Chapter 1
Introduction

This *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* identifies reasonable alternatives and potential impacts associated with the proposed action to enhance the U.S. Department of Energy's existing nuclear facility infrastructure for: (1) the production of isotopes for medical, research, and industrial uses, (2) the production of plutonium-238 for use in advanced radioisotope power systems for future space missions, and (3) supporting the Nation's civilian nuclear energy research and development needs.

1.1 Background

Under the authority of the Atomic Energy Act of 1954, as amended, the U.S. Department of Energy (DOE) is responsible for ensuring the availability of isotopes for medical, industrial, and research applications; meeting the nuclear material needs of other Federal agencies; and undertaking research and development activities related to development of nuclear power for civilian use.

To meet these responsibilities, DOE maintains nuclear infrastructure capabilities that support various missions in areas such as nuclear materials production and testing, and research and development activities related to civilian applications of nuclear power. These infrastructure capabilities include research and test facilities such as research reactors and accelerators used for steady-state neutron irradiation of materials to produce radionuclides, as well as shielded "hot cell" and glovebox facilities used to prepare materials for testing and/or to handle postirradiation materials. An additional component of this infrastructure is the highly trained workforce that specializes in performing complex tasks that have been learned and mastered over the life of these facilities.

Over the years, DOE's nuclear facility infrastructure has diminished because of the shutdown of facilities; recent examples are the High Flux Beam Reactor at Brookhaven National Laboratory, New York, and the Cyclotron Facility at Oak Ridge National Laboratory (ORNL), Tennessee. This, in turn, has hampered DOE's ability to satisfy increasing demands in various mission areas. To continue to maintain sufficient irradiation facilities to meet its obligations under the Atomic Energy Act, DOE has assessed the need for expansion of its existing nuclear infrastructure in light of its commitments to ongoing programs, its commitments to other agencies for nuclear materials support, and its role in supporting civilian nuclear energy research and development programs to maintain the viability of civilian nuclear power as one of the major energy sources available to the United States.

1.2 Purpose and Need for Agency Action

The Nuclear Energy Research Advisory Committee (NERAC) was established in 1998 by DOE in accordance with the Federal Advisory Committee Act to provide independent, expert advice on complex science and technical issues that arise in the planning, management, and implementation of DOE's civilian nuclear energy research programs. The chairman of NERAC has informed the Secretary of Energy that:

- "There is an urgent sense that the nation must rapidly restore an adequate investment in basic and applied research in nuclear energy if it is to sustain a viable United States capability in the 21^{st} Century."

- "[T]he most important role for DOE [Office of Nuclear Energy, Science and Technology] in the nuclear energy area at the present time is to ensure that the education system and its facility infrastructure are in good shape."

- "Of particular need over the longer term are dependable sources of research isotopes and reactor facilities providing high volume flux irradiation for nuclear fuels and materials testing" (Duderstadt 2000).

Under the guidance of NERAC, DOE has completed an internal assessment of its existing nuclear facility infrastructure capabilities. This *Nuclear Science and Technology Infrastructure Roadmap* evaluates the existing DOE infrastructure and identifies gaps for meeting projected demands (DOE 2000a). The basic finding of this assessment also concluded that the capabilities of currently operating DOE facilities will not meet projected U.S. needs for nuclear materials production and testing or research and development.

Consistent with these findings, DOE recognizes that adequate nuclear research reactor, accelerator, and associated support facilities must be available to implement and maintain a successful nuclear energy program. As demand continues to increase for steady-state neutron sources needed for isotope production and civilian nuclear energy research and development, DOE's nuclear infrastructure capabilities to support this demand have not improved. To continue meeting its responsibilities under the Atomic Energy Act and to satisfy projected increases in the future demand for isotope products and irradiation services, DOE proposes to enhance its existing nuclear facility infrastructure to provide for: (1) production of isotopes for medical, research, and industrial uses, (2) production of plutonium-238 for use in advanced radioactive isotope (radioisotope) power systems for future National Aeronautics and Space Administration (NASA) space exploration missions, and (3) support of the Nation's civilian nuclear energy research and development needs.

To evaluate the potential environmental impacts associated with this proposed enhancement, DOE has prepared this *Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (*Nuclear Infrastructure Programmatic Environmental Impact Statement* [NI PEIS]). This NI PEIS evaluates impacts from new facility construction, modification, startup, and 35 years of operation, followed by decommissioning when applicable. For analysis purposes, a 35-year operating period was established based on the projected availability of existing DOE irradiation facilities to potentially support these missions. This timeframe also accommodates current projections that indicate the demand for radioisotopes and civilian nuclear energy research and development requiring these enhancements will extend for at least the next 20 years (Wagner et al. 1998; NERAC 2000a; DOE 2000a).

1.2.1 Medical and Industrial Isotope Production

Over the past few decades, isotopes have become vital tools for use in medicine, industry, and scientific research. Isotopes, including both radioisotopes and stable isotopes, play a particularly important role in medical diagnosis, treatment, and research. Currently, more than 12 million nuclear medicine procedures are performed each year in the United States, and approximately one-third of all patients admitted to U.S. hospitals undergo at least one medical procedure that employs the use of medical isotopes (NERAC 2000a). Many medical isotopes are produced in the United States by DOE in nuclear reactors and particle accelerators. In limited cases, some medical isotopes can also be produced by extracting them from existing radioactive materials, such as thorium-229 obtained from DOE's existing stockpile of uranium-233. Radioisotopes are used for both diagnosis and therapy. Diagnostic radioisotopes are used for imaging internal organs. Unlike conventional radiology, imaging with radioisotopes reveals organ function and structure, which provides additional data for a more accurate diagnosis, and assists in the early detection of abnormalities. In ongoing clinical testing, therapeutic isotopes have proven effective in treating cancer and other illnesses by cell-directed localized radiation therapy (i.e., deploying antibodies or carriers of radioisotopes to seek and destroy invasive cancer cells). This directed therapy can minimize adverse side effects (e.g., healthy tissue damage, nausea, hair loss), making it an effective, attractive alternative to traditional chemotherapy or radiation treatments.

For nearly 50 years, DOE has actively promoted the use of radioisotopes to improve the health and well-being of U.S. citizens. DOE's use of its unique technologies and capabilities to develop isotopes for civilian purposes has enabled the widespread application of medical and industrial isotopes seen today. DOE must provide an adequate supply of isotopes to keep pace with the growing and changing needs of the research community if it is to continue to serve this key role.

An Expert Panel convened by DOE in 1998 reviewed several industry projections for growth in demand for medical isotopes. The Expert Panel concluded that the growth rate in medical isotope use will be significant over the next 20 years (Wagner et al. 1998). Specifically, the panel estimated that the expected growth rate of medical isotope use during the next 20 years would range from 7 to 14 percent per year for therapeutic applications and from 7 to 16 percent per year for diagnostic applications. The panel noted that these growth rates are attainable only if basic research in nuclear medicine is supported and if modern, reliable isotope production facilities are available. In the period since the initial estimates were made, the actual growth of medical isotope use has tracked at levels consistent with the Expert Panel findings. DOE and NERAC have agreed with the following findings and recommendations provided by the Expert Panel:

- Several isotopes have proven their clinical efficacy, but supply and cost concerns could dramatically affect the use of these isotopes in the practice of nuclear medicine.

- Although commercial and research applications for certain isotopes have been or are being developed, their limited availability and high prices are inhibiting their use in clinical applications.

- Research isotopes that have shown promise as diagnostic and therapeutic materials are not being explored because of their lack of availability or high price.

- At present, there is no domestic production facility to guarantee the continued supply of many of these isotopes.

- To meet current and future needs of the biomedical sciences community, the Expert Panel recommended:

  > ". . . the United States develop a capability to produce large quantities of radionuclides [radioisotopes] to maintain existing technologies and to stimulate future growth in the biomedical sciences. The successful implementation of such a program would help insure our position as an international leader in the biomedical sciences well into the twenty-first century. The panel recommends that the U.S. Government build this capability around a reactor, an accelerator, or a combination of both technologies as long as isotopes for clinical and research applications can be supplied reliably, with diversity in adequate quantity and quality" (Wagner et al. 1998).

In its recent report from the Subcommittee for Isotope Research and Production Planning, NERAC further identified that:

> "It is now widely conceded that limited availability of specific radionuclides is a constraint on the progress of research. The problem is especially apparent in a number of medical research programs that have been terminated, deferred, or seriously delayed by a lack of isotope availability . . . The lack of radionuclides significantly inhibits progress in evaluating a host of promising diagnostic and therapeutic drugs in patients with debilitating and fatal diseases, examining

> fundamental basic science questions, studying human behavior and normal growth and development, and exploring the aging process and the products of transgene expression . . . the DOE long-term goal to have a reliable isotope supply system in place that would enable scientists to bring their creative ideas into practical use safely, quickly and efficiently is appropriate, be it basic science research, clinical medicine, or industrial endeavors. The discovery and dissemination of new knowledge should continue to be a core mission, and basic science and the application of basic science to clinical research discoveries to improve the diagnosis and treatment outcomes should be a crucial component of that mission. [DOE], in providing a federal system for the reliable supply of stable and radioactive isotopes for research, will be an important aspect of fulfilling the federal responsibility to support biomedical research" (NERAC 2000a).

Current domestic and global producers of radioisotopes include governments that operate reactors and accelerators at national laboratories or institutes, and private sector companies that own and operate accelerators. There are also many partnership arrangements where companies lease irradiation space in government reactors or operate processing facilities in coordination with the government. A few universities also produce radioisotopes, but their ability to provide reliable and diverse supplies is generally limited by the small-scale capabilities or operating schedules of their facilities.

DOE's production and sale of radioisotopes fall into two categories: "commercial" and "research." Commercial radioisotopes are those that are produced in large, bulk quantities and sold to pharmaceutical companies or distributors, or to equipment or sealed source manufacturers. DOE only produces commercial isotopes when there is no U.S. private sector capability or when foreign sources do not have the capacity to meet U.S. needs reliably.

In contrast, research radioisotopes are typically produced and sold in small quantities in response to specialty orders from researchers preparing experiments in the field of medicine, with small quantities of these radioisotopes also purchased by industrial researchers. Because small-quantity production of research isotopes is not financially attractive to private sector producers, it is generally not undertaken. DOE attempts to provide all research radioisotopes that are requested, subject to production capability, inventory, and financial constraints. As successful application of a specific research isotope is established, the production and sales of that radioisotope may shift from research to commercial status. In recent years, over 95 percent of DOE's sales of radioisotopes by dollar volume were commercial, and 5 percent were for research.

DOE produces radioisotopes using the High Flux Isotope Reactor (HFIR) at ORNL, the Advanced Test Reactor (ATR) at Idaho National Engineering and Environmental Laboratory (INEEL), and the Annular Core Research Reactor at Sandia National Laboratories (SNL). DOE also produces radioisotopes using accelerators, namely the Isotope Production Facility at Los Alamos National Laboratory (LANL) and the Brookhaven LINAC (Linear Accelerator) Isotope Producer at Brookhaven National Laboratory. At each of these DOE sites, the radioisotope production mission shares the reactor or accelerator with other basic energy sciences or defense missions that are generally much larger and exercise considerable influence on facility schedules and priorities. As such, radioisotope production is often relegated to fulfilling a secondary mission that is dependant on the operating constraints of these larger, primary missions. Currently, approximately 50 percent of DOE's isotope production capability is being used. Assuming a midpoint growth curve for future isotope demand and a diversity and redundancy of isotope supply, DOE estimates that its isotope production facilities would be fully used within a 5- to 10-year timeframe if no enhancements to the existing nuclear facility infrastructure are implemented. This projection was made in the context of a worldwide market for radioisotopes. Although DOE's market share is a small fraction of the overall total, it is very significant for some radioisotopes and particularly important for a large number of radioisotopes that are used in relatively small quantities for research. These isotopes, which are used almost exclusively by researchers at universities and hospitals, are not purchased in quantities that would attract private industry to take over their production. However, DOE may need to significantly increase the production levels of these radioisotopes as world demand changes and promising research developments in their medical use are brought to commercialization.

Recent analyses indicate that the greatest challenge to meeting projected isotope market requirements over the next 20 years will be in the area of therapeutic medical isotopes, several of which are currently unavailable or are available only in limited quantities (Battelle 1999). For the purpose of analysis in this NI PEIS, a representative set of isotopes was selected on the basis of the recommendations of the Expert Panel, medical market forecasts (Frost & Sullivan 1997), reviews of medical literature, and more than 100 types of ongoing clinical trials that use radioisotopes for the treatment of cancer and other diseases. These isotopes are listed in **Table 1–1**, along with a brief description of their medical and, in some cases, industrial applications. Currently, these medical applications primarily involve the diagnosis and treatment of three major classes of disease—cancer, vascular disease, and arthritis. Although these isotopes are a representative sample of possible isotopes which could be produced, DOE expects that the actual isotopes produced as a result of the proposed action would vary from year to year in response to the focus of clinical research and the specific market needs occurring at that time.

The United States currently purchases approximately 90 percent of its medical isotopes from foreign producers, most notably Canada. However, Canada only supplies a limited number of economically attractive commercial isotopes (primarily molybdenum-99), and it does not supply research isotopes or the diverse array of medical and industrial isotopes considered in this NI PEIS. As such, reliance on Canadian sources of isotopes to satisfy projected U.S. isotope needs would not meet DOE's mission requirements.

