are not expected to participate in the program (Atomenergie in Belgien, UIC 2003). This event has eliminated two of the four upper limit source terms considered in the EIS cask radiological release accident analyses, the BR-2 and the RHF fuel designs. Put another way, much of the "hottest" SNF expected will not be returned under the Acceptance Program. The BR-2 and RHF were selected for analysis in the EIS because they bounded all similar designed aluminum-clad FRR SNF. The fact that BR-2 and RHF SNF will not be sent to the United States is a qualitative indicator of the conservatism and bounding nature of the fission product source term used in all accident analyses involving aluminum-clad plate, concentric tube, and annular SNF in the EIS for both port and overland transport.

The assumptions directly related to FRR SNF characteristics and properties are not affected by the proposed action, and are discussed here to show the extent of conservatism built into the original EIS radiological impact analysis. However, some assumptions have changed as a result of the proposed action, and some new information has become available since the publication of the *FRR SNF EIS*, specifically the following:

1) The implementation period of the program would be extended by either 5 or 10 years, to a total of either 18 or 23 years instead of the 13 years analyzed in 1996.
2) Including the RRR in the program would introduce approximately 96 additional fuel elements to the total of 22,743 fuel elements projected and analyzed in the *FRR SNF EIS*, as discussed in Section 4.3. The additional fuel elements, which would amount to an increase in absolute terms of less than one-half of 1 percent of the total fuel eligible under the program, would be managed at SRS. As cited in other sections of this SA, reactors in other nations such as Belgium and France have decided to manage their fuel by other means and therefore, will send less SNF than expected in the original EIS.
3) The 1996 *FRR SNF EIS* used population data based on the 1990 census. The Supplement Analysis uses population data based on the 2000 census, with projections to 2015 and 2020.
4) The FRR SNF uses a risk factor of 0.0005 LCF per person-rem for the public and 0.0004 LCF per person-rem for workers. DOE guidance (DOE 2003), since the publication of the 1996 EIS, was revised to recommend using a factor of 0.0006 LCF per person-rem for both the general public and workers. The new, more conservative guidance is used in estimating LCF under the proposed action.

6.3 Marine Transport Impacts

Potential marine transport impacts from the implementation of the policy to accept FRR SNF in the United States are discussed in Section 4.2.1 and associated Appendix C of the *FRR SNF EIS* (DOE 1996a). As discussed in the *FRR SNF EIS,* nonradiological impacts associated with the marine shipment of the containerized transportation casks would be minimal. The radiological impacts of transporting the FRR SNF by sea were considered for two conditions, incident-free and accident conditions.

Incident-free Conditions

The primary impact of incident-free marine shipping of FRR SNF would be upon the crews of the ships used to carry the SNF casks. This involves crew exposure during loading, daily inspection, and unloading of the transportation casks. One specific activity, daily cask inspection, would result in the highest doses to the ship's crew, with the inspectors considered the maximally exposed workers.

The analysis presented in the *FRR SNF EIS* indicated that multiple casks in a single vessel would maximize the incident-free exposure for individual crew members on a per-trip basis, but would tend to lower the total program exposure for the crews of all ships, since the number of trips would be reduced. The maximum individual and total crew exposures were based on the regulatory limit external dose rate of 10 millirem per hour at 2 meters from the surface of the cask. As discussed in Section 6.2, the EIS assumed exposures were about 40 times greater (see explanation in Section 6.2) than has been shown to have occurred. As of April 2004, actual received cask dose rate measurements, representing about 35 percent of all expected SNF elements, show that normal operational doses to workers and the public have been about a factor of 40 (see explanation in Section 6.2) lower than estimated in the EIS.

The environmental analysis contained in the *FRR SNF EIS* also assumed that 65 minutes would be required to unload each cask. Operational experience shows that average unloading times are closer to 20 minutes per cask and so potential radiological exposures are less than estimates reported in the EIS. Inspection personnel who perform daily inspection of the casks during ocean voyages and who are wearing radiation dosimetry badges have reported no measurable dose has yet been observed.

Under EIS assumptions, 721 casks would have been shipped to the United States from overseas over a period of 13 years (1996 to 2009). This corresponds to approximately 56 casks per year or 7 trips per year, assuming an average of 8 casks per trip. The maximum exposure for a member of the ship's crew was calculated to be 238 millirem per trip which, had it occurred, would have exceeded the annual exposure limit of 100 millirem allowed by regulation (10 CFR 20.1301). Since this maximum individual exposure would not have been allowed to exceed the 100 millirem limit, the 13-year program total for a member of the crew would be limited to 1.3 rem under the conservative assumption that the same crew member would perform the same function over the 13-year implementation period (which has not occurred). This exposure corresponds to an LCF risk of 0.00052, or a chance of approximately 1 in 1,900 that the crew member would incur a fatal cancer due to the 13-year program.

