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**Department of Energy Programmatic
Spent Nuclear Fuel Management
and
Idaho National Engineering Laboratory
Environmental Restoration and
Waste Management Programs
Draft Environmental Impact Statement**

**Volume 1
Appendix D
Part A**

Naval Spent Nuclear Fuel Management

June 1994

**U.S. Department of Energy
Office of Environmental Management
Idaho Operations Office**

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**Appendix D
to Volume 1 of
Department of Energy
Programmatic Spent Nuclear Fuel Management
and
Idaho National Engineering Laboratory
Environmental Restoration and
Waste Management Programs
Environmental Impact Statement

Naval Spent Nuclear Fuel Management**

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SUMMARY

INTRODUCTION

Volume 1 to the Department of Energy's Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Management Programs Environmental Impact Statement evaluates a range of alternatives for managing naval spent nuclear fuel expected to be removed from U.S. Navy nuclear-powered vessels and prototype reactors through the year 2035. The Environmental Impact Statement (EIS) considers a range of alternatives for examining and storing naval spent nuclear fuel, including alternatives that terminate examination and involve storage close to the refueling or defueling site. The EIS covers the potential environmental impacts of each alternative, as well as cost impacts and impacts to the Naval Nuclear Propulsion Program mission.

This Appendix covers aspects of the alternatives that involve managing naval spent nuclear fuel at four naval shipyards and the Naval Nuclear Propulsion Program Kesselring Site in West Milton, New York. This Appendix also covers the impacts of alternatives that involve examining naval spent nuclear fuel at the Expanded Core Facility in Idaho and the potential impacts of constructing and operating an inspection facility at any of the Department of Energy (DOE) facilities considered in the EIS. This Appendix also considers the impacts of the alternative involving limited spent nuclear fuel examinations at Puget Sound Naval Shipyard. This Appendix does not address the impacts associated with storing naval spent nuclear fuel after it has been inspected and transferred to DOE facilities. These impacts are addressed in separate appendices for each DOE site.

BACKGROUND

The Naval Nuclear Propulsion Program is a joint U.S. Navy and DOE program responsible for all matters pertaining to naval nuclear propulsion. The Program is responsible for the nuclear propulsion plants aboard over 120 nuclear-powered warships powered by over 140 naval reactors and for nuclear propulsion work performed at six naval shipyards and two private shipyards. Removal of spent nuclear fuel from ships is ending at two of those shipyards as a result of recent decisions on base closures, and nuclear propulsion work at one of the private shipyards has not involved handling spent nuclear fuel for more than 15 years. The Program is also responsible for two government-owned, contractor-operated laboratories, two moored training ships, three land-based prototype

reactors, and the Expended Core Facility located at the Naval Reactors Facility. The Naval Reactors Facility is located at the Idaho National Engineering Laboratory (INEL).

NAVAL SPENT NUCLEAR FUEL MANAGEMENT

Naval spent nuclear fuel is the fuel removed from naval nuclear propulsion plants. Naval fuel is designed to meet the demanding requirements needed to support long-term operation in a warship. To meet these requirements, it is designed to withstand battle shock and to retain its radioactivity so as to minimize radiation dose to the ships' operating personnel who must live and work in close proximity to the reactor. Even after decades of service, the spent nuclear fuel retains its strength and high integrity.

For nearly 40 years, naval spent nuclear fuel has been shipped by rail in shielded shipping containers from naval shipyards and prototypes to the Expended Core Facility in Idaho where it is removed from the shipping containers and placed into water pools at the Expended Core Facility. All fuel is examined for specific characteristics and for abnormalities. Selected fuel is given more detailed examination. Naval fuel examinations provide assurance that operations of shipboard reactors can continue without restriction. These examinations have significantly contributed to the longer core lives and continued safe performance of current naval reactor designs. This work has also resulted in substantial reduction in the amount of spent nuclear fuel generated by the Naval Nuclear Propulsion Program.

DESCRIPTION OF ALTERNATIVES

The EIS considers five general alternatives for spent nuclear fuel management. The general alternatives are described in Chapter 3 of Volume 1. Naval spent nuclear fuel would be managed under each of these general alternatives as follows.

No Action

Naval reactors would be refueled and defueled as planned. Naval spent nuclear fuel would be stored in transport casks at the Navy or DOE facility where defueling was conducted. (Fuel generated from ships at Newport News Shipbuilding would be transferred to Norfolk Naval Shipyard.) No further spent nuclear fuel examination would be conducted. This alternative would

require a phase-in period while additional containers are procured for spent nuclear fuel storage. During an approximately 3-year period, spent nuclear fuel would be transported in shipping containers to the Expended Core Facility in Idaho. The containers would be unloaded and used to support additional refuelings and defuelings.

Decentralization

For naval spent nuclear fuel, three options are considered. Each option would require a phase-in period while facilities are developed. The length of the phase-in period would depend on the option and mode of storage selected. During the phase-in period, spent nuclear fuel would be transported in shipping containers to the Expended Core Facility in Idaho. The containers would be unloaded and used to support additional refuelings and defuelings.

a. Store naval spent nuclear fuel at the Navy or DOE facility where defueling is conducted. (Fuel generated from ships at Newport News Shipbuilding would be transferred to Norfolk Naval Shipyard.) At each storage location, dry storage in shipping containers and dry casks as well as wet storage in a water pool facility are considered.

b. Modify the existing water pool facility at Puget Sound Naval Shipyard to conduct the maximum practical amount of naval spent nuclear fuel examinations at that site. Store naval spent nuclear fuel at the Navy or DOE facility where defueling is conducted. (Fuel generated from ships at Newport News Shipbuilding would be transferred to Norfolk Naval Shipyard.) At each storage location, dry storage in shipping containers and dry casks as well as wet storage in a water pool facility are considered.

c. Ship naval spent nuclear fuel to the Expended Core Facility for examination, then return the fuel after examination to the Navy or DOE facility where defueling is conducted. (Fuel generated from ships at Newport News Shipbuilding would be transferred to Norfolk Naval Shipyard.) At each storage location, dry storage in shipping containers and dry casks as well as wet storage in a water pool facility are considered.

1992/1993 Planning Basis

The historic practice of transporting all spent nuclear fuel removed from naval reactors to the Expanded Core Facility in Idaho for examination would resume. Following examination, fuel would be transferred to DOE for management at the Idaho Chemical Processing Plant pending final disposition.

Regionalization

The overall Regionalization alternative includes two options. The first option involves managing spent nuclear fuel at three DOE sites (Hanford Site, the INEL, and the Savannah River Site) based on fuel type. Under this option, the historical practice of transporting spent nuclear fuel removed from naval reactors to the Expanded Core Facility in Idaho for examination would resume. Following examination, fuel would be transferred to DOE for management at the Idaho Chemical Processing Plant pending final disposition.

The second overall option involves managing spent nuclear fuel at a Western Regional Site and an Eastern Regional Site, based primarily on the originating location of the fuel. Under this option, naval fuel would be allocated to one site, either the western or the eastern site, for examination and storage. This Appendix evaluates the potential impacts of examining naval spent nuclear fuel at all of the potential sites.

Centralization

The Centralization alternative would collect all of the DOE's current and future spent nuclear fuel at one DOE site. The Hanford Site, the INEL, the Nevada Test Site, the Oak Ridge Reservation, and the Savannah River Site have been considered as candidates for this single site. If the INEL were selected, then naval spent nuclear fuel would be examined at the Expanded Core Facility and would be stored at the Idaho Chemical Processing Plant. If a site other than INEL were selected, then the Expanded Core Facility would be shut down and a new or modified facility for examination and additional storage facilities would be constructed at the selected site.

SITES CONSIDERED FOR NAVAL SPENT NUCLEAR FUEL MANAGEMENT

Naval Shipyards and Prototypes - The EIS evaluates four naval shipyards, Puget Sound Naval Shipyard at Bremerton, Washington; Norfolk Naval Shipyard at Portsmouth, Virginia; Portsmouth Naval Shipyard at Kittery, Maine; and Pearl Harbor Naval Shipyard at Pearl Harbor, Hawaii, for management of naval spent nuclear fuel only. The EIS also evaluates the Kenneth A. Kesselring Prototype Site at West Milton, New York. The four shipyard locations are industrial in nature and located near harbor areas. The Kesselring Site is a 3900-acre facility located in the mid-eastern sector of New York State in a wooded rural environment.

Idaho National Engineering Laboratory - This is the location of the Naval Reactors Facility which is also the present location of the Expanded Core Facility. It is located in southeastern Idaho and occupies about 890 square miles of desert. The Idaho National Engineering Laboratory is presently used for industrial and support operations associated with energy research and waste management activities, grazing, recreational uses, and environmental research. It is remote from urban areas and occupies a controlled federal reservation which is largely undisturbed from its natural state.

Savannah River Site - The Savannah River Site in South Carolina is the location of one of the Department of Energy's weapons production sites. The P, K, and L Reactors at this location produced plutonium and tritium in support of the nation's nuclear weapons program. The Savannah River Site is located in the eastern United States and is in a heavily wooded environment which is returning to a more natural state from its previous agricultural uses. It is 310 square miles in area.

Hanford Site - The Hanford Site in the State of Washington is the location of one of the Department of Energy's weapons production sites. The N-Reactor at this site was used by the DOE through the years for the production of plutonium in support of the nation's nuclear weapons program. The Hanford Site is in the western United States on open, vacant desert land. It is 560 square miles in area which is largely undisturbed from its original state.

Oak Ridge Reservation - The Oak Ridge Reservation in Tennessee is the location of one of the Department of Energy's facilities which was primarily used to support the nation's nuclear weapons program. The Y-12 Plant at this location was used for processing highly enriched uranium for fuel elements used in the Savannah River reactors. The Oak Ridge Reservation is located in the

eastern United States and is in a heavily wooded environment. It is 55 square miles in area, and consists of three industrialized areas separated by undeveloped forest land.

Nevada Test Site - The Nevada Test Site in Nevada has been a location for performing nuclear weapons testing. This site has been used by the DOE for activities in support of the national nuclear weapons program. The Nevada Test Site is in the western United States and is located in open, vacant desert land. It is 1350 square miles in area.

ANALYSES

This EIS evaluates the potential environmental impact of each alternative, including both the construction of new facilities and management operations at those facilities (transport, receipt, handling, examination, and storage of naval spent nuclear fuel). In general, accident analyses focus on accidents which have the probability to occur at least once every 10 million years. The range of accidents considered includes those resulting from human errors or mechanical failure such as airplane crashes into storage facilities and improper spent nuclear fuel handling, as well as natural disasters such as earthquakes and tornadoes. Both radiological and non-radiological impacts were considered. The cumulative impacts of spent nuclear fuel management and other operations at these facilities have also been evaluated.

RESULTS AND COMPARISON OF ALTERNATIVES

Implementation of some of the alternatives would require construction or modification of facilities for storage of naval spent nuclear fuel at naval sites or a replacement for the Expended Core Facility at a DOE site. The locations for any new facilities would be selected from space already available on existing federally owned property, so no additional land would be withdrawn from public use at any site. The only exception to this might occur if the Barnwell Nuclear Fuel Plant at Savannah River were to be purchased and removed from the public domain. New facility locations would be chosen to avoid impacts on the cultural, archaeological, aesthetic, or scenic values of the area and to ensure that the rights or interests of Native American or Native Hawaiian groups would not be infringed. No site listed in the National Register of Historic Places would be affected. Ecologically sensitive areas, such as those in the vicinity of any threatened or endangered species, would be avoided. Construction activities associated with any naval spent nuclear fuel storage or examination facility would comply with all applicable laws and regulations, using established

procedures for preserving air and water quality and previously unknown archaeological or cultural artifacts encountered and for minimizing such impacts as noise and disturbance or destruction of habitat.

No new naval spent nuclear fuel storage or examination facility would release water carrying radioactive or hazardous material to the environment. In 40 years of receipt, transportation, handling, and examination of naval spent nuclear fuel, the Naval Nuclear Propulsion Program has never had a release of radioactivity that has had a significant effect on the environment. Based on the operations that would be performed and the controls that would be in place, the impacts on air, water, ecological, or geological resources of any naval facility considered would be negligible. Furthermore, experience has shown that since naval spent nuclear fuel management is a low-intensity industrial activity, its contributions to noise and traffic would be inconsequential and its utility needs would generally be within the capabilities of the candidate sites. The Hanford Site and Nevada Test Site are possible exceptions to this because they are already operating at or near their electrical utility capacities and may require additional capacity to accommodate a new Expanded Core Facility.

In the unlikely event of any accident involving naval spent nuclear fuel, it is estimated that no more than 210 acres of land would be affected for the most severe case, and in the other accidents analyzed, smaller areas of land would be affected. The affected area would require decontamination and during this cleanup, access controls would have to be established. However, due to the limited land area affected, it is judged that these restrictions would only be temporary and the impact on issues such as economics, treaty rights, tribal resources, ecology, and land use would be small and limited in time. The remediation actions would be simpler in rural areas than in urban areas, but, provided that prudent controls and remediation operations were promptly implemented, the affected land and buildings could be recovered in either case. As demonstrated in the accident analyses in this appendix, the human health effects would not be large and the effects on wildlife and other biota would also not be large, partly due to the relatively small area affected and partly because of the limited effects of the accident.

The radiological and non-radiological impacts of all the alternatives considered would be small. After consideration of the full range of environmental impacts and other effects associated with the management of naval spent nuclear fuel, it is judged that for all of the alternatives considered, the impacts on the ecology, cultural and aesthetic values, air and water resources, geology, and such areas as noise, traffic, and utilities, normally associated with most daily activities,

would be so small and differ so little among alternatives for naval spent nuclear fuel that they would be of little assistance in differentiating among the alternatives.

The areas of impact which are of special interest to the public or which provide the most distinct contrasts among the alternatives are public health, socioeconomics, cost, and the Naval Nuclear Propulsion Program mission.

Public Health Impacts

A primary concern for most people is the risk to the public from exposure to radiation or radioactive material for each of the alternatives. The exposure could be a result of normal operations or an accident. A practical method often used to characterize the public risk resulting from federal actions such as these is to estimate the number of prompt fatalities or cancer fatalities that might result.

The analyses in this EIS show that there would be no prompt fatalities from the radiation exposure associated with accidents (or normal operations) for any of the alternatives considered and that there would be no latent cancer fatalities under any of the alternatives. However, for the No Action and Decentralization alternatives, under which naval spent nuclear fuel would be stored at a naval shipyard, the risks to a member of the public would be higher than for other alternatives.

Figure S-1 provides an overall comparison of the alternatives in terms of the calculated increase in the number of cancer fatalities that might occur in the general population over 40 years of operation for each alternative. It is important to emphasize that these cancer fatalities are calculated results rather than actual expected fatalities. This is because the expected number of such fatalities during normal operations is so small as to be indistinguishable relative to the larger number of such deaths expected from naturally occurring conditions and other man-made effects not related to naval spent nuclear fuel operations. This is not meant to trivialize the importance of radiation-induced cancer fatalities but, rather, is meant to put the issue in perspective. In all the alternatives, thousands of years of facility operation and transportation of naval spent nuclear fuel would be required before a single additional fatal cancer might be expected to occur. To provide some perspective, the naturally occurring radioactive materials in fertilizer used to produce food crops contribute about 1 to 2 millirem per year to an average American's exposure to radiation. Using the same calculational method used to determine the cancer fatality risk for the Naval Nuclear Propulsion Program

* The risk of cancer fatalities varies under the decentralization alternative depending on the mode of storage. The greatest risk occurs when using wet storage in water pools. The smallest risk occurs during dry storage in shipping containers or storage casks.

Figure S-1. Risk from normal operations by alternative (fatal cancers to the general population over 40 years from facility operations and transportation).

alternatives, the exposures from consuming food grown with fertilizer result in 125 to 250 cancer fatalities annually in the United States.

The most severe risks for a facility accident were determined to be from an airplane crash into a dry storage container at the Pearl Harbor Naval Shipyard. This accident was calculated to result in 26 cancer fatalities and had a probability of occurring about once every 100,000 years. This accident has been calculated to produce a risk of less than 0.0003 additional cancer fatalities per year. The risks from all other accidents associated with examination or storage of naval spent nuclear fuel were much less than this. In general, the risks from facility accidents tended to be worse for the No Action and Decentralization alternatives, because for these alternatives fuel would be stored at sites which are located close to large population centers. For transportation accidents, the potential risks varied with the distances to be traveled, being least for the No Action and the Decentralization - No Examination alternatives which would involve transportation over short distances to storage locations near where the fuel is removed from reactors.

Socioeconomic and Cost Impacts

The socioeconomic impacts of implementing each of the alternatives would differ somewhat and are summarized in Table S-1. The primary socioeconomic impact of the alternatives considered would be on employment. Nation-wide employment levels would not vary significantly among alternatives for managing naval spent nuclear fuel and therefore do not provide a basis to distinguish among the alternatives. The maximum impact on local employment levels would be caused by alternatives requiring development of new naval spent nuclear fuel examination capability at a DOE facility other than INEL while terminating these activities at INEL. Continuing current practices of transporting naval spent nuclear fuel to the Expanded Core Facility at INEL for examination followed by transfer to the DOE for storage would result in the minimum disruption of employment levels.

As shown in Figure S-2, there are large differences in the costs associated with all alternatives. These costs include the costs that would be incurred from construction of new facilities and containers, naval spent nuclear fuel transportation, and facility operation. In general, lower costs are associated with those alternatives that support examination of naval spent nuclear fuel with existing facilities and those alternatives that terminate or severely curtail spent nuclear fuel examination. The higher costs are associated with those alternatives that require construction of a new Expanded Core Facility and those alternatives that use shipping containers for storage.

Table S-1. Summary of potential socioeconomic impacts.

Alternative	Long-term Impacts at INEL	Long-term Impacts at Other Sites
1. No Action	Lose 500 jobs	Add 50-100 jobs at naval sites
2. Decentralization		
- No Examination	Lose 500 jobs	Add 50-200 jobs at naval sites
- Limited Examination	Lose 500 jobs	Add 110-260 jobs at naval sites
- Full Examination	No change	Add 50-200 jobs at naval sites
3. 1992/1993 Planning Basis	No change	No change
4/5. Regionalization or Centralization		
- Idaho National Engineering Laboratory	No change	No change
- Hanford Site	Lose 500 jobs	Add 500 permanent jobs and some construction jobs at Hanford
- Savannah River Site	Lose 500 jobs	Add 500 permanent jobs and some construction jobs at Savannah River
- Nevada Test Site	Lose 500 jobs	Add 500 permanent jobs and some construction jobs at NTS
- Oak Ridge Reservation	Lose 500 jobs	Add 500 permanent jobs and some construction jobs at ORR

* The cost varies under the decentralization alternative depending on the mode of storage. The most expensive options are those that use shipping containers for storage; the least expensive options are those that use immobile dry storage containers.

Figure S-2. Summary of costs by alternative (facility and transportation costs over 40 years).

Mission Impacts

Two important components of Naval Nuclear Propulsion Program operations are the safe management of naval spent nuclear fuel and support of the Navy's fleet of nuclear-powered warships. Based on the analyses in this EIS, all alternatives considered would allow safe storage of naval spent nuclear fuel until a permanent repository becomes available. However, some of the alternatives would not provide equal levels of Fleet support. Alternatives which limit or terminate naval spent nuclear fuel examination would severely impact ongoing research and development work. Naval spent nuclear fuel examination results are used to confirm the adequacy of design features, explore material performance, and confirm or adjust computer predictions of fuel performance. This information contributes to the design and manufacturing of new naval reactor cores as well as the safe operation of nuclear-powered warships. Of the alternatives allowing full examination at the INEL, Hanford Site, Savannah River Site, Oak Ridge Reservation, or Nevada Test Site, examination at the INEL would have the smallest mission impact due to the presence of existing facilities and equipment for performing this work, and the presence of a highly skilled work force, all of which would need to be relocated or reassembled if a new examination site were selected.

CONCLUSION - PREFERRED ALTERNATIVE

The Navy's preferred alternative for the management of naval spent nuclear fuel would continue the historic, technically sound and safe practice of conducting refueling and defueling of nuclear-powered warships and prototypes as planned, transporting naval spent nuclear fuel to the Expanded Core Facility at INEL for full inspection and examination, and transferring naval spent nuclear fuel to the DOE facility for storage pending availability of a method for permanent disposition. This preferred alternative is based on consideration of environmental, socioeconomic, cost, and mission impacts of each alternative.

The analyses contained in this EIS demonstrate that the environmental impacts of implementing any of the alternatives would be very small for normal operations and accident conditions. The analysis results do not provide a basis to distinguish among the alternatives in most of these areas. The socioeconomic impacts of the alternatives also do not provide a basis to distinguish among the alternatives.

The Navy's preferred alternative is, therefore, based on impact to the Navy's mission and on cost. Alternatives that limit or terminate naval spent nuclear fuel examination would adversely affect Fleet support and the development of new naval reactors. Primarily because of the existing infrastructure, examination followed by storage at INEL would best support the Naval Nuclear Propulsion Program mission and would be the least cost alternative allowing for full examination of naval spent nuclear fuel.

The alternatives which involve the Navy's preferred alternative are: 1992/1993 Planning Basis alternative and the Regionalization and Centralization alternatives that include the use of the Expended Core Facility at INEL.

1. INTRODUCTION

This appendix describes the alternatives which have been evaluated for the examination and storage of spent nuclear fuel from U. S. naval nuclear shipboard and prototype reactors. The spent fuel is removed during reactor refuelings and defuelings at naval and commercial shipyards and at the prototype sites. The alternatives include a range of options for managing naval spent fuel through the year 2035. The options for spent fuel examination include ceasing all examinations, examining a limited amount of fuel at a naval shipyard, and performing a full range of examinations at the current facility (Idaho National Engineering Laboratory) or at another Department of Energy (DOE) facility. The options for naval spent fuel storage include storage at the refueling and defueling sites (in some cases, it is necessary to move the fuel to the closest acceptable Navy shipyard), storage at the current facility, or storage at another DOE facility. Spent fuel transportation aspects will depend on the examination and storage alternatives selected.

Naval spent fuel examination, whether at a naval or DOE site, will remain the responsibility of the Naval Nuclear Propulsion Program. This appendix therefore addresses the environmental impacts of naval spent fuel examination. This appendix also addresses the environmental impacts of long-term storage of spent fuel at naval shipyards and prototype sites. The environmental impacts of long-term spent fuel storage at DOE facilities are addressed in the Environmental Impact Statement appendices applicable to those sites.

2. BACKGROUND

2.1 NAVAL NUCLEAR PROPULSION PROGRAM OVERVIEW

The Naval Nuclear Propulsion Program is a joint Navy/Department of Energy (DOE) organization responsible for all matters pertaining to naval nuclear propulsion pursuant to Presidential Executive Order 12344, enacted as permanent law by Public Law 98-525 (42 USC 7158). The Program is responsible for:

- a. The nuclear propulsion plants aboard over 120 warships powered by over 140 naval reactors.
- b. Moored Training Ships located in Charleston, South Carolina used for naval nuclear propulsion plant operator training.
- c. Nuclear propulsion work performed at eight shipyards (six public and two private).
- d. Two DOE government-owned, contractor-operated laboratories devoted solely to naval nuclear propulsion research, development, and design work.
- e. Three land-based prototype naval reactors used for research and development work and training of naval nuclear propulsion plant operators.
- f. The Expanded Core Facility, located at the Naval Reactors Facility which is a part of the Idaho National Engineering Laboratory.

More detailed discussion is available in the references listed in Section 2.5 (DOE/DOD 1993; Duncan 1990; Hewlett and Duncan 1974).

2.2 HISTORY AND MISSION OF THE PROGRAM

In 1946, at the conclusion of World War II, Congress passed the Atomic Energy Act, which established the Atomic Energy Commission (AEC) to succeed the wartime Manhattan Project, and gave it the sole responsibility for developing atomic energy. At that time, Captain Hyman G. Rickover was assigned to the Navy Bureau of Ships, the organization responsible for naval ship design. Captain Rickover recognized the military implications of successfully harnessing atomic power for submarine propulsion, and that it would be necessary for the Navy to work with the AEC to develop such a program. By 1949, Captain Rickover had forged an arrangement between the AEC and the Navy that led to the formation of the Naval Nuclear Propulsion Program. In 1954, the nuclear submarine USS NAUTILUS put to sea and demonstrated the basis for all subsequent U.S. nuclear-powered warship propulsion designs. In the 1970's, government restructuring moved the AEC part of the Naval Nuclear Propulsion Program from the AEC (which was disestablished) to what became the Department of Energy. Although the Naval Nuclear Propulsion Program grew in size and scope over the years, it retained its dual responsibilities within the Department of Energy and the Department of the Navy, and its basic organization, responsibilities, and technical discipline have remained much as when it was first established.