Industrial isotope applications fall into three broad categories: nucleonic instrumentation, irradiation and radiation processing, and technologies that use radioactive tracers. Examples of nucleonic instrumentation include gauges for measuring physical parameters (e.g., detection systems for pollutants, explosives, drugs, ores, petroleum, and natural gases; nondestructive testing by gamma radiography; and smoke detectors). Irradiation and radiation processing technologies include radiation sterilization of food and medical products and the curing of plastics. Radioactive tracer applications include studies of chemical synthesis reactions; mass transfer monitoring in industrial plants; analysis of the transport and uptake of nutrients, fertilizers, herbicides, and waste materials in plants, soils, and groundwater; and laboratory-based studies of the properties of materials.

In proposing to expand its radioisotope production capability, DOE intends to continue to complement the commercial availability of these radioisotopes. Consistent with current isotope production activities, DOE will continue to make its facilities available to the private sector to support the production and sale of isotopes.

1.2.2 Plutonium-238 Production for Space Missions

As part of its charter under the Atomic Energy Act, DOE and its predecessor agencies have been developing and supplying radioisotope power systems to NASA for space exploration for more than 30 years. These radioisotope power systems include radioisotope thermoelectric generators used to power electrical components and radioisotope heater units used to keep spacecraft instruments warm. Previous NASA space missions that have used radioisotope power systems include the Apollo lunar scientific packages and the Pioneer, Viking, Voyager, Galileo, and Ulysses deep space probes. More recent missions include the Mars Pathfinder mission launched in 1996 and the Cassini mission launched in 1997. These radioisotope power systems have repeatedly demonstrated their performance, safety, and reliability in various NASA space missions. Without these power systems, these types of space exploration missions could not have been performed by NASA.

Table 1–1 Representative Radioisotopes

Radioisotope	Applications
Actinium-227	Parent of radium-223 (monoclonal antibody attachment used for cancer treatment by radioimmunotherapy)
Astatine-211	Alpha-emitting radioisotope being studied for a variety of radioimmunotherapy applications
Gold-198	Ovarian, prostate, and brain cancer; intracavity therapy
Cadmium-109	Cancer detection; pediatric imaging; industrial detection systems for pollutants, explosives, drugs, ores, petroleum, and natural gas
Copper-64	Diagnostic imaging, dosimetry studies, cerebral and myocardial blood flow, colorectal cancer therapy
Copper-67	Cancer treatment/diagnostics, cancer treatment by radioimmunotherapy, planar imaging, diagnostic imaging
Fluorine-18	Cancer detection/diagnostics
Gadolinium-153	Osteoporosis detection, diagnostic imaging
Germanium-68	Diagnostic imaging calibration, potential antibody labeling
Holmium-166	Treatment of rheumatoid arthritis, radiolabeling, and monoclonal antibody techniques
Indium-111	Cancer treatment/diagnostics
Iodine-123	Alzheimer's Disease and Schizophrenia diagnostic, breast cancer imaging, cardiac imaging, radioimmunotherapy of Parkinson's Disease
Iodine-125	Osteoporosis detection, diagnostic imaging, tracer drugs, monoclonal antibodies, brain cancer treatment (iodine-131 replacement), radiolabeling, tumor imaging, mapping of receptors in the brain, interstitial radiation therapy, brachytherapy for treatment of prostate cancer, determination of glomerular filtration rate, determination of plasma volume, detection of deep vein thrombosis of the legs
Iodine-131	Lymphoid tissue tumor/hyperthyroidism treatment; antibody labeling; brain biochemistry in mental illness; diagnosis of thyroid disorders by gamma camera imaging or counting; radioimmunotherapy; imaging; cellular dosimetry; adrenal medulla scintigraphy; treatment of Grave's disease, goiters, prostate cancer, hepatocellular carcinoma, neuroblastoma and malignant pheochromocytoma, thyroid carcinoma, and melanoma; locating metastatic lesions; internal (systemic) radiation therapy; study of kidney functions; construction of renogram; adrenal cortex imaging; investigations of hepatobillary function; determination of plasma volume
Iridium-192	Brachytherapy, brain and spinal cord tumor treatment, heart disease treatment (restenosis therapy), seed implants for breast and prostate tumors, industrial nondestructive testing by gamma radiography
Krypton-81m	Cardiac imaging
Lutetium-177	Heart disease treatment (restenosis therapy), cancer treatment by radioimmunotherapy
Molybdenum-99	Parent for technetium-99m generator used for brain, liver, lungs, heart imaging
Osmium-194	Monoclonal antibody attachment used for cancer treatment by radioimmunotherapy
Phosphorus-32	Polycythemia rubra vera (blood cell disease) and leukemia treatment, bone disease diagnosis/treatment, diagnostic imaging of tumors, pancreatic and liver cancer treatment, radiolabeling, labeling nucleic acids for in vitro research, diagnosis of superficial tumors, heart disease treatment (restenosis therapy), intracavity therapy
Phosphorus-33	Leukemia treatment, bone disease diagnosis/treatment, diagnostic imaging of tumors, radiolabeling, heart disease treatment (restenosis therapy)
Palladium-103	Prostate cancer treatment
Platinum-195m	Noninvasive monitoring of drug biodistribution and metabolism, studies with intra-arterial platinum-195m-cisplatin
Rhenium-186	Cancer treatment/diagnostics, monoclonal antibodies, bone cancer pain relief, treatment of rheumatoid arthritis, treatment of prostate cancer
Scandium-47	Bone cancer pain relief, cancer treatment by radioimmunotherapy
Selenium-75	Radiotracer used in brain studies, imaging of adrenal cortex by gamma-scintigraphy, lateral locations of steroid secreting tumors, pancreatic scanning, detection of hyperactive parathyroid glands, measuring the rate of bile acid loss from the endogenous pool
Samarium-145	Treatment of ocular cancer
Samarium-153	Cancer treatment/diagnostics, bone cancer pain relief, treatment of leukemia
Strontium-85	Detection of bone lesions, brain scans
Strontium-89	Bone cancer pain relief, treatment of prostate cancer, treatment of multiple myeloma, osteoblastic therapy, potential agent for treatment of bone metastases from prostate and breast cancer
Thorium-228	Cancer treatment by radioimmunotherapy, monoclonal antibodies, parent of bismuth-212
Thorium-229	Grandparent of bismuth-213 (alpha-emitter used in cancer treatment by radioimmunotherapy), parent of actinium-225, daughter of uranium-233

Table 1–1 Representative Radioisotopes (Continued)

Radioisotope	Applications
Tin-117m	Bone cancer pain relief
Tungsten-188	Cancer treatment by radioimmunotherapy, parent for rhenium-188 generator
Xenon-127	Neuroimaging for brain disorders, research on variety of neuropsychiatric disorders (especially schizophrenia and dementia), higher resolution diagnostic studies with lower patient dose, lung imaging evaluation of pulmonary ventilation, indicator for measurement of local cerebral blood flow
Yttrium-91	Cancer treatment by radioimmunotherapy, cellular dosimetry
Zinc-62	Parent for copper-64 generator used for diagnostic imaging

Source: Battelle 1999.

The radioisotope used in these power systems is plutonium-238. Through a Memorandum of Understanding with NASA, DOE provides these radioisotope power systems, and the plutonium-238 that fuels them, for space missions that require or would be enhanced by their use (DOE and NASA 1991). In addition, under the National Space Policy issued by the Office of Science and Technology Policy in September 1996, and consistent with DOE's charter under the Atomic Energy Act, DOE is responsible for maintaining the capability to provide the plutonium-238 needed to support these missions. The Intersector Guidelines section of the National Space Policy states that, "The Department of Energy will maintain the necessary capability to support space missions which may require the use of space nuclear power systems" (The White House 1996). Although research to identify other potential fuel sources to support these space exploration missions has been conducted, no viable alternative to using plutonium-238 has been established.

Historically, the reactors and chemical processing facilities at DOE's Savannah River Site (SRS) were used to produce plutonium-238; however, downsizing of the DOE nuclear weapons complex resulted in the shutdown of the last remaining SRS operating reactor, K-Reactor, in early 1996. Also, in 1992 then-Secretary of Energy Watkins issued a decision to phase out operations at the two chemical processing facilities (F-Canyon and H-Canyon) at SRS. In accordance with that decision, the separation facilities are planned to be shut down following completion of their current missions to stabilize and prepare for the disposition of Cold War legacy nuclear materials and certain spent nuclear fuel, and a determination that a new nonchemical processing technology is capable of preparing aluminum-based research reactor spent nuclear fuel for ultimate disposition.

In order to obtain a source of plutonium-238 to support NASA space missions, DOE signed a 5-year contract in 1992 to purchase plutonium-238 from Russia, authorizing the United States to purchase up to 40 kilograms (88.2 pounds) of plutonium-238, with the total available for purchase in any one year limited to 10 kilograms (22 pounds).[1] Under this contract, DOE purchased approximately 9 kilograms (19.8 pounds) of plutonium-238[2]. This material constitutes the only available U.S. inventory that has been reserved for space missions, an amount that is expected to be depleted by approximately 2005. DOE's practice of purchasing on an as-needed basis has avoided the costs from processing the plutonium-238 to remove the decay products that would result from storing it for an extended period of time. In 1997, DOE extended the contract for another 5 years; therefore, it is set to expire in 2002. Any purchases beyond 2002 would likely require the negotiation of a new contract and may require additional National Environmental Policy Act (NEPA) review. The long-term viability of pursuing additional contract extensions or entering into a new contract is unclear.

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[1] The NI PEIS presents the weight of plutonium-238 in terms of kilograms of isotope. In contrast, NASA documentation expresses this weight in terms of plutonium oxide. The equivalent plutonium oxide weight can be approximated by multiplying the isotope kilogram weight by 1.134.

[2] The environmental impacts of purchasing plutonium-238 from Russia are evaluated and documented in the *Environmental Assessment of the Import of Russian Plutonium-238* (DOE 1993), prepared by DOE's Office of Nuclear Energy.

The political and economic climate in Russia creates uncertainties that could affect its reliability as a source of plutonium-238 to satisfy future NASA space mission requirements. Reestablishing a domestic plutonium-238 production capability would ensure that the United States has a long-term, reliable supply of this material. In doing so, the United States would have greater control over the available supply, plans for satisfying future demand, and the nuclear safety and nonproliferation implications of the material. As such, DOE's preference is to reestablish a domestic plutonium-238 production capability rather than to rely on Russia as the sole long-term supplier. A plutonium-238 production rate of 2 to 5 kilograms (4.4 to 11 pounds) per year is expected to be sufficient to meet NASA's estimated long-term requirements.

DOE is planning to provide radioisotope heater units for several NASA Mars Exploration missions over the next 10 years. Each heater unit would require approximately 2 grams (0.07 ounce) of plutonium-238. The number of heater units varies depending on the spacecraft. Each of the two Mars missions in 2003 is projected to require up to 11 heater units. In May 2000, NASA provided preliminary guidance to DOE to also plan for the potential use of radioisotope power systems for the Pluto/Kuiper Express mission scheduled for launch in 2004, the Europa Orbiter mission scheduled for launch in 2006, and the Solar Probe mission scheduled for launch in 2007 (NASA 2000a). The amount of plutonium-238 needed for these missions was approximately 7.4 kilograms (16.3 pounds) for the Pluto/Kuiper Express mission, which would use an existing spare radioisotope thermoelectric generator, and approximately 3 kilograms (6.6 pounds) each for the Europa Orbiter and Solar Probe missions, which would use the Stirling radioisotope power system (SRPS). With NASA's current emphasis on smaller and less expensive spacecraft, the SRPS is being developed as a new, more efficient and lighter weight power system requiring one-third less plutonium-238 as its fuel source. However, the SRPS technology is developmental, and NASA has requested that the plutonium-238 needed for a large radioisotope thermoelectric generator be maintained as backup.

A plutonium-238 production goal of 2 to 5 kilograms (4.4 to 11 pounds) per year could produce sufficient quantities of plutonium-238 to theoretically yield an SRPS every 8 months if production were maintained at the high end of the range. However, DOE chose the 5-kilogram (11-pound) per year production rate as an upper bound due to uncertainties in the SRPS technology development requirements for backup units, and variability in the amount of plutonium-238 that may be needed for each of the units to meet NASA's power requirements.

In updated mission planning guidance provided in September 2000, NASA indicated that for programmatic and technical reasons, implementation of the Pluto/Kuiper Express mission as currently conceived was being deferred, and that the SRPS generators were candidate power systems for the Europa Orbiter and Solar Probe missions (NASA 2000b, 2000c). NASA also requested that the spare radioisotope thermoelectric generator and assembling and fueling a spare thermoelectric converter be maintained as backups for the Europa Orbiter mission in the event the SRPS technology was not ready in time. If NASA chooses to use the SRPS to support the Europa Orbiter and Solar Probe missions, there would be no change in NASA's requirements regarding the plutonium-238 needed for these two missions (i.e., approximately 3 kilograms [6.6 pounds] each, as described above), although the remaining quantity of plutonium-238 would not be sufficient to support additional deep space or long-lived exploration missions. Should NASA decide to use the backup radioisotope thermoelectric generators rather than the SRPS to support the Europa Orbiter mission, approximately 8 kilograms (17.6 pounds) of plutonium-238 would be needed, which would effectively expend all of DOE's available plutonium-238 inventory prior to supporting the Solar Probe mission. While this latest NASA guidance modifies the specific radioisotope power systems and missions for which DOE needs to plan, it does not fundamentally change NASA's overall potential plutonium-238 requirements, or the expectation that the available U.S. inventory of this material would effectively be depleted by approximately 2005.[3]

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[3] Applicable NASA mission planning correspondence is presented in Appendix R.