The exposure for all crew members was also calculated on a per-trip basis. Assuming an average of 8 casks per trip, 721 casks require approximately 90 trips, regardless of the length of the implementation period. The total crew exposure was estimated to be 0.837 person-rem per trip, or 75.4 person-rem for the 13-year implementation period. This corresponds to an LCF of 0.030. This means that there would be less than a 1 in 33 chance that an excess LCF would occur among all crew members of all ships involved in the program.

The maximally exposed ship worker dose and the program dose total for all ships' crew members were estimated for the proposed 5-year and 10-year proposed extensions of the program. The comparison to the impacts estimated in the *FRR SNF EIS* is shown in **Table 3**. In addition, DOE developed a Mitigation Action Plan after issuance of the *FRR SNF EIS* to limit radiation exposure to port and transportation workers involved in the movement of FRR SNF (DOE 1996b).

Table 3. Incident-Free Marine Transportation Impacts

	FRR SNF EIS	***5-Year Extension***	***10-Year Extension***
Maximally Exposed Worker Dose (rem) [a]	1.3	1.8	2.3
LCF	0.00052	0.0010	0.0014
Chance of Cancer Fatality	1/1,923	1/1,000	1/714
Crew Members' Dose (person-rem)	75.4	75.4	75.4
LCF	0.030	0.045	0.045
Chance of Excess Cancer Fatality	1/33	1/22	1/22

[a] Program total; assuming the same individual throughout program.

The maximum exposure for a member of the crew under the proposed action (5-year or 10-year extension), using the conservative EIS assumptions, would still be 238 millirem per trip, which would exceed the regulatory limit of 100 millirem per year. However, this individual would be limited by established procedures (in the Mitigation Action Plan) to 100 millirem per year. A 5-year extension would limit the maximum crew member exposure to a program total of 1.8 rem. A 10-year extension would limit the maximum crew member exposure to a program total of 2.3 rem. The LCF risk would be 0.0010 for a 5-year extension and 0.0014 for a 10-year extension. That is a chance of approximately 1 in a thousand (5-year extension), or 1 in 714 (10-year extension), that this crew member would incur a cancer due to the entire extended program.

The program dose total for all crew members would remain the same, at 75.4 person-rem, under either the 5-year or the 10-year extension, since it depends on the total number of casks to be shipped. This would correspond to an LCF of 0.045, at a chance of 1 in 22 that an excess LCF would occur among all crew members involved in the program.

As stated earlier, the incident-free exposure would be reduced by more than a factor of 40 (see explanation in Section 6.2) if the more realistic surface dose rate and unloading times supported by operational experience were assumed for the marine transportation casks.

Including the Australian RRR in the program would introduce 96 additional fuel elements to the total of approximately 22,700 fuel elements analyzed in the *FRR SNF EIS*. The return of these fuel elements to the United States could require two or three additional casks, depending on cask and transport availability. The additional risk to ships' crew members from the marine transport of two additional casks over the entire program would be too small to affect the results of the calculations.

The direct radiation from the transportation casks during routine marine transport would not have a measurable effect on marine plants and animals, and none is expected from the proposed action.

Based on the foregoing, the proposed action would increase the incident-free radiological risk to the postulated maximally exposed crew member primarily because of the assumption that a single individual could be involved in sufficient marine trips to reach the regulatory limit, each year, for the duration of the program. This has not been the case in operational experiences. The dose total to all crew members would remain the same, with a small increase in LCF risk due to changes in the guidance for converting dose to LCF. The analysis in the EIS has enough conservatism built into the assumptions (now quantified as more than a factor of 40 [see explanation in Section 6.2] based on measurement of casks received through April 2004) to ensure that the proposed action would not alter the conclusions reached in the *FRR SNF EIS*. Furthermore, DOE developed a Mitigation Action Plan after issuance of the *FRR SNF EIS.* This plan established programmatic procedures to be specified in acceptance contracts that will ensure radiation exposure to port and transportation workers remains below regulatory limits (DOE 1996b). DOE will continue to follow the Mitigation Action Plan requirements in implementing the proposed action.

Marine transport radiological cumulative impacts are discussed in Section 4.2.1.4 of the *FRR SNF EIS*. DOE has not identified any other activities, existing or reasonably foreseeable, that could have an effect on the marine transport cumulative impacts which were not considered in the *FRR SNF EIS*.