By eliminating altogether the need for oxygen for propulsion, nuclear power offered a way to drive a submerged submarine without the need to resurface frequently. In addition, nuclear power offered a way to drive a submerged submarine at high speed without concern for fuel consumption.

Nuclear propulsion, though originally developed for submarines, significantly enhances the military capability of surface ships. Nuclear propulsion provides virtually unlimited high-speed endurance without dependence on tankers and their escorts. Moreover, the space normally required for propulsion fuel in oil-fired ships can be used for weapons and aircraft fuel in nuclear-powered ships.

The nuclear fuel in naval nuclear propulsion reactors uses highly corrosion-resistant materials for fuel and cladding which can withstand high-intensity radiation and harsh environments. As a result, the fuel is very strong and has very high integrity. The fuel is designed, built, and tested to ensure that the fuel construction will contain and hold the radioactive fission products. Naval fuel totally contains fission products within the fuel - there is no fission product release from the fuel in

normal operation. Since the nuclear reactor core contains a large quantity of fission products, it is essential to contain them within the nuclear fuel in order to minimize radiation exposure to a ship's crew. Naval fuel is extremely rugged. It can withstand combat shock loads which are well in excess of 10 times the seismic loads for which commercial nuclear power plant fuel is designed. It routinely operates with rapid changes in power level since naval ships must be able to change speed quickly in operational situations. Naval fuel consists of solid components which are non-explosive, non-flammable, and non-corrosive. The ruggedness of naval fuel is demonstrated by the fact that two nuclear-powered ships were lost at sea in the 1960's, and subsequent environmental monitoring shows no release of fission products from the fuel despite the catastrophic nature of the loss of the ships (NNPP 1993). Although spent nuclear fuel is highly radioactive, it is not regarded as "waste"; it requires special handling procedures, shielding, and other measures to isolate it from people and the environment.

The integrity of naval nuclear fuel is due in part to a long-standing program of examination of spent fuel after it has been removed from prototype reactor plants and operating ships. These examinations have been conducted at the Idaho National Engineering Laboratory (INEL) since the beginning of the Naval Nuclear Propulsion Program. Construction and early operation of the original INEL Expanded Core Facility (ECF) occurred between 1957 and 1962. The original building contained a water pool and nine shielded cells connected to the water pool by a transfer tunnel. As examination requirements changed, the ECF underwent several expansion programs.

The first and second expansions, in 1962 and 1963, were prompted by the initiation of irradiated test specimen examinations at ECF. In the 1970's, the third expansion occurred with the addition of new, larger hot cells. The fourth expansion (1979-1987) included the extension of the ECF building and water pools for the addition of the Breeding Nondestructive Assay Facility. This addition was for the receipt and examination of the Light Water Breeder Reactor nuclear fuel following its operation in the former PWR Shippingport Atomic Power Station. The work at ECF has continued at or near capacity, receiving, handling, and examining spent fuel from naval reactor plants.

2.3 REGULATORY FRAMEWORK

The Naval Nuclear Propulsion Program includes activities conducted by both the U.S. Navy and the Department of Energy. Executive Order 12344, enacted as permanent law by Public Law 98-525, and the Atomic Energy Act of 1954 establish the responsibility and authority of the Director of the Naval Nuclear Propulsion Program (who is also the Deputy Assistant Secretary for Naval Reactors within the Department of Energy) for all facilities and activities that comprise the Program. These executive and legislative actions establish that the Director is responsible for all matters pertaining to naval nuclear propulsion, including direction and oversight of environmental, safety, and health matters for all program facilities and activities.

The federal permits, licenses, and other entitlements listed below may need to be obtained to implement the alternative selected. Existing federal permits, licenses, and entitlements will be modified as required. Applicable state and local permits, licenses, and entitlements will be obtained or modified, as necessary.

- National Pollutant Discharge Elimination System (NPDES) Permit as required by the Federal Water Pollution Control Act (FWPCA), 33 U.S.C. § 1251 et seq.
- NPDES General Permit for Stormwater Discharges from Construction Sites as required by the FWPCA, 33 U.S.C. § 1251 et seq.
- Permit to emit hazardous air pollutants (radionuclides) under the Clean Air Act (CAA), 42 U.S.C. § 7401 et seq., as amended by the Clean Air Act Amendments of 1990.
- Department of Energy Certificate of Compliance for Radioactive Materials Packages in accordance with the Atomic Energy Act (AEA), 42 U.S.C. § 2011 et. seq.

2.4 NAVAL SPENT NUCLEAR FUEL

2.4.1 Summary of Naval Spent Nuclear Fuel Operations

For approximately 40 years, naval spent nuclear fuel has been shipped by rail to the Naval Reactors Facility at the INEL, where it is removed from the shielded shipping containers and placed into the water pools at the ECF. All spent fuel received at the ECF is visually examined externally for evidence of any unusual condition such as unexpected corrosion, unexpected wear, or structural defects. After the fuel assembly structural components have been removed, the interior of the assembly is examined for the conditions discussed above. In addition, the assembly is examined for distortions from irradiation, heat, or the fission process which could interfere with the even distribution of primary coolant and consequent heat removal. The inspection also checks for possible flow obstructions due to foreign material or excessive corrosion product buildup. Selected cores are given more detailed examinations for such purposes as confirming the adequacy of new design features, exploring materials performance concerns, and obtaining detailed information to confirm or adjust computer predictions of neutron physics, heat transfer, or hydraulic flow and distortion. These detailed examinations may include metallography to determine corrosion film thicknesses, dimensional measurements to determine fuel assembly distortion, and radiochemical analysis to determine core depletions, as well as other inspections.

Since satisfactory operation during a normal shipboard lifetime does not provide assurance that the core would have been acceptable under the worst case operating conditions for which it was designed, the examination of each core is necessary to confirm that nothing has occurred in the material selection, manufacturing process, or operation of the core which would invalidate the assumptions upon which safe operation of naval reactor plants is based. The inspections performed on each core provide the assurance needed that operation of shipboard reactors can continue without restriction. These examinations have significantly contributed to the longer core lives and continued safety of current naval reactor designs. This work has also resulted in reductions in the amount of spent nuclear fuel generated by the Naval Nuclear Propulsion Program.

A limited quantity of naval fuel is retained following examination for reference and further study. After examination, most spent fuel is loaded into shielded containers and transferred to the DOE's Idaho Chemical Processing Plant (ICPP) at the INEL for storage. The transportation of naval

spent nuclear fuel from shipyards and prototypes is described in Attachment A. The receipt and handling at ECF of the spent fuel from naval reactors is described in Attachment B.

The Naval Nuclear Propulsion Program evaluates small samples of both fuel and non-fuel materials for possible use in naval reactor systems. The samples are irradiated at the INEL Test Reactor Area and then examined at ECF. A typical sample undergoes several cycles of irradiation and examination over several months or years.

The basic process for managing naval spent nuclear fuel starts with the spent fuel from the reactor plant loaded in a container. There are many stringent control steps in the actual process that are necessary to ensure the safety and health of the workers, the public, and the environment. These controls have been established by the conservative philosophy of the Naval Nuclear Propulsion Program and, as a minimum, meet the applicable regulations of federal and state agencies. Those controls will also apply to any and all of the alternatives that are being considered for the management of naval spent nuclear fuel.

Historically, the main steps that have been used for many years for managing spent fuel consist of the following:

- Step 1. The process starts with spent fuel that has been removed from the reactor and loaded in a shielded shipping container at a prototype site or shipyard authorized to perform naval reactor refuelings or defuelings.
- Step 2. The loaded shipping container is transported by rail to the ECF at the INEL.
- Step 3. The spent fuel is received at ECF.
- Step 4. The spent fuel is separated from structural material and examined in the ECF water pool.
- Step 5. The spent fuel is transferred, in a shielded container, to the ICPP.

At the ICPP, naval spent nuclear fuel is stored in water pools to shield workers from radiation. Naval nuclear fuel is designed to operate for decades in high-temperature water without substantial corrosion. This means that it can be stored in the cool water in storage pools with very,

very little corrosion for centuries because the rate of corrosion, which is very slow at the temperatures inside naval reactors, decreases rapidly as the temperature of the water around the fuel decreases. Experience at the Expanded Core Facility and the Idaho Chemical Processing Plant has shown that naval spent nuclear fuel has not degraded during many years in water pools.

2.4.2 Facilities Related to Naval Spent Nuclear Fuel

The shipyards that perform the refueling and defueling operations are also responsible for shipping the naval spent nuclear fuel to the facility where structural material is removed and examinations are conducted. Since 1957, these operations have been conducted at the ECF at INEL. After the specified operations and examinations are complete, ECF is responsible for transferring the spent fuel to ICPP, the storage location.

The operations at the shipyards for removing the spent fuel from the ship require the use of special, heavily shielded equipment to remove the spent fuel from the reactor to the shipping container (which is also heavily shielded) while protecting the workers from the radiation from the spent fuel. The shipping containers are designed and tested to transport the spent fuel by rail while protecting the workers and any nearby persons from the radiation of the spent fuel. At ECF, the spent fuel is unloaded from the shipping containers with special, heavily shielded transfer casks to protect the workers from radiation. The spent fuel is removed from the transfer cask in the water pool where the depth of the water is sufficient to shield the workers from the radiation of the exposed spent fuel modules. The subsequent machining operations and examinations of the spent fuel are performed in the water pool under the required depth of water, or in a heavily shielded cell where certain operations and examinations can be performed safely. After the work on the spent fuel is completed, the spent fuel is loaded into a shielded transfer cask (under water) for transit to the storage location, such as the ICPP. These are the main pieces of special equipment and facilities that are required to perform the necessary operations with naval spent nuclear fuel. There are many other pieces of equipment and apparatus that are also used along with the main equipment to do the necessary work safely and efficiently.

2.5 REFERENCES

DOE/DOD (U.S. Department of Energy and U.S. Department of Defense), 1993, *The United States Naval Nuclear Propulsion Program*, June.

Duncan, F., 1990, *Rickover and the Nuclear Navy: the Discipline of Technology*, The United States Naval Institute.

Hewlett, R. G. and F. Duncan, 1974, *Nuclear Navy, 1946-1962*, The University of Chicago Press.

NNPP (Naval Nuclear Propulsion Program), 1993, Report NT-93-1, *Environmental Monitoring and Disposal of Radioactive Wastes from U.S. Naval Nuclear Powered Ships and their Support Facilities*, Washington, D.C., February.

3. ALTERNATIVES

This section describes the alternatives which were evaluated for the management of naval spent nuclear fuel removed during reactor refuelings and defuelings at naval and commercial shipyards and at the prototype sites. Since Chapter 3 of Volume 1 provides a complete description of the Department of Energy's alternatives for all types of spent nuclear fuel under its cognizance, the descriptions in this section are limited to aspects of the alternatives related to naval spent nuclear fuel.

1. **No Action:** Spent fuel from naval reactors at naval shipyards and prototype sites would be stored in shielded containers at facilities close to the refueling and defueling sites. There would be no spent fuel examinations.
2. **Decentralization:** There are three different variations to this alternative. The first is similar to the No Action alternative except that additional spent fuel storage options would be pursued. In the second variation, a limited amount of spent fuel would be examined in detail at Puget Sound Naval Shipyard to provide information on nuclear fuel performance. This limited amount of fuel would be stored at the examination site and the remainder would be stored at or near the refueling and defueling sites. In the third variation, all spent fuel would be shipped to the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) and examined as it has been in the past, then returned for storage to facilities at or near the refueling and defueling sites; all planned ECF improvements, including the dry cell expansion (Attachment B), would be completed.
3. **1992/1993 Planning Basis:** Spent fuel would continue to be received, examined, and stored at INEL as it has been in past years. All planned ECF improvements, including the dry cell expansion (Attachment B), would be completed.
4. **Regionalization:** Current and future naval spent nuclear fuel would be received, examined, and stored at the Hanford Site, INEL, the Savannah River Site, the Nevada Test Site, or the Oak Ridge Reservation. If INEL were the site selected for Regionalization of naval spent nuclear fuel, then this alternative would be essentially the same as the 1992/1993 Planning Basis alternative.

5. **Centralization:** Current and future spent fuel would be collected and stored at one Department of Energy (DOE) site. Examination and storage facilities would be constructed, as necessary. All examinations would be performed at that one site. There would be no difference between the Regionalization and the Centralization alternatives for naval spent nuclear fuel.

This section also describes other alternatives which were considered and then eliminated from detailed analysis.

3.1 NO ACTION

This alternative is restricted to the minimum actions deemed necessary for continued safe and secure handling and storage of naval spent nuclear fuel. It is important to note that this alternative is not a status quo condition. Naval reactors would be refueled and defueled as planned. Naval spent nuclear fuel would be stored in shipping containers at a Navy or DOE facility. These shipping containers would be modified and recertified as discussed in Section D.1.2.1 of Attachment D. No further naval spent nuclear fuel examination would be conducted and research and development activities associated with examination of the spent fuel would not be performed. The Expanded Core Facility at INEL would be shut down.

Under this alternative, the transportation of naval spent nuclear fuel to INEL would be ended after about 3 years, during which additional shipping containers would be purchased and actions to prepare naval sites to serve as storage locations would be completed (see Section 3.8). The spent fuel from naval reactors at naval shipyards or active prototype sites would be stored at a naval shipyard or prototype, in most instances where it was removed from the reactor during servicing. The spent fuel would be removed from the reactors and placed directly into shipping containers for storage without detailed examination. Newport News Shipbuilding, a private shipyard located in Newport News, Virginia, does refueling and defueling work for the Navy. Spent fuel removed from ships refueled or defueled at Newport News Shipbuilding would be transported to the nearest naval site, Norfolk Naval Shipyard, in Portsmouth, Virginia. Norfolk Naval Shipyard is about 10 miles (about 250 miles by rail) from Newport News Shipbuilding. The spent fuel would be stored in such a way that it would be protected from damage or intruders and that workers, the public, and the environment would be protected. The fuel would remain in storage until the DOE is prepared to take receipt of the fuel.

Since no additional spent fuel examinations would be performed at ECF, the work associated with examination of test specimens irradiated in the Advanced Test Reactor at INEL would be transferred to another site at INEL. The selected site might require modifications to accommodate this work.

If this alternative and its minimum actions were selected, it would be necessary to construct and certify approximately 500 additional shipping containers and to construct the associated rail spur tracks for the naval sites to be able to store the spent fuel from all of the nuclear-powered ships that will be refueled or defueled until the time that a permanent disposal facility becomes operational. During the period of time when containers would not yet be available, naval spent nuclear fuel would be transported in shipping containers to the Expanded Core Facility at INEL. These containers would be unloaded and used to support additional refuelings and defuelings.

A major result of this and any other alternative which precludes detailed examination of naval spent nuclear fuel is that the further development of improved nuclear fuel for U.S. Navy ships would be hindered. Examination of spent fuel provides useful information on the performance of existing fuel system designs. Without a continuing flow of such information, eventually confidence in the ability of naval nuclear fuel to perform satisfactorily under design conditions would decrease. This information is also important in developing improvements in future fuel designs.

Attachment D contains a more detailed description of storing naval spent nuclear fuel at or close to its removal location.

3.2 DECENTRALIZATION

Under this alternative, DOE would maintain existing naval spent nuclear fuel in storage at INEL, and new naval spent nuclear fuel would be stored at or near the sites where it was removed from reactors. Three different variations of this Decentralization alternative have been considered. In general, these variations are similar to the No Action alternative with regard to their location and method for long-term storage of spent nuclear fuel. At each storage location under all three options, storage in shipping containers, dry storage casks, and wet storage in water pools has been considered. All of them would require a transition period while facilities are developed (see Section 3.8).

3.2.1 Store Naval Spent Nuclear Fuel at or Close to Locations Where Removed Without Examination

Similar to the No Action alternative, this alternative would include storage of the spent fuel from reactors at naval shipyards or active prototype sites close to the locations where it was removed during refueling or defueling. The spent fuel would be placed directly into storage without detailed examination. Storage would be in water pools, dry casks, or shipping containers. The spent fuel would be protected from damage or intruders, and workers, the public, and the environment would be protected. The fuel would remain in storage until a permanent disposal site became available.

No further naval spent nuclear fuel examination would be conducted. Without this examination program, further development of improved nuclear fuel for U.S. Navy ships would be hindered. Naval spent nuclear fuel examination provides useful information on the performance of existing fuel system designs. A continuing flow of such information is needed to prevent confidence in the ability of naval nuclear fuel to perform satisfactorily under design conditions from decreasing over time. Information from examination of naval spent nuclear fuel is also important in developing improvements in future designs. In addition, the work associated with examination of irradiated test specimens, which is also essential to the development of advanced designs, would no longer be performed at the Expanded Core Facility at INEL and would have to be relocated to other facilities at INEL. The Expanded Core Facility at INEL would be shut down.

The environmental effects associated with this alternative would be determined primarily by the choice among water pool, dry storage casks, or shipping container storage. The shipping containers could be mobile storage casks, which could also be used for shipping. Like the other options under this alternative, a transition period would be required during which it would be necessary to design, construct, and certify enough shipping containers or dry storage casks to store the spent fuel from all nuclear-powered ships being refueled or defueled or to design, construct, and certify water pools for fuel storage at naval sites. During this transition period, naval spent nuclear fuel would continue to be shipped to the Expanded Core Facility at INEL where the shipping containers would be unloaded and used to support additional refuelings and defuelings.

Attachment D contains a more detailed description of storing naval spent nuclear fuel at or close to its removal location.

3.2.2 Examine a Limited Amount of Naval Spent Nuclear Fuel in the Puget Sound Naval Shipyard Water Pit Facility and Store All Naval Spent Nuclear Fuel at Navy Facilities

Under this alternative, the existing water pool facility at Puget Sound Naval Shipyard, originally built to support the refueling of nuclear-powered aircraft carriers, would be modified to conduct the maximum amount of naval spent nuclear fuel examinations practical at that site. The difference between this alternative and the one described in the preceding section is that only a small amount of spent nuclear fuel could be examined to provide information on nuclear fuel performance for use in the development of improved nuclear fuel.

The only existing facility available within the Naval Nuclear Propulsion Program, other than the facility at ECF, which could be used to examine spent fuel from naval reactors is the water pool at the Puget Sound Naval Shipyard at Bremerton, Washington. However, the use of this facility for visual and dimensional examinations of high-priority spent fuel assemblies would require removal of the presently installed aircraft-carrier refueling equipment. As a result, Puget Sound would no longer have the capability to refuel nuclear-powered aircraft carriers. This facility has no shielded cells for performing destructive examinations of spent fuel. Although this alternative would provide a limited capability for examination and analysis of spent fuel, the ability to sustain further development of the advanced nuclear reactors needed to ensure the safety and performance superiority of U.S. Navy ships would be jeopardized. Continuous performance of naval spent nuclear fuel examinations at Puget Sound Naval Shipyard would preclude the performance of aircraft-carrier refuelings at Puget Sound because the needed water pit would no longer be available.

The limited amount of spent fuel examined in the modified facility and all naval spent fuel removed from reactors at Puget Sound Naval Shipyard would be stored at that shipyard. The naval spent fuel removed at other naval shipyards or active prototype sites would be stored at a site close to the location where it was removed during refueling or defueling. The limited amount of fuel to be examined would be transported from the originating site to Puget Sound Naval Shipyard in the shipping containers currently used for naval spent nuclear fuel.

Like the other options under this alternative, a transition period would be required for development of facilities utilizing shipping containers, dry storage casks, or water pools for fuel

storage at naval sites. During this transition period, naval spent nuclear fuel and test specimens would continue to be shipped to the Expanded Core Facility at INEL where the shipping containers would be unloaded and used to support additional refuelings and defuelings.

Under this option, the Expanded Core Facility at INEL would be shut down after the end of the transition period. The examination of irradiated test specimens would be performed as discussed under the No Action alternative (Section 3.1).

Attachment D contains a more detailed description of the examination and storage of naval spent nuclear fuel for this alternative. The transportation of fuel to be inspected at Puget Sound Naval Shipyard is described in Attachment A.

3.2.3 Examine All Naval Spent Nuclear Fuel at the INEL and Return to Naval Facilities for Storage

Under this option, all naval spent nuclear fuel would be shipped to the Expanded Core Facility at the INEL for examination. After examination, this fuel would be returned to a naval or DOE facility for long-term storage near the location where the fuel was removed from a reactor. The examination of spent fuel under this alternative would be performed at the INEL Expanded Core Facility as has been done in past years. As with other options under this alternative, the naval spent nuclear fuel would be stored in shipping containers, dry storage casks, or water pools. All planned improvements to the Expanded Core Facility, including the dry cell expansion, would be completed.

The receipt, examination, and preparation for storage for this alternative would be the same as described in more detail in Attachment B, and the storage would be the same as that described in Attachment D for shipyard and prototype storage. Transportation of the spent fuel would be accomplished in the same manner as described in Attachment A.

3.3 1992/1993 PLANNING BASIS

The practice of transporting spent nuclear fuel removed from naval reactors to the Expended Core Facility in Idaho for examination would be resumed. Following examination, the spent nuclear fuel would be transferred to DOE for management at the Idaho Chemical Processing Plant pending final disposition. All planned improvements in fuel examination capability for naval spent nuclear fuel at INEL, including the ECF dry cell expansion, would be completed. Operation of an ECF Dry Cell Facility is included in the supporting analysis and the assumptions of this Environmental Impact Statement.

The shipment of naval spent nuclear fuel from shipyards and prototypes to INEL is described in Attachment A, and receipt and handling at INEL of the spent fuel from naval reactors and active prototypes is described in Attachment B. Attachment B also includes a description of the ECF Dry Cell Facility.

3.4 REGIONALIZATION

Two options have been considered under this alternative. Under the first Regionalization option considered, DOE would manage all spent nuclear fuel at the Hanford, INEL, and Savannah River sites, allocating each type of spent nuclear fuel to one of these sites according to its characteristics, such as the type of cladding. Under the second option, spent nuclear fuel under DOE cognizance would be managed at one DOE site in the eastern portion of the United States and one DOE site in the western part of the United States, with all spent nuclear fuel assigned to one of these two sites on the basis of its point of origin. The eastern site would be either the Savannah River Site or the Oak Ridge Reservation, and the western site would be the Hanford Site, INEL, or the Nevada Test Site. The Expended Core Facility at INEL would be shut down in all cases where INEL would not be used for naval spent nuclear fuel examination and storage.

3.4.1 Regionalization Using Storage at Three Sites (Hanford, INEL, and Savannah River)

This option under the Regionalization alternative would result in all naval spent nuclear fuel being managed at the INEL in the same manner as the 1992/1993 Planning Basis alternative because all naval nuclear fuel has similar characteristics and would be managed at a single site. Under DOE plans, all Zircaloy-clad fuel would be managed at the INEL and since naval fuel is Zircaloy-clad, it would be assigned to INEL. The practice of transporting spent nuclear fuel removed from naval reactors to the Expanded Core Facility in Idaho for examination would be resumed. Following examination, the fuel would be transferred to DOE for management at the Idaho Chemical Processing Plant pending final disposition. All planned improvements in fuel examination capability for naval spent nuclear fuel at INEL would be completed.

3.4.2 Regionalization Using Storage at Only Two Sites

Under this option, DOE would collect all spent nuclear fuel at one existing large DOE site in the eastern United States (either the Oak Ridge Reservation or the Savannah River Site) and at one existing large DOE site in the western part of the country (either the Hanford Site, INEL, or the Nevada Test Site). Spent nuclear fuel would be collected at one or the other of these two sites, based on its original location. Only one of the two locations would be used for examination and storage of naval spent nuclear fuel under this option, but the impacts of managing naval spent nuclear fuel at all of the possible sites have been evaluated because the site for naval spent nuclear fuel has not been chosen.

