DOE/EIS-0203-SA-07
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SUPPLEMENT ANALYSIS

PROPOSED SHIPMENT OF COMMERCIAL SPENT NUCLEAR FUEL TO DOE NATIONAL LABORATORIES FOR RESEARCH AND DEVELOPMENT PURPOSES

Office of Nuclear Energy
U.S. DEPARTMENT OF ENERGY

DECEMBER 2015

CONVERSION FACTORS

Metric to English			English to Metric		
Multiply	by	To get	Multiply	by	To get
Area					
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Concentration					
Kilograms/sq. meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/sq. meter
Milligrams/liter	1[a]	Parts/million	Parts/million	1[a]	Milligrams/liter
Micrograms/liter	1[a]	Parts/billion	Parts/billion	1[a]	Micrograms/liter
Micrograms/cu. meter	1[a]	Parts/trillion	Parts/trillion	1[a]	Micrograms/cu. meter
Density					
Grams/cu. centimeter	62.428	Pounds/cu. ft.	Pounds/cu. ft.	0.016018	Grams/cu. centimeter
Grams/cu. meter	0.0000624	Pounds/cu. ft.	Pounds/cu. ft.	16,025.6	Grams/cu. meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Micrometers	0.00003937	Inches	Inches	25,400	Micrometers
Millimeters	0.03937	Inches	Inches	25.40	Millimeters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F − 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cu. meters/second	2,118.9	Cu. feet/minute	Cu. feet/minute	0.00047195	Cu. meters/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1,233.49	Cubic meters
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
English to English					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion factor is only valid for concentrations of contaminants (or other materials) in water.

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ACRONYMS AND ABBREVIATIONS

ANL	Argonne National Laboratory
ALARA	as low as reasonably achievable
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CIRFT	Cyclic Integrated Reversible-Bending Fatigue Tests
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPRI	Electric Power Research Institute
FR	*Federal Register*
GHG	greenhouse gas
GTCC	Greater-than-Class-C
HLW	high-level waste
INL	Idaho National Laboratory
ISFSI	Independent Spent Fuel Storage Installation
LLW	low-level radioactive waste
MTHM	metric tons of heavy metal
NDE	non-destructive examination
NEPA	*National Environmental Policy Act*
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PEIS	programmatic environmental impact statement
PIE	post-irradiation examination
PNNL	Pacific Northwest National Laboratory
R&D	research and development
ROD	Record of Decision
RPL	Radiochemical Processing Laboratory
SA	supplement analysis
SAR	Safety Analysis Report
SEIS	supplemental environmental impact statement
SNF	spent nuclear fuel
SWEIS	site-wide environmental impact statement
TRU	transuranic (waste)
WIPP	Waste Isolation Pilot Plant

UNDERSTANDING SCIENTIFIC NOTATION

DOE has used scientific notation in this supplement analysis to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers of 10. The number written in scientific notation is expressed as the product of a number between 1 and 10 and a positive or negative power of 10. Examples include the following:

Positive powers of 10	Negative powers of 10
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on, therefore,	and so on, therefore,
10^6 = 1,000,000 (or 1 million)	10^{-6} = 0.000001 (or 1 in 1 million)

1 INTRODUCTION

DOE prepared this Supplement Analysis (SA) in accordance with DOE *National Environmental Policy Act* (NEPA) Implementing Procedures at 10 *Code of Federal Regulations* (CFR) 1021.314 and *Recommendations for the Supplement Analysis Process* (DOE 2005). This SA evaluates whether the proposed action warrants preparing a supplement to the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995) and the *Final Supplemental 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 2008), a new environmental impact statement (EIS) altogether, or no further NEPA documentation. In this SA, DOE considers if there are substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns.

1.1 PURPOSE AND NEED FOR THE AGENCY ACTION

In the 1980s and early 1990s, the Dry Cask Storage Characterization Project provided data that confirmed the safety of low burnup[1] commercial spent nuclear fuel (SNF) in extended storage and transportation operational environments. This project was a joint effort between the U.S. Department of Energy (DOE), the Electric Power Research Institute (EPRI), and the U.S. Nuclear Regulatory Commission (NRC). In this low burnup project, a cask that had been loaded with SNF was opened after approximately 15 years and the fuel and internals inspected. All of the materials, including the fuel assemblies, appeared as they did when the cask was first loaded, thus confirming the expectations based on laboratory data.

Similar data supporting the extended dry storage and transportation of high burnup commercial SNF are much more limited. In addition, high burnup fuel is known to have different properties than low burnup fuel. During relicensing proceedings, the NRC raised questions about the ability of high burnup SNF to maintain its integrity during extended storage and transportation. DOE and EPRI developed the High Burnup Spent Fuel Data Project to address such questions. The U.S. nuclear industry has referred to the anticipated data from this project as justification for the long-term storage of high burnup SNF, and the NRC has accepted this rational, illustrating the need for this work. The proposed action (described in Section 1.2) analyzed in this supplement analysis (SA) is intended to provide important information on whether high burnup SNF can maintain its integrity during extended storage and transportation.

Under the High Burnup Spent Fuel Data Project, an NRC-licensed storage cask (TN-32B) would be loaded with 32 high burnup SNF assemblies at Dominion's North Anna Nuclear Power Station in Lake Anna, Virginia. The cask would be stored at the North Anna Nuclear Power Station Independent Spent Fuel Storage Installation (ISFSI), where temperatures would be monitored and gas samples taken. In parallel, under the proposed action, 25 individual high

[1] "Burnup" is a way to measure the amount of uranium fuel used in a reactor. On average, high burnup fuel has been in the reactor 50 percent longer than low burnup fuel.

burnup fuel rods (“sister rods”) would be removed either from assemblies going into the TN-32B cask or from assemblies with similar irradiation histories. Over approximately 9 years, DOE would perform a variety of experiments (described in Section 1.2) on these 25 sister rods to provide a baseline of properties against which to compare the SNF stored in the TN-32B cask at the North Anna Nuclear Power Station ISFSI. Comparing the sister rod baseline data with data from the SNF after long-term storage would provide the necessary validation of potential degradation mechanisms that could then be used to predict SNF performance under extended storage and transportation environments (DOE 2014).

1.2 PROPOSED ACTION

DOE is proposing to transport a small quantity of commercial power SNF from the North Anna Nuclear Power Station to the Oak Ridge National Laboratory (ORNL) in Tennessee for research purposes consistent with the mission of DOE. The research actions included in this work will generate radioactive waste, which is discussed in Section 3.1.3 of this document. The shipment would consist of one cask of 25 SNF rods, totaling approximately 0.04 to 0.05 metric ton of heavy metal (MTHM)[2] (approximately 40 to 50 kilograms [88 to 110 pounds] of heavy metal). Each SNF rod is approximately the diameter of a pencil and approximately 13 feet long. The shipment, which would occur via truck, is proposed for the first quarter of calendar year 2016.

Upon receipt, the 25 SNF rods would be transferred directly into a hot cell in the Irradiated Fuels Examination Laboratory (IFEL), Building 3525, to begin the research activities. The IFEL, which is the center for post-irradiation examination (PIE) at ORNL, typically conducts operations on materials similar to those being proposed and evaluated herein. Additional facilities at ORNL that would be utilized for the associated PIE (and are currently used for similar activities) include the Radiochemical Engineering Development Center (Building 7920), the Irradiated Materials Examination and Testing hot cell facility (Building 3025E), and the Metals and Ceramic Building (Building 4508).

The initial research at ORNL would involve detailed non-destructive examination (NDE), or characterization, of all 25 sister rods. The NDE specifically would include:

- Full-length, high-resolution video examination;
- Detailed profilometry (to include rod length and multiple diameters taken at various axial locations and orientations); and
- High-resolution, full-length gamma scan (DOE 2014).

The NDE results are essential to providing the baseline characteristics necessary to determine the strength of the material (DOE 2014). In addition to NDE, the rods would undergo destructive testing to provide further characterization. One of the parameters for characterization would be the puncture of each individual rod to determine the end-of-life rod internal pressure. All 25 rods would be subjected to puncture and internal gas pressure measurement at ORNL (DOE 2014).

[2] SNF inventories are generally described in terms of metric tons of heavy metal. Heavy metal refers to the mass of actinide elements (elements with atomic numbers greater than 89) in the SNF.

Once the rods had been punctured, ORNL researchers would cut them into sections according to detailed diagrams determined by the results of the gamma scans conducted during NDE, usually in 3-, 4-, or 6-inch lengths, for further testing. Small segments from various axial locations of each rod would be tested at ORNL for total hydrogen content and hydride orientation and density. The pellet/clad bonding would also be examined via various optical and electro-optical techniques. ORNL researchers would produce a characterization report for each rod (DOE 2014).

Following sectioning, 10 rod equivalents would be transported by truck from ORNL to the Pacific Northwest National Laboratory (PNNL) near Richland, Washington. At PNNL, research activities associated with the 10 rod equivalents would be conducted in the Radiochemical Processing Laboratory (RPL, Building 325). PNNL researchers would conduct highly destructive mechanical testing on the fuel and cladding. For the majority of segments, this would include removal of the fuel from the cladding through a combination of drilling and dissolution, followed by mechanical testing of the cladding. For some smaller subset of the test fragments, researchers would perform mechanical testing on cladding that had not been defueled. These analyses would give insight into the strength and other physical properties of the irradiated cladding and fuel. An understanding of these effects is critical to assuring the safety of stored SNF and in designing storage and transportation systems to verify that safety. The fuel dust from these highly destructive examinations would be safely stabilized in a grout matrix to minimize radiological exposure associated with the activity. (PNNL 2015a).