Accident Conditions

The *FRR SNF EIS* (Section 4.2.1.3) considered two accident scenarios:

> *Scenario A:* As the result of a maritime casualty (e.g., collision, foundering, fire), the vessel sinks in coastal waters, resulting in the submersion of the cask on the ocean floor. The cask is not retrieved. Analyses were done for two cases: (1) damaged cask, and (2) undamaged cask.

> *Scenario B:* As the result of a maritime casualty, the vessel sinks in deep ocean waters, resulting in the submersion of the cask on the ocean floor. The cask is not retrieved. Analyses were done for a damaged cask because it was assumed that submersion in the deep ocean would damage the cask.

Under these scenarios, the maximum dose risk to the MEI was estimated to be 6.4 H 10^{-7} millirem per year (3.8 H 10^{-10} LCF) for a damaged cask in coastal water and 4.3 H 10^{-6} millirem per year (2.6 H 10^{-9} LCF) for an undamaged cask. Risk to the MEI associated with a submerged, unrecovered cask in the deep ocean was 1.9 H 10^{-4} millirem per year (1.1 H 10^{-7} LCF) for a damaged cask.

The maximum dose risk to fish, crustaceans, and mollusks was estimated to be 2.9 H 10^{-8}, 3.0 H 10^{-8}, and 6.4 H 10^{-7} millirad per year respectively for a damaged cask in coastal waters, and 1.8 H 10^{-6}, 1.9 H 10^{-6}, and 4.8 H 10^{-6} millirad per year for an undamaged cask. These were not considered to be threatening to plant and animal populations.

The proposed action of the policy extension (5 years or 10 years) does not affect the scenarios or assumptions made in the *FRR SNF EIS* concerning accident conditions during marine transport because each accident condition assumes the involvement of a single cask. Also, the inclusion of the Australian RRR in the program would not affect the impacts from accident conditions analyzed in the *FRR SNF EIS*, because the cask carrying RRR spent fuel would not exceed the upper limit estimate for the source term assumed in the *FRR SNF EIS* analysis. The radiological impacts from accident conditions to humans, plants, and animals analyzed shown in the *FRR SNF EIS* (Section 4.2.1.3) would remain the same.

6.4 Port Activities Impacts

The potential port activities impacts from the implementation of the policy to accept FRR SNF in the United States are discussed in Section 4.2.2 and associated Appendix D of the *FRR SNF EIS* (DOE 1996a). As with the marine transport, the port impacts were evaluated for two conditions: incident-free and accident conditions.

Incident-free Conditions

As stated in the *FRR SNF EIS*, no SNF transportation cask has ever released its contents (radioactive material), even as a result of an accident. For this reason, as in the *FRR SNF EIS*, release of radioactive material was not considered as part of the incident-free analysis. The only impact considered is radiation exposure due to radiation emitted by FRR SNF contained within the transportation casks. Since no radioactive material would be released, there would be no impacts on land, water, or air quality in any of the ports or any waterways used by ships in the transport of FRR SNF.

Relevant assumptions made in the *FRR SNF EIS* with respect to the risk from radiation exposure to port workers and other personnel were that 721 casks would be received at U.S. ports, and the external radiation for an intact shipping package was assumed to be at the regulatory limit of 10 millirem per hour at a distance 2 meters from the surface of the container. As discussed in Section 6.2, based on actual experience to date this assumption overestimates the risks by approximately a factor of 40 (see explanation in Section 6.2). The per-cask doses were multiplied by the number of casks to determine the maximally exposed worker dose and the collective dose to workers.

Under EIS assumptions, there were 721 casks to be shipped to the U.S. from overseas over a period of 13 years (1996 to 2009). This corresponds to an average of 56 casks per year. The postulated maximum exposure for a port worker was estimated to be 3.8 millirem per cask. At 56 casks per year and the very conservative assumption that the same port worker would handle all casks annually, the exposure limit of 100 millirem allowed by regulation could be exceeded. Since the maximum individual exposure would not be allowed to exceed the 100 millirem per year limit by procedures, the 13-year program total for a port worker would be limited to 1.3 rem. This exposure corresponds to an LCF risk of 0.00052. That is a chance of approximately one in 1,900 that the port worker would incur a cancer due to the 13-year program.

The exposure for all port workers was also calculated on a per-cask basis. The collective dose was estimated to be 0.042 person-rem per cask handled. Therefore, the total port worker population dose for 721 casks was estimated to be 30 person-rem. This exposure corresponds to an LCF of 0.0012.