A new naval spent nuclear fuel examination facility would have to be constructed at the site selected if it were other than INEL, and the Expanded Core Facility at INEL would be shut down. The new facility would have capabilities equivalent to those of the existing Expanded Core Facility at INEL and would support all examinations and experimental work required for the development of naval reactors. The new examination facility would be operated by the Naval Nuclear Propulsion Program.

Naval spent nuclear fuel would be removed from naval reactors and transported by rail to the new examination facility, as described in Attachment A. The fuel would be unloaded and examined in the water pools and shielded cells constructed for this purpose, in a manner similar to that described in Attachment B. After completion of all examination work, the naval spent nuclear fuel would be transferred to storage facilities operated by the DOE at the same site. None of the DOE sites considered in this alternative, other than INEL, currently has facilities adequate to store the amount of spent nuclear fuel involved in this option. Therefore, the DOE would have to construct new storage facilities suitable for spent nuclear fuel, including naval spent nuclear fuel, if this option were selected.

It should be understood that the Navy would operate only one facility for examination of all naval spent nuclear fuel, and all naval spent nuclear fuel examined during the period covered by this Environmental Impact Statement would be stored at the same DOE site where the examinations would be performed. Therefore, there are no differences for management of naval spent nuclear fuel between the Regionalization alternative and the Centralization alternative (described in the next section) for the same site.

3.5 CENTRALIZATION

As implied by its name, this alternative would collect all current and future DOE spent nuclear fuel at one DOE site. The sites analyzed include the Hanford Site, INEL, the Savannah River Site, the Oak Ridge Reservation (ORR), and the Nevada Test Site (NTS). As in the Regionalization alternative, the Navy would operate a facility for examination of naval spent nuclear fuel at only one DOE site, and all naval spent nuclear fuel examined during the period evaluated would be stored at the DOE site where it was examined, so there are no differences between the Regionalization alternative and the Centralization alternative for management of naval spent nuclear fuel.

If INEL were chosen as the DOE site for centralized long-term storage of naval spent nuclear fuel, the Expanded Core Facility would continue to operate. After examination at the Expanded Core Facility, naval spent nuclear fuel would be transferred to the Idaho Chemical Processing Plant. There would be no need to modify the Expanded Core Facility since it is a safe, modern facility providing all the capabilities needed for naval spent nuclear fuel examinations. However, any planned facility

changes to provide improved or additional fuel handling and examination capability, such as the ECF Dry Cell Facility, would be completed.

If a DOE site other than INEL were chosen for the centralized long-term spent nuclear fuel storage facility, then the Expended Core Facility at INEL would be closed. A new naval spent nuclear fuel examination facility would need to be constructed at the selected site, or an existing facility would have to be modified to perform the needed examinations of naval spent nuclear fuel. This facility would provide capabilities equivalent to those of the existing Expended Core Facility at INEL. Similarly, additional spent nuclear fuel storage facilities would have to be constructed at the selected site since there are insufficient facilities at other sites suitable for storage of spent nuclear fuel from INEL.

Adjacent to the Savannah River Site is the site of the Barnwell Nuclear Fuel Plant. This privately owned facility is not being used currently. It could be purchased at an undetermined price, annexed to the Savannah River Site, and subsequently modified to provide capabilities equivalent to those at the Expended Core Facility. Similarly, at Hanford there exists the Fuels and Materials Examination Facility (FMEF) that could be modified to provide capabilities equivalent to those at the Expended Core Facility. It is expected that the modifications to either of these two facilities would cost less than the construction of a new Expended Core Facility.

Shipments of naval spent nuclear fuel to the Expended Core Facility in Idaho would resume during the first 3 years of the time required to construct a new naval spent nuclear fuel examination facility at the selected location (see Section 3.8). All naval spent nuclear fuel would be transferred to the central site after the new facilities were placed into operation.

The receipt, handling, and storage of naval spent nuclear fuel for this alternative are described in Attachments B and E, and transportation of the spent fuel is described in Attachment A.

3.6 ALTERNATIVES ELIMINATED FROM DETAILED ANALYSIS

Several other alternatives were considered in addition to those described above. However, these other alternatives were not analyzed to the same depth as those described above. These alternatives and the reasons for not analyzing them in detail are discussed in this section.

3.6.1 Use Other Combinations of Sites for Examination and Storage of Naval Spent Nuclear Fuel

Some variations of alternatives can be conceived in which spent fuel would be shipped from the site at which it was removed from a reactor to some other facility for examination or preparation for storage and subsequently shipped to another facility for storage. Evaluating all such combinations for examination, treatment, and storage as separate alternatives would be complicated because of the large number of alternatives which could result. Furthermore, detailed treatment of such a large number of alternatives would complicate the evaluation of environmental effects.

However, it is not necessary to consider each of these combinations individually because the processes involved and the possible environmental effects generally can be represented by combinations of the effects of alternatives already discussed. For example, the impacts of examining spent fuel at a DOE site other than INEL followed by shipment back to a shipyard for storage would be essentially the same as those for examination of fuel under the alternative of examination and storage of the fuel at the alternate DOE site, described in Section 3.5, except for transportation. Continuing the example, the effects of storing the naval spent nuclear fuel at a shipyard as part of such an alternative would be the same as those for storing spent fuel at the shipyard without inspection, described in Section 3.2.1. The effects of shipping the fuel back and forth between the DOE site and a shipyard for such an approach would be approximately double the effects of shipment to the DOE site for inspection and storage because the same sites are involved but a second trip would be required to return the fuel from the inspection site to the storage site.

In a similar fashion, the effects of other possible combinations of inspection and storage sites can be deduced from combinations of the alternatives discussed in earlier sections. In order to avoid complication and confusion, these alternative combinations were not explicitly analyzed in this statement.

3.6.2 Examine or Store Spent Nuclear Fuel from Naval Reactors in Foreign Facilities

The design and operating characteristics of the fuel for naval reactors are classified information and are not releasable to foreign interests without going through a complex procedure prescribed in the Atomic Energy Act. Some of these classified design details and characteristics are obvious from the physical form of the fuel, and others could be learned from detailed examination or analyses. In addition, the fuel for naval reactors utilizes enriched uranium, so transfer to other nations would be contrary to the goals and requirements of the Treaty for the Non-Proliferation of Nuclear Weapons. These factors, along with others such as the security required for foreign shipment and storage, make this alternative impractical. Based on these considerations, this alternative is not practical and was eliminated from detailed analysis.

3.6.3 Do Not Remove Naval Spent Nuclear Fuel from Nuclear-Powered Ships

It is physically possible to retain spent fuel in the reactors in nuclear-powered vessels and moor the ships at shipyards until a decision on the ultimate disposition of spent nuclear fuel is reached. Most inactive Russian nuclear-powered submarines have been tied up at shipyards without removing their spent fuel. After a decision on ultimate disposition is made and implemented, the fuel could be removed from the ships and transported to the permanent disposal facility.

Implementing this alternative would require extensive modifications to facilities at shipyards, including increasing the number of piers and the availability of waterfront utilities to support the ships at their moorings. Other shipyard facilities also might have to be modified or replaced as a result of the use of waterfront space to moor the numbers of ships involved during the 40-year period. The construction of piers and other needed facilities would cause impacts on the waterfronts and harbors and could affect the local ecology. The radiological effects on the environment or people in the vicinity would be negligible as long as the nuclear-powered vessels and propulsion plants were maintained under the same procedures and discipline used for operating ships, since the environmental effects of operating U.S. Navy nuclear-powered vessels are well documented and known to be negligible.

This method for storing naval spent nuclear fuel would cause some increase in construction activities, but in the long run it would result in the idling of skilled workers as the shipyards ran out of room and work schedules were disrupted by the loss of ship servicing work. Mooring the ships without removing the naval spent nuclear fuel would also utilize highly trained Navy nuclear ship operators in the unproductive task of watching over shut down ships. The resources dedicated to providing the additional moorings would produce no improvements in a shipyard's ability to perform its mission and would actually decrease its capabilities.

In addition, the costs and impacts on national security resulting from such an approach would be large; it would affect the ability of the U.S. Navy to carry out its mission. Further, the costs of maintaining the ships with spent nuclear fuel remaining installed under Navy operating procedures and providing the additional piers and waterfront services and utilities would be large. The costs of this approach would be high both for ships which are to be decommissioned and for ships which would normally be refueled and returned to duty. In the case of ships which are being decommissioned at the end of their life, the primary cost of this alternative would be to maintain qualified nuclear operators, shipboard equipment, and associated shipyard support, including security, to ensure nuclear and radiological safety for the workers and the public. This would be more costly than removal of the spent fuel for storage because of the need to maintain operating personnel aboard the ships until they are defueled. Failure to remove the spent fuel from Navy ships which are still needed for service would result in these ships being unavailable once their currently installed reactor fuel reaches the end of useful life. This is impractical and even more expensive than leaving the spent fuel in decommissioned ships because the ships would have to be replaced or the Navy would be forced to operate without the full complement of ships required to execute national policies.

In summary, this alternative would be costly and would involve extensive actions which would have an effect on the environment due to construction activities. This alternative would also not permit continued service of many Navy ships and only postpone decisions on a satisfactory storage location. As a result of these considerations, this alternative was eliminated from detailed analysis.

3.7 COMPARISON OF ALTERNATIVES

This section provides a comparison of the alternatives as they relate to the activities which fall under the Naval Nuclear Propulsion Program (NNPP). The comparison focuses on those areas which are projected to have the most significant impacts. As discussed in Sections 5.1 through 5.6, the impacts projected for most impact categories are very small or nonexistent. Such impact categories include: land use, cultural resources, aesthetic and scenic resources, geology, water resources, ecological resources, noise, utilities and energy, waste management, and irreversible and irretrievable commitment of resources. Consequently, the impacts in these areas provide no basis for distinguishing among alternatives.

It is important to note that in the No Action alternative and in two of the options of the Decentralization alternative, examination of naval spent nuclear fuel would cease or be seriously reduced and important scientific information would be lost. Beyond this issue, the principal differences among the alternatives occur in the categories of occupational and public health and safety (including normal operations and accidents for facility operations and transportation operations), cumulative impacts, and socioeconomics. Even in these areas, the overall impacts and the differences are small and represent the few unavoidable adverse effects that remain after the years of experience have been factored into the operations and the necessary mitigative measures have been applied.

DOE has adopted two quantitative safety goals to limit the risks of fatalities associated with its nuclear operations. The goals are:

- The risk to an average individual in the vicinity of a DOE nuclear facility for prompt fatalities that might result from accidents should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatalities resulting from other accidents to which members of the population are generally exposed.
- The risk to the population in the area of a DOE nuclear facility for cancer fatalities that might result from operations should not exceed one-tenth of one percent (0.1%) of the sum of all cancer fatality risks resulting from all other causes.

A comparison of the calculated risks associated with each of the Naval Nuclear Propulsion Program alternatives indicates that the implementation of any of these alternatives would be well within the DOE facility safety goals.

3.7.1 Summary of Impacts

The most salient of the environmental impacts are summarized below. These impacts are presented under two categories:

- Human Health Impacts
- Other Impacts.

3.7.1.1 Human Health Impacts. Table 3-1 provides an overall comparison of the alternatives. This comparison is presented in terms of the increase in the number of cancer fatalities that could occur in the general population for any given year after an alternative has been implemented and has achieved a stable level of operation. This increase in the risk of developing fatal cancers is broken down to show how much risk increase is associated with normal operations, the highest risk facility accident, and transportation operations. For example, it is calculated that for the 1992/1993 Planning Basis alternative in which naval spent nuclear fuel would continue to be received, examined, and prepared for storage at the ECF at INEL, there would be:

- an increase of about 0.0000009 cancer fatalities per year for the general population around INEL (i.e., about one additional cancer fatality nationwide in 1,000,000 years among the 116,000 people who live within a 50-mile radius of INEL) due to normal ECF operations.
- an increase of 0.000026 cancer fatalities per year for the general population along the transportation routes due to normal transportation of naval spent nuclear fuel from the shipyards to the ECF.
- an increase of 0.00000017 cancer fatalities per year for the general population due to the facility accident with the highest risk (in this case it would be the accidental draining of a water pool used for examination and storage of naval spent nuclear fuel).

Table 3-1. Risk (fatal cancers to the general population per year) by alternative.

Alternative	Normal Operations Risk		Transportation Incident-Free Risk	Most Severe Risk from a Facility Accident	Transportation Accident Risk
	Storage at NNPP Sites	Examination			
1. No Action	2.2×10^{-5}	N/A	4.3×10^{-6}	2.6×10^{-4}	1.1×10^{-7}
2. Decentralization					
• No Exam					
- Dry Storage	2.2×10^{-5}	N/A	4.3×10^{-6}	2.6×10^{-4}	1.1×10^{-7}
- Water Pool Storage	3.4×10^{-4}	N/A	4.3×10^{-6}	1.1×10^{-5}	1.1×10^{-7}
• Limited Exam					
- Dry Storage	2.2×10^{-5}	6.5×10^{-5}	1.1×10^{-5}	2.6×10^{-4}	2.2×10^{-7}
- Water Pool Storage	2.7×10^{-4}	6.5×10^{-5}	1.1×10^{-5}	1.1×10^{-5}	2.2×10^{-7}
• Full Exam					
- Dry Storage	2.2×10^{-5}	8.5×10^{-7}	4.1×10^{-5}	2.6×10^{-4}	1.5×10^{-6}
- Water Pool Storage	3.4×10^{-4}	8.5×10^{-7}	4.1×10^{-5}	1.1×10^{-5}	1.5×10^{-6}
3. 1992/1993 Planning Basis ⁽¹⁾		8.5×10^{-7}	2.6×10^{-5}	1.7×10^{-7}	1.0×10^{-6}
4/5. Regionalization or Centralization ⁽¹⁾⁽²⁾					
• INEL	-	8.5×10^{-7}	2.6×10^{-5}	1.7×10^{-7}	1.0×10^{-6}
• Hanford	-	4.0×10^{-6}	6.0×10^{-5}	4.7×10^{-7}	1.7×10^{-6}
• S. River	-	1.8×10^{-5}	1.5×10^{-4}	9.6×10^{-6}	1.1×10^{-5}
• NTS	-	9.0×10^{-8}	7.5×10^{-5}	7.2×10^{-8}	7.5×10^{-6}
• ORR	-	5.0×10^{-5}	1.4×10^{-4}	8.4×10^{-6}	3.6×10^{-6}

⁽¹⁾ For alternatives 3, 4, and 5, the risk due to storage of naval spent nuclear fuel is not included in this evaluation. It is included in the evaluation of the individual DOE sites.

⁽²⁾ Both the Regionalization and Centralization alternatives would locate an ECF at one of the five DOE sites. For this reason, the risk is the same for these alternatives.

- an increase of 0.000001 cancer fatalities per year for the general population due to risks of transportation accidents.

Table 3-1 shows that the cancer risks due to Naval Nuclear Propulsion Program activities for any of the alternatives are small. In all of these cases, thousands of years of repetition of the alternate action would be required before a single additional fatal cancer would occur. Risk is defined as the product of the probability of occurrence of an event leading to radiation exposure and the level of impact of exposure to radiation in terms of the increased number of fatal cancers that would result. A discussion of the key points in the development of an estimate of cancer fatalities is provided below; more detailed discussions of the parameters, analyses, and results are provided in Attachments A and F.

The increased number of fatal cancers is based on the calculated increase in exposure to radiation that would be seen by the general public as a result of each of the alternatives. The average annual exposure to a member of the population in the U.S. from background radiation is approximately 0.3 rem (300 millirem). The average annual collective exposure to all of the population in the U.S. from background radiation is approximately 69 million person-rem. When people are exposed to additional radiation, the number of additional radiation-induced cancer and other health effects needs to be considered. An estimate for radiation-induced cancer can be briefly summarized as follows:

- In a typical group of 10,000 persons who do not work with radioactive material, a total of about 2000 (20 percent) will normally die of cancer.
- If each of the 10,000 persons received an additional 1 rem of radiation exposure (10,000 person-rem) in their lifetime, then an estimated 5 additional cancer deaths (0.05 percent) might occur.
- Therefore, the likelihood of a person contracting fatal cancer during their lifetime could be increased nominally from 20 percent to 20.05 percent by exposure to 1 additional rem of radiation.

The "factor" for such a person to contract a fatal cancer, considering all possible organs, can be expressed as 0.0005 fatal cancers per rem of exposure. This is mathematically equivalent to 5.0 fatal cancers from 10,000 person-rem of collective exposure to a large group of persons.

Further, a collective exposure of 10,000 person-rem would be expected to produce, on the average, approximately 7.3 health detriments due to non-fatal and fatal cancers and severe genetic defects. These are two of the factors for the health detriments that may result from exposure to additional radiation. The results in this section are given in terms of fatal cancers. The total number of health detriments is the ratio $7.3/5.0$ or 1.46 times these values.

The risks associated with all of the alternatives are low compared to the risks encountered in daily life. The risks of normal operations may be placed in perspective by considering other commonly encountered risks. For example, the average American is exposed to approximately 0.5 millirem each year from the radioactivity released from combustion of fossil fuels (NCRP 1987), which produces a lifetime risk of an average individual dying from cancer of about 1 chance in 50,000. As a further comparison, the naturally occurring radioactive materials in fertilizer used to produce food crops contribute about 1 to 2 millirem per year to an average American's exposure to radiation (NCRP 1987). This results in a risk of death from cancer between 1 chance in 12,500 and 1 chance in 25,000.

A frame of reference for the risks from accidents associated with spent nuclear fuel management alternatives can be developed by comparing them to the risks of death from other accidental causes. For example, the risk of death in a motor vehicle accident is about 1 chance in 80 (NSC 1993). Similarly, the risk of death for the average American from fires is approximately 1 chance in 500 and the risk of death from accidental poisoning is about 1 chance in 1000 (NNPP 1993b).

It must be remembered that no member of the public will receive as much as one one-thousandth of a rem from 40 years of the normal operations associated with any of the alternatives considered. Examining the results shown in the tables of radiation exposures (Attachments A and F) shows that the principal source of the difference in the exposures associated with radiation and radioactive materials released from normal operations and from hypothetical accidents for the alternatives is the number of people who live in the vicinity of the alternative sites and where they live relative to the facility itself. When the emissions from the sources are essentially the same, the

resulting impacts depend directly on the size of the surrounding population, on the way the population is distributed around the site in terms of the distances and directions from the particular facility, and on the characteristics of the local meteorology.

3.7.1.2 Other Impacts. The principal impact in the employment portion of the socioeconomics category is the number of jobs created by the construction and operation of a new (or modified) facility. The magnitude of the effect is relatively small in populations of the sizes under consideration, except to those people who benefit either directly or indirectly from the jobs. The creation of the jobs has some negative impacts: the jobs may be created at a distant location, or the jobs created locally may cause some small but adverse effect on the local community in terms of additional people and an increased need for additional public services.

The cost of operating and constructing new facilities or modifying existing ones to achieve the necessary capabilities for handling and storing spent fuel is an important economic impact. Depending on the site affected and the alternative under consideration, the cost may be as much as 5.7 billion dollars for construction and 40 years of operation.

In the unlikely event of a serious accident involving naval spent nuclear fuel, it is estimated that only about 210 acres of land would be affected for the most severe case (this is described in more detail in Attachment F), and in the other accidents analyzed, smaller areas of land would be affected. The affected area would require decontamination, and during this cleanup access controls would have to be established. However, due to the limited land area affected, it is judged that these restrictions would only be temporary and the impact on issues such as economics, treaty rights, tribal resources, ecology, and land use, would be relatively small and limited in time. The remediation actions would be simpler in rural areas than in urban areas; however, provided that prudent controls and remediation operations were promptly implemented, the affected land and buildings could be recovered in either case. As demonstrated in the accident analyses in Attachments A and F and summarized above, the human health effects are not large and the effects on wildlife and other biota would also not be large, partly due to the limited area affected.

Examination of naval spent nuclear fuel and irradiated test specimens has been conducted at the ECF at INEL since 1957. This program has made and continues to make important contributions to the safety, cost, and operational performance of naval nuclear propulsion plants. However, the No Action alternative and two of the Decentralization alternatives would result in substantial

curtailment of this program. The Centralization, Regionalization, 1992/1993 Planning Basis, and the Decentralization - Full Examination alternatives would maintain the needed examination capability.

The safety of operating Naval reactor plants has benefitted directly from the ECF examination programs. The result has been the construction of rugged reactor cores that are more tolerant of extreme conditions (such as corrosion, high temperatures, and intense radiation) without release of any fission products. The Naval Nuclear Propulsion Program's commitment to improved safety continues to be driven by two major issues:

- Protection of the Environment - In more than 40 years of operating and maintaining reactors in very demanding conditions, the Naval Nuclear Propulsion Program has never experienced a reactor accident, criticality accident, or a release of radioactivity that has had a significant effect on the environment.
- Personnel Safety - The importance of ensuring the integrity of the fuel is emphasized by the fact that the sailors onboard the ships live in very close proximity to an operating reactor 24 hours a day. Any release of radioactivity from the fuel into the reactor coolant would increase the radiation exposure of the ship's crew.

Since the inception of the Naval Nuclear Propulsion Program, the useful lifetime of naval reactors has been extended by more than a factor of 10. The examination programs at ECF played a major role in making this improvement possible. As a result of the extended reactor lifetimes, billions of dollars in ship refueling costs and spent nuclear fuel storage costs have been saved. In addition, longer reactor lifetimes permit the ships to spend a larger fraction of their lifetime on sea duty rather than in the shipyards, thus saving costs by reducing the number of ships required. Further reductions in nuclear propulsion plant costs are being pursued through improvements in many areas of nuclear fuel systems.

The improvements in nuclear fuel performance that have been developed in part through the knowledge gained from the examination program have contributed to improved ship operational characteristics. Major improvements have been made in power density, maneuverability, stealth, and simplicity. These improvements translate into important tactical advantages for our ships. Maintaining this advantage with ever improving technologies elsewhere in the world is vitally important to the safety of our sailors and to protecting our national interests.

In the final analysis, the most important differences are:

- The transfer of jobs associated with the Expended Core Facility among the alternative sites considered for locating the examination facility, or the outright loss of these jobs at INEL.
- The costs if new facilities are required.
- The loss or maintenance of naval spent nuclear fuel examination capability.

Sections 3.7.2, 3.7.3, and 3.7.4 provide additional summary information on the principal areas of impact.

3.7.2 Impacts Due to Normal Operations

During normal operations, there are public impacts due to direct radiation or due to the release of radioactive materials to the environment. These impacts are presented in the form of potential cancer fatalities due to exposure to the small amounts of radiation involved or radioactive materials released. It is important to emphasize that these cancer fatalities are calculated results rather than actual expected fatalities. This is because the expected number of such fatalities during normal operations is so small as to be unmeasurable and indistinguishable relative to the larger number of such deaths expected from naturally occurring conditions and other man-made effects not related to naval spent fuel operations. This is not meant to trivialize the importance of radiation-induced cancer fatalities but, rather, is meant to put the issue in perspective.

Table 3-2 presents a summary comparison of the calculational prediction of the number of fatal cancers per year that might be expected due to normal operations within each of the alternatives under consideration for naval spent nuclear fuel handling. This table provides the calculated impacts to the entire population. The impacts to selected individuals including workers are provided in Attachments A and F. Table 3-2 reflects the two possibilities (water pool and dry storage) for storing naval spent nuclear fuel at the Navy sites. In the case of dry storage at Navy sites, the impact from

Table 3-2. Fatal cancers per year to the general population from normal operations.