Although future space mission schedules over a long-term planning horizon of 10 to 35 years cannot be specified at this time, DOE anticipates that NASA space exploration missions conducted during this period will continue to require plutonium-238-fueled power systems. For example, NASA announced in a recent press conference (October 26, 2000) that mission launches in 2014 and 2016 for the long-term exploration of Mars would involve long-life rover vehicles. Radioisotope power systems would be required to provide the long-life capability.

Therefore, DOE proposes to reestablish a domestic capability for producing and processing this material. Because the SRS facilities previously used for plutonium-238 production are no longer available, DOE needs to evaluate other DOE irradiation and chemical processing facilities, as well as potential commercial light water reactors (CLWR), for this mission. Unless an assured domestic supply of plutonium-238 is established, DOE's ability to provide radioisotope power systems to support future NASA space exploration missions may be lost.

1.2.3 Civilian Nuclear Energy Research and Development

Nuclear energy is an important contributor in reducing greenhouse gas emissions in the United States, Asia, and Europe. Globally, nuclear energy produces 17 percent of the world's electricity. In the United States, nuclear energy generated 20 percent of all electricity consumed in 1999. In view of these energy and environmental contributions, there is a renewed interest in nuclear power to meet an equivalent portion of the Nation's future expanding energy requirements.

In January 1997, President Clinton tasked his Committee of Advisors on Science and Technology (PCAST) to evaluate the current national energy research and development portfolio and to provide a strategy that ensures the United States has a program to address the Nation's energy and environmental needs for the next century. In its November 1997 report responding to this request, the PCAST Energy Research and Development Panel determined that restoring a viable nuclear energy option to help meet our future energy needs is important and that a properly focused research and development effort to address the potential long-term barriers to expanded use of nuclear power (e.g., nuclear waste, proliferation, safety, and economics) was appropriate. The PCAST panel further recommended that DOE reinvigorate its nuclear energy research and development activities to address these potential barriers.

Clean, safe, reliable nuclear power has a role today and in the future for our national energy security. Recognizing this need, two new significant nuclear energy research and development programs have been initiated: the Nuclear Energy Research Initiative (NERI) and Nuclear Energy Plant Optimization (NEPO). The NERI program, initiated in fiscal year 1999, sponsors new and innovative scientific and engineering research and development to address the potential long-term barriers identified by the PCAST panel affecting the future use of nuclear energy. The NEPO program, a cost-shared program with industry initiated in fiscal year 2000, sponsors applied research and development to ensure that current nuclear plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial 40-year license period by resolving open issues related to plant aging and by applying new technologies to improve plant reliability, availability, and productivity.

The NERAC Subcommittee on Long-Term Planning for Nuclear Energy Research has set forth a recommended 20-year research and development plan to guide DOE's nuclear energy programs in areas of material research, nuclear fuel, and reactor technology development (NERAC 2000b). This plan stresses the need for DOE facilities to sustain the nuclear energy research mission in the years ahead. Such civilian nuclear energy research and development initiatives requiring an enhanced DOE nuclear facility infrastructure fall into three basic categories: materials research, nuclear fuel research, and advanced reactor development.

Materials Research. The high radiation fields, high temperatures, and corrosive environments in nuclear reactors (terrestrial or space) and other complex nuclear systems (e.g., accelerator transmutation of waste [ATW] systems) can accelerate the degradation of pressure vessels and structural material, component materials, material interfaces, and joints between materials (e.g., welds). Radiation effects in materials can cause a loss of mechanical integrity (fracture toughness and ductility) by embrittlement, dimensional changes (creep and swelling), and fatigue and cracking (irradiation-assisted stress corrosion cracking). Acquiring a fundamental understanding of radiation effects in current and future reactor materials (engineered steel alloys, ceramics, composites, and refractory metals), as well as the experimental validation of analytical models and computational methods, would require material irradiation testing over a range of neutron energies (thermal and fast flux) and doses. Material testing under simulated reactor conditions would be required to ensure the compatibility of advanced materials with the various moderators/coolants of future reactor concepts. In addition, the thermophysical properties and behaviors of liquid metal coolants being considered for advanced reactor (terrestrial or space) and ATW systems would require further irradiation testing. One key area of materials research that is important to plant safety and the license renewal of existing nuclear power plants is the accelerated aging of materials to simulate radiation effects over a plant lifetime. Researchers from the United States and many foreign countries use DOE's high-flux research reactors for materials testing and experimentation. These facilities have the capability to maintain a high density of neutrons in a given test volume for materials testing; shorten the time needed for such testing; tailor the neutron flux to simulate the different reactor types and conditions; and instrument the core for close monitoring of the test conditions.

Nuclear Fuel Research. Increasing demands are being placed on nuclear fuel and cladding material performance as the fuel burnup limits are extended in existing light water reactors to maximize plant performance and economic benefits. New fuel types and forms are being investigated that offer potential benefits such as enhanced proliferation resistance (uranium-thorium fuel), higher burnup, and improved waste forms for the new reactor concepts being researched and developed by DOE. In addition, plutonium-based mixed oxide fuels are being developed for the disposition of surplus weapons material, and high temperature, long-life fuels may be required for space reactors. Each of the various fuel and cladding types, forms, and material compositions would require research and irradiation testing under prototypical reactor conditions to fully understand fuel performance, cladding performance, cladding/fuel interaction, and cladding/coolant material compatibility. Fuel research includes a variety of thermal and fast spectrum power reactor fuel forms (ceramic, metal, hybrids such as cermet) and various fuel types (oxides, nitrides, carbides, and metallics). Irradiation experiments to characterize fuel performance would require the capability to test fuel pellets, pins, and fuel assemblies under steady-state and transient conditions in the higher temperature environments expected in future reactor designs. Reactor physics and criticality safety data for benchmarking computational codes and analytical methods used in fuel design and performance analysis would also be required.

Advanced Reactor Development. Certification and licensing of advanced reactor and complex nuclear systems would require the demonstration and validation of reactor and safety system thermal and fluid dynamic properties under steady-state and transient conditions. Typically, nonnuclear test loops are used to perform this research. However, because of the unique nature of some proposed advanced reactor concepts, test loop operation under prototypical temperature and neutron flux conditions would be necessary to adequately test and demonstrate coolant/moderator physics and thermal properties, heat transfer, fluid flow, and fuel-moderator performance.

1.3 DECISIONS TO BE MADE

In reaching programmatic decisions regarding potential enhancements to its existing nuclear facility infrastructure, DOE will factor the analytical results of this NI PEIS together with the findings presented in the ancillary *Cost Report for Alternatives Presented in the Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope*

Production Missions in the United States, Including the Role of the Fast Flux Test Facility (NI Cost Report) and *Nuclear Infrastructure Nonproliferation Impact Assessment for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (NI Nonproliferation Impact Assessment)*[4], the *Nuclear Science and Technology Infrastructure Roadmap* (which will be updated periodically), recommendations of NERAC and its various subcommittees, public input, and other DOE policy and programmatic considerations.

With the benefit of this broad base of information, DOE intends to make the following decisions:

- Whether to enhance its current nuclear facility infrastructure to meet projected requirements for future medical and industrial isotope production, plutonium-238 production, and civilian nuclear energy research and development.

- If a decision is made to enhance DOE's existing nuclear facility infrastructure, whether to construct new facilities (one or two accelerators or a research reactor).

- Whether to restart the Fast Flux Test Facility (FFTF) at the Hanford Site in Richland, Washington, as part of a nuclear infrastructure enhancement program and, if not, whether to remove FFTF from standby mode and permanently deactivate it in preparation for its eventual decontamination and decommissioning.

- If DOE's existing nuclear facility infrastructure is not enhanced, select from existing operating facilities those needed to support the proposed plutonium-238 mission, or decide whether to continue purchasing plutonium-238 from Russia to support future NASA space missions. Existing operating facilities performing medical, research, and/or industrial isotope production missions and/or civilian nuclear energy research and development missions would continue to support existing missions at current levels.

- Whether DOE inventories of neptunium-237 should be relocated and stored for future plutonium-238 production needs.

The programmatic decisions reached in association with this NI PEIS will address isotope production and civilian nuclear energy research and development missions which are the responsibility of the DOE Office of Nuclear Energy, Science and Technology. In addition to the range of reasonable programmatic alternatives evaluated in this NI PEIS, DOE could choose to combine components of several alternatives in selecting the most appropriate strategy. For example, DOE could select a low-energy accelerator to produce certain medical, research, and industrial isotopes, and an existing operating reactor to produce plutonium-238 and conduct civilian nuclear energy research and development. If alternatives were selected involving the siting, construction, and operation of one or two new accelerators or a new research reactor, appropriate site- and project-specific NEPA documentation, tiered from this NI PEIS, would be prepared.

1.4 Issues Identified During the Scoping Process

On October 5, 1998, DOE published in the Federal Register (63 FR 53398) a Notice of Intent to prepare an environmental impact statement (EIS) on the proposed production of plutonium-238 for use in advanced radioisotope power systems for future space missions. With that announcement, DOE began preparing the

[4] The findings of the *NI Cost Report* and the *NI Nonproliferation Impact Assessment* are summarized in Appendixes P and Q, respectively.

Environmental Impact Statement for the Proposed Production of Plutonium-238 for Use in Advanced Radioisotope Power Systems for Future Space Missions (*Plutonium-238 Production EIS*). The scope of the *Plutonium-238 Production EIS* was established through a public scoping process conducted from October 5, 1998, through January 4, 1999. As part of the scoping process for that draft, DOE announced that FFTF would not be considered a reasonable alternative for the plutonium-238 production mission unless restart of the facility were proposed for other reasons.

Since then, the Secretary of Energy announced on August 18, 1999, that DOE would prepare the NI PEIS. Because plutonium-238 production would be among the missions considered, the scope of the *Plutonium-238 Production EIS* in its entirety was incorporated within the scope of this NI PEIS, and preparation of the *Plutonium-238 Production EIS* as a separate NEPA review was terminated.

On September 15, 1999, DOE published in the Federal Register a Notice of Intent to prepare the NI PEIS (64 FR 50064). In the Notice, DOE invited the public to comment on the proposed actions during the 45-day NI PEIS scoping period that ended October 31, 1999. During this period, DOE held public scoping meetings at seven locations: Oak Ridge, Tennessee; Idaho Falls, Idaho; Richland and Seattle, Washington; Hood River and Portland, Oregon; and Washington, D.C. The written and oral comments, and the additional comments received via U.S. mail, electronic mail, and toll-free faxes and telephone calls, were reviewed and considered by DOE in preparing this NI PEIS. Similarly, DOE reviewed and considered all comments and input originally received from the public during the *Plutonium-238 Production EIS* scoping period in the preparation of this NI PEIS.

For the *Plutonium-238 Production EIS*, approximately 750 scoping comments were received by DOE. At the scoping meetings, the following general issues and concerns were raised:

- Additional irradiation service alternatives, such as CLWRs and accelerators
- Additional storage, target fabrication, and target processing alternatives, such as Argonne National Laboratory–West's Hot Fuels Examination Facility and the SRS H-Canyon and HB-Line
- Generation of additional waste
- Costs of implementing the various alternatives

In general, the people who attended the meetings in Idaho and Tennessee were supportive of DOE's proposed plans to produce plutonium-238 domestically for future space missions. However, in Richland, Washington, the meeting was attended by several stakeholder and environmental groups who voiced considerable opposition to DOE's consideration of FFTF for plutonium-238 production.

At the meeting in Richland, Washington, the main concern was that DOE should not consider restarting FFTF; that DOE has worked hard over the years to change Hanford's mission from "production" to "cleanup"; and that DOE should continue to honor its commitment to cleanup. There were concerns about the generation of additional waste at the site and the operational safety of FFTF. There was strong opposition to restart of FFTF for any mission.

For this NI PEIS, approximately 7,000 scoping comments were received by DOE. At the scoping meetings, the most prevalent concerns were:

- Status of and commitment to cleanup at Hanford and the impact of FFTF's restart on the existing waste cleanup at Hanford

- Lack of justification for the identified missions
- Costs of implementing the various alternatives
- Need for an additional alternative calling for the permanent deactivation of FFTF coupled with the No Action Alternative elements; that is, no plutonium-238 production and no additional research and development or medical isotope production beyond existing operating levels

The number of people who commented at the scoping meetings conducted in Oak Ridge, Tennessee; Idaho Falls, Idaho; and Washington, D.C., was smaller in comparison to the meetings held in the Pacific Northwest. At the scoping meeting in Oak Ridge, Tennessee, a commentor was concerned with the relationship of this NI PEIS to other DOE programs and the relative merits of accelerator and reactor performance. The commentor stated that the NI PEIS should include an explanation of mixed oxide fuel disposition. In addition, the commentor supported medical isotope production in Oak Ridge because it is near a transportation hub and some medical isotopes are short-lived; therefore, transportation is key.