The maximally exposed port worker dose and the program dose total for all port workers was estimated for the proposed 5-year and 10-year proposed extensions of the program. The comparison to the impacts calculated in the *FRR SNF EIS* is shown in **Table 4**.

Table 4. Incident-Free Port Impacts

	FRR SNF EIS	***5-Year Extension***	***10-Year Extension***
Maximally Exposed Worker Dose (rem) [a]	1.3	1.8	2.3
LCF Chance of Cancer Fatality	0.00052 1/1,900	0.0010 1/1,000	0.0014 1/714
Port Workers Dose (person-rem)	30	30	30
LCF Chance of Excess Cancer Fatality	0.0012 1/830	0.0018 1/550	0.0018 1/550

[a] Program total, assuming the same individual throughout program.

The maximum exposure for a port worker under the proposed action (5-year or 10-year extension) is still assumed to be 3.8 millirem per cask handled. Therefore, the regulatory limit of 100 millirem per year (10 CFR 20.1301) would be exceeded if more than 26 casks were received annually. This is considered to be likely for either the 5- or the 10-year extensions. Since the maximum port worker exposure would not be allowed to exceed the 100 millirem per year limit by procedures, the 18-year program total for a port worker would be limited to 1.8 rem and the 23-year program total for a port worker would be limited to 2.3 rem. The LCF risk would be 0.0010 for a 5-year extension and 0.0014 for a 10-year extension. That is a chance of approximately 1 in 1,000 (5-year extension), or 1 in 714 (10-year extension) that this individual would incur a cancer due to the entire extended program.

The program dose total for all port workers would remain the same, at 30 person-rem, under either the 5-year or the 10-year extension, since it depends on the total number of casks to be handled. This corresponds to an LCF of 0.0018 or a chance of 1 in 550 that an excess LCF would occur among all port workers involved in the program.

The above risks would be reduced by more than a factor of 40 (see explanation in Section 6.2) if the more realistic surface dose rate supported by operational experience was assumed for the marine transportation casks.

Including the Australian RRR in the program would introduce 96 additional fuel elements to the total of approximately 22,700 fuel elements analyzed in the *FRR SNF EIS*. The return of these fuel elements to the United States could require two or three additional casks, depending on cask and transport availability. The additional risk to port workers from handling two additional casks over the entire program would be too small to significantly affect the results of the calculations.

Direct radiation from the transportation casks during port activities would have no measurable effect on plants and animals given the distance from the casks and the short transit time involved, and none is expected from the proposed action.

In conclusion, the proposed action would increase the radiological risk to a postulated maximally exposed port worker primarily because of the conservative assumption that a single individual could be involved in handling the casks at a single port, for all trips, each year for the duration of the program, which has not occurred in actual experience. The dose total to the port workers would remain the same, with a small increase in LCF risk due to the change in guidance for converting dose to LCF. These would be increases to an already very low risk estimated in the EIS. As discussed earlier, the analysis in the *FRR SNF EIS* is conservative enough (by more than a factor of 40, as explained in Section 6.2) to ensure that either policy period extension, and the proposed acceptance of Australian RRR SNF, would not represent a significant change to conclusions reached in the *FRR SNF EIS*.

Port radiological cumulative impacts are discussed in Section 4.2.2.4 of the *FRR SNF EIS*. DOE has identified no other activities, existing or reasonably foreseeable, that could affect the port cumulative impacts.

Accident Conditions

As considered in the *FRR SNF EIS*, the overall probability of a cask collision and cask release (per shipment risk) depends upon the number of voyages and transversely stowed casks. In the EIS, a maximum number of two casks in the hold was assumed, but the potential risk from accidents was modeled as occurring in one cask per shipment. As was stated in the EIS, the consequences of the accident with two casks in the hold could be twice as severe as the consequences of an accident involving one cask, but the per voyage probability of an accident involving the ship carrying the two casks is half that one of the two ships carrying a single cask being involved in an accident. More recent analysis has shown that the cask damage scenarios postulated in the EIS were very conservative (DOE 1998). In reality, a spent fuel cask is much stronger than the hull of the vessel carrying it. If there were to be a collision involving penetration of the hull of the spent fuel carrying vessel, a spent fuel cask would be pushed out the other side of the vessel before enough force could be brought to bear on the cask to breach it. Thus, the most recent conclusion is that, at most, only one cask could be breached during a severe accident, regardless of the number of casks stowed transversely in a hold. This conclusion holds true for the proposed changes to the scenarios introduced by this Supplement Analysis.