Alternative		INEL	Puget Sound	Pearl Harbor	Portsmouth	Norfolk	Kesselring	Transportation	Total
1.	No Action	-	1.2×10^{-6}	9.3×10^{-9}	2.3×10^{-7}	2.1×10^{-5}	4.1×10^{-12}	4.3×10^{-6}	2.7×10^{-5}
2.	Decentralization								
	• No Exam								
	- Dry Storage	-	1.2×10^{-6}	9.3×10^{-9}	2.3×10^{-7}	2.1×10^{-5}	4.1×10^{-12}	4.3×10^{-6}	2.7×10^{-5}
	- Water Pool Storage	-	6.5×10^{-5}	7.0×10^{-5}	2.3×10^{-5}	1.4×10^{-4}	4.1×10^{-5}	4.3×10^{-6}	3.4×10^{-4}
	• Limited Exam								
	- Dry Storage	-	6.6×10^{-5}	9.3×10^{-9}	2.3×10^{-7}	2.1×10^{-5}	4.1×10^{-12}	1.1×10^{-5}	9.8×10^{-5}
	- Water Pool Storage	-	6.5×10^{-5}	7.0×10^{-5}	2.3×10^{-5}	1.4×10^{-4}	4.1×10^{-5}	1.1×10^{-5}	3.5×10^{-4}
	• Full Exam								
	- Dry Storage	8.5×10^{-7}	1.2×10^{-6}	9.3×10^{-9}	2.3×10^{-7}	2.1×10^{-5}	4.1×10^{-12}	4.1×10^{-5}	6.4×10^{-5}
	- Water Pool Storage	8.5×10^{-7}	6.5×10^{-5}	7.0×10^{-5}	2.3×10^{-5}	1.4×10^{-4}	4.1×10^{-5}	4.1×10^{-5}	3.8×10^{-4}
Alternative		INEL	Hanford	Savannah River	NTS	ORR		Transportation	Total
3.	1992/1993 Planning Basis	8.5×10^{-7}	-	-	-	-		2.6×10^{-5}	2.7×10^{-5}
4/5.	Regionalization or Centralization								
	• INEL	8.5×10^{-7}	-	-	-	-		2.6×10^{-5}	2.7×10^{-5}
	• Hanford	-	4.0×10^{-6}	-	-	-		6.0×10^{-5}	6.4×10^{-5}
	• S. River	-	-	1.8×10^{-5}	-	-		1.5×10^{-4}	1.7×10^{-4}
	• NTS	-	-	-	9.0×10^{-8}	-		7.5×10^{-5}	7.5×10^{-5}
	• ORR	-	-	-	-	5.0×10^{-5}		1.4×10^{-4}	1.9×10^{-4}

normal operations is due to calculated levels of direct radiation from storage casks at the shipyards. The environmental releases that were used to calculate the water pool values in the table are based on measured releases from the existing Expanded Core Facility at the INEL. Also, the way in which direct radiation or environmental releases impact the population would be a function of the population distribution and the meteorological conditions present at the release location. To account for these differences, actual data on the population and meteorology for the various specific sites were used. The data in Table 3-2 are for a typical year in the future when the situation has stabilized at each location (that is, capabilities consistent with those described for the stated alternative have been achieved and are in operation at a facility at the indicated site).

All alternatives have some estimated number of fatalities, albeit a very small fraction. The lowest estimated number of cancer fatalities is associated with the 1992/1993 Planning Basis, Regionalization at INEL, and Centralization - INEL alternatives. The largest single estimate for the total number of cancer fatalities is only 0.00038 per year for the Decentralization - Full Examination alternative. Another way to view this is that if this alternative is selected and operations continue for 10,000 years, between three and four extra cancer fatalities might be expected in that entire time period due to normal operations.

3.7.3 Impacts Due to the Most Severe Accidents

Accidents may occur during operation of naval spent nuclear fuel handling and storage facilities and during transportation of naval spent nuclear fuel. Specific accidents considered to be more severe than all other reasonably foreseeable accidents were analyzed to determine their potential impacts on the general population. For sites with spent fuel storage in water pools, the facility accident analyzed was a drained water pool or an accidental criticality since these produced the greatest consequences. For sites with dry spent fuel storage, the facility accident analyzed was an airplane crash if its probability was greater than 1×10^{-7} per year (1 chance in 10 million per year); otherwise, a wind-driven missile was the accident analyzed. Details of analyses of foreseeable accidents which might occur during fuel handling and storage are described in Attachment F. Details of the transportation accident analyses are described in Attachment A.

In Table 3-3, the potential impacts of facility and transportation accidents with the greatest consequences are expressed in terms of fatal cancers per accident. These are calculated by using the relation that 0.0005 cancer fatalities could occur for each person-rem of exposure for the general population. The impacts are based on hypothetical occurrences of the accidents and do not reflect the very low probabilities of the accidents actually occurring. For each alternative, the maximum impact of either a facility or transportation accident is listed rather than a total of the individual impacts since it is reasonable that only one severe accident would occur at one time.

For facility accidents, the greatest potential impact is associated with dry spent fuel storage at the Pearl Harbor Naval Shipyard. This is due to an airplane crash into a dry storage container. For transportation accidents, the risks vary with the distances to be traveled, being least for the No Action and the Decentralization - No Examination alternatives which involve only minimal transportation to local storage.

Table 3-4 lists the most severe risks (probability of occurrence times the number of fatal cancers) from facility accidents in terms of potential cancer fatalities per year.

3.7.4 Cumulative, Socioeconomic, and Cost Impacts

A summary of the estimated cumulative impacts from the radiological operations associated with each of the alternatives evaluated in detail is presented in Table 3-5. It is based on achieving a stable level of operation by 1995 for any given alternative. The impacts are expressed as fatal cancers to the population within 80 kilometers (50 miles) and apply to the reasonably foreseeable impacts for the 40-year period ranging from 1995 to 2035. The impacts were based on annual results for normal operations multiplied by 40. The impacts due to both wet and dry storage are presented. For the cumulative effect of storage at Navy shipyards and prototypes, the sum over all the Navy sites was used to provide a comparison for the same amount of fuel. The total for each alternative was then calculated by summing the fatal cancers for transportation, receipt and examination operations, and storage. The results show that the impacts for all alternatives would be negligible.

Table 3-3. Most severe consequences (fatal cancers to the general population) from an accident.*

Alternative	INEL ⁽¹⁾	Puget Sound ⁽²⁾	Pearl Harbor ⁽³⁾	Portsmouth ⁽³⁾	Norfolk ⁽³⁾	Kesselring ⁽³⁾	Transportation	Maximum
1. No Action*	-	0.017	26	9.0	16	7.5	0.013	26
2. Decentralization								
• No Exam								
- Dry Storage	-	0.017	26	9.0	16	7.5	0.013	26
- Water Pool Storage	-	0.51	1.1	0.34	0.60	0.25	0.013	1.1
• Limited Exam								
- Dry Storage	-	0.017	26	9.0	16	7.5	0.065	26
- Water Pool Storage	-	0.51	1.1	0.34	0.60	0.25	0.065	1.1
• Full Exam								
- Dry Storage	0.017	0.017	26	9.0	16	7.5	1.7	26
- Water Pool Storage	0.017	0.51	1.1	0.34	0.60	0.25	1.7	1.7
Alternative	INEL ⁽¹⁾	Hanford ⁽¹⁾	Savannah River ⁽⁴⁾	NTS ⁽⁴⁾	ORR ⁽⁴⁾		Transportation	Maximum
3. 1992/1993 Planning Basis	0.017	-	-	-	-		2.1	2.1
4/5. Regionalization or Centralization								
• INEL	0.017	-	-	-	-		2.1	2.1
• Hanford	-	0.047	-	-	-		2.1	2.1
• S. River	-	-	4.8	-	-		2.1	4.8
• NTS	-	-	-	0.18	-		2.1	2.1
• ORR	-	-	-	-	8.4		2.1	8.4

+ Based on accidents with a probability of occurrence of 1×10^{-7} or greater.

* Dry storage is the only option considered under the No Action alternative.

(1) The most severe accident is a drained water pool.

(2) The most severe accident involving storage or examination in a water pool is a drained water pool.

For the dry storage alternatives, the most severe accident is mechanical damage from a wind-driven missile. The limited exam - dry storage option at Puget Sound also includes examination in a water pool; the consequences shown for this option are due to accidents occurring during dry storage operations only.

(3) The most severe accident is from a plane crash for dry storage and a drained water pool for water pool storage.

(4) The most severe accident is from a plane crash.

Table 3-4. Most severe risk to the general population from a facility accident.

Alternative		INEL ⁽¹⁾	Puget Sound ⁽²⁾	Pearl Harbor ⁽³⁾	Portsmouth ⁽³⁾	Norfolk ⁽³⁾	Kesselring ⁽³⁾	Maximum
1.	No Action	-	1.7×10^{-7}	2.6×10^{-4}	9.0×10^{-7}	1.6×10^{-5}	7.5×10^{-7}	2.6×10^{-4}
2.	Decentralization							
	• No Exam							
	- Dry Storage	-	1.7×10^{-7}	2.6×10^{-4}	9.0×10^{-7}	1.6×10^{-5}	7.5×10^{-7}	2.6×10^{-4}
	- Water Pool Storage	-	5.1×10^{-6}	1.1×10^{-5}	3.4×10^{-6}	6.0×10^{-6}	2.5×10^{-6}	1.1×10^{-5}
	• Limited Exam							
	- Dry Storage	-	1.7×10^{-7}	2.6×10^{-4}	9.0×10^{-7}	1.6×10^{-5}	7.5×10^{-7}	2.6×10^{-4}
	- Water Pool Storage	-	5.1×10^{-6}	1.1×10^{-5}	3.4×10^{-6}	6.0×10^{-6}	2.5×10^{-6}	1.1×10^{-5}
	• Full Exam							
	- Dry Storage	1.7×10^{-7}	1.7×10^{-7}	2.6×10^{-4}	9.0×10^{-7}	1.6×10^{-5}	7.5×10^{-7}	2.6×10^{-4}
	- Water Pool Storage	1.7×10^{-7}	5.1×10^{-6}	1.1×10^{-5}	3.4×10^{-6}	6.0×10^{-6}	2.5×10^{-6}	1.1×10^{-5}
Alternative		INEL ⁽¹⁾	Hanford ⁽¹⁾	Savannah River ⁽⁴⁾	NTS ⁽⁴⁾	ORR ⁽⁴⁾	Maximum	
3.	1992/1993 Planning Basis	1.7×10^{-7}	-	-	-	-	1.7×10^{-7}	
4/5.	Regionalization or Centralization							
	• INEL	1.7×10^{-7}	-	-	-	-	1.7×10^{-7}	
	• Hanford	-	4.7×10^{-7}	-	-	-	4.7×10^{-7}	
	• S. River	-	-	9.6×10^{-6}	-	-	9.6×10^{-6}	
	• NTS	-	-	-	7.2×10^{-8}	-	7.2×10^{-8}	
	• ORR	-	-	-	-	8.4×10^{-6}	8.4×10^{-6}	

* Dry storage is the only option considered under the No Action alternative.

(1) The most severe accident is from a drained water pool.

(2) The most severe accident involving storage or examination in a water pool is a drained water pool.

For the dry storage alternatives, the most severe accident is mechanical damage from a wind-driven missile. The limited exam - dry storage option at Puget Sound also includes examination in a water pool; the risks shown for this option are due to accidents occurring during dry storage operations only.

(3) The most severe accident is from a plane crash for dry storage and a drained water pool for water pool storage.

(4) The most severe accident is from a plane crash.

Table 3-5. Summary of cumulative impacts (fatal cancers to the general population).

Alternative	Fatal Cancers (1995-2035) ¹			
	Transport ²	Exam Operations ³	Storage ³ (Dry) [Wet]	Total (Dry) [Wet]
1. No Action	1.7 x 10 ⁻⁴	0	(9.0 x 10 ⁻⁴)**	(0.0011)**
2. Decentralization				
• No Exam	1.7 x 10 ⁻⁴	0	(9.0 x 10 ⁻⁴) [0.014]	(0.0011) [0.014]
• Limited Exam	4.2 x 10 ⁻⁴	0.0026	(9.0 x 10 ⁻⁴) [0.011]	(0.0039) [0.014]
• Full Exam	0.0017	3.4 x 10 ⁻³	(9.0 x 10 ⁻⁴) [0.014]	(0.0026) [0.015]
3. 1992/1993 Planning Basis	0.0011	3.4 x 10 ⁻³	*	0.0011
4/5. Regionalization or Centralization				
• INEL	0.0011	3.4 x 10 ⁻³	*	0.0011
• Hanford	0.0024	1.6 x 10 ⁻⁴	*	0.0026
• Hanford/FMEF	0.0024	1.6 x 10 ⁻⁴	*	0.0026
• S. River	0.0060	7.2 x 10 ⁻⁴	*	0.0067
• S. River/Barnwell Plant	0.0060	7.2 x 10 ⁻⁴	*	0.0067
• Nevada Test Site	0.0030	3.6 x 10 ⁻⁶	*	0.0030
• Oak Ridge Reservation	0.0055	0.0020	*	0.0075

Notes:

1 Fatal cancers for 1958-1995 were calculated to be about 0.001 for transport and ECF operations.

Fatal cancers were calculated at 5.0 x 10⁻⁴ fatal cancers per person-rem.

2 Values from Attachment A.

3 Values from Attachment F.

*DOE storage, not NNPP.

**There is no wet storage under the No Action alternative.

The historical impact of transportation and ECF operations for the period ranging from 1958 to 1995 was calculated to be about 0.001 fatal cancers. This is the total number of fatal cancers that are estimated among the several million people along transportation routes coupled with the 116,000 people located within 50 miles of INEL. This estimate was based on the calculated incident-free transportation results from Attachment A, and the calculated results of normal operations and storage from Attachment F. The calculated results from Attachment F were adjusted from an annual basis (1995) to the historical basis by multiplying by 38 years and by a factor of 1.7 to take into consideration the variations in the number of ships and operations. No extra factor was applied to the estimates of the historical impact or the future impact to account for the vulnerabilities that might be associated with facility or spent fuel aging because naval spent nuclear fuel is very strong and has very high integrity (Section 2.2), and historical experience has disclosed no important vulnerability. The factor of 1.7 represents the ratio of the average to the current radiation exposures received by all military and civilian personnel in the Naval Nuclear Propulsion Program during the historical period (NNPP 1993a). In the case of the Limited Examination alternative, the analysis includes both the material shipped to Puget Sound for examination and storage, as well as the material stored there and at other sites from defuelings without examination.

Table 3-6 presents the cumulative impact from the radiological operations to a hypothetical maximally exposed worker and a hypothetical maximally exposed individual at the site boundary. The impacts are presented in terms of the likelihood of fatal cancer for the affected individual. These values were determined based on a projected 40-year exposure at the location of the affected individual. The radiological doses for workers represent the largest average dose from the particular facilities involved in an alternative. The average radiation dose for workers was selected by using the 1992 annual average shipyard or DOE site radiation exposure summaries (NNPP 1993b; NNPP 1993c). The radiological doses for maximum off-site individuals are the largest values calculated for a person located at the site boundary, closest to any facility involved under an alternative. These doses are based on the values for these individuals presented in Attachment F.

Employment impacts were determined from the nature of each alternative based on the experience at INEL. Table 3-7 presents a summary of potential socioeconomic impacts at each of the various sites for each of the alternatives evaluated in detail. The results indicate that as many as 500 long-term jobs and several hundred shorter-term construction jobs might be lost or gained at an affected site depending on the alternative selected.

Table 3-6. Likelihood of fatal cancer from cumulative radiation dose.

		Maximally Exposed Worker		Maximally Exposed Individual	
		Total Radiation Dose (rem)	Likelihood of Fatal Cancer	Total Radiation Dose (rem)	Likelihood of Fatal Cancer
1.	No Action	4.7	0.0019	0.12	6.0×10^{-5}
2.	Decentralization				
	• No Exam	4.7	0.0019	0.12	6.0×10^{-5}
	• Limited Exam	4.7	0.0019	0.12	6.0×10^{-5}
	• Full Exam	4.7	0.0019	0.12	6.0×10^{-5}
3.	1992/1993 Planning Basis	3.4	0.0014	1.0×10^{-5}	5.0×10^{-9}
4/5.	Regionalization or Centralization:				
	• INEL	3.4	0.0014	1.0×10^{-5}	5.0×10^{-9}
	• Hanford	3.4	0.0014	9.6×10^{-6}	4.8×10^{-9}
	• Hanford/FMEF	3.4	0.0014	1.8×10^{-5}	9.0×10^{-9}
	• S. River	3.4	0.0014	1.9×10^{-5}	9.5×10^{-9}
	• S. River/Barnwell Plant	3.4	0.0014	1.5×10^{-4}	7.5×10^{-8}
	• Nevada Test Site	3.4	0.0014	1.4×10^{-5}	6.8×10^{-9}
	• Oak Ridge Reservation	3.4	0.0014	0.0040	2.0×10^{-6}

Table 3-7. Summary of potential socioeconomic impacts.

Alternative		Impacts Associated with the Affected Site						
		INEL	Hanford	Savannah River	Nevada Test Site	ORR	Five NNPP Sites	
							Exam.	Store
1.	No Action	Lose 500 jobs	No change	No change	No change	No change	No change	Add 50-100 jobs
2.	Decentralization							
	• No Exam	Lose 500 jobs	No change	No change	No change	No change	No change	Add 50-200 jobs
	• Limited Exam	Lose 500 jobs	No change	No change	No change	No change	Add 60 jobs at Puget Sound	Add 50-200 jobs
	• Full Exam	No change	No change	No change	No change	No change	No change	Add 50-200 jobs
3.	1992/1993 Planning Basis	No change	No change	No change	No change	No change	No change	No change
4/5.	Regionalization or Centralization							
	• INEL	No change	No change	No change	No change	No change	No change	No change
	• Hanford	Lose 500 jobs	Gain 500 perm. jobs and some const. jobs	No change	No change	No change	No change	No change
	• S. River	Lose 500 jobs	No change	Gain 500 perm. jobs and some const. jobs	No change	No change	No change	No change
	• Nevada Test Site	Lose 500 jobs	No change	No change	Gain 500 perm. jobs and some const. jobs	No change	No change	No change
	• Oak Ridge Reservation	Lose 500 jobs	No change	No change	No change	Gain 500 perm. jobs and some const. jobs	No change	No change

Cost impacts were estimated from the nature of each alternative based on experience at INEL. Table 3-8 presents a summary of the cost impacts for each of the alternatives evaluated in detail. The summary provides the costs which would be incurred from construction as well as transportation and operation costs over the next 40 years. In all alternatives, there would be large costs, ranging up to \$5.7 billion. For three of the alternatives involving continued operation of the ECF at INEL (1992/1993 Planning Basis, Regionalization at INEL, and Centralization at INEL), there would be only minor construction cost impact; however, the cost of continued ECF operation for an additional 40 years would be \$2.6 billion. The cost values considered in preparing Table 3-8 include facility construction costs ranging from zero for alternatives involving no new facilities to a high of \$800 million for those requiring a new facility with full examination capability. The transportation costs depend on destination and logistics and range from a low of \$10 million to a high of \$110 million. Fuel storage container costs range from a low of zero for those alternatives utilizing water pool storage to a high of \$3.2 billion for shipping containers on railcars for the No Action alternative. Also included are operating costs over 40 years ranging up to \$2.6 billion for the various alternatives, and Idaho ECF shutdown costs for those alternatives in which the present ECF is shut down.

The largest cost (\$3.8 to \$5.7 billion) would be needed for new storage facilities or containers in addition to the ECF operational costs under the Decentralization - Full Examination alternative. Approximately \$0.8 billion would be needed for the construction of new receipt, handling, and examination facilities at the alternative site if a Regionalization or Centralization alternative other than INEL were selected, thereby resulting in a cost of \$3.5 billion over 40 years of operation. Somewhat less than \$800 million would be needed for modifications to existing facilities if either of those options at Hanford or Savannah River were selected. Also, if the alternative involving the Barnwell Nuclear Fuel Plant at Savannah River were selected, additional funds would be needed to buy the Barnwell Plant as well as to modify it to meet the Program needs.

A hidden cost associated with the No Action alternative and two of the Decentralization alternatives is the loss or major reduction in the capability to examine naval spent nuclear fuel. Full examinations of naval spent nuclear fuel at the Expanded Core Facility at INEL have been conducted since 1957. The examinations are a critical aspect of the Naval Nuclear Propulsion Program's ongoing advanced fuel research and development program. The information derived from the examinations at ECF provides engineering data on nuclear reactor environments, material behavior, and design performance. These data contribute to the Naval Nuclear Propulsion Program in two very significant ways.

Table 3-8. Summary of cost impacts over 40 years.

	Cost (\$ Billions)
No Action	3.6
Decentralization	
- No Exam	1.5 - 3.4*
- Limited Exam	1.8 - 3.7*
- Full Exam	3.8 - 5.7*
1992/1993 Planning Basis	2.6
Regionalization or Centralization	
- INEL	2.6
- Hanford	3.4
- Savannah River	3.5
- Nevada Test Site	3.5
- Oak Ridge Reservation	3.5

* The cost varies under this alternative depending on the mode of storage. The most expensive options are those that use shipping containers for storage; the least expensive options are those that use immobile dry storage containers.

First, this information is used to support the design of new reactors having extended lifetimes. For example, such examinations have contributed to extending the life of naval fuel from 2 years for the first reactor core in USS NAUTILUS to over 20 years for the latest nuclear-powered warships. The ultimate goal is to develop naval nuclear fuel that lasts the life of the ship; this would mean that no refuelings would be needed. Longer-lived fuel allows fewer refuelings, saves money in the costs of fuel and in the costs of work on ships, makes ships available for longer periods of service, and creates less spent nuclear fuel. Second, information from these examinations has supported the operation of existing naval reactors by providing confirmation of proper design and allowing the fuel they contain to be used for the longest possible time.

Thus, the examinations of naval spent nuclear fuel are an integral part of the outstanding record of nuclear safety of the Naval Nuclear Propulsion Program. In over 4300 reactor-years of operation and more than 300 refuelings and defuelings of naval reactors, there has never been a nuclear reactor accident, criticality accident, or any release of radioactivity that has had a significant effect on the environment. Preventing release of radioactivity from the fuel is extremely important to the safety of the Navy personnel who operate the nuclear-powered warships since they must live aboard ship in close proximity to the reactor 24 hours a day.

While it is difficult to quantify the benefits of an outstanding safety record, increased core life yields an understandable economic gain. The gain is in a reduction in the number of reactor cores that must be procured and in the number of refuelings. Another gain is the increased on-line availability of nuclear-powered warships which is reflected in a decreased number of ships required. It is estimated that by achieving life-of-the-ship fuel and thus eliminating the need for any refuelings, a savings of approximately \$5 billion will accrue for a force structure of less than 100 ships. The improvement in life from 2 years to 20 years has already avoided the need to perform 15 refuelings over the lifetime of each ship and reduced that to a single refueling.

3.8 TRANSITION PERIOD

A transition period would be required before any of the alternatives considered for naval spent nuclear fuel management could be fully implemented, except for those which would resume the historical practice of shipping naval spent nuclear fuel to the Expended Core Facility at INEL, followed by transfer to the Idaho Chemical Processing Plant for storage. This transition period would

be needed to obtain the necessary additional funding and to build the necessary facilities and equipment.

For example, if the Record of Decision were to identify that the alternative of Centralization at Savannah River had been selected, a new Expanded Core Facility would have to be funded and built at the Savannah River Site before shipments of naval spent nuclear fuel from shipyards could be directed to Savannah River. Similarly, if the No Action alternative were selected, additional shipping containers would have to be built since the available shipping containers for naval spent nuclear fuel will all be filled and waiting at the shipyards in June 1995.

Impacts of all alternatives evaluated for naval spent nuclear fuel management are low. Thus, the impacts of combinations of alternatives would also be low. The Environmental Impact Statement focuses on impacts at the time of full implementation in order to simplify the discussion and to calculate ceilings for the impacts. By doing so, it assures that impacts greater than those analyzed would not occur if one alternative were used for a small fraction of the 40-year period followed by a shift to another alternative for the remainder of the 40 years. This section discusses a transition period which is believed to represent a rapid but practical shift from the situation in June 1995 to full implementation of the ultimate alternative selected in the Record of Decision. This transition period would be about the same length for any alternative.

It is expected that the transition period would consist of 3 years of shipments of containers from the shipyards or prototypes to ECF at INEL beginning with issue of the Record of Decision in June 1995. This would result in shipping to INEL the containers which had been filled and at the shipyards at that time. Many of the containers would then be emptied at ECF and returned to the shipyard where they would be reloaded. During this 3-year period, some of these containers would make a second trip to ECF at INEL for unloading after being returned to the shipyard. After these 3 years of shipments, no further shipments to INEL would be made, and the Expanded Core Facility at INEL would be shut down. The shipping containers would then be refilled during the next 3 years, but kept at the shipyards or shipped to the location of the new examination or storage facilities.