At the scoping meeting in Idaho Falls, Idaho, most commentors supported siting the new missions at INEEL. The commentors also stated that the socioeconomic impacts of the alternatives need to be considered in this NI PEIS. A commentor stated that decisions in regard to medical isotope production should be based on the needs of the Nation as a whole and not on perceived commercial needs. The commentor also stated that incremental DOE and commercial investments in the ATR would be sufficient to enhance reactor radioisotope production needs and meet the requirements of the nuclear medicine industry.

At the scoping meetings held in the states of Washington and Oregon, many of the comments concerned using FFTF to accomplish the proposed action. Many who attended the meetings in Seattle, Washington; Portland, Oregon; and Hood River, Oregon, were strongly opposed to the restart of FFTF. Many commentors stated that the Hanford cleanup mission would be jeopardized, especially when DOE has not met the cleanup milestones. Many of the comments received at the Richland, Washington, meeting supported restarting FFTF, stating that the restart would not hamper Hanford's cleanup mission, and further stating that the operation of FFTF could help save many lives by producing isotopes to be used in new ways to treat cancer, heart disease, and other illnesses. Commentors were also concerned about the potential generation of radioactive and hazardous wastes as a result of the proposed action, as well as DOE's commitment to ongoing cleanup programs, particularly at Hanford.

At the scoping meeting in Washington, D.C., the commentors supported the need for medical isotope production. Several commentors were against the restart of FFTF; others stated that DOE needs to consider partnerships with private industry to generate necessary funds for the restart. Some commentors thought a cost study should be prepared to include avoiding future health care costs as well as cost savings to the national Medicare and Medicaid programs that could be realized by using nuclear isotopes in medical applications. Proliferation concerns were also raised as some commentors stated that: (1) the United States would be sending the wrong message by restarting FFTF; (2) a change in the U.S. nonproliferation policy would be required to import German mixed oxide fuel; and (3) the use of highly enriched uranium would be contrary to existing U.S. nonproliferation policy. Other concerns included waste generation, the Hanford cleanup, and safety at FFTF.

Comments received during the scoping periods were systematically reviewed by DOE. As a means of summarizing the issues raised during the scoping process, those comments with similar or related topics were grouped into categories to identify specific issues of public concern. After these issues were identified, they were further evaluated to determine whether they fell within or outside the proposed scope of this NI PEIS.

In several instances, the original scope was expanded to accommodate additional issues resulting from the public scoping process.

Comments received that contributed to expansion of the scope included the following general areas:

- Deactivate FFTF: Alternative 5, Permanently Deactivate FFTF with no new missions at existing facilities, has been added to the scope of this NI PEIS.
- Cleanup at Hanford: although not within the scope of this NI PEIS, information is included about the cleanup mission at Hanford and land-use planning efforts.
- Environmental contamination at Hanford: information is included about the groundwater quality at the Hanford Site.
- Nonproliferation issues: the proposed import of German SNR–300 fuel is addressed, and a separate *NI Nonproliferation Impact Assessment* report was prepared and distributed to the public in September 2000.
- Transition of FFTF stewardship after it is deactivated: the appropriate transition information is included.
- Restart of FFTF and budget constraints: DOE has made a commitment that implementation of the Record of Decision will not divert or reprogram budgeted funds designated for Hanford cleanup.
- Tri-Party Agreement at Hanford: information about the Tri-Party Agreement and its relationship to this NI PEIS is included.

Public comments and materials submitted during the public scoping periods for both the *Plutonium-238 Production EIS* and this NI PEIS were logged and placed in the Administrative Record for this NI PEIS. Appendix N summarizes the comments received during both public scoping periods.

1.5 Issues Raised During the Public Comment Period on the Draft NI PEIS

DOE published the Draft NI PEIS in July 2000. In accordance with Council on Environmental Quality (CEQ) and DOE NEPA regulations, DOE announced the availability of the Draft NI PEIS in the Federal Register (65 FR 46443) and invited interested parties to provide comments on the Draft NI PEIS analysis and results. The Draft NI PEIS or Summary was distributed to approximately 6,000 individuals.

NEPA regulations mandate a minimum 45-day comment period after the U.S. Environmental Protection Agency's Notice of Availability of a draft EIS to provide an opportunity for the public to comment on the EIS analysis and results. The original 45-day comment period on the Draft NI PEIS began on July 28, 2000. To provide interested parties with additional time to comment, the deadline for transmittal of comments was changed from September 11, 2000 (as stated in the transmittal letter of the Draft PEIS and the Summary) to September 18, 2000. During the 52-day comment period, DOE held seven hearings to discuss the proposed action and to receive oral and written comments on the Draft NI PEIS. These hearings were held at Oak Ridge, Tennessee; Idaho Falls, Idaho; Hood River, Oregon; Portland, Oregon; Seattle, Washington; Richland, Washington; and Arlington, Virginia. In addition, the public was encouraged to submit comments via U.S. mail, e-mail, a toll-free phone line, and a toll-free fax line. During the public comment period, DOE received approximately 3,400 submittals containing over 6,200 comments. DOE has responded to all comments received during the public comment period. These comments are presented in Volume 3 of this Final NI PEIS.

DOE considered comments received after the close of the public comment period to the extent practicable (see Section 1.5.6).

The public comments received on the Draft NI PEIS addressed a wide range of issues. The following discusses the major issues raised, and DOE's responses to these issues. Changes made in response to comments received on the Draft NI PEIS are described in Section 1.8.

Major issues raised addressed purpose and need for the proposed action; impact of FFTF on Hanford cleanup; waste management and spent nuclear fuel; cost of the various alternatives; nuclear nonproliferation policy; public involvement; and environmental impacts. Aside from comments on the proposed action and its environmental impacts, many commentors expressed support for or opposition to FFTF restart, the major point of public controversy associated with the NI PEIS.

1.5.1 Purpose and Need for the Proposed Action

Many commentors expressed the opinion that DOE failed to demonstrate a compelling argument for the projected need for medical isotopes, and that such medical isotopes could be produced or purchased elsewhere, particularly in Canada. In contrast, a large number of commentors expressed support for expanded isotope production by sharing personal stories of how medical isotopes had either saved a relative or friend, or could have saved them had isotopes been available. As presented in Section 1.2.1, DOE sought independent analysis of trends in the use of medical isotopes, and established two advisory bodies, the Expert Panel and the NERAC. DOE has adopted these growth projections as a planning tool for evaluating the potential capability of the existing nuclear facility infrastructure to meet programmatic requirements. In the period since the initial estimates were made, the actual growth of medical isotope use has tracked at levels consistent with the Expert Panel findings. While Canada currently provides a large amount of the medical radioisotopes used in the United States, it only supplies a limited number of economically attractive commercial isotopes (primarily molybdenum-99), and it does not supply research isotopes or the diverse array of medical and industrial isotopes considered in the NI PEIS.

A number of commentors also questioned the suitability of using FFTF for producing research isotopes in light of findings presented in the NERAC Subcommittee for Isotope Research and Production Planning Report (NERAC 2000a). While it would not be cost effective to restart FFTF for the singular purpose of producing small quantities of various research isotopes, sustained operation of FFTF for the production of larger quantities of both research and commercial isotopes would be viable if FFTF were operated in concert with producing plutonium-238 and conducting nuclear energy research and development for civilian applications. In recognition of these constraints on its operational feasibility, the NI PEIS only evaluates the use of FFTF for isotope production when coupled with these other missions.

Commentors also questioned the need for the United States to reestablish domestic production of plutonium-238. In particular, commentors pointed to the availability of plutonium-238 that could be purchased from Russia, and recent guidance from NASA stating that DOE no longer needed to support certain radioisotope power systems. As discussed in Section 1.2.2, DOE could purchase plutonium-238 from Russia. However, for supply reliability reasons and concern of nuclear nonproliferation, DOE's preference is to establish a domestic plutonium-238 production capability. Current NASA guidance to DOE is also discussed in Section 1.2.2. The May 22, 2000, correspondence from NASA identifies that it no longer has a planned requirement for Small Radioisotope Thermoelectric Generator (SRTG) power systems (NASA 2000a). This does not mean that NASA no longer requires DOE to provide the necessary plutonium-238 to support deep space missions. Rather, SRTG development efforts were stopped in order to permit reprogramming of funds to support development of a new radioisotope power system based on the SRPS technology. This new radioisotope power system, referred to in the subject correspondence, requires one-third less plutonium as its fuel source. Because the SRPS technology is developmental, NASA has requested in a September 22, 2000, letter to DOE that the plutonium-238 needed for a large radioisotope thermoelectric generator be maintained as a backup (NASA 2000b).

1.5.2 Impact of FFTF Restart on Hanford Cleanup

A number of commentors expressed concern that DOE's primary mission at Hanford needs to be cleanup, including compliance with the Tri-Party Agreement. Although beyond the scope of this NI PEIS, ongoing Hanford cleanup activities are high priority to DOE. Hanford environmental restoration activities are conducted in accordance with the Tri-Party (i.e., DOE's Richland Operations Office, EPA, and the State of Washington Department of Ecology) Agreement. This agreement specifies milestones and schedules for restoration of all parts of Hanford. FFTF milestones in the Tri-Party Agreement were placed in abeyance (suspension) by agreement of the three parties until a decision is made on the future of FFTF. Public meetings were held on this formal milestone change. DOE is fully committed to honoring this agreement.

A number of commentors also expressed concern that funding for Hanford cleanup would be diverted for FFTF restart and hamper the progress of cleanup activities. The U.S. Congress funds Hanford cleanup through the Office of the Assistant Secretary for Environmental Management. Congress also funds FFTF through the Office of Nuclear Energy, Science and Technology (NE). The nuclear infrastructure missions described in Section 1.2 would also be funded through NE, which has no funding connection to Hanford cleanup activities. As stated in Section N.3.2, implementation of the nuclear infrastructure alternatives would not divert or reprogram budgeted funds designated for Hanford cleanup, regardless of the alternative(s) selected.

1.5.3 Waste Management and Spent Nuclear Fuel

A number of commentors expressed concern over the generation and disposition of waste resulting from the proposed action. In particular, commentors pointed to past DOE waste management practices and questioned whether wastes resulting from proposed NI PEIS activities would be properly managed. This NI PEIS addresses wastes produced for each alternative, as well as cumulative impacts related to waste production. Waste minimization programs at each of the alternative sites are also addressed. These programs would be implemented for the alternative selected in the Record of Decision. The waste generated from any of the alternatives considered in this NI PEIS would be managed (i.e., treated, stored, and disposed of) in a safe and environmentally protective manner and in compliance with all applicable Federal and state laws and regulations and applicable DOE orders.

A number of commentors expressed specific concern over the generation and disposition of waste resulting from FFTF restart and operation, and how this would impact Hanford's existing waste management infrastructure. Management of wastes that would be generated under implementation of Alternative 1 (Restart FFTF) is discussed in Section 4.3 (e.g., Section 4.3.1.1.13). Section 4.3.1.1.13 was revised to clarify that the Hanford waste management infrastructure is analyzed in this NI PEIS for the management of waste resulting from FFTF restart and operation. This analysis is consistent with policy and DOE Order 435.1, *Radioactive Waste Management*, that DOE radioactive waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste is generated, if practical, or at another DOE facility. However, if DOE determines that use of the Hanford waste management infrastructure or other DOE sites is not practical or cost effective, DOE may issue an exemption under DOE Order 435.1 for the use of non-DOE facilities (i.e., commercial facilities) to store, treat, and dispose of such waste generated from the restart and operation of FFTF. In addition, Sections 4.3.3.1.13 and 4.4.3.1.13 also address the potential impacts associated with the waste generated from the target fabrication and processing in the Fuels and Materials Examination Facility (FMEF) and how this waste would be managed at the site.

A number of commentors also raised concern that processing of irradiated targets for production of plutonium-238 would generate high-level radioactive waste. DOE Manual 435.1, *Radioactive Waste Management,* defines high-level radioactive waste as "the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation." DOE has prepared an implementation guide to M 435.1 to assist in implementing the requirements contained in that manual. For this particular "requirement," the definition of high-level radioactive waste, the guide is intended to facilitate the classification of indefinite waste as to whether or not they are high-level radioactive waste. It is recognized that the definition of high-level radioactive waste is not precise and is essentially a source-based definition that also alludes to concentrations of a given waste stream. Page II-8 of the guide notes that "For the purpose of managing high-level waste under DOE M 435.1-1 [sic], spent nuclear fuel includes spent driver elements and/or irradiated target elements that contain transuranium elements." This statement was included in the guide because the concentrations of long-lived isotopes are likely to be somewhat high during reprocessing and it also meets the source-based definition. As a result of reviewing this guide and to address the comments raised, DOE is considering whether the waste from processing of irradiated neptunium-237 targets should be classified as high-level radioactive waste and not transuranic waste. As a result, the Waste Management sections (i.e., Sections 4.3.1.1.13, 4.3.2.1.13, 4.3.3.1.13, and 4.4.3.1.13) of this NI PEIS have been revised to reflect this different classification from what was assumed in the Draft NI PEIS. As discussed in these revised sections, irrespective of how the waste is classified (i.e., transuranic or high-level radioactive waste), the composition and characteristics are the same, and the waste management (i.e., treatment and onsite storage) for this NI PEIS would be the same. In addition, even if the waste were managed as high-level radioactive waste, it would have no impact on the existing high-level radioactive waste management infrastructure (e.g., high-level waste storage tanks) because the high-activity waste from processing the targets would be initially stored and vitrified within the processing facility (i.e., FMEF, the Radiochemical Engineering Development Center [REDC], or the Fluorinel Dissolution Process Facility [FDPF]).