The EIS addressed the impacts of possible accidents at representative ports. Thirteen ports were selected representing the full range of ports in the United States, based on population and geography. Three of the ports were high-population density ports, two on the East Coast (Elizabeth, New Jersey and Philadelphia, Pennsylvania) and one on the West Coast (Long Beach, California). Five of the ports (Portland, Oregon; Tacoma, Washington; Concord NWS, California; Jacksonville, Florida; and Norfolk, Virginia) are medium-population density ports, three on the West Coast and two on the East Coast. The remaining ports (Military Ocean Terminal Sunny Point, North Carolina; Galveston, Texas; Savannah, Georgia; Wilmington, North Carolina; and Charleston, South Carolina) are low-population density ports. The 13 potential ports of entry for which accidents were analyzed collectively have a range of populations and geography to ensure the results of these analyses are representative of the results that would have been reached if the analyses had been conducted for all ports.

The consequences of ship collisions that occur in ports were estimated using the MELCOR Accident Consequences Code System (MACCS). The MACCS calculations require as input the radioactive inventory of the cask at the time of the accident, release fractions and probability of release for the source term caused by the accident, plume characteristics for the radioactivity released to the atmosphere by the accident, meteorological data characteristic of the region where the port is located, the population distribution around the port where the accident occurs, and emergency response assumptions (i.e., evacuation times, shielding conditions, etc.).

The port accident risks estimated in the *FRR SNF EIS* range from a high of 0.070 person-rem and 0.000029 LCF, which assumes that all shipments would be made through two high-population intermediate ports into Elizabeth, New Jersey, to a low of 0.0007 person-rem and 0.00000032 LCF, which assumes that the shipments are made directly to Military Ocean Terminal Sunny Point, North Carolina.

Using 2000 census data and growth factors to project a population distribution to the year 2015 (to include the 5-year extension of the policy) and the year 2020 (to include the 10-year extension of the policy), the population exposure and risk under the proposed action was estimated for the most high-density port, Elizabeth, New Jersey, and the least low-density port, Military Ocean Terminal Sunny Point at Wilmington, North Carolina.

A comparison of the port accident risks under the proposed action and those analyzed in the *FRR SNF EIS* is presented in **Table 5**.

Table 5. Port Accident Consequences and Risk

	FRR SNF EIS	***5-Year Extension***	***10-Year Extension***
Population (person-rem)	0.070 - 0.0007	0.080 - 0.0013	0.081 - 0.0014
LCF	0.000029 - 0.00000032	0.000048 - 0.00000076	0.000049 - 0.00000084
Chance of Excess Cancer Fatality	1/34,500 - 1/3,125,000	1/20,800 - 1/1,316,000	1/20,400 - 1/1,190,000

Note: The high number in the range represents the Port of Elizabeth, New Jersey, and the low number in the range represents Military Ocean Terminal Sunny Point at Wilmington, North Carolina.

The port accident risks associated with the entire program under the 5-year extension of the policy would range from a high 0.080 person-rem and 0.000048 LCF for all shipments through Elizabeth, New Jersey, to a low 0.0013 person-rem and 0.00000078 LCF for all shipments directly to Military Ocean Terminal Sunny Point, North Carolina. The inclusion of the Australian RRR in the program would not affect the impacts from accident conditions analyzed in the *FRR SNF EIS*, because the cask carrying RRR spent fuel would not exceed the upper limit estimate for the source term assumed in the *FRR SNF EIS* analysis.

The potential population exposures from port accidents are low enough to assure that the effect on plants and animals would be minimal (see *FRR SNF EIS*, Section 4.1.6 and 4.2.1.3). As discussed in the *FRR SNF EIS*, if a cask or casks were sunk in coastal waters, DOE would employ underwater search techniques to locate and recover the cask(s), thus minimizing the potential impacts to marine life. The maximally exposed ship worker dose and the program dose total for all ships' crew members were calculated for the proposed 5-year and 10-year proposed extensions of the program.

In summary, the proposed action would increase the radiological risk to the population around the ports of entry because of the projected population growth and the change in guidance for converting dose to LCF. However, these would be small increases to the very low risk calculated in the *FRR SNF EIS* (Section 4.2.2).

6.5 Ground Transportation Impacts

Potential impacts from ground transportation of FRR SNF within the United States are discussed in Section 4.2.3 and associated Appendix E of the *FRR SNF EIS* (DOE 1996a). As with marine transport and port activities, the ground transportation impacts were evaluated for two conditions: incident-free and accident conditions. The risk assessment approach used was to determine the incident-free and accident risk factors on a per-shipment basis, assuming one cask per overland shipment and then to multiply those factors by the projected number of overland shipments. The *FRR SNF EIS* assumes that 837 single-cask overland shipments would be made from U.S. seaports and Canadian border crossings to DOE facilities, and 161 single-cask overland shipments would be made between DOE facilities.