If an alternative which does not continue storage of naval spent nuclear fuel at INEL were selected, procurement and contract actions to implement the course of action selected in the Record of Decision would be initiated during these two 3-year periods. In accordance with the course of action selected in the Record of Decision, additional shipping containers or immobile dry storage casks

would be built or construction of water pools would be initiated at shipyards or a new ECF at a DOE site would be started. It is assumed that these procurements or construction would have proceeded sufficiently that the shift to the selected option would be in full swing at this time.

3.9 PREFERRED ALTERNATIVE FOR NAVAL SPENT NUCLEAR FUEL

The specific elements discussed in each category of environmental impacts have been evaluated to determine the Navy's preferred alternative for managing naval spent nuclear fuel until means for permanent disposition become available. The costs and mission impacts have also been considered in selecting a preferred alternative.

Environmental Impacts: This Environmental Impact Statement (EIS) documents the potential environmental impacts of each alternative for naval spent nuclear fuel management. It considers environmental impacts under normal operations and hypothetical accident conditions on resources such as water quality and wetlands, air quality, land use, and public health. This EIS considers a range of potential accident initiators, such as natural hazards, transportation, and fuel handling.

The analyses demonstrate that the environmental impacts of implementing any of the alternatives would be very small for both normal operations and accident conditions. All alternatives would result in radiological impacts well below established DOE safety performance goals (SEN-35-91) of one tenth of one percent of the risk of fatal cancers from all sources (including natural causes). The impacts from any of the alternatives in non-radiological areas would also be extremely small. The analysis results do not provide a basis to distinguish among the alternatives in most of these areas.

Socioeconomic Impacts: The socioeconomic impact of implementing each of the alternatives would differ somewhat. The primary determinant of socioeconomic impact of the alternatives considered is employment. Total nation-wide employment levels would not vary significantly among alternatives for managing naval spent nuclear fuel, and therefore do not seem to provide a basis to distinguish among the alternatives. The maximum impact on existing employment levels would arise from alternatives requiring development of new naval spent nuclear fuel examination capability at a DOE facility other than INEL while terminating these activities at INEL. Resuming current practices

of transporting naval spent nuclear fuel to the ECF at INEL for examination followed by transfer to the DOE for storage would result in the minimum disruption of employment levels.

Mission Impacts: Two important components of Naval Nuclear Propulsion Program operations are the safe management of naval spent nuclear fuel and support of the Navy's fleet of nuclear-powered warships. Based on the analyses in this EIS, all alternatives considered would allow safe storage of naval spent nuclear fuel until permanent disposition. However, some of the alternatives would not provide equal levels of Fleet support. Alternatives which limit or terminate naval spent nuclear fuel examination would severely impact ongoing research and development work. Naval spent nuclear fuel examination results are used to confirm the adequacy of design features, explore material performance, and confirm or adjust computer predictions of fuel performance. This information contributes to design and manufacturing of new naval reactor cores as well as understanding of operating ships. Of the alternatives allowing full examination at the INEL, Hanford Site, Savannah River Site, Oak Ridge Reservation, or Nevada Test Site, examination at the INEL would have the smallest mission impact due to the presence of existing facilities and equipment for performing this work, and the presence of a highly skilled work force, all of which would need to be relocated or reassembled if a new examination site were selected.

Cost Impacts: There are large differences in the costs associated with all alternatives. Few additional costs would be associated with continuing the historic practice of shipping naval spent nuclear fuel to INEL for examination, followed by transfer to the DOE for storage pending permanent disposition. Alternatives involving developing facilities for storage of naval spent nuclear fuel at naval shipyards or developing examination facilities at a DOE site other than INEL would involve billions of dollars in additional costs, relative to historic practices, without any discernible improvement in safety or reduced environmental impacts.

Based on the analyses presented in this EIS, the Navy prefers an alternative which resumes the historic, technically sound, and safe practice of conducting refueling and defueling of nuclear-powered warships and prototypes as planned, transporting naval spent nuclear fuel to the Expanded Core Facility at the INEL for full inspection and examination, and transferring naval spent nuclear fuel to the DOE for storage at that site. As summarized above, this preferred alternative avoids disruption of research and development work, minimizes disruption to existing employment levels and infrastructure, represents the lowest cost, and does not involve appreciable environmental impact.

This preferred alternative can be accommodated under the 1992/1993 Planning Basis, Regionalization, or Centralization at Idaho.

3.10 REFERENCES

- NCRP (National Council on Radiation Protection and Measurements), 1987, Report No. 95, *Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources*, National Council on Radiation Protection and Measurements, Bethesda, Maryland, December 30.
- NNPP (Naval Nuclear Propulsion Program), 1993a, Report NT-93-1, *Environmental Monitoring and Disposal of Radioactive Wastes from U.S. Naval Nuclear Powered Ships and their Support Facilities*, Washington, D.C., February.
- NNPP (Naval Nuclear Propulsion Program), 1993b, Report NT-93-2, *Occupational Radiation Exposure from U.S. Naval Nuclear Plants and Their Support Facilities*, Washington, D.C., February.
- NNPP (Naval Nuclear Propulsion Program), 1993c, Report NT-93-3, *Occupational Radiation Exposure from Naval Reactors Department of Energy Facilities*, Washington, D.C., March.
- NSC (National Safety Council), 1993, *Accident Facts*, 1993 Edition.

4. AFFECTED ENVIRONMENT

4.1 NAVY AND PROTOTYPE SITES FOR NAVAL SPENT NUCLEAR FUEL

4.1.1 PUGET SOUND NAVAL SHIPYARD: BREMERTON, WASHINGTON

4.1.1.1 Overview

The Puget Sound region lies in the northwest corner of Washington State as shown on Figure 4.1.1-1. The region is defined by the Olympic Mountain Range to the west and the Cascade Mountain Range to the east. The lowlands contrast dramatically with the mountains, with numerous channels, bays, and inlets on the inland sea that is Puget Sound. The Puget Sound Naval Shipyard is located inside the city limits of Bremerton, Washington at 47° 33' 30" north latitude and 122° 38' 8" west longitude. Bremerton is located in Kitsap County on the Sinclair Inlet 14 miles across Puget Sound west of Seattle and about 20 air miles northwest of Tacoma. Topography in the Bremerton area is characterized by rolling hills with an elevation range from sea level to +200 feet above mean sea level (msl) in West Bremerton and ranging up to ± 300 feet above msl in East Bremerton (area east of Port Washington Narrows). The predominant native vegetation in the area are douglas fir, cedar, and hemlock. Within a distance of 25 to 40 miles in a westerly direction from Bremerton, the Olympic Mountains rise to elevations of 4,000 to 7,000 feet. The higher peaks are covered with snow most of the year and there are several glaciers on Mount Olympus (elevation 7,954 feet). In an easterly direction and within a distance of 60 miles, the Cascade Range rises to average elevations of 5,000 to 7,000 feet with snowcapped peaks in excess of 10,000 feet.

Puget Sound Naval Shipyard is the largest activity of the Bremerton Naval Complex, which also includes the Fleet and Industrial Supply Center, Puget Sound and Naval Sea Systems Command Detachment, and Planning and Engineering for Repair/Alteration of Aircraft Carriers. Tenant activities include Naval Inactive Ship Maintenance Facility, Naval Reserve Center, and the Defense

Printing Service. Figure 4.1.1-2 provides a shipyard vicinity map, and Figure 4.1.1-3 illustrates the Puget Sound Naval Shipyard.

4.1.1.2 Land Use

Kitsap County has historically been a semi-rural county. Roughly 80 to 85 percent of Kitsap County's total area is either forest, farmland, or undeveloped. The city of Bremerton and the surrounding vicinity is the largest population and economic center in the county and therefore has a lower percentage of agriculture and undeveloped land. Most development in Kitsap County is clustered around the commercial nodes of Bremerton, Port Orchard, Bainbridge Island, Kingston, Poulsbo, Silverdale, and Gorst, and near the shorelines.

The second largest land use category is residential, which is further broken down into low and medium density housing. More land area is devoted to single-family (low density) residential than to multi-family (medium density) development in this area.

Other land use delineations are parks and open space; commercial, which includes industry; mining; and much of the Navy buildings. The nearby land uses are typical of an area developed to a moderate intensity. The area contains residential, commercial, industrial, educational, and recreational facilities. The local waters support recreational and commercial activities including regularly scheduled ferry traffic.

Bremerton Naval Complex includes a total of approximately 1,347 acres consisting of uplands and submerged lands. Puget Sound Naval Shipyard has 327 acres of upland and is highly developed. Puget Sound Naval Shipyard also owns about 338 acres of submerged tidelands. The waterfront dry dock area is the high-security portion of the shipyard where most production takes place. It includes production shops, administration, and some public works and supply functions. The upland area of the shipyard is the military support area which provides services to military personnel, including housing, retail goods and services, recreation, counseling, dental care, and other support services. The industrial support area in the southwestern portion of the shipyard includes several piers for homeported ships and inactive fleet, the power plant, warehouses, steel yard, public works shops, and parking.

STATE OF WASHINGTON

Figure 4.1.1-1. Location of Puget Sound Naval Shipyard within Washington.

Figure 4.1.1-2. Puget Sound Naval Shipyard vicinity map.

Figure 4.1.1-3. Puget Sound Naval Shipyard site map.

4.1.1.3 Socioeconomics

Bremerton is the largest city within Kitsap County. The major population centers in Kitsap County other than Bremerton include Port Orchard, Poulsbo, Silverdale, Bainbridge Island, and Kingston. Kitsap County also has two reservations: the Port Madison Indian Reservation governed by the Suquamish Tribe, and the Port Gamble Indian Reservation governed by the S'Klallam Tribe.

The region surrounding the shipyard, within 50 miles, contains a population of approximately 3 million. Figure 4.1.1-4 provides a population distribution rose centered on the shipyard and covering a 50-mile radius. During 1989, Kitsap County ranked 7th as the most populous county in the state (Washington SESD 1990). According to the 1990 census, Kitsap County was the fifth fastest growing county in the state with a 28.9% growth rate for the decade for a total population of 189,731. The most recent estimate (April 1992), puts Kitsap's population at 205,600. The Kitsap Regional Planning Council projects the number of inhabitants to reach 280,985 by the year 2010, an increase of 48.10% over the 1990 figure.

Kitsap County's economy is largely affected by the federal government. Government is Kitsap County's largest employment sector, with the federal government having the greatest impact. As of 1993, Puget Sound Naval Shipyard was the largest employer in the county, employing about 10,200 civilian personnel. In 1990, the government sector's share of county employment was approximately 45 percent. The retail trade and services sectors are the county's next highest employers. Many of the service industries, such as the growing number of engineering and management firms, directly or indirectly support the military. By 1989, the services sector accounted for 21 percent of employment in the county and the retail trade sector accounted for 20.5 percent (Navy 1991a).

The majority of the labor force that would be employed at the shipyard for construction and operation of the naval spent nuclear fuel area would be expected to reside within about 20 miles from the shipyard. The calculated total population, labor force, and employment within this region for the base year (1995) are presented in Table 4.1.1-1. Projections of employment and population for the years beyond 1995 have not been presented because, as discussed in Section 5, the number of additional jobs that might be created at the shipyard under any alternative could be small.

Table 4.1.1-1. Regional employment factors at Puget Sound Naval Shipyard.

Regional Employment	Regional Labor Force	Regional Population
492,900	527,000	979,070

There are seven port districts in the county. The Port of Bremerton is the largest, with Bremerton and Port Orchard within its boundaries. The Port of Bremerton owns Bremerton National Airport, Olympic View Industrial Park, marinas in downtown Bremerton and Port Orchard, and the First Street Dock in Bremerton. Kitsap County is governed by a Board of Commissioners and is divided into three districts. Bremerton is split between the three districts. Regional planning is the responsibility of the Kitsap Regional Planning Council, and the Puget Sound Regional Planning Council, which is made up of elected officials from King, Kitsap, Pierce, and Snohomish counties and cities, and from the Indian tribal councils. Land use outside the shipyard is regulated by the city of Bremerton Comprehensive Plan and Zoning Ordinance. The Bremerton Area Council of Neighborhoods is made up of nine neighborhoods. The group was established to encourage citizen participation in Bremerton city planning (Navy 1991a).

Agencies responsible for environmental protection are the U.S. Army Corps of Engineers, U.S. Coast Guard, the Environmental Protection Agency (EPA), and the United States Fish and Wildlife Service (USFWS). The Washington State Department of Ecology and the city of Bremerton are responsible for the Coastal Zone Management Plan. The Department of Natural Resources has jurisdiction over marine lands management, and the Department of Fisheries and Department of Game protect wildlife resources. Washington's system of freeways, highways, and ferries is the responsibility of the Washington State Department of Transportation. Historic preservation programs for the state are administered by the Office of Archaeology and Historic Preservation.

4.1.1.4 Cultural Resources

Until the mid 1880s, Kitsap County was inhabited by several Native American tribes of the Salish language group who lived on the shores of Puget Sound. For about 100 years, the principal settlement of the Suquamish Tribe lay along the west shore of Agate Passage.

Miles	People	Cumulative People
0-5	90,353	90,353
5-10	65,589	155,942
10-20	823,124	979,066
20-30	1,254,058	2,233,124
30-40	549,636	2,782,760
40-50	193,050	2,975,810

Based on 1990 Census

Figure 4.1.1-4. 50-mile population distribution around Puget Sound Naval Shipyard.

Congressional funding in 1891 led to the purchase of 190 acres of land on Sinclair Inlet for the construction of a dry dock, repair, and overhaul base for the U.S. Navy. This base was called the Puget Sound Naval Station.

No prehistoric archaeological sites have been identified at the Puget Sound Naval Shipyard. In addition, no submerged cultural resources have been recorded in the immediate vicinity of the shipyard. There are no Native American properties or ceremonial sites in the areas where spent nuclear fuel would be stored.

There is one National Historic Landmark and four National Registered Historic Districts within the shipyard. The east industrial portion of the shipyard was designated as a National Historic Landmark in 1992 as a part of the "World War II in the Pacific" group and contains buildings, piers, dry docks, and equipment that were used in World War II warship repairs. The four Historic Districts are: Officer's Row, Old Puget Sound Radio Station, Old Naval Hospital, and the Old Marine Reservation.

4.1.1.5 Aesthetic and Scenic Resources

The Puget Sound region offers a striking contrast in terrain, with mountains; low, rolling hills; flat-topped ridges; and plateaus. These areas are separated by numerous channels, bays, inlets, lakes, and valleys. The shoreline along the county is characterized by moderate to steep irregular cliffs. The county has large areas of farmlands and forest.

The city of Bremerton and the Puget Sound Naval Shipyard are urbanized areas. The shipyard has an industrialized character along the shoreline, with parking areas, dry docks, warehouses, and ship traffic along Sinclair Inlet. The upland section of the shipyard contains housing, recreational facilities, and retail businesses. Chainlink fences mark the shipyard boundaries. The area within the shipyard where the naval spent nuclear fuel would be stored has low visual sensitivity since the area is an industrial site.

4.1.1.6 Geology

4.1.1.6.1 General Geology. The Kitsap Peninsula consists of several geological phenomena which have occurred over the past 60 million years. The upper layers of rock are generally underlain by hard, dense, fine-grained lava with an accumulation of several thousand feet (in most places) of marine sedimentary rocks above the lava flows. Uplifting of the Cascade and Olympic Mountain ranges caused the Kitsap Peninsula and other Puget Trough lowlands to become sites of deposition for sedimentary materials washed down from the surrounding ranges. More recently, glaciation, as well as erosion, have been responsible for carving the low, hilly, rolling topography of the area (Navy 1991a). The following geological discussion was obtained from "Site Inspection Report Puget Sound Naval Shipyard" (URS 1992).

Puget Sound Naval Shipyard is within the Puget Sound Lowland between the Olympic Mountains and the older Cascade Mountains to the east. Before the glaciation which occurred up to 1.7 to 2.2 million years ago, the Puget Sound Lowland probably contained a large river valley draining to the north and west into what is now the Strait of Juan de Fuca. Glaciation of the Puget Sound Lowland produced the arms and embayments of Puget Sound.

4.1.1.6.2 Geologic Resources. Geological materials found in Puget Sound include hard, dense volcanic rock formed up to 63 to 65 million years ago, and fragmented sedimentary rocks, as well as unconsolidated sediments deposited by glaciers up to 1.7 to 2.2 million years ago. At least four separate glacial advances and accompanying periods between glaciers have been hypothesized for the Puget Sound Lowland. Soil layers deposited by glaciers are generally coarse sand and gravel, sand, silt from lakes, and low-permeability deposits left by glaciers. The soils from the periods between glaciers are generally fine-grained silts and sands deposited by rivers or lakes, interbedded with lenses of sand and gravel.

Most of the geologic material in Kitsap County is glacial deposits. The Kitsap Peninsula is the remnant of a plain formed from the debris deposited by glaciers. Volcanic bedrock outcrops near the south end of Sinclair Inlet and at Gold Mountain south and west of Bremerton. Sedimentary bedrock outcrops on the south end of Bainbridge Island and at the adjacent tip of the peninsula east of Bremerton.

Kitsap County has four basic soil types: soils underlain by cemented hard-packed subsoil or bedrock substrate; soils with permeable, distinctly stratified sublayers which are coarse and have good internal drainage; the organic soils represented by small, widely scattered areas of peat and muck; and soils having little or no agricultural or building potential. Typical landforms include rough mountainous land, steep broken land, coastal beaches, and tidal marshes.

The natural topography of the shipyard has been altered substantially from its original condition. Portions of the upland areas of the complex were cut to fill marshes and create level land. The resulting fill material was predominantly a silty, gravelly sand with occasional pockets of silts and clays. The surface of the filled areas is a solid layer of earth. The remaining areas of natural soils vary from dense deposits from glaciers to soft bay mud and peat. The upland soil is a stiff hard-packed clay soil with low permeability. (URS 1992)

There are no economic geologic resources at the shipyard.

4.1.1.6.3 Seismic and Volcanic Hazards. Seismic risk related to structural damage may be represented in the United States by a relative scale of 0 through 4, with Zone 0 not expected to encounter damage and Zone 4 expected to encounter the greatest seismic risk. The Puget Sound Naval Shipyard is located in Zone 3. (UBC 1991) The Uniform Building Code seismic classification provides a means for a comparable assessment of the seismic hazard between the alternate sites. If the Record of Decision identifies this site for the interim storage of naval spent fuel, then a detailed seismic evaluation would be conducted. More detailed information regarding the design basis considerations for storage of naval spent nuclear fuel at the shipyard is provided in Attachment D.

The largest probable earthquake which could be expected in the Central Puget Sound area could have a magnitude of up to 7.5 on the Richter scale. There have been approximately 200 earthquakes since 1840, most of which caused little or no damage. The most recent earthquakes of high magnitude in the region were near Olympia (approximately 40 miles from Bremerton) in 1949 (7.1 on the Richter scale) and near Seattle in 1965 (6.5 on the Richter scale). Additional details are provided in "Seismic Design Study - Water Pit Facility, Puget Sound Naval Shipyard, Bremerton, Washington" (Navy 1978).

There is no known fault line within 3000 feet of the Bremerton Naval Complex; however, two known fault traces have been identified in Kitsap County. The Kingston-Bothell trace, in the

northern portion of the county, and the Seattle-Bremerton trace, located a few miles north of Bremerton. There has been no known surface faulting in conjunction with earthquakes in the shipyard region.

Potential hazards from volcanism are minimal and limited to wind-borne volcanic ash. Both the distance of the shipyard from the Cascade vents and the configuration of the intervening topography exclude other volcanic hazards. Only ash from a "large" or "very large" eruption would reach the shipyard. The 1980 eruption of Mount St. Helens, Washington, approximately 120 miles south of the shipyard, resulted in a very slight coating of ash at the shipyard.

The potential hazard from large waves generated by volcanoes or earthquakes is minimal (Navy 1978). The system of straits and inlets surrounding Puget Sound provides a natural barrier for the Puget Sound Area, which effectively dampens the propagation of distantly generated large waves. The risk of a local large wave generated by seismic events occurring that would affect the shipyard is highly unlikely. Because the largest earthquakes of record in the area are deep seated (more than 60 kilometers (37 miles)), and no major surface rupture is known to have occurred, the hazard of generation of a large wave by a local earthquake is minimal. The potential for landslide-generated waves is controlled by the geologic conditions; however, development of an earthquake-induced landslide of sufficient size to create a large wave is not expected.

A more detailed description of the regional geology and seismicity is documented in "Seismic Design Study - Water Pit Facility, Puget Sound Naval Shipyard, Bremerton, Washington" (Navy 1978).

4.1.1.7 Air Resources

4.1.1.7.1 Climate and Meteorology. The general meteorological conditions of the Puget Sound area are typical of a marine climate, since the prevailing air currents at all elevations are from the Pacific Ocean. The relatively cool summers, mild winters, and wetness characteristic of a marine climate are enhanced by the presence of Puget Sound. The area tends toward damp, cloudy conditions much of the year. The Cascade Range to the east serves as a partial barrier to the temperature extremes of the continental climate of eastern Washington.

The normal annual precipitation near Bremerton is 38.33 inches. The rainy season extends from October to March and accounts for more than 75 percent of the yearly precipitation.

The mean annual temperature is 51.4°F. Normally, January is the month with the lowest average temperature of 39°F and July is the month with the highest average temperature of 64.5°F.

The average annual mean wind speed at the Seattle-Tacoma Airport is 9.0 miles per hour (mph), with a recorded maximum speed of 1-minute duration of 49 mph. Prevailing winds are from the southwest.

The mean annual relative humidity at the Seattle-Tacoma Airport at 4:00 a.m. (PST) is 83 percent, decreasing to 62 percent by 4:00 p.m. There is an average of 43.4 days per year that fog reduces visibility to 0.25 mile or less. The mean annual percent of possible sunshine is 46 percent. The month with the greatest mean percent of possible sunshine is July with 65 percent and the month with the least is December with 21 percent (Navy 1991a).

4.1.1.7.2 Air Quality. An area can be designated by the Environmental Protection Agency as having air quality that is better than defined by the National Ambient Air Quality Standards (attainment) or as exceeding one or more of those standards (nonattainment for one or more pollutants). The Code of Federal Regulations, Title 40, Part 81, states that the Air Quality Control Region for the shipyard is better than national standards for total suspended particulate matter and SO₂. The area has no specific classification for ozone, carbon monoxide, and NO₂. The nearest Class I Area is the Olympic National Park, approximately 24 kilometers (15 miles) from the shipyard.

4.1.1.7.3 Existing Radiological Conditions. Radiological facilities at all naval shipyards are designed to ensure that there are no uncontrolled discharges of radioactivity in airborne exhausts. Radiological controls are exercised to preclude exposure of working personnel to airborne radioactivity exceeding federal limits. Air exhausted from radiological work facilities is passed through high-efficiency particulate air filters and monitored during discharges. The annual airborne radioactivity emissions from the shipyards do not result in any measurable radiation exposure to the general public. Calculations of site radioactive airborne emissions for 1992 have been performed as described in Attachment F. These calculations have shown that emissions of radionuclides from each shipyard result in an effective dose equivalent of less than 0.1 mrem per year to any member of the general public.

4.1.1.8 Water Resources

4.1.1.8.1 Surface Water. Numerous freshwater sources are found in Kitsap County, with numerous lakes dotting the county's landscape. Kitsap Lake, in west Bremerton, is one of the largest at 238 acres. Lakes and reservoirs are used for recreation and other public uses. Water for the city of Bremerton comes from surface and groundwater supplies.

Freshwaters in the Bremerton area are monitored by the Washington State Department of Ecology. Puget Sound Naval Shipyard has no important surface freshwaters.

Sinclair Inlet is located in Puget Sound. It is a narrow body of marine water approximately 1.1 miles wide at its widest point and approximately 3.5 miles long. A majority of the shoreline of Sinclair Inlet has been developed. The dominant feature is the shipyard, lying on the northern shore. The city of Port Orchard borders the southern shore. Localized areas of Sinclair Inlet contain toxic chemicals as a result of historic urban and industrial activities. Contaminants of concern include polychlorinated biphenyls (PCBs); polycyclic aromatic hydrocarbons (PAH); and toxic metals, such as chromium and mercury (Tetra Tech 1990). Fish taken from these localized areas show elevated concentrations of PCBs, mercury, and chromium.