At ORNL, 1.5 rod equivalents would be defueled using methods similar to those described above for PNNL. These 1.5 defueled rod equivalents (cladding only) would be transported from ORNL to the Argonne National Laboratory (ANL) near Lemont, Illinois (see Figure 1-1) for additional research.

At ANL, research activities associated with the 1.5 defueled rod equivalents of cladding would occur in the Irradiated Materials Laboratory in Building 212. ANL would conduct ring compression tests on bare cladding (i.e., the fuel has been removed). These tests help determine the ductile-to-brittle-transition temperature, the temperature below which a sample exhibits a less ductile materials behavior. (ANL 2015a).

For the rod segments remaining at ORNL, 3.5 rod equivalents would be used for Cyclic Integrated Reversible-Bending Fatigue Tests (CIRFT). These tests would be performed on segments with the fuel still in the cladding to determine the external force and number of cycles necessary for the fuel to fail (i.e., break). CIRFT are key to determining how the fuel/clad bond creates a composite structure to better withstand potential handling drops or transient shocks of normal conditions of transport that occur in addition to normal vibrations. Similar to PNNL activities, the fuel dust resulting from this highly destructive test would be stabilized in a grout matrix to minimize radiological exposure. (ORNL 2015).

Of the total 25 sister rods, the equivalent of 15 rods would be used in the destructive testing described above. The balance of 10 rod equivalents would remain at ORNL for potential future (i.e., beyond the year 2025) testing. Specific future testing would be determined by the test results described above and could include ring compression, CIRFT, or material properties determination under other conditions such as thermal annealing or elevated temperatures typical of temperatures during transportation (DOE 2014). This SA includes an analysis of the potential cumulative impacts associated with these future tests at ORNL, based on the potential impacts that could occur for these types of tests (see Section 4 of this SA).

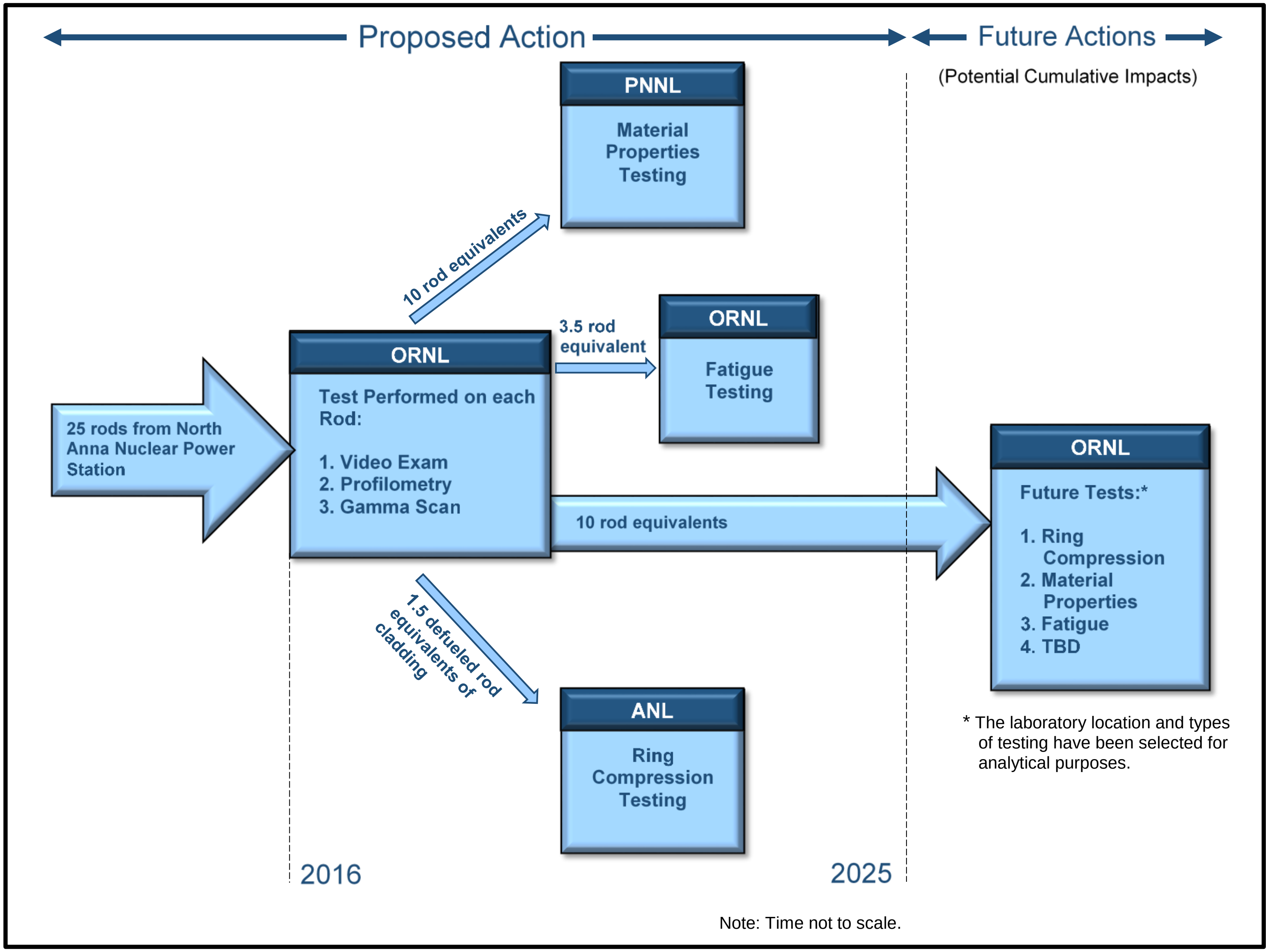

Figure 1-1. Overview of the Proposed Action

1.3 SCOPE OF THIS SUPPLEMENT ANALYSIS

As identified in the Introduction, this SA evaluates whether the proposed action warrants preparing a supplement to any existing NEPA document, a new EIS, or that no further NEPA documentation is required. In this SA, DOE considers if there are substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns. To aid in understanding the evaluation in this SA, a brief discussion of the notable historic events related to SNF operations within the DOE Complex follows.

In April 1995, DOE completed the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (DOE/EIS-0203)* (hereafter, 1995 PEIS) (DOE 1995). The 1995 PEIS contains an analysis of the potential environmental impacts associated with managing DOE's complex-wide SNF Program from 1995 until 2035, and includes an analysis of a broad spectrum of fuel element designs (including both DOE and commercial SNF). The 1995 PEIS included a detailed assessment of the existing SNF Program at the Oak Ridge Reservation[3] (ORR) (see Appendix F of Volume 1), and also analyzed the potential environmental impacts of managing SNF at ORR under two separate alternatives: (1) a Centralization Alternative, in which existing and projected SNF would be consolidated and managed at ORR until disposition; and (2) a Regionalization Alternative, in which a portion of the existing and projected SNF would be managed at ORR based primarily on geographic location. At the time the 1995 PEIS was prepared, less than 1 percent of DOE's SNF inventory was located at ORR. The SNF at ORNL consisted "primarily of spent fuel from research or experimental reactors that are operating or have operated at ORNL. Samples of SNF left over from research on fuel elements removed from commercial or demonstration reactors utilized by DOE predecessor agencies for advancement of nuclear science are also present" (DOE 1995).

In the June 1995 Record of Decision (ROD) for the 1995 PEIS, DOE selected Alternative 4a (Regionalization by Fuel Type). Under that ROD, DOE decided to consolidate existing and newly generated SNF at three existing Departmental sites—the Hanford Site, the Idaho National Engineering Laboratory (now the Idaho National Laboratory [INL]), and the Savannah River Site—based on the fuel type, pending future decisions on ultimate disposition (60 *Federal Register* (FR) 28680, June 1, 1995). DOE did not decide to consolidate any SNF at ORR. Instead, DOE decided that ORR would ship "some or all of their existing inventory to the Savannah River Site and Idaho National Engineering Laboratory, depending on fuel type." An amended ROD (61 FR 9441, March 8, 1996) reduced the number of shipments of SNF into the State of Idaho.

1.4 RELEVANT NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTS

The following NEPA documents are relevant to the proposed action described in Section 1.1. The discussions that follow describe the relevance of these NEPA documents to the proposed

[3] The ORNL is one of two major facilities located at the ORR. The other is the Y-12 National Security Complex.

action and explain how DOE used these documents to help determine whether there are any significant new circumstances or information relevant to environmental concerns.