Commentors also expressed concern over the potential impacts of spent nuclear fuel generation from FFTF restart and operation, particularly regarding human health risk. This NI PEIS estimates that about 16 metric tons of heavy metal spent nuclear fuel would be generated over 35 years of operation of FFTF. Hanford is currently managing about 2,000 metric tons of heavy metal spent nuclear fuel. As indicated in Table 4–173, the radiation risk to a maximally exposed individual from normal operational activities during management of the current stored spent nuclear fuel over 35 years is 1.4×10^{-8} latent cancer fatality. The risk to the maximally exposed individual that would be associated with the new nuclear infrastructure operations to restart FFTF and operate FMEF or the Radiochemical Processing Laboratory is 9.5×10^{-8} latent cancer fatality. Furthermore, only a small fraction of this risk would be attributable to management of the additional spent nuclear fuel at FFTF. The annual dose to the maximally exposed individual from all current and reasonably foreseeable activities at Hanford is less than 0.2 millirem. This dose is well within the DOE dose limits given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. As discussed in that order, the dose limit from airborne emissions is 10 millirem per year, as required by EPA regulations under the Clean Air Act; the dose limit from drinking water is 4 millirem per year, consistent with the EPA drinking water criteria under the Safe Drinking Water Act; and the dose limit from all pathways combined is 100 millirem per year. The risk to the population from all activities at Hanford would be 0.21 latent cancer fatality over 35 years. DOE has committed to remove the spent nuclear fuel at Hanford for ultimate disposition in a geologic repository.

1.5.4 Cost of the Various Alternatives

Commentors expressed opinions about the costs related to the stated missions. Commentors stated that a cost-benefit analysis was necessary to show the value of production of medical isotopes balanced against facility costs, in particular, the restart of FFTF, and noted that perhaps facilities would be able to pay for themselves. There were concerns that FFTF restart would take funds away from the cleanup of Hanford. Commentors noted that the decommissioning costs were not included for the restart FFTF option in the *NI Cost Report*. Several commentors remarked that the expense of plutonium-238 production cannot be justified when DOE needs to clean up existing problems at its sites.

Although the costs of proposed actions are not required by NEPA and CEQ regulations to be included in a PEIS, DOE prepared a separate *NI Cost Report*. This report would provide additional pertinent information to the Secretary of Energy so that he may make an informed decision with respect to the alternatives presented in this Final NI PEIS. Pursuant to CEQ regulations (40 CFR Section 1505.1(e)), such documents comparing alternatives should be made available to the public prior to any decision being made. DOE mailed this document to more than 730 interested parties on August 24, 2000. This report was made available immediately upon release on the NE web site (http://www.nuclear.gov) and in the public reading rooms. DOE has also provided the summary of the *NI Cost Report* in Appendix P of this Final NI PEIS.

1.5.5 Nuclear Nonproliferation Policy

Commentors expressed opinions about the nuclear nonproliferation implications of the proposed action. Commentors were concerned about keeping plutonium-238 out of the hands of third parties, and it was suggested that the purchase of plutonium-238 from Russia would stop proliferation of the material and the United States would know the disposition of the quantity purchased. Several commentors raised concerns about specific facilities described in the NI PEIS, including the FDPF and FFTF. The use of highly enriched uranium fuel in FFTF was questioned related to possible violation of U.S. nuclear nonproliferation policy. Conversely, the shutdown of FFTF that occurred previously was characterized as being done to discourage proliferation of nuclear weapons worldwide, but had instead weakened the U.S. position as a world leader in nuclear technology. There were comments about the timeliness of release of the *NI Nonproliferation Impact Assessment*, that no nonproliferation information was included in the Draft NI PEIS, and that nuclear nonproliferation policy should be considered by DOE in selection of its preferred alternative.

The plutonium being considered for production in the NI PEIS is plutonium-238, which is not the same isotope of plutonium that is used in nuclear weapons. The production of plutonium-238 does not present a nonproliferation concern. DOE developed the separate *NI Nonproliferation Impact Assessment*, published in September 2000, that analyzed the nonproliferation impacts of the actions considered in this PEIS and found that there are no U.S. nonproliferation policies, laws, regulations, or international agreements that preclude the use of any of the facilities in the manner described in the Draft NI PEIS. Although this policy analysis is not required under NEPA, it is an essential element in the decision-making process for the DOE nuclear infrastructure. A summary of the *NI Nonproliferation Impact Assessment* is included in Appendix Q of this Final NI PEIS. It is also available on the DOE NE web site (http://www.nuclear.gov).

1.5.6 Public Involvement

Commentors expressed opinions about the length of the comment period on the Draft NI PEIS, and said they wanted additional time to obtain and review relevant documents, including the *NI Cost Report* and *NI Nonproliferation Impact Assessment*. As identified in Section 1.5, the deadline for transmittal of comments was changed from September 11, 2000 (as stated in the transmittal letter of the Draft NI PEIS and the Summary) to September 18, 2000. While the official comment period ended on September 18, 2000, DOE addressed late comments to the extent practicable and considered all comments received through October 31, 2000, in preparing this Final NI PEIS. Comments that were received through September 25, 2000, along with corresponding responses, have been included in Chapter 2 of the comment response volume. Direct responses are not included to comments that were received after September 25, 2000. However, all of these comments were considered and are characterized by other comments received during the comment period (for which a response has been provided).

Many commentors expressed the opinion that public input is intended for "show only," and that DOE has already made its decisions. Commentors also stated that they had given the same comments over and over again and that DOE representatives were not listening. DOE policy encourages effective public participation in its decision-making process. In compliance with NEPA and CEQ regulations, DOE provided opportunity to the public to comment on the scope of the NI PEIS and the environmental impact analysis of DOE's proposed alternatives. DOE gave equal consideration to all comments. In preparing this Final NI PEIS, DOE carefully considered all comments received from the public.

Some commentors expressed opinions about the conduct of the hearings, both positive and negative. The public hearing format was designed to be fair. The public hearing format used was based on stakeholder input and was presented in the Notice of Availability (65 FR 46443 et seq.) for the Draft NI PEIS. This format was intended to encourage public participation, regardless of the motivation for attending the hearing. It provided an opportunity for the participants to meet, exchange information and share concerns with DOE personnel available throughout the course of each hearing to answer questions. The meetings were facilitated by an independent moderator to ensure that all persons wishing to speak had an opportunity to do so. Persons wishing to comment were selected at random from the audiences rather than according to the order in which they registered. This was accomplished by a random number drawing. In addition to the comment recorder stationed at the main hearing, a second recorder was available in an adjacent room to receive comments without the need to await selection at the main proceeding. The hearing format promoted open and equal representation by all individuals and groups.

1.5.7 Environmental Impacts

A number of commentors questioned the results of the environmental impact analysis and cumulative impacts, specifically at Hanford. Many of these comments focused on concerns that the proposed action would result in negative impacts to the health of individuals residing in the Hanford region. The NI PEIS analyzes the impacts of the various alternatives, and the environmental impacts associated with all proposed nuclear infrastructure activities are addressed in detail in Chapter 4. Specifically, the environmental impacts associated with operation of the Hanford facilities during normal operations and from postulated accidents are presented in Section 4.3. These assessments were made using well-established and accepted analytical methods, as described in Appendixes G through L. The analytical methodology is conservative by nature; the actual impacts to the environment would be expected to be less than calculated. All impacts have been shown to be small. No fatalities among workers or the general public would be expected over the 35-year operational period. The impacts to the biosphere (air, water, and land) were also evaluated and determined to be small.

Some commentors raised specific concern over potential contamination of the Columbia River resulting from the restart of FFTF. However, FFTF is approximately 4.5 miles from the Columbia River. There are no discharges to the river from FFTF and no radioactive or hazardous discharges to groundwater. As indicated in analyses presented in Chapter 4 (e.g., Sections 4.3.1.1.4, 4.3.3.1.4, 4.4.3.1.4, 4.5.3.2.4, and 4.6.3.2.4), there would be no discernible impacts to groundwater or surface water quality at Hanford from operation of Hanford facilities that would support the nuclear infrastructure missions described in Section 1.2.

A number of commentors also expressed concern that DOE would expose individuals in the Pacific Northwest to risks associated with importing weapons-grade plutonium. None of the proposed alternatives involve the shipment of any weapons-grade plutonium to any port in the United States. Alternative 1 does postulate that DOE might decide at some point to import mixed oxide fuel from Europe to fuel FFTF. At this time, however, DOE has not proposed to import this fuel through any specific port. If DOE ultimately decides to import fuel from Europe, it would perform a separate NEPA analysis to select a port. This review would address all relevant potential impacts of overseas and inland water transportation, shipboard fires, package handling, land transportation, as well as safeguards and security associated with the import of SNR–300 mixed oxide fuel through a variety of specific candidate ports on the west and east coasts. It would take into account all public comments, including local resolutions, concerning the desirability of bringing mixed oxide fuel into the proposed alternative ports.

In the event that DOE decides to enhance its nuclear infrastructure, it would not expose any population to high, unacceptable risks under any alternative. Any transportation activities that would be conducted by DOE would comply with U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Transportation regulations. Associated transatlantic shipments would comply with International Atomic Energy Agency requirements. In Section J.6.2, DOE reviewed the potential maximum impacts from the marine transportation of mixed oxide fuel from Europe to a representative military port (Charleston, South Carolina), and overland transportation to Hanford. Also in that section, the results of a bounding analysis show that the maximum potential radiological risks to the surrounding public from mixed oxide fuel shipments would be extremely small (e.g., less than 1 chance in a trillion for a latent cancer fatality per shipment from severe accidents at docks and in channels and less than 1 chance in 50 billion for a latent cancer fatality per shipment from overland highway accidents).

1.6 Alternatives Evaluated in This NI PEIS

This NI PEIS analyzes the potential environmental impacts using various irradiation and processing facilities to meet the following projected DOE irradiation service mission needs for 35 years: (1) production of medical, research, and industrial isotopes; (2) production of up to 5 kilograms (11 pounds) per year of plutonium-238 for use in advanced radioisotope power systems for future NASA space missions; and (3) support for U.S. civilian nuclear energy research and development activities. The proposed irradiation facilities include those that are currently operating, those that could be brought online, or those that could be constructed and operated to meet DOE's nuclear facility infrastructure requirements. This NI PEIS evaluates a No Action Alternative and five programmatic alternatives:

No Action Alternative
Alternative 1—Restart FFTF
Alternative 2—Use Only Existing Operational Facilities
Alternative 3—Construct New Accelerator(s)
Alternative 4—Construct New Research Reactor
Alternative 5—Permanently Deactivate FFTF (with No New Missions)

Each of the alternatives in this NI PEIS would contribute to fulfilling some of the proposed missions. However, none of the alternatives can completely meet all of the projected nuclear infrastructure needs. It is possible during the Record of Decision process that a combination of the alternatives could be selected, for example, a low-energy accelerator in combination with the existing reactors to optimize research isotope production, or in combination with FFTF to optimize research and therapeutic isotope production. The alternatives, their associated facility options, and their relative capabilities are described in detail in Chapter 2. DOE's Preferred Alternative for accomplishing expanded civilian nuclear energy research and development and isotope production missions in the United States is Alternative 2, Use Only Existing Operational Facilities, Option 7. Under this alternative and option, DOE would reestablish domestic production of plutonium-238, as needed, using irradiation capabilities at both ATR at INEEL and HFIR at ORNL. REDC at ORNL would be used to store neptunium-237 and to fabricate and process the targets irradiated at ATR and HFIR. The production of medical and industrial isotopes and support of civilian nuclear energy research and development would continue and increase to the extent possible under current reactor operating levels. FFTF at Hanford would be permanently deactivated.

1.7 RELATED NEPA REVIEWS

This section provides brief summaries of NEPA documents related to ongoing DOE programs, including documents that address other aspects of DOE's nuclear facility infrastructure, the management of various waste types across the DOE complex, and activities currently under way or planned at candidate sites that are analyzed in this NI PEIS.

The *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland, Washington,* (DOE/EA-0993, May 1995; Finding of No Significant Impact [FONSI], May 1995) analyzes the environmental impacts associated with permanent shutdown (deactivation) of FFTF and the activities required to support it. Based on the environmental assessment, DOE determined that the proposed shutdown would not result in significant environmental impacts as defined under NEPA. This NI PEIS summarizes the impacts presented in the environmental assessment for those alternatives that consider permanent deactivation of FFTF (i.e., Alternatives 2, 3, 4, and 5) (DOE 1995a).