Puget Sound tides are of the twice-daily, mixed type with two unequal highs and two unequal lows per day. Tides in the inlet are similar to those in Seattle, the primary reference station. The principal forces that produce currents in Sinclair Inlet are tidal. Generally, weak currents oscillate in direction moving water in and out of the inlet. The flushing capacity of the inlet is low due to low freshwater input (Navy 1991a).

Based on Flood Insurance Rate Map (FIRM) COMMUNITY-PANEL No. 530093 0015 and topographical maps, the Puget Sound Naval Shipyard is not in the 100 or 500 year floodplain.

4.1.1.8.2 Groundwater. Groundwater is generally found within 100 feet of the ground surface in sand and gravel layers caused by material from receding glaciers. The rate of groundwater recharge in Kitsap County is estimated to be approximately 12 inches annually, equating to approximately 0.5 million gallons per day per square mile. The nature of the geology in the area is such that a well in almost any location can tap a number of aquifers at different depths. The quality of most

groundwater near Bremerton is good. Groundwater is used for approximately 35 percent of the public water supply for Bremerton. Groundwater at Puget Sound Naval Shipyard is poor due to salinity caused by intrusion from Sinclair Inlet. (Navy 1991a).

4.1.1.8.3 Existing Radiological Conditions. The normal activities associated with current naval nuclear operations at all naval shipyards do not result in the intentional discharge of any radioactive liquid effluent. However, there were occasions, primarily in the early 1960's, when measurable levels of radioactivity were discharged with liquid effluent. In all cases, effluent releases were less than permitted under the then current limits imposed by state and federal agencies.

The United States Environmental Protection Agency Office of Radiation Programs has performed monitoring of the water, plant life, aquatic life, and sediment in the vicinity of Puget Sound Naval Shipyard to confirm that the general public is not affected by operations of Puget Sound Naval Shipyard. "Radiological Surveys of Naval Facilities on Puget Sound" (Lloyd and Blanchard 1989) discusses the most recent Environmental Protection Agency monitoring data. Pertinent conclusions are as follows:

1. "A trace amount of cobalt-60 (0.04 pCi/g +/- 0.01 pCi/g) was detected in one sediment sample at PSNS. All other radioactivity detected in the 80 sediment samples is attributed to naturally occurring radionuclides or fallout from past nuclear weapons tests and the Chernobyl reactor accident in 1986."
2. "Results of core sampling did not indicate any previous deposit of cobalt-60 in the sediment."
3. "Water samples contained no detectable levels of radioactivity other than those occurring naturally."
4. "External gamma-ray measurements did not detect any increased radiation exposure to the public above natural background levels."
5. "Based on the current radiological surveys, shipyard and nuclear-powered warship operations have resulted in no increases in radioactivity that would result in major population exposure or contamination of the environment."

Environmental monitoring is conducted by the shipyard. The results of this monitoring program corroborate the Environmental Protection Agency's conclusions.

4.1.1.9 Ecological Resources

4.1.1.9.1 Terrestrial Ecology. Vegetation and wildlife on Puget Sound Naval Shipyard are limited to "open spaces," noncontiguous, undeveloped areas which comprise approximately 46 acres of the entire Bremerton Naval Complex (Navy 1991a). Most of these areas have been previously disturbed and are currently landscaped with native and ornamental trees and shrubs.

Tree species include Douglas fir (Pseudotsuga menziesii), vine maple (Acer circinatum), big leaf maple (Acer macrophyllum), western red cedar (Thuja plicata), madrone (Arbutus menziesii), and western hemlock (Tsuga heterophylla). There are various types of thick underbrush present such as salal (Gaultheria shallon), sword fern (Polystichum sp.), Oregon grape (Berberis nervosa), and rhododendron (Rhododendron spp.) (Navy 1986).

Because of its location on the Pacific flyway, Puget Sound exhibits a diverse avifauna from an influx of seasonal migrants. Many of the migrants, particularly waterfowl, remain and overwinter in the sound because of the mild climate, abundance of bays and coves, and the availability of food. Due to the extensive industrial nature of the shipyard, its resident bird community is characterized by "urban species." Resident bird species include Stellar's jay (Cyanocitta stelleri), starling (Sturnus vulgaris), flicker (Colaptes spp.), American crow (Corvus brachyrhynchos), black-capped chickadee (Parus atricapillus), goldfinch (Spinus tristis), pigeon (Columba fasciata), robin (Turdus migratorius), golden-crowned kinglet (Regulus satrapa), evening grosbeak (Hesperiphona vespertina), and ring-necked pheasant (Phasianus colchicus) (Navy 1986). In addition, numerous glaucous-winged gulls (Larus glaucescens) inhabit the waterfront areas.

Although abundant mammal populations originally existed in the Puget Sound area, the current populations of mammals at the shipyard are extremely limited. The only mammals currently reported at the shipyard are gray squirrels (Sciurus griseus), mice, and shrews (Navy 1990a).

With few exceptions, reptiles and amphibians are not particularly abundant in the Puget Sound area. The lack of suitable habitat restricts the population of reptiles and amphibians at the shipyard to garter snakes, salamanders, newts, and frogs (Navy 1990a).

No environmental concerns associated with vegetation or wildlife have been identified at the shipyard.

4.1.1.9.2 Wetlands. There are no freshwater wetlands on the shipyard. There are no streams, rivers, ponds, or lakes located on the shipyard (Navy 1986). The majority of the shipyard is developed and covered with an impervious surface. The shipyard does own 338 acres of water area (deep-water tidal property) along the waterfront.

4.1.1.9.3 Aquatic Ecology. Salt marsh and brackish marsh communities formerly existed along much of the shoreline of Puget Sound. For a number of years, these areas were perceived as swampy wastelands and thousands of acres were diked, drained, and reclaimed.

The original landform of the shipyard has been greatly altered to accommodate its continuing development. Projects have increased the usable land by filling in the marsh area in the northwest corner and by extending the shoreline with quaywalls and landfill. The shoreside of the shipyard consists primarily of riprap, concrete bulkheads, and old wooden piers. Marine vegetation along the shipyard shoreline consists primarily of sea lettuce (Ulva lactuca), rockweed (Fucus distichus), and debris of algae that have been dislodged from their subtidal moorings and carried inshore. There are no waterfront areas at the shipyard that have clam beds, eelgrass, kelp beds, or similar habitat (Navy 1986).

Resident fish populations inhabiting the shipyard intertidal shoreline include sculpins (Cottidae), surf perch (Embiotocidae), and flatfish (Pleuronectidae). Migratory fish species include Pacific salmon (Oncorhynchus spp.), sea-run cutthroat trout (Oncorhynchus clarki), Pacific tomcod (Microgadus proximus), Pacific cod (Gadus macrocephalus), Pacific herring (Clupea harengus pallasii), rockfish (Sebastes spp.), and two or three species of migratory smelt (Osmeridae) (Navy 1986). There is near-shore migration of juvenile salmon and other fish species annually, from March 15 to June 15. Herring mill in the vicinity of the shipyard from January 20 through April 15 (Navy 1991a). No recreational or commercial fishing is allowed within the confines of the shipyard.

4.1.1.9.4 Endangered and Threatened Species. As required under Section 7 of the Endangered Species Act of 1973, the responsible agency of a major federal action must conduct a biological assessment to identify any endangered or threatened species which are likely to be affected by such action. The United States Fish and Wildlife Service had previously provided a list of endangered and threatened species that may be in the Bremerton area (Navy 1991a). The list included one species, the bald eagle (Haliaeetus leucocephalus). Wintering bald eagles may occur in the Bremerton area from about October 31 through March 31.

Bald eagles are regularly seen along most of the inland waters of Puget Sound. Eagles are active during the day and feed on a variety of animals (preferring fish or waterfowl) and carrion. They nest and rest most often in conifers, choosing large, open-crowned trees near water (Navy 1991a). Eagles are capable of tolerating a certain amount of intrusion and change; however, they tend to seek privacy for rearing their young.

Although no eagles have been reported nesting on the shipyard, there are several active nests within 1 mile of the shipyard (Navy 1991a). Trees suitable for perching and roosting are found in the non-industrialized area at the shipyard, but not near the waterfront. Bald eagles may feed within Sinclair Inlet anywhere and at any time. It is not likely that eagles feed on fish near the shipyard on a regular basis because of the high level of human activity and the variability of fish populations. Eagles in this area feed primarily on seagulls and other birds (Navy 1991a).

Marine mammals are afforded full federal protection under the Marine Mammal Protection Act of 1972. Pinnipeds (seals and sea lions) and cetaceans (whales, dolphins, and porpoises) that regularly or occasionally are found in central Puget Sound include the Pacific harbor seal (Phoca vitulina), California sea lion (Zalophus californianus), killer whale (Orcinus orca), Dall porpoise (Phocoenoides dalli), and harbor porpoise (Phocoena phocoena) (Navy 1991a).

The National Marine Fisheries Service had previously provided a list of endangered and/or threatened species under its jurisdiction that may occur in Puget Sound waters in support of the "Final Programmatic Environmental Impact Statement Fast Combat Support Ship (AOE-6 Class) U.S. West Coast Homeporting Program" (Navy 1991a). The list included two endangered mammals, the gray whale (Eschrichtius robustus) and the humpback whale (Megaptera novaeangliae); one threatened mammal, the Steller sea lion (Eumetopias jubatus); and one endangered turtle, the leatherback sea turtle (Dermochelys coriacea).

None of the sensitive, threatened, or endangered species are represented in the aquatic life of the shipyard (Navy 1991a).

4.1.1.10 Noise

Puget Sound Naval Shipyard is an existing industrial-type environment characterized by noise from truck and auto traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related compressors for those and other liquids. In addition, new construction of buildings, reconstruction and rehabilitation activities for streets, buildings, parking lots, and ships all contribute to an industrial environment. Primary noise sources are located along the naval shore support facilities (piers and associated land-side facilities) and are dampened to the residential areas by the hills adjacent to the industrial area.

4.1.1.11 Traffic and Transportation

Primary regional land access to the Seattle/Tacoma/Bremerton area is achieved via two interstate highways, I-90 and I-5. Major transportation corridors in Kitsap County are based upon a network of state routes. The county's municipalities and population centers are accessed by State Routes (SR) 104, 303, 304, 305, and 308. The major thoroughfare in south Kitsap County is SR 16, which runs south from Bremerton to Tacoma and connects with I-5 in Tacoma.

Bremerton's primary access routes include SR 3, which is a major north-south thoroughfare that travels through western Bremerton; SR 303, which originates within Bremerton as Warren Avenue and continues through eastern Bremerton to Silverdale; SR 304, which travels through Bremerton as Callow Avenue, Burwell Street, and Washington Avenue; Kitsap Way, which turns into 6th Street within the city; 11th Street, which provides local east-west circulation; and Wycoff, Montgomery, and Naval avenues, which provide local north-south circulation. The proposed Gorst to Bremerton Connector is a road-widening project that will improve accessibility to downtown Bremerton from SR 3 and SR 16.

Kitsap Transit provides transportation service to various areas of Kitsap County including population centers, ferry docks, and other activity centers, through a Public Transit Benefit Authority.

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In addition, tours and charters are available locally through Cascade Trailways which also offers a twice daily scheduled run to Tacoma. Taxi service is also available throughout the Kitsap County area.

Bremerton National Airport, used for general aviation, is the largest of three airfields located in Kitsap County and is located near SR 3 south of Bremerton. The other two airfields in the county are Port Orchard Airport and Apex Airpark near Silverdale.

Two ferry systems provide services to the Bremerton area. The Washington State Ferry System provides numerous daily runs from Bremerton, Kingston, Bainbridge Island, and Southworth to the Seattle area. There is also a state ferry run in the northern part of the county connecting Kingston to Edmonds, Washington, north of Seattle. In addition to the cross sound service provided by the Washington State Ferry System, Horluck Transportation Company runs a passenger-only service connecting downtown Port Orchard to Bremerton.

Burlington Northern Railroad provides scheduled and on-demand freight rail service to a number of locations in the southern and central portions of Kitsap County. A Navy-owned spur line from Shelton, Washington, provides additional rail service to the shipyard and Bangor Naval Submarine Base.

Naval spent nuclear fuel has been removed from Navy nuclear-powered ships and transported to the Idaho National Engineering Laboratory Expanded Core Facility (ECF) for examination and evaluation as a routine part of their operating cycle. Starting in 1962, the naval spent nuclear fuel originating at Pearl Harbor Naval Shipyard was transported by ocean vessel to Puget Sound Naval Shipyard for subsequent rail shipment to ECF. From 1962 to the present, a total of 20 naval spent nuclear fuel shipments have been made from Pearl Harbor Naval Shipyard to Puget Sound Naval Shipyard, then on to ECF. In 1966, Puget Sound Naval Shipyard began removing naval spent nuclear fuel from Navy nuclear-powered ships and transporting it by rail to ECF. From 1966 to the present, a total of 114 shipments of naval spent nuclear fuel originating at Puget Sound Naval Shipyard have been made to ECF. Attachment A provides a list of the spent nuclear fuel shipments made to date by year and by originating shipyard. Attachment A also contains detailed descriptions of the shipping containers used for naval spent nuclear fuel shipments from shipyards.

Puget Sound Naval Shipyard has 23 miles of railroad tracks, 8 piers, 4 mooring sites, and 6 large dry docks.

4.1.1.12 Occupational and Public Health and Safety

4.1.1.12.1 Occupational Radiological Health and Safety. The Navy has well established and effective Occupational Safety, Health, and Occupational Medicine programs at all of its shipyards. In regard to radiological aspects of these programs, the Naval Nuclear Propulsion Program policy is to reduce to as low as reasonably achievable the external exposure to personnel from ionizing radiation associated with naval nuclear propulsion plants. These stringent controls on minimizing occupational radiation exposure have been successful. No civilian or military personnel at Navy sites have ever exceeded the federal accumulated radiation exposure limit which allows 5 rem exposure for each year of age beyond age 18. Since 1967, no person has exceeded the federal limit which allows up to 3 rem per quarter year and since 1980, no one has received more than 2 rem per year from radiation associated with naval nuclear propulsion plants. The average occupational exposure of each person monitored at all shipyards is 0.26 rem per year. The average lifetime accumulated radiation exposure from radiation associated with naval nuclear propulsion plants for all shipyard personnel who were monitored is 1.2 rem. (NNPP 1993a) This corresponds to the likelihood of a cancer fatality of 1 in 2083.

The Navy's policy on occupational exposure from internal radioactivity is to prevent radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by federal regulations for radiation workers. As a result of this policy, no civilian or military personnel at shipyards have ever received more than one-tenth the federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with naval nuclear propulsion plants.

For work operations involving the potential for spreading radioactive contamination, containments are used to prevent personnel contamination or generation of airborne radioactivity. The controls for contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into radiological areas because the contamination control limits used in these areas were well below the levels of fallout and natural contamination occurring outside in the general public areas. A basic requirement of contamination control is

monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves (i.e., frisk), and their performance is checked by radiological control personnel. Frisking of the entire body is required, normally using sensitive hand-held survey instruments. Major work facilities are equipped with portable monitors, which are used in lieu of hand-held friskers. These stringent controls to protect the workers and the public from contamination have proven effective in the past.

In 1991, researchers from Johns Hopkins University, Baltimore, Maryland, completed a very comprehensive epidemiological study of the health of workers at the six naval shipyards and two private shipyards that service the Navy's nuclear-powered ships (Matanoski 1991). This independent study evaluated a population of 70,730 civilian workers over a period from 1957, beginning with the first overhaul of the first nuclear-powered submarine, USS NAUTILUS, through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels of gamma radiation.

The Johns Hopkins study found no evidence to conclude that the health of people involved in work on U.S. naval nuclear-powered ships has been adversely affected by exposure to low levels of radiation incidental to this work. Additional studies are planned to investigate the observations and update the shipyard study with data beyond 1981.

The radiation exposure during normal operations at each shipyard for workers who have their radiation levels monitored is determined based on the annual radiation exposure of 0.26 mrem per worker for all shipyards based on Naval Nuclear Propulsion Program Report NT-93-2 (NNPP 1993a). The total number of shipyard personnel monitored for radiation exposure associated with the Naval Nuclear Propulsion Program has been about 164,000.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within DOE standards for occupationally

exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.1.12.2 Occupational Non-radiological Health and Safety. The shipyard has an occupational health/preventive medicine unit and a branch clinic (industrial dispensary) which are run by Naval Hospital Bremerton. Personnel may also be taken to Harrison Memorial Hospital as needed.

The shipyard maintains two fire stations with approximately 50 personnel. The shipyard has a fire department that is fully equipped for structural and industrial firefighting and hazardous material spill response.

The shipyard has a security force of approximately 177 personnel providing law enforcement services, emergency services, security clearances, and parking and traffic control for the Bremerton Naval Complex.

In the non-radiological Occupational Safety, Health, and Occupational Medicine area, the Navy complies with the Occupational Safety and Health Administration regulations. The Navy policy is to maintain a safe and healthful work environment at all naval facilities. Due to the varied nature of work at these facilities, there is a potential for certain employees to be exposed to physical and chemical hazards. These employees are routinely monitored during work and receive medical surveillance for physical hazards such as exposure to high noise levels or heat stress. In addition, employees are monitored for their exposure to chemical hazards such as organic solvents, lead, asbestos, etc., and where appropriate are placed into medical surveillance programs for these chemical hazards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

4.1.1.12.3 Public Radiological Health and Safety. In order to quantify the exposures resulting from normal shipyard radiological releases to the general public, detailed analyses were performed based on very conservative estimates of radioisotopic releases since releases began. Attachment F provides detailed annual release values used in the analyses.

The GENII computer code (Napier et al. 1988) was used to calculate exposures to human beings due to the estimated radionuclide releases from normal operations at the shipyards.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from stored fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F.

The hypothetical exposures calculated in Attachment F for the period 1995 through 2035 were adjusted from an annual basis (1995) to the historical basis by multiplying by 38 years and by a factor of 1.7 to take into consideration variations in the number of ships and operations.

The calculated accumulated exposures through 1995 to the general population within 50 miles of the site (about 3 million people) are 1.3 person-rem. To provide perspective, the exposures received due to natural radiation sources through 1995 are approximately 34 million person-rem, based on 0.3 rem per person per year.

The results of environmental monitoring as described in Naval Nuclear Propulsion Program Report NT-93-1 show that Naval Nuclear Propulsion Program activities had no distinguishable effect on normal background radiation levels at site perimeters (NNPP 1993b).

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities.

All of the radiation exposures to the general population correspond to much less than one incident cancer, which means that it is unlikely that there has been any past health impact to the

public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.1.12.4 Public Non-radiological Health and Safety. Kitsap County has two hospitals, Harrison Memorial Hospital in East Bremerton and the Naval Hospital Bremerton.

Fire protection in Kitsap County is administered by local fire departments and fire districts. The Bremerton Fire Department has three stations. Police protection services in Kitsap County are provided by the County Sheriff's Office, the city of Bremerton, and other local jurisdictions providing mutual aid.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.1.13 Utilities and Energy

Public water systems supply the majority of Kitsap County's water requirements. Wells are the primary source of water for outlying areas. The Bremerton watershed, located in the Gold Mountain area, is the largest single source for the city of Bremerton. A dam on the Union River provides the water storage reservoir. Freshwater is received at the shipyard from the city of Bremerton public water supply. A saltwater system is used at the piers and dry docks for firefighting, flushing, and cooling of ship systems. Refer to Section 4.1.1.8 for further discussion of water resources.

The Bonneville Power Administration and the Puget Sound Power and Light Company provide electrical service to Kitsap County. Rates for electrical power are relatively low due to the close proximity of hydroelectric facilities. The shipyard steam plant provides emergency electrical service, as well as steam.

A limited industrial natural gas distribution system exists in the east end of the complex. A majority of the military support area in the west end of the shipyard has been converted to natural gas. Natural gas is used industrially, since most of the buildings are heated by steam. The forge shop, foundry, and pipe shops are the largest users of gas. The only natural gas space heating in the industrial area is in the foundry (Navy 1991a).

Shipyard freshwater usage is approximately 676 million gallons annually.

Electricity usage is about 247,000 megawatt hours annually.

4.1.1.14 Materials and Waste Management

All of Bremerton's sewage is treated by the Bremerton Wastewater Utility at the Charleston Water Treatment Plant, located at the intersection of State Routes 3 and 304. This plant was completed in 1985 to provide secondary treatment. Navy ships produce sewage which is transferred to the city of Bremerton's Water Treatment Plant. Berthed ships generally have on-board pumps to discharge their sewage into the piers' sewage lines. In some cases, portable pumps are utilized to lift and pressurize.

Most of the solid waste produced by the shipyard is hauled by a private contractor to the privately owned Olympic View landfill. Miscellaneous acid and alkaline cleaning solution (concentrated liquid) is collected, stored on base, and eventually shipped to hazardous waste treatment storage and disposal facilities. Solid and liquid chemical wastes are collected, characterized, packaged, and labeled at the shipyard, then turned over to a contractor for disposal. A facility at the Manchester Fuel Department provides for the collection and recycling of oily wastes, sludges, and bilge waters (Navy 1991a).

Solid radioactive waste materials are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites licensed by the U.S. Nuclear Regulatory Commission or a State under agreement with the U.S. Nuclear Regulatory Commission. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites. During 1992, approximately 851 cubic yards of routine low-level radioactive waste containing 59 curies were shipped from the shipyard for burial.

Waste which is both radioactive and chemically hazardous is regulated under both the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA) as "mixed waste." Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid commingling radioactive and chemically hazardous substances so as to minimize the potential for generation of mixed waste. For example, these efforts include avoiding the use of acetone solvents, lead-based paints, lead shielding in disposal containers, and chemical paint removers. Radioactive wastes, including those containing chemically hazardous substances, are handled in accordance with long-standing Program radiological requirements. Such handling includes solidification to immobilize the radioactivity, separation of the radioactive and chemically hazardous substances, removal of liquids from solids, and other simple techniques. A determination is then made as to whether the resulting waste is hazardous. As a result of Program efforts to avoid the use of chemically hazardous substances in radiological work, Program activities typically generate only a few hundred cubic feet of mixed waste each year. This small amount of mixed waste, along with limited amounts of mixed waste from Program work conducted prior to 1987, will be stored pending the licensing of commercial treatment and disposal facilities.

Since the complex contains so much pavement, surface drainage is required. An extensive storm sewer system exists, which is separate from the sanitary sewer system. The storm sewer discharges runoff into Sinclair Inlet through 15 outfalls (Navy 1991a).

4.1.2 NORFOLK NAVAL SHIPYARD: PORTSMOUTH, VIRGINIA

4.1.2.1 Overview

Norfolk Naval Shipyard is located in the Tidewater region of Virginia as shown on Figure 4.1.2-1. The shipyard is contiguous with the city of Portsmouth at 36° 49' 5" north latitude and 76° 17' 38" west longitude. The shipyard consists of over 1,200 acres and includes over 500 administrative, industrial, and support structures and 4 miles of shoreline. Figure 4.1.2-2 provides a vicinity map, and Figure 4.1.2-3 provides the site map for the Norfolk Naval Shipyard. For information, Figures 4.1.2-4 and 4.1.2-5 show the location and vicinity of Newport News Shipbuilding. Six city areas are within 15 miles of the shipyard: Portsmouth, Chesapeake, Norfolk, Virginia Beach, Hampton and Newport News, and Suffolk. The cities of Portsmouth to the immediate west, Chesapeake to the south, and Norfolk to the north and east surround the shipyard. The land area of Norfolk is separated from the shipyard proper by the Southern Branch of the Elizabeth River to the east and by the confluence of the Southern, Eastern, and Western Branches of the Elizabeth River to the north.

4.1.2.2 Land Use

Over 95 percent of the land area within the boundaries of the shipyard is covered by structures or paved with concrete and asphalt. The shipyard is divided internally into a controlled industrial area and a non-industrial area. All of the piers, dry docks, and work facilities accomplishing naval nuclear propulsion plant work are within the controlled industrial area.

The surrounding six city areas are a mix of urban, suburban, light industrial, and rural areas with the land areas dissected by the numerous rivers, creeks, bays, and wetlands.

Portsmouth is predominantly urban and suburban. The two main industries are the shipyard and the Portsmouth Marine Terminals, which are cargo shipping terminals operated by Virginia International Terminals. There are few undeveloped tracts of land in Portsmouth.