- ***Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, DOE/EIS-0203* (DOE 1995).** As discussed in Section 1.3 of this SA, the 1995 PEIS contains an analysis of the potential environmental impacts associated with managing DOE's complex-wide SNF Program from 1995 until 2035. The 1995 PEIS provides the NEPA analysis for:
  - Shipments of SNF, such as those proposed in this SA, to the ORR (see specifically Appendix I of the 1995 PEIS).
  - Research and operations involving SNF, such as those proposed in this SA, at ORR (see specifically Appendix F of Volume 1 of the 1995 PEIS). For example, the 1995 PEIS analyzed the potential impacts of constructing and operating a new SNF management complex at ORR. The analysis included consideration of SNF receiving and canning, technology development, and interim dry storage. The technology development facility was designed to "investigate the applicability of dry storage technologies and pilot-scale technology development for disposal of the various types of SNF." Those actions are the types of actions that would occur under the proposed action addressed in this SA. As such, the 1995 PEIS provides a baseline against which the potential impacts of the proposed action in this SA can be compared and evaluated. Specifically, this SA evaluates: (1) the potential transportation impacts of the proposed action against the transportation analysis in Appendix I of the 1995 PEIS; and (2) the potential impacts associated with research and operations at ORNL related to the treatment of SNF against the analysis in the 1995 PEIS. This SA accounts for conditions that may have changed since that PEIS was prepared.
- ***Waste Isolation Pilot Plant (WIPP) Disposal Phase Final Supplemental Environmental Impact Statement (SEIS), DOE/EIS-0026-S-2* (DOE 1997).** In September 1997, DOE completed the WIPP SEIS, which provides an analysis of the potential environmental impacts associated with disposing of TRU waste from defense activities and programs of the U.S. Government. The WIPP SEIS includes an analysis of the transportation of TRU waste from ORNL, ANL, and PNNL to WIPP, as well as the disposal of TRU waste at WIPP, such as waste that may result from the proposed action evaluated in this SA.
- **Final Site-Wide Environmental Impact Statement (SWEIS) for the Continued Operation of the Department of Energy/National Nuclear Security Administration (NNSA) Nevada National Security Site (NNSS) and Offsite Locations in the State of Nevada, DOE/EIS-0426 (DOE 2013).** In October 2013, DOE/NNSA completed the NNSS SWEIS, which provides an analysis of the potential environmental impacts associated with continued operation of the NNSS. The SWEIS includes an analysis of the transportation of LLW from sites at ORNL, ANL, and PNNL to NNSS, as well as the

disposal of LLW at NNSS, such as waste that may result from the proposed action evaluated in this SA.

- ***Final Supplemental 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-0250F-S1* (DOE 2008).** In June 2008, DOE completed the Yucca Mountain SEIS, which provides an analysis of the potential environmental impacts associated with constructing, operating, monitoring, and eventually closing a geologic repository at Yucca Mountain for the disposal of SNF and high-level radioactive waste (HLW). The SEIS also evaluates the potential impacts of transporting SNF, including SNF associated with the proposed action evaluated in this SA.

1.5 Categorical Exclusions Relevant to the Proposed Action

In addition to the NEPA documents identified in Section 1.4, several Categorical Exclusions are potentially relevant to the proposed action. Categorical Exclusions are classes of actions which DOE has determined "do not individually or cumulatively have a significant effect on the human environment" (10 CFR 1021, Subpart D, Appendix B). Because the proposed action involves the transport of SNF and radioactive materials, as well as small-scale R&D activities, the following Categorical Exclusions are potentially applicable (these Categorical Exclusions are presented verbatim from the implementing procedures at 10 CFR Part 1021, Subpart D, Appendix B):

- ***B1.30 Transfer actions* –** Transfer actions, in which the predominant activity is transportation, provided that (1) the receipt and storage capacity and management capability for the amount and type of materials, equipment, or waste to be moved already exists at the receiving site; and (2) all necessary facilities and operations at the receiving site are already permitted, licensed, or approved, as appropriate. Such transfers are not regularly scheduled as part of ongoing routine operations.
- ***B3.6 Small-scale research and development, laboratory operations, and pilot projects* –** Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions; that is, actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.

DOE has prepared this SA rather than applying and relying on these Categorical Exclusions. However, in the course of preparing this SA, DOE identified, reviewed, and referenced site-specific Categorical Exclusion documents prepared by DOE for activities at ORNL, PNNL, and ANL that address prior actions which are similar to the proposed action. Example documents, which are briefly described below, provide a basis for estimating the potential impacts of the proposed action by documenting the similarity of the proposed action to other actions that previously had been determined to not individually or cumulatively significantly affect the human environment.

- ***Categorical Exclusion for Research and Development Activities Conducted by ORNL Materials Science and Technology Division (3352X)*** **(ORNL 2007)**. This documents the ORNL activities involving materials science R&D that are similar to those evaluated in this SA.
- ***Categorical Exclusion for Research and Development Activities Conducted by ORNL Nuclear Science and Technology Division (3059X)*** **(ORNL 2005)**. This documents the ORNL activities involving science and technology R&D that are similar to those evaluated in this SA.
- ***Categorical Exclusion (06-ESQ-168) for Shipments of Radioisotopes, Richland, Washington*** **(DOE 2006)**. This documents the PNNL activities involving the transportation and R&D for nuclear materials that are similar to those evaluated in this SA.
- ***Categorical Exclusion (01-STO-005) for Acceptance of Offsite Waste Samples for Research and Development Efforts at the Hazardous Waste Treatment Unit, Radiochemical Processing Laboratory, Hanford Site, Richland, Washington*** **(DOE 2000)**. This documents the PNNL activities involving transport and R&D for nuclear materials in the RPL that are similar to those evaluated in this SA.
- ***Categorical Exclusion (98-STO-082) for Spent Nuclear Fuel Research and Development, Pacific Northwest National Laboratory, Hanford Site, Richland, Washington*** **(DOE 1998)**. This documents the PNNL activities involving transportation and R&D for nuclear materials in the RPL that are similar to those evaluated in this SA.
- ***Categorical Exclusion (ARG-CX-076) for Cladding Metallurgy at High Burnup, Argonne National Laboratory-East*** **(ANL 1997)**. This documents the ANL activities involving the mechanical properties of cladding segments from fuel rod segments that are similar to the work evaluated in this SA.

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2 METHODOLOGY

2.1 DESCRIPTION OF SA METHODOLOGY

Figure 2-1 illustrates the process of assessing the potential environmental impacts DOE used in this SA. As this figure indicates, DOE conducted an initial screening review to determine if there were new circumstances or information relevant to environmental concerns or impacts associated with the proposed action evaluated in this SA that would warrant additional NEPA analysis. As part of the initial screening review, DOE identified the resource areas the proposed action could affect (Section 2.2), as well as those resources that would not be affected (Section 2.3). Section 2.4 discusses new information related to NEPA compliance which DOE considered in this SA process.

2.2 RESOURCE AREAS CONSIDERED IN THIS SUPPLEMENT ANALYSIS

Because the proposed action involves the transport of SNF from the North Anna Nuclear Power Station to the ORNL Site and the transport of SNF from ORNL to PNNL, this SA evaluates transportation activities and associated potential environmental impacts.[4] In addition to potential transportation impacts, subsequent activities could result in radiological emissions (which could impact human health) and generate wastes. Therefore, this SA evaluates the potential impacts associated with radiological emissions on human health (including accidents and intentional destructive acts), and the disposition of wastes. Information related to these resources follows.

2.2.1 Transportation

North Anna Nuclear Power Station to ORNL. The likely shipment route from the North Anna Nuclear Power Station overlaps the representative route that was analyzed in the 1995 PEIS for shipments of SNF from Hampton Roads, Virginia, to ORNL. The distance from Hampton Roads, Virginia to ORNL is approximately 550 miles. Only 20 miles of the likely route from the North Anna Nuclear Power Station were not covered in the analysis conducted for the Hampton Roads shipments.[5] The route from the North Anna Nuclear Power Station to ORNL (Figure 2-2) is approximately 420 miles, or approximately 130 miles shorter than that used in the analysis for shipments of SNF from Hampton Roads. With regard to population changes that have occurred since the 1995 PEIS was prepared, see the sub-section below entitled, “Population Changes.”

ORNL to PNNL. The likely shipment route from ORNL to PNNL overlaps the representative route that was analyzed in the 1995 PEIS for shipments of SNF from ORNL to PNNL for the alternative to consolidate SNF at the Hanford Site.

[4] The single shipment from ORNL to ANL would involve defueled cladding sent in approved containers via standard commercial shipment. Because no SNF or dispersible radiological material would be associated with that shipment, no significant impacts would be expected and transportation impacts are not further analyzed. Non-radiological impacts are also nonsignificant, as analyzed and documented in Table 3-1.

[5] This 20 miles involves highway transport with similar conditions and population densities as the representative route for the 550-mile segment.