Calculation of risk factors was accomplished by first using the HIGHWAY and INTERLINE computer codes to choose representative routes. These codes provided population estimates along the routes so that the RADTRAN and RISKIND codes could be used to determine the risk factors associated with ground transportation activities.

Incident-Free Conditions

As in the case for marine impacts discussed in Section 6.2, the very conservative assumption was made that the radiation field outside the transportation casks would be at the regulatory limit of 10 millirem per hour at 2 meters.

The highest estimated ground transport maximally exposed worker risk estimated in the *FRR SNF EIS* was 0.00052 LCF, just like the marine transport and port worker risks. This estimate was based on the conservative assumption that one truck driver would make enough trips to reach the regulatory limit of 100 millirem per year every year for 13 years. This exposure corresponds to an LCF risk of 0.00052, or a chance of approximately one in 1,900 that the truck driver would incur a fatal cancer due to the 13-year program.

Because of the large number of ports, receiving sites, and truck or rail options, the *FRR SNF EIS* presents the incident-free ground transportation impacts to the general population and workers in ranges. The estimated LCF risk due to radiation exposure for transportation workers ranged from 0.006 to 0.071. The estimated number of radiation LCF for the general population ranged from 0.007 to 0.22, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.001 to 0.052. These ranges represent all ground transportation corridors evaluated in the *FRR SNF EIS*.

Most of the overland shipments to date have been made through Charleston, South Carolina to SRS. To provide an estimate of the ground transportation impacts to the health and safety of the transportation workers and the public under the proposed action, it was assumed that this route would be the preferred route for the rest of the shipments. The estimate considers population data based on the 2000 census, projected to years 2015 and 2020 to account for the proposed policy extensions, and the change in guidance for converting dose to LCF. The results appear in **Table 6**.

Table 6. Incident-Free Ground Transportation Impacts

	FRR SNF EIS	*5-Year Extension*	*10-Year Extension*
Maximally Exposed Worker Dose (rem) [a]	1.3	1.8	2.3
LCF Chance of Cancer Fatality	0.00052 1/1,900	0.0010 1/1,000	0.0014 1/714
Public Risk (LCF) Chance of Excess Cancer Fatality	0.007 - 0.22 [c] 1/143 – 1/4	0.087 [b] 1/11	0.089 [b] 1/11
Worker Risk (LCF) Chance of Excess Cancer Fatality	0.006 - 0.071 [c] 1/167 – 1/14	0.035 [b] 1/28	0.035 [b] 1/28
Nonradiological Risk Chance of Nonradiological Fatality	0.001 - 0.052 [c] 1/1,000 – 1/19	0.001 - 0.052 1/1,000 – 1/19	0.001 - 0.052 1/1,000 – 1/19

[a] Program total, assuming the same individual throughout program.
[b] Estimated for the Charleston, South Carolina to SRS and SRS to INEEL corridors.
[c] The range represents all ground transportation corridors.

The maximum potential exposure for a transportation worker under the proposed action would be 1.8 rem for the 5-year extension and 2.3 rem for the 10-year extension, corresponding to 0.0010 and 0.0014 LCF respectively, just like the marine transport and port worker risks. The public risk would be 0.087 LCF for the 5-year extension and 0.089 LCF for the 10-year extension. These increases over the SNF EIS estimate are due to population growth estimates and the change in guidance for converting dose to LCF. The worker risk is 0.035 LCF for both the 5-year and the 10-year extensions. This increase over the *FRR SNF EIS* estimates is due only to the change in guidance for converting dose to LCF, since there is no growth associated with the number of workers. The risk for nonradiological fatalities would not be affected by the proposed action since it a function only of distance traveled which would not change under the proposed action. The above radiological risks would be substantially lowered by more than a factor of 40 (see explanation in Section 6.2) if the more realistic surface dose rate supported by operational experience was assumed for the transportation casks.

The inclusion of the Australian RRR in the program would introduce 96 additional fuel elements to the total of approximately 22,700 fuel elements analyzed in the *FRR SNF EIS*. The return of these fuel elements to the United States could require transportation of two or three additional casks. Transportation of these casks could, at the most, require 1 additional shipment although the more likely case would be that the casks would be combined with other FRR shipment. The *FRR SNF EIS* has included provisions for longer shipment times from Australia to the United States in its calculation of ship crew doses. The additional 96 fuel elements would not significantly change the results reported in the *FRR SNF EIS* for the shipments from Australia. The additional risk to ground transportation workers and the public along the transportation routes from the overland transportation of two additional casks over the entire program would be very small.