STATE OF VIRGINIA

Figure 4.1.2-1. Location of Norfolk Naval Shipyard within Virginia.

Figure 4.1.2-2. Norfolk Naval Shipyard vicinity map.

Figure 4.1.2-3. Norfolk Naval Shipyard site map.

STATE OF VIRGINIA

Figure 4.1.2-4. Location of Newport News Shipbuilding within Virginia.

Figure 4.1.2-5. Newport News Shipbuilding vicinity map.

Norfolk is north and east of the shipyard and separated from the Portsmouth land mass by the Elizabeth River. Downtown Norfolk is about 2.5 miles north-northeast of the shipyard and is the financial, cultural, and educational hub of the Southside area. Norfolk is primarily urban and suburban with light industrial centers scattered throughout the city. The Norfolk waterfront has commercial shipyards, coal terminals, various piers for bulk cargo such as gypsum and phosphate, and the Norfolk Naval Base. Like Portsmouth, Norfolk has few undeveloped tracts of land.

The Chesapeake corporate limit adjoins the Norfolk corporate limit just south of the St. Helena Annex and the Portsmouth corporate limit mid-stream of the Southern Branch of the Elizabeth River due east of the shipyard. The majority of the shipyard industrial area is across the river from Chesapeake. The land area immediately along the riverfront is industrial, bulk cargo terminals, and manufacturing. Chesapeake is a mixture of suburban and rural areas. The Western Branch Area adjoins Portsmouth and is primarily suburban with large tracts of undeveloped land currently used for crops to the south and west. Greenbriar adjoins Norfolk and is the central commercial hub of Chesapeake. Great Bridge adjoins Virginia Beach and is primarily residential with commercial corridors and regional shopping areas. The southern part of Chesapeake partially contains the Great Dismal Swamp and is rural with isolated residential areas scattered throughout the region.

Virginia Beach is not contiguous with any shipyard property but is within 15 miles. Virginia Beach adjoins Norfolk and Chesapeake on their eastern borders and fronts the Atlantic Ocean from Cape Henry to the North Carolina state line. The area between the ocean front resort strip and the Norfolk city line has undergone explosive growth over the past 20 years. The area is primarily residential with several commercial corridors connecting various parts of the city. A so-called "Green Line" divides the southern agricultural rural area from the developed areas in the northern part of Virginia Beach. This line has moved south in steps over the years in response to increasing pressure for further development.

Hampton and Newport News are adjoining cities lying on a peninsula formed by the James and York rivers. Newport News Shipbuilding and port facilities for coal and containerized cargo are the major industries. Although within 15 miles, the peninsula cities have historically been isolated from the southside cities economically and demographically as well as politically. This is slowly changing with the opening of the bridge-tunnel connecting western Tidewater with the peninsula. Inclusion of the peninsula cities into the Regional Standard Metropolitan Statistical Area joined the

regions demographically. Land use is primarily suburban with several major commercial corridors dissecting and connecting the two cities. A downtown area of Newport News sits at the tip of the peninsula separated from the James River waterfront by coal terminals and the Newport News Shipbuilding facilities. The limited agricultural land is being rapidly supplanted by expanding residential and commercial development.

Suffolk is the westernmost of the southside cities. Suffolk is predominantly rural and has substantial land area under cultivation with peanuts, soybeans, and produce vegetables being the major crops. Residential areas are scattered but are becoming more numerous as land in Portsmouth and the Western Branch Area of Chesapeake is developed.

4.1.2.3 Socioeconomics

The shipyard is centrally located in relation to the six city population centers that comprise the Tidewater region. At the time of the 1990 census, approximately 1.5 million persons resided within a 50-mile radius of the shipyard. The six-city metropolitan area houses most of this population. Figure 4.1.2-6 provides a population distribution rose showing the population density and population for principal centers within 50 miles of the shipyard. Population data are based on the 1990 census.

As of 1993, Norfolk Naval Shipyard employed approximately 8,500 civilian personnel. The number of military personnel at the shipyard is typically between 2,000 and 3,000 and can vary at times up to approximately 15,000.

The majority of the labor force that would be employed at the shipyard for construction and operation of the naval spent nuclear fuel area would be expected to reside within about 20 miles from the shipyard. The total calculated population, labor force, and employment within this region for the base year (1995) are presented in Table 4.1.2-1. Projections of employment and population for the years beyond 1995 have not been presented because, as discussed in Section 5, the number of additional jobs that might be created at the shipyard under any alternative could be small.

Miles	People	Cumulative People
0-5	247,051	247,051
5-10	425,626	672,677
10-20	465,718	1,138,395
20-30	192,949	1,331,344
30-40	120,431	1,451,775
40-50	87,227	1,539,002

Based on 1990 Census

Figure 4.1.2-6. 50-mile population distribution around Norfolk Naval Shipyard.

Table 4.1.2-1. Regional employment factors at Norfolk Naval Shipyard.

Regional Employment	Regional Labor Force	Regional Population
498,000	533,000	1,138,400

4.1.2.4 Cultural Resources

Founded November 1, 1767 under the British flag, the shipyard pre-dates the United States Navy Department by 30 years. The first drydocking in the western hemisphere occurred at the shipyard on June 17, 1833. Dry dock 1 is a National Historic Landmark. Over the years, the shipyard has been greatly expanded. Beginning in 1963, the yard was authorized to perform Naval Nuclear Propulsion Program work.

The Naval Shipyard Museum located at the foot of High Street in downtown Portsmouth contains many historical photographs and drawings, valuable artifacts, and archives of records tracing the 226-year history of the shipyard and its close ties to the city of Portsmouth. This museum is open to the public and to researchers.

No prehistoric archaeological sites have been identified at the Norfolk Naval Shipyard. In addition, no submerged cultural resources have been recorded in the immediate vicinity of the shipyard. There are no Native American properties or ceremonial sites in the areas where spent nuclear fuel would be stored. In the area where naval spent nuclear fuel would be stored, there are no historic sites that are potentially eligible or listed on the National Register of Historic Places (NPS 1991). Due to the historic nature of the shipyard, there might be areas of archaeological interest. In the past, artifacts from the early shipbuilding era have been uncovered during construction excavation.

4.1.2.5 Aesthetic and Scenic Resources

The lower Chesapeake Bay - Hampton Roads region is a flat coastal plain with minimal topographic relief. The numerous bays, rivers, and creeks that dissect the region provide access to various wetlands consisting of saltwater marshes, bogs, and swamps. The unique ecology of these wetlands provides habitat for numerous indigenous and migratory species of aquatic and avian

wildlife. Area beaches fronting the Atlantic Ocean from Cape Henry southward and along the Chesapeake Bay westward from Cape Henry provide both scenic and recreational opportunities to area residents and visitors.

The shipyard is centrally located in a highly developed urban area and has an industrialized character. The area within the shipyard where the naval spent nuclear fuel would be stored has low visual sensitivity since the area is an industrial site. The original character of the area has been extensively modified in the 300 years that western man has occupied the area.

4.1.2.6 Geology

4.1.2.6.1 General Geology (Coch 1971). The coastal plain is characterized by a series of marine transgressions with extended periods of non-marine erosion and deposition of river sediment. From the surface down to a depth of about 120 feet, the most recent sediments of the Columbia Group occur. Underlying the Columbia Group is the Yorktown Formation (deposits of fine silt, sand, and shells), which, at the location of the shipyard, is about 100 feet thick. The Calvert Formation, with a thickness of about 345 feet, underlays the Yorktown Formation.

The Calvert Formation consists of usually consolidated greenish-brown clays, silty clays, and silicon-based clays over a basic layer of coarse sand. The Calvert clays form an impermeable hard-packed barrier which limits the vertical migration of shallow groundwater. This barrier also isolates the Columbia and Yorktown regional aquifers from deeper lying aquifers contained in permeable formations underlying the Calvert. Extensive studies of the Coastal Plain of Virginia sponsored by the Virginia Division of Mineral Resources have been conducted and published in various bulletins and reports (Teifke and Onuschak 1973; Coch 1971).

4.1.2.6.2 Geologic Resources. There are no unique or economic geological resources in the shipyard region. (Teifke and Onuschak 1973; Coch 1971)

4.1.2.6.3 Seismic and Volcanic Hazards. Seismic risk related to structural damage may be represented in the United States by a relative scale of 0 through 4, with Zone 0 not expected to encounter damage and Zone 4 expected to encounter the greatest seismic risk. The Norfolk Naval Shipyard is located in Zone 1. (UBC 1991) No volcanic hazards exist. The Uniform Building Code

seismic classification provides a means for a comparable assessment of the seismic hazard between the alternate sites. If the Record of Decision identifies this site for the interim storage of naval spent fuel, then a detailed seismic evaluation would be conducted. More detailed information regarding the design basis considerations for storage of naval spent nuclear fuel at the shipyard is presented in Attachment D.

4.1.2.7 Air Resources

4.1.2.7.1 Climate and Meteorology. The Tidewater area is nearly surrounded by water with Chesapeake Bay to the north, Hampton Roads to the west, and the Atlantic Ocean to the east. The area contains numerous bays and is traversed by several rivers and creeks. The climate of the region is essentially marine. The land is level and low with an average elevation of 13 feet above sea level.

Based on the 1951 through 1980 period, the average first occurrence of 32 degrees Fahrenheit is November 17 and the average last occurrence is March 23. Temperatures of above 100 degrees are infrequent and below zero temperatures are almost nonexistent. The proximity to the surrounding water modifies the invading air masses. Summer winds are predominantly from the south and southwest, pulling large amounts of moisture up from the Gulf of Mexico. During the summer months, afternoon thunderstorms due to daytime heating of the near surface air are very common. Large areas of high pressure frequently stall just east of the southern coast. These "Bermuda Highs" can lead to extended periods of hot, humid weather with very little precipitation other than scattered thunderstorms. Thunderstorms occasionally spawn isolated tornadic activity throughout the region. Although locally destructive, the tornados move through the area rapidly along with storm centers.

Precipitation is distributed fairly evenly throughout the year and totals about 43 inches on the average. Snowfall is usually light and is frequently gone within 24 hours. Large accumulations do occur but are infrequent. July and August are generally the wettest months due to thunderstorms while November and December are the driest. Average monthly precipitation is 3.5 inches. Spring weather can begin as early as March but more frequently occurs in April. This is a transitional period between winter and summer weather patterns. During the spring, summer-like days, rain, snow, and cold-humid weather can and frequently do occur during the same week. Mild weather in the fall usually extends through Thanksgiving.

Winter climate is primarily determined by the latitude of the upper level jet stream which steers eastwardly moving arctic air masses. Usually, winters are mild with alternating periods of cold and warm weather. Winter rains are frequent due to the frontal boundaries formed from low-pressure storm cells to the north and moisture-laden Gulf air moved into the area by a high-pressure area to the south. North to northeast winds predominate during the winter months. Northeast winds can affect the Atlantic Coast from the Carolinas northward. Strong northeast winds and heavy rains can cause localized flooding of low-lying areas. Since the Chesapeake Bay is shallow, a strong northeast wind can move large amounts of water from the north end of the bay southward. When this elevated water level is combined with a high tide, flooding occurs. Added to this is the heavy rainfall and poor drainage due to the low elevation. High tide levels 6 to 8 feet above normal are experienced during major northeast winds along with major beach erosion from Cape Henry to Cape Hatteras.

4.1.2.7.2 Air Quality. An area can be designated by the Environmental Protection Agency as having air quality that is better than defined by the National Ambient Air Quality Standards (attainment) or as exceeding one or more of those standards (nonattainment for one or more pollutants). The Code of Federal Regulations, Title 40, Part 81, states that the Air Quality Control Region, in which the shipyard is located, is in marginal nonattainment for ozone and is better than national standards for total suspended particulate matter and SO₂. The area has no specific classification for carbon monoxide and NO₂. The nearest Class I Area is the Swanquarter National Wilderness Area, approximately 161 kilometers (100 miles) from the shipyard.

4.1.2.7.3 Existing Radiological Conditions. Radiological facilities at all naval shipyards are designed to ensure that there are no uncontrolled discharges of radioactivity in airborne exhausts. Radiological controls are exercised to preclude exposure of working personnel to airborne radioactivity exceeding federal limits. Air exhausted from radiological work facilities is passed through high-efficiency particulate air filters and monitored during discharges. The annual airborne radioactivity emissions from the shipyards do not result in any measurable radiation exposure to the general public. Calculations of site radioactive airborne emissions for 1992 have been performed as described in Attachment F. These calculations have shown that emissions of radionuclides from each shipyard result in an effective dose equivalent of less than 0.1 mrem per year to any member of the general public.

4.1.2.8 Water Resources

4.1.2.8.1 Surface Water. Hampton Roads is a relatively wide body of water formed by the confluence of the James, Elizabeth, and Nansemond Rivers. It connects on the east with the Chesapeake Bay. The natural depth of the main part of Hampton Roads ranges from 20 to 80 feet; however, the harbor shoals to less than 10 feet toward shore. Two channels are maintained at a depth of 40 feet by dredging. The currents in Hampton Roads are influenced considerably by the winds and have a velocity of 0.5 m/sec.

The Elizabeth River is the most downriver tributary of the James River. The Elizabeth River system is comprised of a main stem, running from Sewell's Point and Craney Island to Town and Pinner Points, plus four tributary arms: the Lafayette River and the Eastern, Western, and Southern Branches.

Deep navigation channels are maintained from Hampton Roads up the main stem and Southern Branch of the Elizabeth River. Project depths decrease from 45 feet at the mouth to 35 feet between the Norfolk Naval Shipyard and Newton Creek. The channels in the Eastern and Western Branch and Lafayette River are maintained at 25 feet, 14 feet, and 8 feet, respectively.

The Southern Branch of the Elizabeth River is an estuarine body of water in which tidal action brings about a mixing of salt and fresh water. This portion of the river is a slow-moving, heavily sediment-laden body of water. The movement of the water is affected by the narrowness of the channel and the influence of tidal action.

Located along the river banks and in the surrounding territory are extensive and important naval bases and docking facilities, pleasant exurbs and yacht clubs, dry docks and international shipping terminals, the commercial centers of Norfolk and Portsmouth, relatively quiet rural areas, and the Great Dismal Swamp.

Neither the Southern Branch of the Elizabeth River, nor the Hampton Roads Harbor, is fished commercially. Within these waterbodies, it has been established by the Virginia Department of Health that it shall be unlawful for any person, firm, or corporation to take shellfish from the condemned areas for any reason.

Norfolk Naval Shipyard is located on the Southern Branch of the Elizabeth River in a highly industrialized area of the city of Portsmouth, Virginia, 8 miles upstream from the confluence of the James and Elizabeth Rivers. The Southern Branch is a deep-water river which provides access to heavy industry (i.e., ship repairs, gas and oil distribution, etc.) in the vicinity of the shipyard. In addition, the Southern Branch is a major north-south part of the Army Corp of Engineers Intercoastal Waterway System.

The Southern Branch is brackish and is not a source of drinking water. The Southern Branch of the Elizabeth River-Naval Shipyard waterbody extends from Jones and Paradise Creeks to the Downtown Tunnel (Route 264). Shellfish condemnations impact 429 acres. This condemnation is due to historical sediment toxic contamination, and the potential for pollutants of fecal coliform bacteria (Virginia WCB 1992a). Sixteen industrial facilities discharge to the Southern Branch Elizabeth River main stem and tributaries. Surveys of finfish in the Elizabeth River (primarily in the Southern Branch) show obvious signs of stress and/or disease, especially among those species exposed to the contaminated bottom sediments. Many fish have external lesions, fin erosion, inflamed fins, and cataracts.

The bottom sediments of the Elizabeth River are highly contaminated with a variety of organic and inorganic compounds at several locations (Virginia WCB 1992a). The majority of the contamination problems occur in the highly industrialized Southern Branch. Of particular concern among the synthetic organic compounds found in the Southern Branch of the Elizabeth are polynuclear aromatic hydrocarbons (PAH's). They are long-lived, and many are mutagenic and carcinogenic. PAH's are found in a variety of sources including creosote, coal tar, coal pile runoff, fly and bottom ash from coal-fired boilers, roofing tar, asphalt oil, petroleum oil, bilge discharge, diesel soot, and wood stove soot. One source of this class of compounds in the Elizabeth River has been attributed to the wood-preserving facilities, which have been in operation along the Southern Branch since the early 1900's.

The James River-Hampton Roads waterbody encompasses the James River mainstem and tributaries from Old Point Comfort to Willoughby Spit (northern border) to the west side of Craney Island (eastern border), west to Barrel Point (southern border), and north to Boat Harbor, Hampton River, and Mill Creek. Shellfish condemnations impact 17,281 acres (Virginia WCB 1992a). This condemnation is due to historical toxic contamination, and the potential for fecal coliform bacteria

pollution. This portion of the James River mainstem receives additional discharges from 14 facilities, at least half of which are seafood preparation waste discharges.

Surrounding the Nansemond River watershed are seven lakes (Lake Kilby, Lake Cahoon, Lake Meade, Speights Run Lake, Lake Prince, Lake Burnt Mills, and Western Branch Reservoir) which are used as public water supply sources for the surrounding cities. Lake Taylor, located in the city of Norfolk, is the closest lake and is approximately 7 miles from Norfolk Naval Shipyard. The other lakes are approximately 20 miles to the west of the shipyard.

The Flood Insurance Rate Map (FIRM COMMUNITY-PANEL No. 515529 0060 B) shows that most of the Norfolk Naval Shipyard, including the location considered for the interim storage of naval spent nuclear fuel, is in the 100-year floodplain. However, the location considered for naval spent nuclear fuel is not in a high-hazard area (as defined by Title 10, Part 1022 of The Code of Federal Regulations for floodplains) which is an area where frequent flooding occurs.

4.1.2.8.2 Groundwater. Shallow groundwater underlies the whole region. Designated as the Columbia aquifer, it is composed primarily of sediments that were deposited up to 1.7 to 2.2 million years ago as channel fill and river or ocean terraces. The aquifer is composed of interbedded gravel, sand, silt, and clay and is unconfined throughout the region. The saturated thickness of the Columbia aquifer is about 80 feet in the Tidewater area.

A consolidated layer of silty clay underlies the water table and separates it from the Yorktown Formation. In general, water flow within the Columbia aquifer is from the topographic highs to topographic lows. This flow distribution is modified locally by the pumping of wells, dewatering of borrow pits, and by the upper contours of the Yorktown Formation. As a result, the depth of shallow wells can vary drastically in only a few hundred yards.

Underlying the Columbia aquifer are seven distinct aquifers that originate east of the Fall Line and progressively deepen as they proceed eastward. The names of the aquifers and their approximate depths at the location of the shipyard are shown in Table 4.1.2-2.

The material confining the individual aquifers thickens from west to east so that the vertical leakage between aquifers due to gravity or artesian pressure differentials decreases eastward. The Yorktown-Eastover aquifer is both confined and unconfined, depending on location, and consists of

fine to coarse sand interbedded with clay, shell, and sandy clay. The formation thickness is about 100 feet in the vicinity of the shipyard. Where the aquifer is unconfined, it is a major source of recharge to both the water table aquifer and to underlying confined flow systems.

Table 4.1.2-2. Aquifers that underlie the Columbia aquifer.

Aquifer	Depth Below Sea Level (ft)
Yorktown - Eastover	Sea Level
Chickahominy - Piney Point	200
Aquia	400
Brightseat	500
Upper Potomac	750
Middle Potomac	900
Lower Potomac	> 1500

Artesian pressure existing in the confined portions of the Yorktown aquifer causes an upward vertical leakage from the Yorktown aquifer into the water table aquifer. In the vicinity of the shipyard, the thickness of the confining layer is about 80 feet. The confining layer consists of blue-gray to green-gray clay interbedded with massive silty clay, fine sand, and chalky shell fragments.

The Yorktown aquifer is a major source of domestic, commercial, and light industrial water. Yields are reported to range from 20 to 250 gallons per minute. This aquifer is the usual source of drinking and domestic consumption water for those localities within the region not served by municipal water systems. The groundwater aquifers have been extensively monitored and results published in numerous papers, bulletins, and reports (Siudyla et al. 1981; USGS 1990). Groundwater quality is monitored by several state agencies and boards with annual reports submitted to the EPA and Congress (Virginia WCB 1992b).

Since the underlying layers slope downward from west to east, the flow of groundwater in the vicinity of the shipyard generally trends from west to east, with localized modifications as previously described.

Rivers and creeks bound the shipyard on the immediate east and south. The confluence of the Southern, Eastern, and Western Branches of the Elizabeth River occurs about 1.5 miles north of the shipyard. These stream beds are below sea level and thus intercept the water table aquifer.

Where an aquifer is interfaced with surface streams or impoundments, the net flow within the aquifer is toward the surface water. In the case of the shipyard, the water table aquifer is intercepted on three sides (N, E, S) by a surface stream. This confines any contaminant infiltrating into the aquifer to the area of and immediately adjacent to the shipyard property. With a net easterly flow due to gravity, any contaminant infiltrating from the shipyard area would percolate through the soil zone into the water table under the shipyard and be intercepted by bounding surface waters.

4.1.2.8.3 Existing Radiological Conditions. The normal activities associated with current naval nuclear operations at all naval shipyards do not result in the intentional discharge of any radioactive liquid effluent. However, there were occasions, primarily in the early 1960's, when measurable levels of radioactivity were discharged with liquid effluent. In all cases, effluent releases were less than permitted under the then current limits imposed by state and federal agencies.

The United States Environmental Protection Agency Office of Radiation Programs has performed monitoring of the water, plant life, aquatic life, and sediment in the vicinity of Norfolk Naval Shipyard to confirm that the general public is not affected by operations of Norfolk Naval Shipyard. "Radiological Surveys of the Norfolk Naval Station, the Norfolk Naval Shipyard, and Newport News Shipbuilding" (Sensintaffar and Blanchard 1988) discusses the most recent Environmental Protection Agency monitoring data. Pertinent conclusions are as follows:

1. "The trace amounts of cobalt-60 measured in the harbor sediments are significantly less than observed during the 1968 survey and exist about 5 inches beneath the surface of the sediment, indicating that no detectable cobalt-60 has been deposited in the sediments since the 1968 survey.

2. In addition to cobalt-60, only radionuclides of natural origin plus trace amounts of cesium-137 from previous nuclear weapons testing were detected in any of the harbor sediment samples.
3. No tritium or gamma-ray emitters, other than those occurring naturally, were detected in harbor water, or samples of sediment, water, and vegetation collected from public areas.
4. Drinking water samples contained no detectable levels of radioactivity other than those occurring naturally.
5. The shoreline gamma-ray surveys failed to detect any elevated exposure levels except at one location where the levels are attributed to the naturally occurring radionuclides that exist in granite rock.
6. The levels and locations of radioactivity identified and the limited media in which it was found show that operations related to nuclear-powered warship activities resulted in no discernible adverse effects on public health or the environment."

Environmental monitoring is conducted by the shipyard. The results of this monitoring program corroborate the Environmental Protection Agency's conclusions.

4.1.2.9 Ecological Resources

4.1.2.9.1 Terrestrial Ecology. The shipyard area is highly developed and its surface is about 95% covered with impervious materials. The few green areas are outside the controlled industrial area and have been extensively graded. Landscaping consists primarily of turf grasses and native trees. The oldest growth areas are in the vicinity of the Shipyard Commander's residence and Trophy Park. Appendix B of the "Land Management Plan for Norfolk Naval Shipyard" (NFEC 1991) lists those plants known to or likely to occur on the shipyard or its annexes.

The shipyard bird population consists of urban species commonly found in southeastern Virginia. These species include pigeons, jays, robins, finches, chickadees, starlings, flickers, blackbirds, grackles, cowbirds, chimney swifts, martins, mocking birds, cardinals, herons, egrets,

terns, and several species of gulls. There are few mammals that inhabit the shipyard and their populations are limited. Squirrels and other rodents common to developed areas are observed.

The shipyard offers little refuge for reptiles and amphibians. Non-poisonous garter snakes and the occasional black snake are found in vegetated areas and in warehouse structures. Toads, newts, salamanders, and other semi-aquatic reptiles can be found in wet areas where suitable forage and habitat exists. Sightings are infrequent due to the dispersed habitat locations and the limited number of suitable sites.