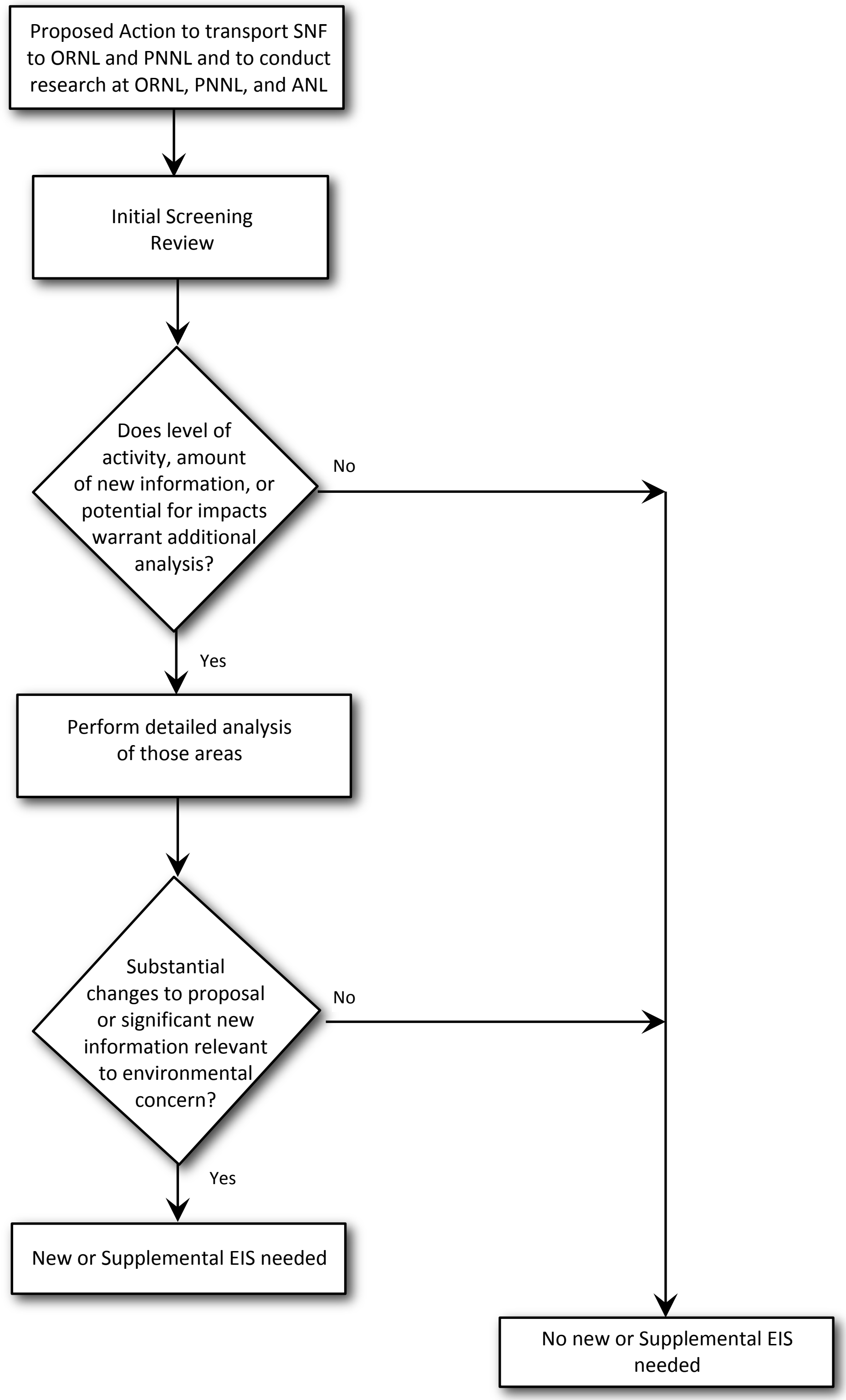

Figure 2-1. Assessment Process Used in this Supplement Analysis

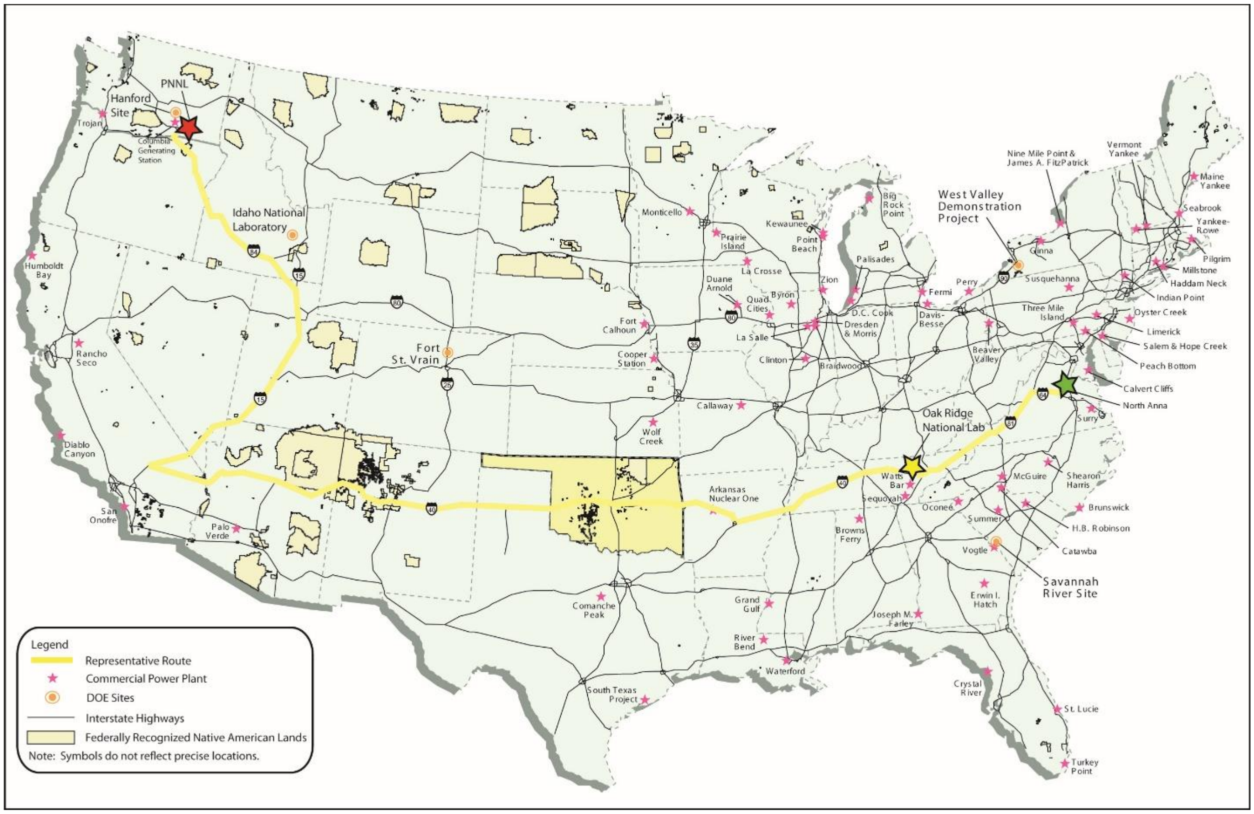

Figure 2-2. Representative SNF Transportation Routes Associated with the Proposed Action (Source: DOE 2008, modified)

Population Changes. The population along the representative transportation routes has changed since the 1995 PEIS was prepared. Given that the transportation routes extend across much of the length of the Continental United States, the analysis in this SA assumes that the population along the transportation routes has changed in a manner consistent with the overall population change for the United States. Since approximately 1995, the U.S. population has increased by approximately 20 percent; from 265 million people to approximately 320 million people today (Census 2015). While population change has varied across the country, the transportation analysis in this SA (Section 3.1.1) assumes a uniform 20-percent increase across the transportation routes. As can be seen from the analysis in Section 3.1.1, the potential impacts associated with transportation for the proposed action are small.

Commercial SNF is transported in specially designed NRC-certified casks (Figure 2-3). Casks must meet the following requirements (NRC 2015):

- Prevent the loss of radioactive contents;
- Provide shielding and heat dissipation; and
- Prevent nuclear criticality (a self-sustaining nuclear chain reaction).

To show that it can withstand accident conditions, a cask must pass impact, puncture, fire, and water immersion tests. Casks must survive these tests in sequence, including a 30-foot drop onto a rigid surface followed by a fully engulfed fire of 1,475 degrees Fahrenheit for 30 minutes. The test sequence encompasses more than 99 percent of vehicle accidents (NRC 2015). The SNF evaluated in this SA would be transported in an NRC-licensed cask.

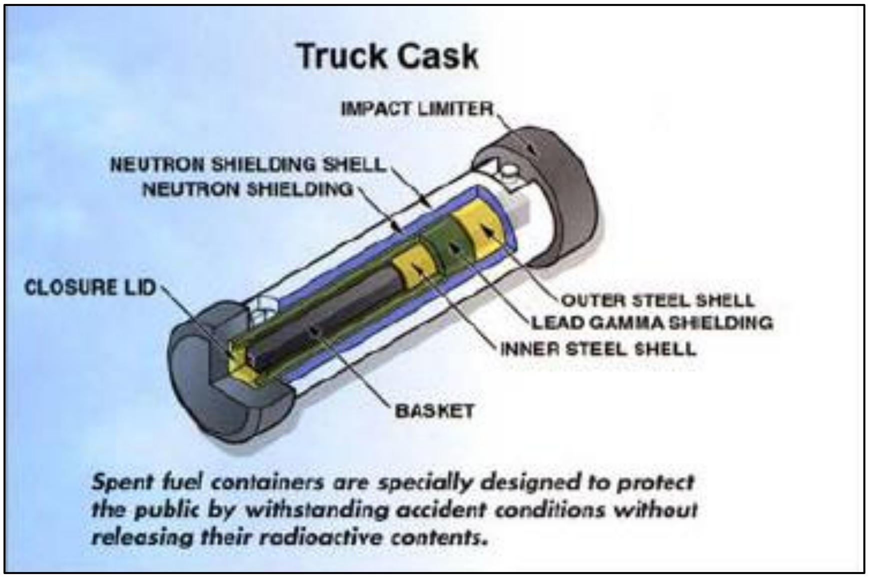

Figure 2-3. Typical Commercial SNF Cask (Source: NRC 2015, modified)

2.2.2 Radiological Emissions/Human Health

Radiological operations associated with the proposed action have the potential to impact the health of the public and workers. This section provides current information related to radiological emissions/human health impacts for the public and workers at ORNL, ANL, and PNNL.