The direct radiation from the casks during ground transportation would have no measurable effect on plants and animals and none is expected from the proposed action.

In conclusion, the proposed action would increase the incident-free radiological risk to the maximally exposed transportation worker if one assumes a single transportation worker could be involved in sufficient trips per year to reach the regulatory limit of 100 millirem per year, each year, for the duration of the extended program. This has not occurred. The radiological risk to the public could increase because of the projections for population growth, but it would remain within the range calculated in the *FRR SNF EIS*. The radiological risk to workers would increase due to the change in guidance for converting dose to LCF, but it would remain within the range calculated in the EIS. The *FRR SNF EIS* used very conservative assumptions in its analysis so that the potential transportation impacts of the proposed action would be unlikely to exceed those reported in the EIS. In implementing the proposed action, however, DOE would continue to utilize its Mitigation Action Plan, which includes measures to reduce radiation exposure to the transportation workers involved in the movement of FRR SNF (DOE 1996b).

Ground transportation radiological cumulative impacts are discussed in Section 4.2.3.4 of the *FRR SNF EIS*. DOE has not identified any other activities, existing or foreseeable, that could have an effect on the port cumulative impacts and have not been considered in the *FRR SNF EIS*.

Accident Conditions

A comparison of ground transportation accident risks under the proposed action and those analyzed in the *FRR SNF EIS* is presented in **Table 7**. As in the case for incident-free conditions, the estimate for the proposed action considers population data based on the 2000 census projected to years 2015 and 2020 to account for the proposed policy extensions and the change in guidance for converting dose to LCF.

Table 7. Ground Transportation Accident Risk

	FRR SNF EIS	*5-Year Extension*	*10-Year Extension*
Public Risk (LCF)	0.000004 - 0.00028 [a]	0.000099 [b]	0.00011 [b]
Chance of Excess Cancer Fatality	1/250,000 - 1/3,600	1/10,000	1/8,700
Nonradiological Risk	0.001 - 0.14 [a]	0.001 - 0.14 [a]	0.001 - 0.14 [a]
Chance of Nonradiological Fatality	1/1,000 - 1/7	1/1,000 - 1/7	1/1,000 - 1/7

[a] The range represents all ground transportation corridors.
[b] Estimated for the Charleston, South Carolina to SRS and SRS to INEEL corridors.

The radiological accident risks estimated in the *FRR SNF EIS* range from a high of 0.00028 LCF to a low of 0.000004 LCF. This range represents all ground transportation corridors analyzed in the *FRR SNF EIS*. The radiological risk to the general public along the Charleston, SC-SRS-INEEL corridor is estimated to be 0.000044 LCF for the 5-year extension period and 0.000065 LCF for the 10-year extension period. These are values within the range estimated in the *FRR SNF EIS*. The inclusion of the Australian RRR in the program would not affect the impacts from accident conditions analyzed in the *FRR SNF EIS*, because the cask carrying RRR spent fuel would not exceed the upper limit estimate for the source term assumed in the *FRR SNF EIS* analysis.

In conclusion, the proposed action would increase the radiological risk to the population residing near the ground transportation routes because of the projected population growth and the change in guidance for converting dose to LCF. However, the estimated risk is within the range calculated in the *FRR SNF EIS*.

6.6 Impacts at SRS and INEEL

The potential impacts at DOE sites, including SRS and INEEL, from the implementation of the policy to accept FRR SNF in the United States are discussed in Section 4.2.4 and associated Appendix F of the *FRR SNF EIS* (DOE 1996a). The potential impacts of a number of options for managing FRR SNF for interim storage, treatment, and packaging prior to ultimate disposition were considered and analyzed.

In addition, management of the aluminum-based FRR SNF at SRS until ultimate disposition is analyzed in the *SRS SNF Management EIS*, issued in March 2000 (DOE 2000). This EIS evaluates potential environmental impacts from managing SNF that is located or expected to be located at SRS including FRR SNF. The management of TRIGA elements at INEEL, including TRIGA FRR SNF, until ultimate disposition is analyzed by the *Programmatic SNF&INEL Final EIS*, Volume 2 (DOE 1995).