The *Environmental Assessment of the Import of Russian Plutonium-238* (DOE/EA-0841, June 1993; FONSI, June 1993) addresses the environmental impacts of importing plutonium-238 from Russia to augment the U.S. inventory for NASA space missions. The proposed action considers shipping up to 40 kilograms (88.2 pounds) of plutonium-238 fuel from Russia to a U.S. port, transporting the plutonium-238 within the United States to either SRS or LANL in Los Alamos, New Mexico, and if necessary, processing the material at SRS to remove impurities from the fuel. The impacts analyzed in the environmental assessment are summarized in this NI PEIS for those alternatives that do not consider re-establishing a domestic plutonium-238 production capability (i.e., the No Action Alternative and Alternative 5) (DOE 1993).

The *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995) analyzes the potential environmental impacts of managing certain nuclear materials at SRS pending decisions on future use or ultimate disposition, as well as the impacts of constructing the SRS Actinide Packaging and Storage Facility. Five related Records of Decision have been issued since this Final EIS was published. On December 12, 1995, DOE issued a Record of Decision and a Notice of Preferred Alternatives (60 FR 65300) concerning interim management of several categories of nuclear materials at SRS. On February 8, 1996, DOE issued a Supplemental Record of Decision (61 FR 6633) concerning stabilization of two of the remaining categories of nuclear materials (Mark-16 and Mark-22 fuel and other aluminum-clad targets) analyzed in the Final EIS. After considering a DOE staff study and recommendation on canyon facility use, DOE issued a second Supplemental Record of Decision on September 6, 1996 (61 FR 48474), concerning stabilization of the neptunium-237 solutions, obsolete neptunium targets, and plutonium-239 solutions. On April 2, 1997, DOE issued a third Supplemental Record of Decision (62 FR 17790) related to stabilization in the F-Canyon and FB-Line facilities of the remaining Taiwan Research Reactor spent nuclear fuel. On October 31, 1997, DOE issued a fourth Supplemental Record of Decision (62 FR 61099) to add another method, processing and storage for vitrification in the Defense Waste Processing Facility, to those being used to manage plutonium and uranium stored in vaults and to amend its September 6, 1996, Supplemental Record of Decision to now enable use of the SRS H-Canyon facilities to stabilize the plutonium-239 and neptunium-237 solutions stored in H-Canyon and the obsolete neptunium-237 targets stored in K-Reactor into oxide forms. This neptunium-237 oxide serves as the target material for the plutonium-238 production mission analyzed in this NI PEIS (DOE 1995b).

The *Final Environmental Impact Statement, Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes* (DOE/EIS-249, April 1996; Record of Decision, September 1996 [61 FR 48921]) analyzes the proposed establishment of a domestic capability to produce molybdenum-99 (a short-lived isotope that decays into technetium-99, an isotope used extensively for medical imaging) and related medical isotopes such as iodine-131, xenon-133, and iodine-125. At the time of this review, the U.S. supply of molybdenum-99 depended on the production capacity of one aging reactor in Canada, so DOE proposed this action to ensure a reliable domestic source for this vital isotope. In the Record of Decision, DOE selected the Annular Core Research Reactor and the Hot Cell Facility at SNL, New Mexico, for the production of molybdenum-99 and the related isotopes. Since that time, the diversity and reliability of the world supply of molybdenum-99 have increased. DOE has determined that, because the vulnerability in supplies of molybdenum-99 has sufficiently diminished, the selected SNL facilities should be further developed for molybdenum-99 production using private funds. Negotiations toward that end are ongoing. Until an agreement is reached, the reactor and hot cell facilities are available for emergency molybdenum-99 production should that need arise. The reactor is also being used for the production of other isotopes such as iodine-125, and has been made available on a services basis to serve defense missions. Any nuclear facility infrastructure enhancements analyzed in this NI PEIS would be separate from, and in addition to, the existing capabilities of these facilities (DOE 1996a).

The *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source* (DOE/EIS-0247, April 1999; Record of Decision, June 1999 [64 FR 35140]) analyzes the potential environmental impacts of constructing and operating a state-of-the-art spallation neutron source facility at one of four sites: ORNL (Preferred Alternative); Argonne National Laboratory–East in Argonne, Illinois; Brookhaven National Laboratory in Upton, New York; and LANL. The spallation neutron source facility is designed to provide a high-flux, short-pulsed neutron source that would give the United States' scientific and industrial research communities a much more intense source of pulsed neutrons than is currently available. Construction of this new facility would also ensure the future availability of a state-of-the-art facility as currently existing sources reach the end of their useful operating lives. In the associated Record of Decision, DOE designated ORNL as the chosen site for construction and operation of the spallation neutron source. The spallation neutron source is currently under construction, and the facility's full capacity has been dedicated to support planned missions. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action. However, the nuclear facility infrastructure enhancements analyzed in this NI PEIS would be separate from, and in addition to, the capabilities of this facility (DOE 1999a).

The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) (DOE/EIS-0200-F, May 1997; Transuranic Waste Record of Decision, January 1998 [63 FR 3629]; Hazardous Waste Record of Decision, August 1998 [63 FR 41810]; High-Level Radioactive Waste Record of Decision, August 1999 [64 FR 46661]; Low-Level Radioactive Waste and Mixed Low-Level Radioactive Waste Record of Decision, February 2000 [65 FR 10061] examines the potential environmental and cost impacts of selected strategic alternatives for managing five types of radioactive and hazardous waste that result from nuclear defense and research activities at sites throughout the United States. The *Waste Management PEIS* provides information on the impacts of the various siting configurations DOE will use to decide where to locate additional treatment, storage, and disposal capacity for each waste configuration. In the transuranic waste Record of Decision, DOE determined that those sites that currently have or will generate transuranic waste will prepare it for storage and store it on site, except SNL, which will transfer its transuranic waste to LANL. The hazardous waste Record of Decision states that DOE will continue the use of offsite facilities to treat nonwastewater hazardous waste, with the exception that Oak Ridge Reservation (ORR) and SRS will treat some of their own nonwastewater hazardous waste on site. The high-level radioactive waste Record of Decision states that immobilized high-level radioactive waste will be stored at Hanford, INEEL, SRS, and the West Valley Demonstration Project in New York until a geologic repository is licensed by the NRC. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that DOE will minimally treat low-level radioactive waste at the generator sites, and that Hanford and the Nevada Test Site will be made available to all DOE sites for low-level radioactive waste disposal. As part of this decision, DOE will treat mixed low-level radioactive waste at INEEL, ORR, and SRS; dispose of mixed low-level radioactive waste at the Nevada Test Site; and both treat and dispose of mixed low-level radioactive waste at Hanford. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action. This NI PEIS analysis also assumes that waste generated as part of the NI PEIS proposed action would be managed in accordance with these decisions (DOE 1997a).

The *Draft 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-0250D, July 1999) analyzes the construction, operation and monitoring, and eventual closure of a potential geologic repository at Yucca Mountain to dispose of commercial and DOE spent nuclear fuel, high-level radioactive waste, and materials that NRC determines by rule require the same degree of isolation. National transportation, Nevada transportation, and waste packaging are evaluated as part of the analysis. Three implementing design alternatives based on thermal load—low, intermediate, and high—are examined. This NI PEIS assumes for analysis purposes that Yucca Mountain is a potential geologic repository site for spent nuclear fuel produced as a result of enhancing the U.S. nuclear facility infrastructure (DOE 1999b).

The *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE/EIS-0189, August 1996; Record of Decision, February 1997 [62 FR 8693]) satisfies the DOE commitment made in the *Disposal of Hanford Defense High-Level, Transuranic and Tank Waste Final Environmental Impact Statement* (DOE/EIS-0113, December 1987; Records of Decision March and April 1988) to prepare a supplemental NEPA analysis. The *Tank Waste Remediation System EIS* was prepared in response to several important changes subsequent to the Record of Decision, including a revised strategy for managing and disposing of tank waste and encapsulated cesium and strontium. As part of the proposed action, the *Tank Waste Remediation System EIS* evaluates continued operation and management of the tank farms, waste transfer system upgrades, and retrieval and treatment of the tank waste, including construction and operation of a facility to vitrify high-level radioactive waste and to vitrify or similarly immobilize low-level radioactive waste. DOE decided to implement the Preferred Alternative for retrieval, treatment, and disposal of tank waste and to defer a decision on the disposition of cesium and strontium capsules. Two supplemental analyses were prepared for the *Tank Waste Remediation System EIS*. The first was *Proposed Upgrades to the Tank Farm Ventilation, Instrumentation, and Electrical Systems under Project W-314 in Support of Tank Farm Restoration and Safe Operations* (DOE/EIS-0189-SA1, June 1997). Based on these supplemental analyses, it was determined that upgrades or planned upgrades to the tank farm do not pose any additional potential environmental impacts and, therefore, no additional NEPA analysis is required. The second supplemental analysis was for the *Tank Waste Remediation System* (DOE/EIS-0189-SA2, May 1998). This analysis provides information on the most recent inventory of chemical and radiological constituents in the tanks and the new waste to be sent to the tanks for treatment. Based on the new data, it was concluded that there would be minimal changes from the impacts identified in the *Tank Waste Remediation System EIS* and, therefore, no additional NEPA analysis is required. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996b).

The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE/EIS-0222-F, September 1999; Record of Decision, November 1999 [64 FR 61615]) focuses on developing an overall strategy for future land use at Hanford and includes a proposed comprehensive land-use plan. The Preferred Alternative, which DOE selected in the Record of Decision, is to consolidate waste management operations in the Central Plateau; allow industrial development in the eastern and southern portions of the site; increase recreational access to the Columbia River; and expand Saddle Mountain National Refuge to include all of the Wahluke Slope, McGee Ranch, and Fitzner-Eberhardt Arid Lands Ecology Reserve. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999c).

The *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (National Park Service June 1994; Record of Decision, July 1996) evaluates impacts related to protection of the Hanford Reach of the Columbia River as a Wild and Scenic River, increased recreation access, and visitor interpretation and education. In the Record of Decision, the National Park Service recommended that Congress designate the Hanford Reach of the Columbia River, public land within one-quarter mile of the river, and all public land on the Wahluke Slope as a new National Wildlife Refuge and National Wild and Scenic River. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (NPS 1994).

The *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F, April 1995; Record of Decision, May 1995 [60 FR 28680]) is a complex-wide evaluation of the alternatives for managing the existing and projected amounts of spent nuclear fuel within the DOE inventory through 2035. The EIS contains an analysis of the impacts of transporting spent nuclear fuel, as well as sitewide alternatives for environmental restoration and waste management programs at INEEL. In the associated Record of Decision, DOE designated Hanford, INEEL, and SRS for regional spent fuel storage and management and made decisions about environmental restoration and waste management activities at INEEL. In March 1996, DOE issued an amendment to the May 1995 Record of Decision to include a decision to regionalize the management of DOE-owned spent nuclear fuel by fuel type, including spent fuel currently stored at Hanford, INEEL, and SRS. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1995c).

The *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218F, February 1996; Record of Decision, July 1996 [61 FR 38720]) evaluates the adoption of a joint DOE/Department of State policy to manage spent nuclear fuel from foreign research reactors, including highly enriched uranium provided by the United States to other countries for research reactors. Management alternatives include a number of implementation options for port selection, transportation, and storage at DOE sites. In the Record of Decision, DOE selected a management policy that returned spent nuclear fuel from various foreign research reactors to the United States using two designated U.S. ports and the management at INEEL and SRS. A supplement analysis (DOE/EIS-0218-SA-2, August 1998) was prepared to examine acceptance of foreign research reactor spent nuclear fuel under three scenarios not specifically examined in the EIS: (1) accepting spent nuclear fuel not included in EIS-estimated inventories, (2) accepting spent nuclear fuel from countries in quantities greater than the quantities identified in the EIS, and (3) transporting more than eight casks of spent fuel on a single oceangoing vessel. The supplement analysis concluded that the potential environmental impacts of these actions are bounded by the analysis performed in the EIS and, therefore, no supplement to the EIS is needed. In turn, DOE issued a revision to the Record of Decision on July 19, 2000 (65 FR 44767) to allow the shipment of up to 16 casks of spent nuclear fuel on a single ocean-going vessel transporting foreign research reactor spent nuclear fuel to the United States. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996c).

The DOE INEEL *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement* (DOE/EIS-0290, January 1999; Record of Decision, April 1999 [64 FR 16948]) evaluates four alternatives: (1) a No Action Alternative under which existing waste management operations, facilities, and projects would continue; (2) the proposed action/Preferred Alternative under which BNFL, Inc., would build and operate an advanced mixed waste treatment project facility using proposed thermal and nonthermal treatment technologies for certification and shipment to the Waste Isolation Pilot Plant or to another acceptable disposal facility; (3) a nonthermal treatment alternative under which some treatment of transuranic, alpha, and low-level mixed waste would occur at an advanced mixed waste treatment project facility at the same location as the proposed action, and waste that requires thermal treatment would be repackaged for storage; and (4) a treatment and storage alternative that would include the same processes as the proposed action/Preferred Alternative, except the treated waste would be placed in Resource Conservation and Recovery Act–permitted storage units at the onsite Radioactive Waste Management Complex for long-term storage. In the Record of Decision, DOE selected the Preferred Alternative, although construction of the thermal treatment component of this alternative has been deferred pending the recommendation of a blue ribbon panel of experts assessing possible technology alternatives. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999d).