ORNL. In 2014, the average annual dose to workers at ORNL was 115 millirem per year and the total dose to the collective worker population was 71.3 person-rem per year (DOE 2015a). For the public in 2014, the total population dose (50-mile radius around the entire ORR) from airborne sources from existing operations was estimated to be approximately 52.8 person-rem per year (ORR 2015). The annual dose to a maximally exposed individual in 2014 (from airborne sources on the ORR Site) was estimated to be about 3 millirem per year, which is approximately 3 percent of the limit given in DOE Order 458.1, “Radiation Protection of the Public and the Environment.”

ANL. In 2014, the average annual dose to workers at ANL was 196 millirem per year and the total dose to the collective worker population was 16.5 person-rem per year (DOE 2015a). For the public in 2014, the total population dose (50-mile radius around the ANL Site) from airborne sources from existing operations was estimated to be approximately 0.58 person-rem per year (ANL 2015b). The annual dose to a maximally exposed individual in 2014 was estimated to be about 0.021 millirem per year, which is less than 1 percent of the limit given in DOE Order 458.1.

PNNL. In 2014, the average annual dose to workers at PNNL was 30.5 millirem per year and the total dose to the collective worker population was 14.6 person-rem per year (DOE 2015a). For the public in 2014, the total population dose (50-mile radius around the PNNL Site) from airborne sources from existing PNNL operations was estimated to be approximately 0.012 person-rem per year (PNNL 2015b). The annual dose to a maximally exposed individual in 2014 was estimated to be about 0.000027 millirem per year, which is less than 1 percent of the limit given in DOE Order 458.1.

2.2.3 Waste Management

In addition to describing the current waste management conditions at ORNL, PNNL, and ANL, this section updates the waste management conditions at WIPP and NNSS because those two sites could receive radiological wastes as a result of the proposed action.

ORNL. Existing activities at ORNL generate radioactive waste.[6] Table 2-1 presents the volume of radioactive waste generated annually from existing ORNL activities and the disposition of these wastes.

Table 2-1. Radioactive Waste Management at ORNL

Waste Category	Volume Generated in 2014[a]	Disposition
LLW	630 cubic meters (22,250 cubic feet)	Disposed of at NNSS.
TRU	24 cubic meters	Stored onsite pending reopening of WIPP. No TRU waste shipments to WIPP in 2014 or 2015 due to the WIPP salt truck fire and radiological event.

a. Estimated 2014 volume based on 9-year annual average of waste volumes generated at ORNL (ORNL 2015b).
Source: ORNL 2015b.

ANL. Existing activities at ANL generate radioactive waste. Table 2-2 presents the volume of radioactive waste generated annually from existing ANL activities and the disposition of these wastes.

[6] This SA presents waste information as follows: (1) LLW quantities are presented in cubic meters, as well as cubic feet, which is the unit of measurement used in the NNSS SWEIS; (2) TRU waste quantities are presented in cubic meters, as that is the unit of measurement used in the WIPP SEIS.

Table 2-2. Radioactive Waste Management at ANL

Waste Category	Volume Generated in 2014	Disposition
LLW	375 cubic meters (13,240 cubic feet)	Disposed of at NNSS.
TRU	14.5 cubic meters	Stored onsite pending reopening of WIPP. No TRU waste shipments to WIPP in 2014 or 2015 due to the WIPP salt truck fire and radiological event.

Source: ANL 2015a.

PNNL. Existing activities at PNNL generate radioactive waste. Table 2-3 presents the volume of radioactive waste generated annually from existing PNNL activities and the disposition of these wastes.

Table 2-3. Radioactive Waste Management at PNNL

Waste Category	Volume Generated in 2014	Disposition
LLW	414 cubic meters (14, 620 cubic feet)	Disposed of at the Hanford Site.
TRU	7.3 cubic meters	TRU is typically shipped to the Hanford Site for eventual disposal at WIPP. No TRU waste shipments to WIPP in 2014 or 2015 due to the WIPP salt truck fire and radiological event.

Source: PNNL 2015a.

Waste Isolation Pilot Plant. Table 2-4 identifies the quantities of TRU waste from ORNL, ANL, and PNNL (which is included within Hanford Site quantities) evaluated in the WIPP SEIS for disposal at WIPP by 2033 (35 years of operations) (DOE 1997). The WIPP SEIS includes an evaluation of the potential transportation impacts associated with TRU waste disposal from ORNL, ANL, and PNNL at WIPP.

Table 2-4. Total Volumes of TRU Waste Evaluated for Disposal at WIPP

Site	Volume Evaluated for Disposal at WIPP
ORNL	4,986 cubic meters
ANL	200 cubic meters
Hanford Site (Includes PNNL)	150,000 cubic meters

Source: DOE 1997.

Nevada National Security Site. The NNSS SWEIS evaluated the disposal of up to 48 million cubic feet of LLW at the NNSS. Of this total, only 1.3 million cubic feet of LLW would result from NNSS activities. The majority of LLW (46.7 million cubic feet) would come from activities at sites other than those at the NNSS, including those at ORNL, ANL, and PNNL (DOE 2013). The NNSS SWEIS includes an evaluation of the transportation impacts associated with LLW disposal from ORNL, ANL, and PNNL to the NNSS.

2.3 RESOURCE AREAS ELIMINATED FROM DETAILED ANALYSIS

Resource areas that would be unaffected by the proposed action evaluated in this SA or any impacts that would be minimal and clearly bounded by analyses in prior NEPA documents were eliminated from detailed analysis in this SA. For example, because the proposed action would not result in any land disturbance, there would be no potential to impact land, cultural, soil, or geologic resources at ORNL. Consequently, the environmental conditions for these resource areas are not further discussed. Table 2-5 identifies the eliminated resource areas and provides the rationale for eliminating these resources from detailed analysis.

Table 2-5. Resource Areas Eliminated from Detailed Analysis

Resource Area Eliminated from Detailed Analysis	Rationale
Land	Proposed action would not disturb land and would not change land uses.
Cultural and Paleontological	Proposed action would not disturb land and would not impact cultural or paleontological resources.
Soil	Proposed action would not disturb land and would not impact soils.
Geology	Proposed action would not disturb land and would not impact geological resources.
Water	Proposed action would not use measurable quantities of water and would not release pollutants to surface water or groundwater.
Noise	Proposed action would not introduce new noise sources and would not change background noise levels.
Ecological	Proposed action would not disturb ecological habitats and would not result in impacts that could affect ecological resources.
Socioeconomics	Proposed action would not change workforce requirements and would not notably impact socioeconomic resources in the region of influence. However, DOE has acknowledged that the funding associated with the research activities would be about $30 million for activities between 2016 and 2025 and about $12.5 million for activities beyond the year 2025.
Environmental Justice	As shown in Section 3 of this SA, none of the impacts associated with the proposed action would be significant. No disproportionately high and adverse impacts to minority and low-income persons would occur.
Utilities	Proposed action would not result in any measurable utility changes compared to existing requirements.
Greenhouse Gas Emissions	Proposed action would not substantially increase carbon dioxide-equivalent emissions or associated climate change impacts (see Section 2.4.3).

2.4 NEW INFORMATION

2.4.1 Intentional Destructive Acts

When DOE prepared the 1995 PEIS, DOE NEPA documents did not normally include an analysis of the potential impacts of intentional destructive acts. Following the terrorist attacks of September 11, 2001, DOE implemented measures to minimize the risk and consequences of potential terrorist attacks on its facilities and consistent with DOE guidance (DOE 2002), also analyzes the potential impacts of intentional destructive acts in NEPA documents. In this SA, DOE has evaluated security scenarios involving intentional destructive acts to assess potential environmental impacts (see Chapter 3). The review addresses both the transportation of SNF and radiological wastes, as well as activities at ORNL, ANL, and PNNL.

2.4.2 Dose Conversion Factor

When converting radiological doses to potential latent cancer fatalities, the 1995 PEIS used a factor of 5×10^{-4} fatality per rem for the public and a factor of 4×10^{-4} fatality per rem for workers. The value for workers was lower due to the absence of children and the elderly, who were considered to be more radiosensitive. Since publication of the 1995 PEIS, DOE guidance (DOE 2003) recommends the use of a conversion factor of 6×10^{-4} fatality per rem for both workers and members of the public. The DOE guidance recommends use of factors developed by the Interagency Steering Committee on Radiation Standards (ISCORS 2002). Using the higher conversion factor increases the potential radiological impacts presented in the 1995 PEIS by 50 percent for workers and 20 percent for the public. Chapter 3 of this SA presents the results of this change.