The potential environmental impacts from the management of FRR SNF at SRS and INEEL are primarily a function of the total quantity of SNF that would be treated or stored on the interim basis and the type of treatment or storage that would be used. The proposed action of extending the policy period (5 years or 10 years) for accepting FRR SNF in the United States would not affect the total quantity of the candidate SNF or the type of treatment or storage that would be used. Moreover, the proposed action would not interfere with the storage and duration considered in the *FRR SNF EIS* because the site specific impact analyzed in the *FRR SNF EIS* and the extension does not go beyond 2035. The inclusion of the Australian RRR in the program would introduce 96 additional fuel elements to the 17,800 fuel elements that the FRR EIS analysis assumes for storage and maintenance at SRS. The additional risk to the workers and general public from the storage and maintenance of these 96 additional elements would be too small to affect the calculation. Therefore, the proposed action would not substantially change conclusions reached in the existing NEPA documentation (DOE 1995, DOE 2000).

Potential impacts from terrorism or other intentionally destructive acts cannot be analyzed in NEPA documents in the same way as other types of impact areas, because the information needed to calculate probabilities is unknowable. Nevertheless, accident analyses may be used to provide insight into the potential consequences of intentional destructive acts, because the consequences of such acts may be comparable to those from severe accidents. Implementing the proposed action would include established physical safeguards aimed at protecting the public from harm that could result from terrorism or sabotage and facilitate the recovery of SNF that could come under control of unauthorized persons. For example, safety features of transportation casks that provide containment, shielding and thermal protection also provide protection against sabotage. Thus the proposed action would not be expected to introduce any additional consequences from terrorism beyond those analyzed in the FRR SNF and specific EISs for the U.S. receiving sites, for the most severe accidents analyzed. On the other hand, by consolidating FRR SNF at safe and secure U.S. sites, the proposed action would contribute to the reduction of terrorist threats.

7. Conclusions

Based on the results of the Supplement Analysis presented in Sections 6.3 through 6.6, the calculated estimates of the environmental impacts analyzed under the proposed action are generally within the range of impacts evaluated in the 1996 *FRR SNF EIS*. However, some increases in estimated impacts could occur as a result of the proposed action, as described below:

- The proposed extensions to the policy could increase the estimated total program exposure and LCF risk of the maximally exposed individual (MEI) among the marine shipping crews, the port workers, and the ground transportation workers, based on the conservative assumption that one individual would be involved in sufficient activity to reach the regulatory limit of 100 millirem per year. This increase in postulated risk is not significant. For both MEI and crew members, even with this incremental increase, the LCF is still less than one. As a result, less than one cancer fatality would be expected as a result of the proposed action under a 5- or 10-year extension of the Acceptance Program. In addition, operational experience since 1996 indicates actual exposure has been much lower.

- The proposed extensions to the policy could increase the estimated radiological risk to the general public residing in the vicinity of the port of entry or along ground transportation routes for both incident-free and accident conditions. This increase is due primarily to increases in population that have occurred since 1996 and that can be projected through 2020. In addition, in 2003, DOE recommended a slightly more conservative factor for converting dose to LCF. This new factor results in slightly higher calculations of risk. This incremental increase still results in less than one LCF as a result of the proposed action under a 5- or 10-year extension of the Acceptance Program.

- In effect, the proposed inclusion of the Australian RRR in the program could increase the estimated exposures for all incident-free activities, with the addition of 96 out of a total of 22,700 elements analyzed in the *FRR SNF EIS*. This increase, however, represents less that one-half of 1 percent of the total eligible fuel inventory. The increase in risk associated with acceptance of this material is not considered significant; therefore, acceptance of RRR SNF does not require further environmental analysis. This incremental increase still results in less than one LCF as a result of the proposed action under a 5- or 10-year extension of the Acceptance Program.

8. Determination

In compliance with DOE NEPA regulations, 10 CFR Part 1021, Section 1021.314(c), DOE has examined the circumstances relevant to DOE's FRR SNF Acceptance Program to determine whether a 5-year or 10-year extension of the Acceptance Program and acceptance of SNF from the RRR in Australia during the extension would result in a substantive change to the environmental impacts reported in the *FRR SNF EIS* (DOE 1996a) and related NEPA documents. As discussed in Section 6 of this Supplement Analysis, implementation of the proposed action would be expected to result in environmental impacts that are either within the range of the environmental impacts analyzed in the *FRR SNF EIS* or that present no substantive changes to those impacts. The proposed action would not constitute a substantial change in action relevant to environmental concerns. There are no significant 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) and 10 CFR 1021.314. Therefore, neither a supplement to the *FRR SNF EIS* nor a new EIS is required.

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Linton F. Brooks
Administrator
National Nuclear Security Administration

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