The *Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory* (DOE/EIS-0238, January 1999; Record of Decision, September 1999 [64 FR 50797]) evaluates ongoing and projected new operations and facilities at LANL in support of DOE missions, including the storage of plutonium-238. A decision was made in the LANL Record of Decision to implement the Preferred Alternative, which includes expansion of operations as necessary, increases in existing operations to the greatest reasonably foreseeable levels, and full implementation of the mission elements assigned to LANL. Because the remaining U.S. inventory of usable plutonium-238 is stored at LANL, the NI PEIS evaluates the transport to LANL of the plutonium-238 product resulting from an enhanced nuclear facility infrastructure (DOE 1999e).

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995; Record of Decision, December 5, 1995 [60 FR 63878]) evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at five candidate sites, as well as the use of a CLWR for producing tritium, a gaseous radioactive isotope of hydrogen considered essential to the operation of U.S. thermonuclear weapons. In the Record of Decision, DOE selected a dual-track approach. One track explores the purchase of an operating or partially complete CLWR, or the purchase of irradiation services from such a reactor. A second track would design, build, and test critical components of an accelerator system for production of tritium. The Record of Decision stated that DOE would select one of the alternatives at a later date to serve as the primary tritium source for the U.S. nuclear weapons stockpile, while the other alternative will be developed as a backup source, if feasible. The Record of Decision also stated that DOE would determine whether the operation of FFTF might be able to play any role in future tritium requirements. On December 22, 1998, the Secretary of Energy announced his selection of the CLWR as the primary tritium supply and that an accelerator would be developed but not constructed. In addition, DOE decided that FFTF would have no role in tritium supply plans. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action. Since the accelerator for production of tritium would not be built, it was not considered as a reasonable alternative in the NI PEIS (DOE 1995d).

The *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996; Record of Decision, July 1996 [61 FR 40619) addresses the disposition of a nominal 220 tons of highly enriched uranium declared surplus to the national security needs of the United States. Alternatives include several approaches to blending down the highly enriched material to make it non-weapons-usable and suitable for fabrication into fuel for commercial nuclear reactors. The Record of Decision identifies DOE's intent to blend, over time, as much material as possible (up to 85 percent) for commercial use and blending the remainder for disposal as low-level radioactive waste. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996d).

The *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE/EIS-0229, December 1996; Record of Decision, January 1997 [63 FR 43386]) analyzes the environmental impacts of alternatives considered for the long-term storage of weapons-usable fissile materials (highly enriched uranium and plutonium) and for the disposition of weapons-usable plutonium that has been declared surplus to national security needs. The Record of Decision encompasses two categories of plutonium decisions: (1) the sites and facilities for the storage of nonsurplus plutonium and the storage of surplus plutonium pending disposition; and (2) the programmatic strategy for disposition of surplus plutonium. It also announces the decision to store surplus and nonsurplus highly enriched uranium in upgraded facilities at ORR. DOE studies indicated that significant cost savings could be realized from the transfer of nonpit materials from the Rocky Flats Environmental Technology Center and Hanford earlier than indicated in the *Storage and Disposition PEIS* Record of Decision. DOE issued an amended Record of Decision (August 1998) that supports the early closure of the Rocky Flats Environmental Technology Center and the early deactivation of plutonium storage facilities at Hanford. The amended Record of Decision includes decisions to accelerate shipment of all nonpit surplus plutonium from the Rocky Flats Environmental Technology Center to SRS and the relocation of all Hanford surplus plutonium to SRS, if SRS were selected as the immobilization site. A supplement analysis to the *Storage and Disposition PEIS*, the *Supplement Analysis for Storing Plutonium in the Actinide Packaging and Storage Facility and Building 105–K at the Savannah River Site*, was issued in July 1998. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996e).

The *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283, November 1999; Record of Decision, January 2000 [65 FR 1608]) was tiered from the *Storage and Disposition PEIS* and evaluated reasonable alternatives for the siting, construction, and operation of facilities required to implement DOE's disposition strategy for up to 50 metric tons of surplus plutonium. The disposition facilities analyzed in this EIS include a pit disassembly and conversion facility, a plutonium conversion and immobilization facility, and a mixed oxide fuel fabrication facility. The analyses also considered the potential impacts of fabricating a limited number of lead fuel assemblies for testing in a reactor. In the Record of Decision, DOE decided to provide for the safe, secure disposition using a hybrid approach of immobilizing approximately 17 metric tons (19 tons) and using up to 33 metric tons (36 tons) as mixed oxide fuel. DOE also decided to construct and operate each of the three disposition facilities at SRS, fabricate the lead assemblies at LANL, and conduct postirradiation examination of the lead assemblies at ORNL. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999f).

The *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE/EIS-0269, April 1999; Record of Decision, August 1999 [64 FR 43358]) evaluates the environmental impacts of six alternative strategies for the long-term management of DOE-owned depleted uranium hexafluoride currently stored at the East Tennessee Technology Park in Oak Ridge, Tennessee; the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio. These alternatives involve cylinder technology and design; conversion of depleted uranium hexafluoride to another chemical form; and materials use, storage, disposal, and transportation. As indicated in the Record of Decision, DOE selected the Preferred Alternative—to begin conversion of the depleted uranium hexafluoride as soon as possible, either to uranium oxide, uranium metal, or a combination of both, while allowing for future use of as much of this inventory as possible. This NI PEIS analyzes the conversion of depleted uranium hexafluoride from a representative site (Portsmouth) to uranium dioxide, which would be used as feedstock for immobilization and mixed oxide fuel and lead assembly fabrication. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999g).

The *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, September 1996; Record of Decision, December 1996 [61 FR 68014]) evaluates the potential environmental impacts resulting from activities associated with nuclear weapons research, design, development, and testing, as well as the assessment and certification of their safety and reliability. The stewardship portion of the document analyzes the development of three new facilities to provide enhanced experimental capabilities. The stockpile management portion of the EIS concerns producing, maintaining, monitoring, refurbishing, and dismantling the nuclear weapons stockpile at eight sites, including Pantex and SRS. In the Record of Decision, DOE selected to downsize a number of facilities for stockpile dismantlement and to build experimental facilities at Lawrence Livermore National Laboratory. A draft supplement analysis (DOE/EIS-0236-SA, June 1999) was prepared to examine the plausibility of a building-wide fire at LANL's plutonium facility and to examine new studies regarding seismic hazards at LANL. The draft supplement analysis was issued for public comment and a final supplemental analysis was issued on September 2, 1999. The supplement analysis concluded that there is no need to prepare a supplemental EIS. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996f).

The *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE/EIS-0306, July 2000; Record of Decision, September 2000 [65 FR 56565]) evaluates strategies to remove or stabilize the reactive sodium contained in a portion of DOE's spent nuclear fuel inventory to prepare the spent nuclear fuel for disposal in a geologic repository. The EIS analyzes, under the proposed action, six alternatives that employ one or more of the following technology options at nuclear fuel management facilities at SRS or INEEL: electrometallurgical treatment; the plutonium-uranium extraction process; packaging in high-integrity cans; and the melt and dilute treatment process. In the Record of Decision, DOE decided to implement the preferred alternative of electrometallurgically treating the Experimental Breeder-II spent nuclear fuel and miscellaneous small lots of sodium-bonded spent nuclear fuel at Argonne National Laboratory–West at INEEL. Because of the different physical characteristics of the Fermi-1 sodium-bonded blanket spent nuclear fuel also analyzed in the EIS, DOE decided to continue to store this material while alternative treatments are evaluated. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 2000b).

The *Final Environmental Impact Statement (EIS) for Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/EIS-0305-F, June 2000; Record of Decision, August 2000 [65 FR 48683]) evaluates alternatives to construct, operate, and decontaminate and decommission a transuranic waste treatment facility in Oak Ridge, Tennessee. Four types of waste would be treated at the proposed facility including remote-handled transuranic mixed waste sludge, liquid low-level radioactive waste associated with the sludge, contact-handled transuranic/alpha low-level radioactive waste solids, and remote-handled transuranic/alpha low-level radioactive waste solids. The EIS analyzes the potential environmental impacts associated with five alternatives—No Action; the Low-Temperature Drying Alternative, which is DOE's Preferred Alternative; the Vitrification Alternative; the Cementation Alternative; and the Treatment and Waste Storage at ORNL Alternative. In the Record of Decision, DOE selected the preferred alternative of constructing and operating a Transuranic (TRU) Waste Treatment Facility that will use a low-temperature drying process for treating TRU mixed waste sludge and associated low-level waste supernate, and that will treat TRU solid waste by sorting and compacting. Any solid waste containing hazardous constituents regulated under RCRA will be encapsulated. DOE will dispose of the treated TRU waste at the Waste Isolation Pilot Plant near Carlsbad, New Mexico, and treated low-level waste at DOE's Nevada Test Site. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000c).

The *Environmental Assessment of Melton Valley Storage Tanks Capacity Increase Project at the Oak Ridge National Laboratory in Oak Ridge, Tennessee* (DOE/EA-1044, April 1995) evaluates the potential impacts of the construction and maintenance of additional storage capacity at ORNL in Oak Ridge, Tennessee, for liquid low-level radioactive waste. New capacity would be provided by a facility partitioned into six individual tank vaults containing one 100,000-gallon liquid low-level radioactive waste storage tank each. Alternatives considered include the No Action Alternative, ceasing generation, storage at other ORR storage facilities, source treatment, pretreatment, and storage at other DOE facilities. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1995e).

The *Environmental Assessment and FONSI for the Management of Spent Nuclear Fuel on the Oak Ridge Reservation Oak Ridge, Tennessee* (DOE/EA-1117, February 1996) evaluates the potential impacts of the management of spent nuclear fuel on the DOE Oak Ridge Reservation. Spent nuclear fuel would be retrieved from storage; transferred by truck to a hot cell facility, if segregation by fuel type and/or repackaging is required; loaded into containers/transport casks that meet regulatory requirements; and shipped via truck to offsite storage at either SRS or INEEL. The proposed action may also include construction and operation of a dry cask spent nuclear fuel storage facility on ORR to enable reactor operations to continue in the event of an interruption of offsite spent nuclear fuel shipment. In the No Action Alternative, neither construction of a dry cask storage facility nor shipment of spent nuclear fuel from ORR would occur. Spent nuclear fuel would remain at present storage locations on ORR. Due to space limitations, operations on ORR that generate spent nuclear fuel would have to cease, including operation of the High Flux Isotope Reactor. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996g).

The *Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington* (DOE/EIS-0245F, January 1996; Record of Decision, March 1996 [61 FR 10736]) analyzes the potential environmental impacts of alternatives for managing the spent nuclear fuel located in the K-East and K-West spent nuclear fuel storage basins at Hanford. In the Record of Decision, DOE decided to implement the preferred alternative evaluated in the FEIS with two modifications. The preferred alternative consists of removing the spent nuclear fuel from the basins, vacuum drying, conditioning and sealing it in inert-gas filled canisters for dry vault storage in a new facility, to be built at Hanford, for up to 40 years pending decisions on ultimate disposition. The K Basins will continue to be operated during the period over which the preferred alternative is implemented. The preferred alternative also includes transfer of the basin sludge to Hanford's double-shell tanks for management, disposal of non-spent-nuclear-fuel basin debris in a low-level burial ground at Hanford, disposition of the basin water, and deactivation of the basins pending decommissioning. The two modifications to the preferred alternative that were presented in the Record of Decision addressed the management of the sludge, and the timing of placement of the spent nuclear fuel into the transportation casks: (1) should it not be possible to put the sludge into the double-shell tanks, the sludge will either continue to be managed as spent nuclear fuel, or disposed of as solid waste; and (2) to reduce the radiation exposure to workers, the multicanister overpacks will be placed inside the transportation casks before the spent nuclear fuel is loaded into them, instead of loading the spent nuclear fuel into the multicanister overpacks prior to placing them inside the transportation casks. A supplement analysis (DOE/EIS-0245-SA-01, August 1998) was prepared to examine the potential impacts of deleting the hot conditioning/passivation step from the preferred alternative in the ROD. Based on this supplement analysis, DOE determined that there would be minimal changes from the impacts previously identified in the EIS, and therefore no additional NEPA analysis is required. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996h).

The *Environmental Assessment, Management of Hanford Site Non-Defense Production Reactor Spent Nuclear Fuel (*DOE/EA-1185, March 1997; FONSI, March 1997) assesses the environmental impacts associated with the management of nondefense production reactor spent nuclear fuel at Hanford, and associated activities to support this work. Under the proposed action, DOE would consolidate the site's inventory of this material, stored in various facilities throughout the site, in a cost-effective, radiologically and industrially safe and passive storage condition, pending final disposition. Alternatives considered in the review process included the No Action alternative; the preferred alternative to consolidate Hanford's inventory of nondefense production reactor spent nuclear fuel in aboveground and vault storage in the 200 Area; and alternatives addressing aboveground dry cask storage in the 400 Area and vault storage in the 200 Area. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1997b).