LATENT CANCER FATALITY

A latent cancer fatality is a death from a cancer that results from, and occurs an appreciable time after, exposure to ionizing radiation. Death from radiation-induced cancers can occur any time after the exposure. However, latent cancers generally occur from 1 year to many years after exposure. Using a conversion factor of 0.0006 latent cancer fatality per rem of radiation exposure (ISCORS 2002), the result is the increased lifetime probability of developing a latent fatal cancer. For example, if a person received a dose of 0.033 rem, that person’s risk of latent cancer fatality from that dose over a lifetime would be 0.00002. This risk corresponds to 1 chance in 50,000 of a latent cancer fatality during that person’s lifetime. Because estimates of latent cancer fatalities are statistical, the results often indicate less than 1 latent cancer fatality for cases that involve low doses or small populations. For instance, if a population collectively received a dose of 500 person-rem, the number of potential latent cancer fatalities would be 0.3.

2.4.3 Greenhouse Gas Emissions

In December 2014, the Council on Environmental Quality (CEQ) provided revised draft guidance for public consideration and comment on the ways in which federal agencies can improve their consideration of the effects of greenhouse gas (GHG) emissions and climate change in evaluating proposals for federal actions under NEPA (CEQ 2014). Where appropriate, DOE NEPA documents consider the potential impacts associated with GHG emissions. In the CEQ revised draft guidance, CEQ recommends using a proposed action’s GHG emissions as a proxy for assessing that action’s potential climate change impacts. The guidance recommends that when considering when to disclose a project’s quantitative GHG emissions, agencies use a reference point of 25,000 metric tons of carbon dioxide-equivalent GHG emissions on an annual basis. The proposed action evaluated in this SA would emit less than approximately 4.5 metric tons of carbon dioxide-equivalent GHG emissions in transporting the SNF and other materials associated with the proposed action (DOE 2015b). The GHG emissions, and thus potential impacts on climate change, associated with the proposed action would be minimal.

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3 COMPARISON OF IMPACTS

3.1 ENVIRONMENTAL IMPACTS

3.1.1 Spent Nuclear Fuel Transportation Impacts

This section presents the potential environmental impacts associated with the transport of SNF for the proposed action. Two separate SNF shipments are addressed: (1) North Anna Nuclear Power Station to ORNL and (2) ORNL to PNNL. As noted in the footnote associated with Section 2.2.1, the single shipment from ORNL to ANL would involve defueled cladding; because no SNF would be associated with that shipment, no significant impacts would be expected and transportation impacts are not further analyzed.

North Anna Nuclear Power Station to ORNL. The 1995 PEIS addressed the potential environmental impacts of transporting approximately 5,168 SNF shipments of DOE SNF (which includes special-case commercial SNF)[7] to ORR for the Centralization Alternative (DOE 1995, Volume 1, Table I-2 of Appendix I). The potential impacts associated with the incident-free[8] truck transportation of this DOE SNF were estimated for the population along the routes across the United States as follows (DOE 1995, Table I-18 of Appendix I):

- 0.30 radiation-related latent cancer fatality for transportation workers,
- 0.90 radiation-related latent cancer fatality for the general population, and
- 0.043 non-radiological fatality from vehicular emissions.

These fatalities were estimated over the 40-year period from 1995 through 2035 and were based on an assumption that each SNF cask would contain 5 MTHM and that external dose rates would be the maximum allowed by regulation (10 millirem per hour at any point 2 meters from the transport vehicle [10 CFR 71.47]). The impacts per shipment for DOE SNF would be:

- 5.8×10^{-5} radiation-related latent cancer fatality for transportation workers,
- 1.7×10^{-4} radiation-related latent cancer fatality for the general population, and
- 8.3×10^{-6} non-radiological fatality from vehicular emissions.

In contrast, the proposed action evaluated in this SA would involve one SNF truck shipment to ORNL, containing 25 SNF rods totaling approximately 0.04 to 0.05 MTHM. Based on this much smaller cask loading (a maximum of 0.05 MTHM for the proposed action versus 5 MTHM for the fully loaded cask analyzed in the 1995 PEIS), the potential incident-free radiological impacts of the SNF shipment would be expected to be a fraction (approximately 1 percent) of the potential radiological impacts presented in the 1995 PEIS, assuming no other differences. However, to be conservative, this SA assumes that the external dose from the SNF would not be reduced, but instead would be the maximum allowed by regulation. When taking into account other changes that have occurred since the 1995 PEIS was issued (e.g., a 20-percent increase in

[7] DOE SNF includes special-case commercial, DOE research, other domestic research, graphite, N-Reactor, naval-type, and Savannah River production reactor SNF.
[8] "Incident-free" refers to transportation activities without accidents or other unexpected or unusual occurrences.

the population along the transportation routes and changes in the dose conversion factor [see Sections 2.1 and 2.4.2, respectively]), the potential impacts associated with the incident-free truck transportation of the shipment of SNF to ORNL is estimated as follows:

- 8.7×10^{-5} radiation-related latent cancer fatality for transportation workers,
- 2.5×10^{-4} radiation-related latent cancer fatality for the general population, and
- 1.0×10^{-5} non-radiological fatality from vehicular emissions.

The potential impacts associated with the incident-free truck transportation of the truck shipment of SNF to ORNL would be small and are bounded by the impacts presented in the 1995 PEIS for shipments of DOE SNF.

The 1995 PEIS contains a detailed analysis of the potential impacts associated with transportation accidents involving SNF (see Section I-5 of Appendix I). For the Centralization Alternative at ORR, the total accident risk[9] (from 1995 to 2035) for truck transportation was estimated to be:

- 0.0014 latent cancer fatality and 0.78 traffic fatality (see Table I-54 of Appendix I in the PEIS).

With regard to the proposed action evaluated in this SA, the material in the ORNL shipment would be approximately 1 percent as much as that analyzed in each shipment in the 1995 PEIS. Although release fractions associated with accidents would not change, the source term (i.e., the quantity of radiological material released in a given accident) would be approximately 1 percent as much as that analyzed in the 1995 PEIS. Taking into account all of the factors that would affect the accident risk (e.g., 1 shipment versus 5,168; 1 percent as much material at risk per shipment; a 20-percent increase in the population along the transportation routes; and changes in the dose conversion factor[10]), the total accident risk for truck transportation to ORNL would be:

- 4.9×10^{-9} latent cancer fatality and 0.00015 traffic fatality.

ORNL to PNNL. The 1995 PEIS addressed the impacts of transporting approximately 3,572 SNF shipments of DOE SNF (which includes special-case commercial SNF) to the Hanford Site (which is adjacent to PNNL) for the Centralization Alternative (DOE 1995, Volume 1, Table I-2 of Appendix I). The potential impacts associated with the incident-free truck transportation of this DOE SNF were estimated for the population along the routes across the United States as follows (DOE 1995, Table I-15 of Appendix I):

- 0.17 radiation-related latent cancer fatality for transportation workers,
- 0.50 radiation-related latent cancer fatality for the general population, and
- 0.026 non-radiological fatality from vehicular emissions.

[9] Risk is calculated by multiplying the consequence of an accident times the probability that the accident would occur. The total accident risk is the compilation of all risks.
[10] The 1995 PEIS does not present accident risk separately for the public and workers. Consequently, the accident analysis in this SA conservatively assumes a 50-percent increase in impacts from the dose conversion factor.

These fatalities were estimated over the 40-year period from 1995 through 2035 and were based on an assumption that each SNF cask would contain 5 MTHM and that external dose rates would be the maximum allowed by regulation (10 millirem per hour at any point 2 meters from the transport vehicle [10 CFR 71.47]). The impacts per shipment for DOE SNF would be:

- 4.8×10^{-5} radiation-related latent cancer fatality for transportation workers,
- 1.4×10^{-4} radiation-related latent cancer fatality for the general population, and
- 7.3×10^{-6} non-radiological fatality from vehicular emissions.

In contrast, the proposed action evaluated in this SA would involve one SNF truck shipment to PNNL containing the equivalent of 10 SNF rods totaling approximately 0.016 to 0.02 MTHM. Based on this much smaller cask loading (a maximum of 0.02 MTHM for the proposed action versus 5 MTHM for the fully loaded cask analyzed in the 1995 PEIS), the potential incident-free radiological impacts of the SNF shipment would be expected to be a fraction (a maximum of approximately 0.4 percent) of the potential radiological impacts presented in the 1995 PEIS, assuming no other differences. However, to be conservative, this SA assumes that the external dose from the SNF would not be reduced, but instead would be the maximum allowed by regulation. When taking into account other changes that have occurred since the 1995 PEIS was issued (e.g., a 20-percent increase in the population along the transportation routes and changes in the dose conversion factor [see Sections 2.1 and 2.4.2, respectively]), the potential impacts associated with the incident-free truck transportation of the shipment of SNF to PNNL is estimated as follows:

- 7.2×10^{-5} radiation-related latent cancer fatality for transportation workers,
- 2.0×10^{-4} radiation-related latent cancer fatality for the general population, and
- 8.8×10^{-6} non-radiological fatality from vehicular emissions.

The potential impacts associated with the incident-free truck transportation of the truck shipment of SNF to PNNL would be small and are bounded by the impacts presented in the 1995 PEIS for shipments of DOE SNF.

The 1995 PEIS contains a detailed analysis of the potential impacts associated with transportation accidents involving SNF (see Section I-5 of Appendix I). For the Centralization Alternative at the Hanford Site, the total accident risk (from 1995 to 2035) for truck transportation was estimated to be:

- 0.0050 latent cancer fatality and 0.57 traffic fatality (see Table I-48 of Appendix I in the PEIS).

With regard to the proposed action evaluated in this SA, the material in the PNNL shipment would be a maximum of approximately 0.4 percent as much as that analyzed in each shipment in the 1995 PEIS. Although release fractions associated with accidents would not change, the source term (i.e., the quantity of radiological material released in a given accident) would be a maximum of approximately 0.4 percent as much as that analyzed in the 1995 PEIS. Taking into account all of the factors that would affect the accident risk (e.g., 1 shipment versus 3,572; 1

percent as much material at risk per shipment; a 20-percent increase in the population along the transportation routes; and changes in the dose conversion factor), the total accident risk for truck transportation to PNNL would be:

- 1.0×10^{-8} latent cancer fatality and 0.00016 traffic fatality.

Summary of Transportation Impacts. Table 3-1 summarizes the potential SNF transportation impacts of the proposed action evaluated in this SA and the impacts presented in the 1995 PEIS. As can be seen, the potential accident impacts associated with the transport of SNF for the proposed action evaluated in this SA would be smaller than, and bounded by, the impacts presented in the 1995 PEIS. Transportation of any wastes associated with the proposed action have been addressed in other NEPA documents (DOE 2013, 1997).

Table 3-1. Summary of Potential SNF Transportation Impacts

	SA Proposed Action[a]	1995 PEIS[b]
Total number of SNF shipments	2	5,168
Incident-free impacts		
• Number of radiation-related latent cancer fatalities for transportation workers	1.6×10^{-4}	0.3
• Number of radiation-related latent cancer fatalities for the general population	4.5×10^{-4}	0.9
• Number of non-radiological fatalities from vehicular emissions	1.9×10^{-5}	0.043
Total accident risk		
• Number of latent cancer fatalities	1.5×10^{-8}	0.0050
• Number of traffic fatalities[c]	0.00046	0.78

a. Represents the combined impacts of the shipment of SNF from the North Anna Nuclear Power Station to ORNL and the shipment of SNF from ORNL to PNNL.
b. Based on shipments of DOE SNF (which includes special-case commercial SNF). Entries in this column reflect the bounding impacts from Consolidation Alternative at either ORNL or the Hanford Site, whichever resulted in the highest impact.
c. Number of non-radiological traffic fatalities based on the total number of shipments (3), which includes the shipment of cladding from ORNL to ANL.

3.1.2 Research and Operations at ORNL, PNNL, and ANL

Specific to the proposed action evaluated in this SA, research and operations at ORNL and PNNL would have the potential to generate air pollutants, including but not limited to radionuclides, chemical and combustion emissions, and ozone-depleting substances. At ANL, the research activities would involve cladding material only (which would contain only traces of radionuclides [ANL 2015a]), and no measureable quantities of radionuclides would be released. Consequently, there is no potential to release any significant quantities of radiological materials or cause significant radiological doses; therefore, this SA does not further consider potential impacts at ANL for this activity.

For the proposed action evaluated in this SA, DOE has estimated the radiological air emissions at ORNL and PNNL to be minor, and all emissions would exhaust to continuously monitored and permitted stacks, equipped with pollution prevention devices such as high-efficiency particulate air filters and air scrubbers. The proposed action is within the class of actions for which no significant doses or impacts to the public or the environment would result (See Section 1.5; Categorical Exclusion B3.6).

With respect to worker doses, DOE controls worker doses to as low as reasonably achievable (ALARA), and the proposed action is within a class of actions for which no significant doses or impacts to workers would be expected (See Section 1.5; Categorical Exclusion B3.6). The set of potential pathways from which impacts could occur are common to all populations; as such, there would be no environmental justice impacts.

The proposed action evaluated in this SA would not introduce any new processes or new types of materials into existing facilities than what currently exists, and would not increase the quantities of materials to change the accident analyses for those facilities. The proposed action is within a class of actions for which no significant accident impacts would be expected (See Section 1.5; Categorical Exclusion B3.6).

3.1.3 Waste and Spent Nuclear Fuel Management

Radiological waste types associated with the proposed action evaluated in this SA could include TRU and LLW (ORNL 2015; ANL 2015a; PNNL 2015a).[11] (SNF is not considered a waste and is discussed in more detail below.) Section 1.2 of this SA provides details regarding the types of materials that would be generated as a result of the proposed action and would need to be managed as radiological waste or SNF.

TRU waste would be generated as a result of the removal of fuel from the cladding through a combination of drilling, dissolution, and/or mechanical testing. Any fuel fragment residues or streams would likely be contaminated with residues from defense-related activities that also occur in the ORNL and PNNL facilities. These residues would be grouted to stabilize the waste forms and minimize radiological emissions. LLW would be generated from operations involving cladding, packaging materials, and test equipment.

As shown in Table 3-2, the total projected waste volume is estimated to be approximately 64.5 cubic meters, consisting of 44.5 cubic meters of LLW and 20 cubic meters TRU waste. ORNL, ANL, and PNNL currently have operating waste management facilities and required permits to manage all wastes that are anticipated to be generated as a result of the proposed action. The wastes that would result from the proposed action evaluated in this SA would be managed (and

[11] DOE is not able to make official waste determinations until the waste is actually generated. At that time, and based on the characteristics of the material, DOE will make a waste determination. For purposes of evaluating the potential impacts associated with the management of any wastes from the proposed action, DOE has made conservative assumptions regarding the types and quantities of wastes that may be generated. Although no HLW and GTCC-like waste is expected to be generated from the proposed action, some waste may be managed as HLW or GTCC-like waste. Waste generated from the research would be disposed of according to approved waste management practices by evaluating the material in its final form.

disposed of) in accordance with the waste management practices in place at the time DOE determines the material is no longer useful and is considered waste. The waste would then undergo a waste classification and be sent to the appropriate facilities for disposal.

Table 3-2. Wastes Generated from the Proposed Action

	LLW[a]	TRU Waste
ORNL	32 cubic meters (1,130 cubic feet of LLW)	3 cubic meters
ANL	6.5 cubic meters (230 cubic feet of LLW)	0
PNNL	6 cubic meters (210 cubic feet of LLW)	17 cubic meters
Total	44.5 cubic meters (1,570 cubic feet of LLW)	20 cubic meters

a. LLW quantities are also presented in cubic feet, which is the unit of measurement used in the NNSS SWEIS.

DOE estimates that the proposed action would generate approximately 44.5 cubic meters (1,570 cubic feet) of LLW. Currently, DOE disposes of the majority of LLW from ORNL and ANL at the NNSS and anticipates this disposal option would be available for the duration of the proposed action. The quantities of LLW that could be sent to the NNSS would be inconsequential in comparison with the 1.32 million cubic meters (46.7 million cubic feet) NNSS would receive from the activities at other DOE sites (as evaluated in DOE [2013]), and inconsequential with regard to the number of LLW shipments from ORNL and ANL. LLW from PNNL activities would be disposed of at the Hanford Site. The quantities of LLW from PNNL that could be sent to the Hanford Site would be inconsequential (less than 1.5 percent) in comparison with the annual LLW quantities the Hanford Site receives from ongoing PNNL activities (see Table 2-3).

DOE estimates that the proposed action would generate approximately 20 cubic meters of TRU waste. Current facilities and operations require the use of hot cells at ORNL and PNNL, which are radioactively contaminated as a result of years of management and examination of both defense- and non-defense-related materials and contamination. Because segregation of these two types of materials is virtually impossible, waste generated from the proposed action could be determined to be defense-related TRU and would be eligible for disposal at WIPP. If such waste is determined to be non-defense-related, it would be ineligible for disposal at WIPP and could be managed as Greater-Than-Class C (GTCC)-like waste, SNF, or HLW (as required following waste determination). GTCC-like wastes could be sent to one of the facilities DOE is currently evaluating in the *Environmental Impact Statement for the Disposal of GTCC LLW and GTCC-like Waste* (DOE 2011), or it could be sent to the *Nuclear Waste Policy Act* repository when available, as could materials classified as SNF or HLW. SNF, HLW, and GTCC-like wastes were included in the analysis of potential environmental impacts from waste management operations in the 1995 PEIS.

POTENTIAL WASTES FROM THE PROPOSED ACTION

TRU: Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes with half-lives greater than 20 years per gram of waste, except for (1) high-level radioactive waste; (2) wastes the Secretary of Energy has determined, with the concurrence of the Administrator of EPA, that do not need the degree of isolation required by the disposal regulations; or (3) wastes the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

LLW: As defined by the *Low-Level Radioactive Waste Policy Amendments Act of 1985*, LLW is radioactive waste that is not high-level waste, spent nuclear fuel, transuranic waste, or by-product material (as defined in Section 11e(2) of the *Atomic Energy Act of 1954*, as amended, and material that the NRC, consistent with existing law, classifies as low-level radioactive waste.

OTHER POTENTIAL WASTE MANAGEMENT CLASSIFICATIONS APPLICABLE TO THE PROPOSED ACTION

GTCC-like: As used in this SA, GTCC-like waste refers to radioactive waste that is owned or generated by DOE and has characteristics similar to those of GTCC waste such that a common disposal approach may be appropriate. GTCC-like waste consists of LLW and potential non-defense-generated transuranic waste that has no identified path for disposal. The term is not intended to, and does not, create a new DOE classification of radioactive waste.

HLW: (a) the highly radioactive material resulting from the reprocessing of SNF, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and (b) other highly radioactive material that the [NRC], consistent with existing law, determines by rule requires permanent isolation.