The *Environmental Assessment for Transportation of Low-Level Radioactive Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1315, April 2000) evaluates the potential impacts of the transportation of low-level radioactive waste from ORR in Tennessee for treatment or disposal at various locations in the United States. Low-level radioactive waste from three ORR facilities, ORNL, Oak Ridge Y–12 Plant, and East Tennessee Technology Park, is proposed to be loaded and transported to destinations representative of other DOE sites and licensed commercial nuclear waste treatment or disposal facilities. The treatment and/or disposal facilities include Envirocare of Utah, Inc.; Waste Control Specialists; commercial treatment or disposal facilities near SRS in Aiken, South Carolina; commercial facilities near ORR; commercial facilities near Hanford; and facilities at DOE sites such as the Nevada Test Site, the Hanford Reservation, and SRS. In the No Action Alternative, DOE would not ship and dispose of the existing and projected large quantities of ORR low-level radioactive waste at offsite radioactive waste disposal facilities. Relatively small volumes of ORR low-level radioactive waste would continue to be shipped to DOE or commercial disposal facilities under existing and previously approved categorical exclusions. Low-level radioactive waste would continue to be stored on the ORR site, eventually requiring additional low-level radioactive waste storage facilities. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000d).

The *Environmental Assessment for Selection and Operation of the Proposed Field Research Centers for the Natural and Accelerated Bioremediation Research (NABIR) Program* (DOE/EA-1196, March 2000; FONSI, April 2000) evaluates the potential impacts of adding a Field Research Center component to the existing NABIR Program. The NABIR Program is a 10-year fundamental research program designed to increase the understanding of fundamental biogeochemical processes that would allow the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites. The Field Research Center would be integrated with the existing and future laboratory and field research and would provide a means of examining the fundamental biogeochemical processes that influence bioremediation under controlled small-scale field conditions. The environmental assessment analyzes the No Action Alternative and two alternative sites under the proposed action: ORNL/Y–12 Site, Oak Ridge, Tennessee, and Pacific Northwest National Laboratory/ DOE Hanford 100-H Area, Richland, Washington. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000e).

The *Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement* (DOE/EIS-0287D, December 1999) analyzes the potential environmental consequences of managing two waste types at INEEL. The two waste types are high-level radioactive waste in a calcine form and liquid mixed transuranic waste, historically known as sodium-bearing waste and newly generated liquid waste. The disposition of existing and proposed high-level radioactive waste facilities after their missions have been completed is also analyzed. The waste processing alternatives are No Action, Continued Current Operations, Separations, Non-Separations, and Minimum INEEL Processing. The facilities' disposition alternatives are No Action, Clean Closure, Performance-Based Closure, Closure to Landfill Standards, Performance-Based Closure with Class A Grout Disposal, and Performance-Based Closure with Class C Grout Disposal. The impacts of the proposed action are factored into the assessment of potential impacts resulting from the NI PEIS proposed action (DOE 1999h).

The *Draft Environmental Assessment for Transportation of Low-Level Radioactive Mixed Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1317, July 2000) evaluates the potential impacts of transportation of low-level radioactive mixed waste from Oak Ridge, Tennessee, to treatment and disposal facilities in various locations in the United States. Low-level radioactive mixed waste from three ORR facilities, East Tennessee Technology Park, ORNL, and the Y–12 Plant, is proposed to be packaged as required, loaded, and shipped to licensed, commercial nuclear waste treatment or disposal facilities. The treatment and/or disposal facilities include Envirocare of Utah, Inc.; Waste Control Specialists; Nevada Test Site; and commercial treatment or disposal facilities near SRS in Aiken, South Carolina, ORR, and the Hanford Site in Richland, Washington. The No Action Alternative of continuing to store most low-level radioactive mixed waste on site, and eventually requiring additional low-level radioactive mixed waste storage facilities is also analyzed. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 2000f).

1.8 CHANGES FROM THE DRAFT NI PEIS

In response to comments on the Draft NI PEIS and as a result of information that was unavailable at the time of its issuance, this Final NI PEIS contains revisions and new information. These revisions and new information are indicated by sidebars. A brief discussion of the most important changes included in this Final NI PEIS is provided in the following paragraphs.

Chapter 1

Purpose and Need for Agency Action

As a result of public comments, additional discussion was incorporated to address DOE's production of medical, research, and industrial isotopes relative to global isotope production and availability. In addition, the discussion of the need for plutonium-238 production for space missions was expanded and updated to reflect the most recent planning guidance provided by NASA to DOE.

Issues Raised During the Public Comment Period on the Draft NI PEIS

Section 1.5, Issues Raised During the Public Comment Period on the Draft NI PEIS, was added to this Final NI PEIS.

Related NEPA Reviews

The Final NI PEIS was revised to add descriptions of the *Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington* (DOE/EIS-0245F), and the *Environmental Assessment, Management of Hanford Site Non-Defense Production Reactor Spent Nuclear Fuel (*DOE/EA-1185). The impacts of these NEPA actions were factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action.

This Final NI PEIS was also revised to reflect recent Records of Decision that have been issued for the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218F), the *Final Environmental Impact Statement for Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory Oak Ridge, Tennessee* (DOE/EIS-0305), and the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE/EIS-0306).

Changes from the Draft NI PEIS

Section 1.8, Changes from the Draft NI PEIS, was added to this Final NI PEIS.

Chapter 2

Transportation Requirements

Additional U.S. ports were named as candidates for receiving mixed oxide fuel from Europe.

Alternatives Considered and Dismissed

Information was provided to explain why the Isotope Production Facility at LANL, the Brookhaven LINAC Isotope Producer and the Alternating Gradient Synchrotron accelerator complex at Brookhaven National Laboratory, and CLWRs were not considered reasonable alternatives for the production of medical isotopes.

Information was also provided to explain why increasing the power levels at ATR and/or HFIR or installing rapid radioisotope retrieval systems would be insufficient to meet the long-term growth projection needs and therefore were dismissed as reasonable alternatives.

Preferred Alternative

The discussion of DOE's preferred alternative for accomplishing the proposed action, i.e., Alternative 2, Use Only Existing Operational Facilities, Option 7, is included in this Final NI PEIS.

Summary of Environmental Impacts

Section 2.7 was revised in response to comments that it was difficult to compare environmental impacts among alternatives. Although estimates of the environmental impacts that would result from implementation of the alternatives are the same as those in the Draft NI PEIS, the tables and accompanying text were reformatted for ease in comparing environmental impacts among alternatives and among options within alternatives. Section 2.7 was also revised to focus on incremental impacts that would result from implementation of the alternatives. Baseline environmental impacts were removed from the comparisons among alternatives and options. This information is now presented in Chapter 3.

Chapter 3

Affected Environment

Additional information was provided on the environmental baseline at each site, including graphics to more clearly illustrate existing surface water and groundwater conditions. Estimates of existing impacts for current HFIR/REDC operations were added to Sections 3.2.3.2 (Air Quality), 3.2.9.1.2 (Radiation Exposure and Risk), and 3.2.11.1 (Waste Inventories and Activities). Similarly, estimates for current ATR operations were added to Sections 3.3.3.2 (Air Quality), 3.3.9.1.2 (Radiation Exposure and Risk), and 3.3.11.1 (Waste Inventories and Activities). Estimates of existing impacts of maintaining FFTF in standby were added to Section 3.4.3.1 (Air Quality). Information was also provided on the impacts of the range fires affecting Hanford and INEEL during the summer of 2000. In addition, site data were updated to reflect recent measurements and analyses.

In response to public comments on the Draft NI PEIS, additional information on health studies conducted in the Hanford area was also incorporated.

Chapter 4

Air Quality

Stack parameters used for the air quality modeling were added. In response to public comment, estimates of the ambient air quality concentrations from FFTF sources were added to the deactivation section.

Water Resources

New water use and sanitary wastewater generation increments for REDC and FDPF were added to reflect the revised additional workforce required at these facilities and to be consistent with FMEF. Water use and wastewater generation rates for the new accelerator(s) and new research reactor alternatives were also revised. These changes were also incorporated into the waste management analyses.

Ecological and Cultural and Palentological Resources

These sections were updated to reflect that consultations concerning threatened and endangered species and cultural resources were conducted with appropriate Federal and state agencies. Consultations were also conducted with interested Native American tribes. No major issues were raised as a result of these consultations.

Socioeconomics

Section 4.3.1.1.8 was revised to reflect changes in the number of workers associated with FFTF operations and deactivation. The associated impacts on community services were also incorporated. In addition, the number of workers at the Oak Ridge Reservation was revised to reflect the entire site workforce rather than just the number of workers at the Oak Ridge National Laboratory.

Normal Operations

Based on more recent site data on occupational radiation exposure for workers at REDC, all worker health impacts for target processing at REDC, FMEF, and FDPF and for neptunium target storage at REDC, Chemical Processing Plant–651, and FMEF were updated. Also, low-energy accelerator source terms were modified to properly reflect normal operational emissions resulting in modifications to the population health impacts for all options of Alternative 3.

Facility Accidents

The high-energy accelerator analysis was redone to incorporate a more accurate revised source term, and the incremental risks for currently operating reactors were added to the tables. An additional analysis addressing industrial accidents was also performed and incorporated into Chapter 4.

Transportation

The neptunium inventory was revised to use the recently declassified actual inventory. The number of actual shipments from SRS to the processing facilities and the transportation risk estimates were modified accordingly.

Waste Management

The analysis for the Draft NI PEIS assumed that the waste generated from the processing of irradiated neptunium-237 targets is transuranic waste. However, as a result of comments received during the public comment period, DOE is considering whether the waste from processing of irradiated neptunium-237 targets should be classified as high-level radioactive waste and not transuranic waste. The Waste Management sections (i.e., Sections 4.3.1.1.13, 4.3.2.1.13, 4.3.3.1.13, and 4.4.3.1.13) were revised to reflect this different classification from what was assumed in the Draft NI PEIS.

Spent Nuclear Fuel Management

These sections were revised to quantify the generation of spent fuel from 35 years of operation and to state that dry spent nuclear fuel storage at the FFTF site is similar to NRC-approved methods currently being used for interim storage of commercial spent nuclear fuel. In addition, based on public comments, reference was added about the K Basins spent fuel storage.

Cumulative Impacts

Cumulative impact tables in Section 4.8 were revised to present the contributions from each of the various site actions anticipated during the course of the operational period evaluated in this NI PEIS.

The air quality tables were also revised to incorporate the revised baseline from Chapter 3. In addition, waste management tables were revised to include the sites' treatment, storage, and disposal capacities for easier comparison of the waste generations by waste type to the waste management capacities at the sites.

Chapter 5

In response to public comments, a list of organizations that DOE contacted during the consultation process was added.

Volume 2

Summaries of the *NI Cost Report* and *NI Nonproliferation Impact Assessment* were added as Appendixes P and Q, respectively. NASA mission guidance correspondence was added as Appendix R.

Volume 3

Volume 3 of the NI PEIS was added to present the comments received during the public review period for the Draft NI PEIS and DOE's responses to these comments.

1.9 STRUCTURE OF THIS NI PEIS

This NI PEIS contains 9 chapters and 18 appendixes. The main analyses are included in the chapters in Volume 1, with additional project information provided in the appendixes in Volume 2. Comments received during the public comment period and DOE's associated responses are presented in Volume 3. A Summary of this NI PEIS is also included.

The nine chapters provide the following information:

Chapter 1—Introduction: Background; purpose and need for agency action; decisions to be made; issues identified during the public scoping process; issues raised during the public comment period on the Draft NI PEIS; alternatives evaluated; related NEPA documents; and changes from the Draft NI PEIS

Chapter 2—Program Description and Alternatives: Program missions; candidate facilities and proposed options to enhance U.S. nuclear infrastructure and provide the capabilities needed to meet DOE's mission requirements; operations required to implement DOE program missions and the candidate sites and facilities for these activities; transportation activities associated with the program missions; alternatives considered reasonable for detailed evaluation; alternatives and facilities considered and dismissed from evaluation; a summary of the environmental impacts; implementation schedules associated with the alternatives evaluated; a comparative evaluation of alternatives; and the description of the Preferred Alternative.

Chapter 3—Affected Environment: Aspects of the environment that could be affected by the NI PEIS alternatives

Chapter 4—Environmental Consequences: Analyses of the potential impacts of the NI PEIS alternatives on the environment

Chapter 5—Applicable Laws, Regulations, and Other Requirements: Environmental, safety, and health regulations that would apply to the alternatives of this NI PEIS, and agencies consulted for their expertise

Chapter 6—List of Preparers

Chapter 7—Distribution List

Chapter 8—Glossary

Chapter 9—Index

The 18 appendixes provide the following information:

Appendix A—Plutonium-238 Target Fabrication and Processing Operations

Appendix B—Neptunium-237 Target Irradiation Operations in Currently Operating Reactors for Plutonium-238 Production

Appendix C—Medical and Industrial Isotope Target Fabrication and Processing Operations and Civilian Nuclear Research and Development Targets

Appendix D—Fast Flux Test Facility Operations

Appendix E—Research Reactor Operations

Appendix F—New Accelerator(s)

Appendix G—Methods for Assessing Environmental Impacts

Appendix H—Evaluation of Human Health Effects from Normal Facility Operations

Appendix I—Evaluation of Human Health Effects from Facility Accidents

Appendix J—Evaluation of Human Health Effects of Transportation

Appendix K—Environmental Justice Analysis

Appendix L—Socioeconomics Analysis

Appendix M—Ecological Resources

Appendix N—Public Scoping Process

Appendix O—Contractor Disclosure Statement

Appendix P—*Nuclear Infrastructure Cost Report* Summary

Appendix Q—*Nuclear Infrastructure Nonproliferation Impact Assessment* Summary

Appendix R—NASA Mission Planning Correspondence

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