If there is no existing disposal facility available for wastes generated by the proposed action, the wastes would be stored in existing facilities in accordance with applicable federal and state regulations until it could be disposed of at an offsite facility.

Any intact SNF rods or rod segments would likely require continued management as SNF. The number of SNF rods involved in this proposed action was selected to provide a minimum amount of material necessary for this work and reasonably foreseeable future work. As described in Section 1.2, the work scope requires the SNF rods to undergo a highly destructive process and, therefore, would include the stabilization of fragments and dust in a grout matrix to minimize radiological exposure. The resulting waste forms are expected to bear little to no resemblance to SNF rods other than isotopic content. As such, no long-term storage of SNF is expected to result from the proposed action. In the unlikely event SNF rods or rod segments remained after the proposed work is concluded, they would require long-term storage. DOE would conduct such storage in accordance with regulations and procedures in effect at that time.

3.1.4 Intentional Destructive Acts

When the 1995 PEIS was prepared, DOE NEPA documents did not normally include an analysis of intentional destructive acts. Following the events of September 11, 2001, DOE implemented measures to minimize the risk and consequences of potential intentional destructive acts on its facilities. Consistent with DOE guidance, DOE currently analyzes the potential impacts of intentional destructive acts in NEPA documents. DOE guidance for this analysis is provided in *Recommendations for Analyzing Accidents under the National Environmental Policy Act* (DOE 2002).

It is not possible to predict whether intentional destructive attacks would occur, or the nature or types of such attacks. Nevertheless, DOE has evaluated security scenarios involving intentional destructive acts to assess potential vulnerabilities and identify improvements to security procedures and response measures. Security at its facilities is a critical priority for DOE. Therefore, DOE continues to identify and implement measures to defend and deter attacks. DOE maintains a system of regulations, orders, programs, guidance, and training that form the basis for maintaining, updating, and testing site security to preclude and mitigate any potential intentional destructive attacks.

The conservative assumptions inherent in the accidents analyzed in the 1995 PEIS and facility-specific Safety Analysis Reports (SARs) and Documented Safety Analyses assumed initiation by natural events, equipment failure, or inadvertent worker actions. The accidents evaluated in these documents include earthquakes, fires, criticalities, and airplane crashes, all of which could cause a release of radiological materials to the environment (DOE 1995; ORNL 2015; ANL 2015a; PNNL 2015a). Intentional destructive acts could also potentially cause a release of radiological materials to the environment. If that were to occur, the resulting radiological release and consequences to workers and the public would be similar to those occurring from natural or man-caused events (ORNL 2015; ANL 2015a; PNNL 2015a).

For example, at ORNL, the proposed action involves activities that are currently evaluated in the IFEL (Building 3525) SAR (e.g., fuel handling, inspection, segmenting, and polishing). There are no new types of equipment or hazards associated with the project and, therefore, there are no new types of accidents made possible by the activities associated with the project. The hazard evaluation currently included in the SAR uses the entire quantity of radioactive material allowed in the facility as its material at risk for all accidents evaluated in the SAR. Therefore, because the SNF rods fit within the facility inventory, there can be no increase in potential accident consequences from that documented in the SAR. This same rationale is applicable, and has been verified (ANL 2015a; PNNL 2015a) to the proposed activities at ANL and PNNL.

In the unlikely event that a terrorist attack did successfully breach the physical and other safeguards at DOE facilities resulting in the release of radionuclides, the potential consequences would be no worse than those of the highest consequence accident analyzed in the 1995 PEIS and facility-specific SARs.

There is also a potential for an intentional destructive act during SNF transport. In the Yucca Mountain SEIS, DOE examined the potential impacts associated with intentional destructive acts involving SNF transportation (DOE 2008). That analysis conservatively estimated (that is, tended to overstate the risk) the potential impacts of an intentional destructive act in which a high energy density device penetrated a rail or truck cask of SNF. DOE estimated that there would be 28 latent cancer fatalities in the exposed population if the intentional destructive act occurred in an urban area. If the intentional destructive act took place in a rural area, DOE estimated that there would be no latent cancer fatalities (e.g., the probability of a single latent cancer fatality in the exposed population would be 0.055, or 1 chance in 20) (DOE 2008).

The quantity of SNF that would be transported under the proposed action evaluated in this SA is significantly lower than the quantities of the materials used for the analysis in the Yucca Mountain SEIS (DOE 2008). For example, a typical SNF legal-weight truck cask contains approximately 5 MTHM of SNF, while the maximum quantity of SNF that would be transported for the proposed action would be approximately 0.05 MTHM per shipment. Therefore, the above estimates of risk identified in the Yucca Mountain SEIS bound the risks from an intentional destructive act involving the SNF transported for the proposed action.

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4 CUMULATIVE IMPACTS

CEQ regulations at 40 CFR 1508.7 define cumulative impacts as "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Implementation of the proposed action evaluated in this SA would not require any new construction and would be conducted in existing facilities, all of which currently conduct operations that are similar in nature to the proposed action. As documented in this SA, the potential direct and indirect impacts associated with the proposed action would be minimal.

With respect to other reasonably foreseeable actions that could give rise to cumulative impacts, as discussed in Section 1.2 of this SA, the equivalent of 10 rods would remain at ORNL for potential future (beyond the year 2025) testing. Specific future testing (and locations) would be informed by the early test results generated from the proposed action and could include additional testing related to ring compression, CIRFT, or material properties determination under other conditions such as thermal annealing or elevated temperatures typical of temperatures during transportation (DOE 2014). The following cumulative impacts could occur as a result of the proposed action and these future tests:

Spent Nuclear Fuel Transportation Impacts. If the future tests were to be conducted at ORNL, no additional transportation impacts would result. Therefore, there would be no additional cumulative impacts beyond those from the proposed action. If any of the remaining rod equivalents were transferred to other DOE national laboratories for additional testing, those actions would likely be covered under Categorical Exclusion B1.30, *Transfer Actions*, and would be unlikely to result in significant cumulative transportation impacts.

Research and Operations at ORNL. Future tests as analyzed herein would produce potential environmental impacts at ORNL (or other national laboratory) that would be similar to the proposed action evaluated in this SA. Because these future tests would involve small-scale research and development in a laboratory (Categorical Exclusion B1.30), they would be within the class of actions for which no significant cumulative impacts would result (ORNL 2007, 2005).

Waste and SNF Management. Future tests would generate both TRU waste and LLW. Table 4-1 identifies the waste volumes associated with future tests, the proposed action, and cumulative totals.

Table 4-1. Cumulative Wastes Generated at ORNL

	LLW[a]	**TRU Waste**
Future Tests[b]	80 cubic meters (2,880 cubic feet of LLW)	5.7 cubic meters
Proposed Action in this SA	32 cubic meters (1,130 cubic feet of LLW)	3 cubic meters
Total	112 cubic meters (4,010 cubic feet of LLW)	8.7 cubic meters

a. LLW quantities are also presented in cubic feet, which is the unit of measurement used in the NNSS SWEIS.
b. Assumes future tests are conducted over a 10-year period. ORNL is assumed for analytical purposes. Waste volumes would be representative if testing were to be proposed at other national laboratories.
Source: ORNL 2015.

The quantities of LLW that could be sent to the NNSS would be inconsequential in comparison with the 1.32 million cubic meters (46.7 million cubic feet) NNSS would receive from the activities at other DOE sites (as evaluated in DOE [2013]), and inconsequential with regard to the number of LLW shipments from ORNL. With regard to TRU waste, the total volume generated from the future tests and the proposed action (8.7 cubic meters) would occur over approximately 19 years (9 years for the proposed action and 10 years for the future tests). On an annual basis, approximately 0.45 cubic meter of TRU waste would be cumulatively generated, representing a 1.8-percent increase in TRU waste generation at ORNL (see Table 2-1).

In the event that intact SNF rods or rod segments remained after these future tests, they would require continued management as SNF, as described in Section 3.1.3.

5 CONCLUSION

The 1995 PEIS and the other relevant NEPA documents identified in this SA evaluated the potential impacts of transporting SNF to ORR (ORNL) and the Hanford Site (PNNL), the subsequent research and operations at those sites involving the SNF, and the management and disposition of SNF and waste from the research and operations at those sites. DOE prepared this SA in accordance with 10 CFR 1021.314, which requires a supplemental EIS be issued when "there are substantial changes to the proposal" or there are "significant new circumstances or information relevant to environmental concerns." In accordance with DOE regulations, this SA provides sufficient information to enable DOE to determine whether the 1995 PEIS and the Yucca Mountain SEIS should be supplemented, a new EIS be prepared, or no further NEPA documentation is required.

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6 DETERMINATION

DOE prepared this SA on the 1995 PEIS and the Yucca Mountain SEIS, in accordance with 40 CFR 1502.9 (c) and 10 CFR 1021.314, for the proposal to transport, in one truck shipment, small quantities of commercial power SNF to ORNL (and subsequently to PNNL), as well as cladding material from ORNL to ANL, for research purposes consistent with the mission of DOE. Based on the analysis in this SA, DOE's proposed action does not represent substantial changes to either the 1995 PEIS or the Yucca Mountain SEIS that are relevant to environmental concerns, and there are no significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its environmental impacts. I have therefore determined that no further NEPA documentation is required.

12-28-15

for John Kotek,
Acting Assistant Secretary for Nuclear Energy

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