The Tidewater area is part of the Mid-Atlantic flyway. Migratory species pass through the area or over-winter in the numerous bays, sounds, creeks, and wetlands that occur in the region. During migratory periods and over the winter, more than a hundred species of water fowl have been observed in the region. Since there is no suitable habitat or forage areas on the shipyard, the appearance of migrating species is rare.

4.1.2.9.2 Wetlands. There are no freshwater wetlands on the main shipyard site where naval spent nuclear fuel would be stored. The majority of the shipyard is developed and covered with an impervious surface. National Wetlands Inventory Maps (DOI 1986) show a number of estuarine wetlands along the banks of Paradise, Blows, and St. Juliens Creeks. There are no remaining tidal wetlands along the western shoreline of the Southern Branch from its mouth to Paradise Creek (Silberhorn and Dewing 1989). The total wetland area along Paradise Creek is, according to this reference, about 422 acres.

Blows Creek wetlands occur along the Southern Branch and encompass about 2.54 acres. St. Juliens Creek tidal marshes are subdivided into eight locations and total about 52 acres (Silberhorn and Dewing 1991).

4.1.2.9.3 Aquatic Ecology. The majority of the shipyard property is located on land that has been filled to raise its elevation above the level of the river. The shipyard shoreline consists of concrete bulkheads and finger piers built on concrete pilings. Wooden wharfs and quays have been replaced over the years with concrete structures. Marine vegetation along the shipyard waterfront is limited to red and green algae. As reported in Section 4.1.2.8.1, the marine life in the Southern Branch is limited due to the pollution in the river from sewage treatment plants and riverfront industries. There is no commercial fishing and only limited sport fishing in the Southern Branch. In

the contiguous shipyard waters, there is no fishing due to a security buffer zone and because of the heavy traffic along the river.

Estuarine wetland ecology is principally vegetative and consists of Saltmarsh Cord grass and Reed grass. The abundance of Reed grass in these areas is indicative of disturbed wetlands that have been filled or are impacted by overloads of upland sediment.

Herring gulls, several species of terns, brown pelicans, egrets, herons, cormorants, and migratory bird species common along the Atlantic flyway take refuge in or feed on riverine or marshland environments and biota.

The waters adjoining the shipyard are frequently dredged to maintain the depth along the piers, at the entrance to dry docks, and in the turning basin. The periodic removal of silt and detritus limits the habitat of benthic organisms common in other parts of the lower bay and tributaries.

4.1.2.9.4 Endangered and Threatened Species. There are no critical habitats as defined in 50CFR424.02 within the 15-mile tidal influence area. Several federally designated threatened (T) or endangered (E) species have been identified as existing in the vicinity. The exact locations of specific habitats could not be located; however, surveys of the area have not identified any habitat on shipyard property. The U.S. Fish and Wildlife Service lists the following species as endangered or threatened in the South Hampton Roads area from Suffolk eastward (DOI 1990).

1. Loggerhead turtle (T)
2. Bald eagle (E)
3. Peregrine falcon (E)
4. Piping plover (T)
5. Red-cockaded woodpecker (E)
6. Eastern cougar (E)
7. Dismal Swamp southeastern shrew (T)
8. Northeastern beach tiger beetle (T)

No state rare, threatened, or endangered species exist within the 15-mile tidal influence zone (Buhlmann and Ludwig 1992).

There are no marine mammals that are routinely found within the lower Chesapeake Bay or its tributaries. Manatees and Atlantic Bottlenose dolphins occasionally appear in the bay and Hampton Roads; however, their presence is transient. Stranding and grounding of pods of migratory whales and dolphins as well as carcasses of dead animals occasionally appear along Atlantic beaches from Virginia's Eastern Shore to the North Carolina Outer Banks but sightings of whales in the bay or near the ocean shore are rare.

Various oceanic turtles may nest along the sandy beaches surrounding the Chesapeake Bay and Outer Banks. The highly developed regions along the Elizabeth River do not provide suitable nesting sites for these marine reptiles.

4.1.2.10 Noise

Norfolk Naval Shipyard is an existing industrial-type environment characterized by noise from truck and auto traffic; yard cranes and related internal combustion engine powered equipment; and operating transmission lines for steam, air, and water along with associated pumps and compressors. The eastern shoreline of the Southern Branch contains private shipyards, manufacturing plants, and bulk material handling and storage terminals. These activities, along with Norfolk Naval Shipyard, add to the ambient noise levels of the river corridor.

Intervening structures and distance separate adjacent residential areas to the south and immediately west of the shipyard from the waterfront ship repair activities and thus attenuate the noise generated by those activities.

4.1.2.11 Traffic and Transportation

Within the city of Portsmouth, three main corridors, High Street, Portsmouth Boulevard, and George Washington Highway serve as access to suburban commercial and residential areas. The Downtown and Midtown tunnels link Portsmouth and Norfolk and join via connecting arteries the regional interstate highway network consisting of I-64, I-262, I-464, and I-664. I-64 crosses Hampton Roads while I-664 crosses the lower James River linking the southside cities to Newport News and Hampton on the peninsula. The bridge-tunnels allow the unimpeded flow of the largest commercial ships and warships through Hampton Roads.

Tidewater Regional Transit provides bus services throughout Portsmouth and Norfolk. Only limited public transportation is available in Chesapeake and Virginia Beach.

The Norfolk International Airport provides commercial scheduled passenger and cargo air service to major connecting hubs. Most private and general aviation not operating from Norfolk International operate from airports in Chesapeake, Suffolk, and Virginia Beach.

A passenger ferry across the Elizabeth River connects the Portsmouth downtown area with the Waterside Berths on the Norfolk side. This ferry service is primarily designed for tourist and recreational passengers rather than commuter service.

Norfolk Southern and CSX corporations operate extensive networks of rail transportation for freight and bulk cargo. Norfolk and Newport News are the nation's largest terminals for coal exports and, along with Portsmouth, have a large capacity for containerized and bulk cargos. Lines operated by CSX and Norfolk Southern subsidiaries serve the shipyard at the north and south ends, Southgate, and St. Juliens Creek annexes.

Spent naval nuclear fuel has been removed from Navy nuclear-powered ships and transported to the Idaho National Engineering Laboratory Expanded Core Facility (ECF) for examination and evaluation as a routine part of their operating cycle. Naval spent nuclear fuel shipments from Norfolk Naval Shipyard to ECF were initiated in 1965. Since that time, 10 shipments of naval spent nuclear fuel originating at Norfolk Naval Shipyard have been made to ECF. The naval spent nuclear fuel was shipped by rail. Attachment A provides a list of these shipments made to date by year. Attachment A also contains detailed descriptions of the shipping containers used for naval spent nuclear fuel shipments from shipyards.

Norfolk Naval Shipyard has 30 miles of paved roads, 19 miles of railroad tracks, and dry docks.

4.1.2.12 Occupational and Public Health and Safety

4.1.2.12.1 Occupational Radiological Health and Safety. The Navy has well established and effective Occupational Safety, Health, and Occupational Medicine programs at all of its shipyards. In

regard to radiological aspects of these programs, the Naval Nuclear Propulsion Program policy is to reduce to as low as reasonably achievable the external exposure to personnel from ionizing radiation associated with naval nuclear propulsion plants. These stringent controls on minimizing occupational radiation exposure have been successful. No civilian or military personnel at Navy sites have ever exceeded the federal accumulated radiation exposure limit which allows 5 rem exposure for each year of age beyond age 18. Since 1967, no person has exceeded the federal limit which allows up to 3 rem per quarter year and since 1980, no one has received more than 2 rem per year from radiation associated with naval nuclear propulsion plants. The average occupational exposure of each person monitored at all shipyards is 0.26 rem per year. The average lifetime accumulated radiation exposure from radiation associated with naval nuclear propulsion plants for all shipyard personnel who were monitored is 1.2 rem. (NNPP 1993a) This corresponds to the likelihood of a cancer fatality of 1 in 2083.

The Navy's policy on occupational exposure from internal radioactivity is to prevent radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by federal regulations for radiation workers. As a result of this policy, no civilian or military personnel at shipyards have ever received more than one-tenth the federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with naval nuclear propulsion plants.

For work operations involving the potential for spreading radioactive contamination, containments are used to prevent personnel contamination or generation of airborne radioactivity. The controls for contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into radiological areas because the contamination control limits used in these areas were well below the levels of fallout and natural contamination occurring outside in the general public areas. A basic requirement of contamination control is monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves (i.e., frisk), and their performance is checked by radiological control personnel. Frisking of the entire body is required, normally using sensitive hand-held survey instruments. Major work facilities are equipped with portable monitors, which are used in lieu of hand-held friskers. These stringent controls to protect the workers and the public from contamination have proven effective in the past.

In 1991, researchers from Johns Hopkins University, Baltimore, Maryland, completed a very comprehensive epidemiological study of the health of workers at the six naval shipyards and two private shipyards that service the Navy's nuclear-powered ships (Matanoski 1991). This independent study evaluated a population of 70,730 civilian workers over a period from 1957, beginning with the first overhaul of the first nuclear-powered submarine, USS NAUTILUS, through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels of gamma radiation.

The Johns Hopkins study found no evidence to conclude that the health of people involved in work on U.S. naval nuclear-powered ships has been adversely affected by exposure to low levels of radiation incidental to this work. Additional studies are planned to investigate the observations and update the shipyard study with data beyond 1981.

The radiation exposure during normal operations at each shipyard for workers who have their radiation levels monitored is determined based on the annual radiation exposure of 0.26 mrem per worker for all shipyards based on Naval Nuclear Propulsion Program Report NT-93-2 (NNPP 1993a). The total number of shipyard personnel monitored for radiation exposure associated with the Naval Nuclear Propulsion Program has been about 164,000.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within DOE standards for occupationally exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.2.12.2 Occupational Non-radiological Health and Safety. In the non-radiological Occupational Safety, Health, and Occupational Medicine area, the Navy complies with the Occupational Safety and Health Administration Regulations. The Navy policy is to maintain a safe and

healthful work environment at all naval facilities. Due to the varied nature of work at these facilities, there is a potential for certain employees to be exposed to physical and chemical hazards. These employees are routinely monitored during work and receive medical surveillance for physical hazards such as exposure to high noise levels or heat stress. In addition, employees are monitored for their exposure to chemical hazards such as organic solvents, lead, asbestos, etc., and where appropriate are placed into medical surveillance programs for these chemical hazards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

The shipyard has an occupational health/preventive medicine unit and a branch clinic (industrial dispensary). Personnel may also be taken to Portsmouth Naval Hospital and Portsmouth General Hospital as needed.

The shipyard maintains two fire stations with approximately 60 personnel. The fire department is fully equipped for structural and industrial firefighting and hazardous material spill response.

The shipyard security force has approximately 100 personnel providing law enforcement services, emergency services, security clearances, and parking and traffic control for the Norfolk Naval Shipyard Complex.

Relative to social services, military personnel receive assistance through various programs at Portsmouth Naval Hospital and the Navy's Morale Welfare and Recreation Department.

4.1.2.12.3 Public Radiological Health and Safety. In order to quantify the exposures resulting from normal shipyard radiological releases to the general public, detailed analyses were performed based on conservative estimates of radioisotopic releases since releases began. Attachment F provides detailed annual release values used in the analyses.

The GENII computer code (Napier et al. 1988) was used to calculate exposures to human beings due to the estimated radionuclide releases from normal operations at the shipyards.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from stored fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F.

The hypothetical exposures calculated in Attachment F for the period 1995 through 2035 were adjusted from an annual basis (1995) to the historical basis by multiplying by 38 years and by a factor of 1.7 to take into consideration variations in the number of ships and operations.

The calculated accumulated exposures through 1995 to the general population within 50 miles of the site (about 1.5 million people) are 3.9 person-rem. To provide perspective, the exposures received due to natural radiation sources through 1995 are approximately 18 million person-rem, based on 0.3 rem per person per year.

The results of environmental monitoring as described in Naval Nuclear Propulsion Program Report NT-93-1 show that Naval Nuclear Propulsion Program activities had no distinguishable effect on normal background radiation levels at site perimeters (NNPP 1993b).

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities.

All of the radiation exposures to the general population correspond to much less than one incident cancer, which means that it is unlikely that there has been any past health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.2.12.4 Public Non-radiological Health and Safety. Portsmouth has three hospitals: Portsmouth General Hospital, Maryview Hospital, and Portsmouth Naval Hospital.

Fire protection in Portsmouth is administered by local fire departments and fire districts. The Portsmouth Fire Department has nine stations. Police protection services are provided by the city of Portsmouth.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.2.13 Utilities and Energy

The shipyard purchases all of its water from the city of Portsmouth. Section 4.1.2.8.1 describes the sources of public water supplies for the region. A saltwater system is provided at berths and dry docks for cooling supplies to ship systems and for fire and flushing mains.

Shipyard and ship sewage effluents are discharged to the Hampton Roads sanitation district mains via the Portsmouth sewer system. Sewage treatment plants along the Southern Branch and lower James River receive and treat sewage from surrounding cities.

Electricity is purchased from Virginia Power Company transmission grids and is obtained from the Refuse Derived Fuel Plant located just south of the shipyard and operated by the Southeastern Public Service Authority. During periods of low demand, the Refuse Derived Fuel Plant sells electricity to Virginia Power. The Refuse Derived Fuel Plant also provides yard steam for operations and space heating.

Natural gas serves six buildings within the shipyard. Industrial uses include forging and tempering furnaces, various ovens and torches, laboratory burners, and cooking appliances in the cafeteria. This gas is purchased from Commonwealth Gas Company which serves the Portsmouth area.

Shipyard freshwater usage is approximately 823 million gallons annually.

Electricity usage is about 20,000 megawatt hours annually.

4.1.2.14 Materials and Waste Management

Solid waste generated by the shipyard is collected by a private contractor. Metals are segregated on-site in specially marked dumpsters to be recycled by the Defense Marketing and Reutilization Office. Solid burnable waste is transferred to the Southeastern Public Service Authority where it is either compacted into fuel blocks for use in the Refuse Derived Fuel Plant or disposed of at a regional landfill located in Suffolk. Once turned over, the Southeastern Public Service Authority determines the final disposition depending on the regional waste volume inventory at the fuel plant adjacent to the shipyard.

The Refuse Derived Fuel Plant provides electricity and steam to the shipyard and can provide power to the Virginia Power grid when excess capacity exists.

Liquid chemical wastes are collected, characterized, packaged, and labeled by the shipyard then turned over to a licensed contractor for disposal.

Solid radioactive waste materials are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites licensed by the U.S. Nuclear Regulatory Commission or a State under agreement with the U.S. Nuclear Regulatory Commission. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites. During 1992, approximately 1333 cubic yards of routine low-level radioactive waste containing 15 curies were shipped from the shipyard for burial.

Waste which is both radioactive and chemically hazardous is regulated under both the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA) as "mixed waste." Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid commingling radioactive and chemically hazardous substances so as to minimize the potential for generation of mixed waste. For example, these efforts include avoiding the use of acetone solvents, lead-based paints, lead shielding in disposal containers, and chemical paint removers. Radioactive wastes, including those containing

chemically hazardous substances, are handled in accordance with long-standing Program radiological requirements. Such handling includes solidification to immobilize the radioactivity, separation of the radioactive and chemically hazardous substances, removal of liquids from solids, and other simple techniques. A determination is then made as to whether the resulting waste is hazardous. As a result of Program efforts to avoid the use of chemically hazardous substances in radiological work, Program activities typically generate only a few hundred cubic feet of mixed waste each year. This small amount of mixed waste, along with limited amounts of mixed waste from Program work conducted prior to 1987, will be stored pending the licensing of commercial treatment and disposal facilities.

An extensive storm drain system exists on the shipyard to remove the runoff from precipitation. Outfalls empty into the Southern Branch, Paradise Creek, and St. Juliens Creek. About 100 outfalls serving the shipyard property have been mapped and located.

4.1.3 PORTSMOUTH NAVAL SHIPYARD: KITTERY, MAINE

4.1.3.1 Overview

Portsmouth Naval Shipyard is located in York County, in the southeast corner of Maine as shown on Figure 4.1.3-1. The Portsmouth Naval Shipyard is located in Portsmouth Harbor, the estuary of the Piscataqua River. This river flows between the states of Maine and New Hampshire. The shipyard is located on Seavey Island near the mouth of the river and is separated from Portsmouth, New Hampshire, by the main channel of the Piscataqua River and from Kittery, Maine by a back channel. Access to the shipyard is provided by two bridges from the Kittery shore. Figure 4.1.3-2 provides a shipyard site map.

Seavey Island has an area of 278 acres. The center reference point on the island is at 70°44'22" longitude and 43°04'56" latitude. The Portsmouth Harbor and its tributaries are used extensively for fishing, lobstering, and recreational boating. The port of Portsmouth is involved in importing salt and petroleum products, as well as exporting a variety of products, such as raw lumber.

4.1.3.2 Land Use

At the mouth of the Piscataqua River, several creeks and the river converge and mix with the Atlantic Ocean. The shipyard has been developed over time by filling in between five smaller islands and building a rock causeway to the approximately 5-acre undeveloped Clarks Island.

To the north, across the back channel, is the predominantly low-density residential community of Kittery, Maine. Kittery's land along the river and back channel is virtually all designated for residential use. The exceptions are two commercial areas located on Badgers Island and at the intersection of Routes 103 and 236 and several public use areas consisting of playgrounds and parks. The main commercial land use area is located along Route 1 and the Route 1 bypass. Most of Kittery's land further north is undeveloped due to natural constraints. The developable land is primarily designated for low-density residential use.

Figure 4.1.3-2. Portsmouth Naval Shipyard site map.

Across the river, south of the shipyard, are the city of Portsmouth and the town of New Castle in the state of New Hampshire. Portsmouth's waterfront is nearly fully developed and has played an important role in the growth and prosperity of Portsmouth since it was settled as Strawberry Banke in 1623. Today there are areas of commercial, industrial, residential, and public/semi-public land use along the river.

Further inland, Portsmouth has large undeveloped land areas. Development on some of this land is constrained by wetlands and other natural factors; however, there still remains much acreage to accommodate future development.

Directly south of the shipyard is a large body of estuarine water containing several small islands. These islands are either undeveloped or have low-density housing.

The town of New Castle is predominantly developed with housing and is the location of a Coast Guard Station. Other land uses on the island town include commercial, public, and semi-public land.

4.1.3.3 Socioeconomics

Portsmouth Naval Shipyard is located in the small town of Kittery, Maine, a region of New England that consists predominantly of small rural towns.

Portsmouth, New Hampshire is the closest urban municipality to the shipyard. With a population of about 22,300, it is also the largest municipality in the area. Other larger municipalities within the area include Sanford and Biddeford in Maine and Rochester and Dover in New Hampshire. They have populations of approximately 20,500, 20,700, 26,600, and 25,000, respectively. Portland, Maine has a population of about 64,400. This major southern Maine urban center is located about 55 miles north of the shipyard. Also, the city of Boston, Massachusetts, with a population of about 574,300, is located approximately 50 miles south of the shipyard. Figure 4.1.3-3 provides a population distribution rose centered on the shipyard and covering a 50-mile radius.

Miles	People	Cumulative People
0-5	42,525	42,525
5-10	39,254	81,799
10-20	177,100	258,899
20-30	241,516	500,415
30-40	692,250	1,192,665
40-50	1,239,962	2,432,627

Based on 1990 Census

Figure 4.1.3-3. 50-mile population distribution around Portsmouth Naval Shipyard.

The overall population of the Portsmouth region has grown through the 1980 to 1990 decade. On the Maine side of the Piscataqua River, the increase in population in York County from 1980 to 1990 was 24,848 which was a 17.8% increase. On the New Hampshire side of the river, the municipalities within Rockingham County gained in population through the 1980 to 1990 decade. There was a gain of 55,500 people or about a 29.2% increase.

Portsmouth Naval Shipyard is located within the "seacoast region" which is defined by seven job centers. Each center includes the smaller communities adjacent to them.

The seacoast region is made up of the Portsmouth, Exeter-Epping, Hampton, Dover-Somersworth, and Rochester centers in New Hampshire and the Kittery and Biddeford centers in Maine.

Historically, the economy of the seacoast region has been based on manufacturing. Textiles, shoes, and marine vessels were for many years the most important products of the region. Shipbuilding and ship repair, primarily at Portsmouth Naval Shipyard, have maintained a dominant role in the economy. Textiles and shoe manufacturing have declined over the past 30 years, but have been supplemented in part by plastics, electronics, and metals industries. The wages paid by these employers are low relative to those paid at the shipyard. On balance, the seacoast region has experienced consistent declines in manufacturing employment in recent years.

Non-manufacturing employment, especially in the trade and service sectors, is increasing. The Hampton, Portsmouth, Kittery, and Biddeford job centers have experienced economic growth as vacation resorts. Communities close to Massachusetts such as Hampton and Exeter-Epping, have grown as part of the Boston metropolitan area.

The city of Portsmouth is the seacoast region's trade and cultural center and a major distribution market for points in northern New England.

The generally healthy state of Portsmouth's economy is reflected by its excellent employment situation. As of July 1993, the unemployment rate was just 3.4% compared to the national average of 6.9%. The civilian labor force in the Portsmouth labor market area numbered 14,600 in July 1993.

The majority of the labor force that would be employed at the shipyard for construction and operation of the naval spent nuclear fuel area would be expected to reside within about 20 miles from the shipyard. The calculated total population, labor force, and employment within this region for the base year (1995) are presented in Table 4.1.3-1. Projections of employment and population for the years beyond 1995 have not been presented because, as discussed in Section 5, the number of additional jobs that might be created at the shipyard under any alternative could be small.

Table 4.1.3-1. Regional employment factors at Portsmouth Naval Shipyard.

Regional Employment	Regional Labor Force	Regional Population
115,230	121,550	258,900

Portsmouth has the distinction of being the only natural deep-water harbor between Boston and Portland, making it a major factor in New England seaborne commerce. Modern year-round port facilities, an established Foreign Trade Zone, and reliable container ship service are all available.

The chief commodities transported through the port are petroleum products which comprise over 90 percent of the marine commerce shipped. Large quantities of limestone (gypsum) and salt are also received. The chief products shipped out of Portsmouth are petroleum products and steel scrap. Commercial fishing in the area represents a multi-million dollar industry.

As of 1994, the region's largest employer, with approximately 4900 employees, was Portsmouth Naval Shipyard. The shipyard is the largest employer in the states of Maine and New Hampshire. The 1993 payroll amounted to \$228 million.

Other contributing factors to the region's economic development include Pease Development Authority in Newington, the University of New Hampshire in Durham, and the New Hampshire Vocational/Technical College in Stratham.

The Kittery-York labor market area in York County had 86,165 people in the civilian labor force as of July 1993 and an unemployment rate of 2.3% for July 1993. The majority of the civilian labor force was employed in non-farm related jobs including manufacturing, transportation and utilities, wholesale and retail trade, finances, services, and government.

4.1.3.4 Cultural Resources

The Portsmouth-Kittery area has been part of the country's history since its very beginning. Many structures and sites from the late seventeenth, eighteenth, and nineteenth centuries have survived within the framework of new development over the years, especially in the city of Portsmouth. Considered as a group, these preserved structures and sites constitute an aesthetic, cultural, and educational resource, and a heritage with increasing value to future generations in the Portsmouth-Kittery vicinity.

On November 17, 1977, the National Park Service, Department of the Interior, entered the Portsmouth Naval Shipyard Historic District on the National Register of Historic Places. The district includes 54 acres of land, and 59 buildings and structures. The shipyard qualified for the Historic Status because of its shipbuilding and repair function throughout the history of the United States, its unique industrial site, and its historical and architecturally interesting buildings. From the early colonial period to the present day, this shipbuilding and repair site served first, the British government, later, the revolutionary colonies, and finally, the United States through the eras of sail, steam, and atomic power. Portsmouth Naval Shipyard represents one of the country's earliest complete industrial operations. (Navy 1993a)

There are no known cultural resources in the area of the site where naval spent nuclear fuel would be stored. Due to the historic nature of the shipyard, there might be areas of archaeological interest. In the past, artifacts from the early shipbuilding era have been uncovered during construction excavation.

4.1.3.5 Aesthetic and Scenic Resources

The majority of the 303 acres (278 acres on the shipyard, 25 in Admiralty Village) that make up the Portsmouth Naval Shipyard is considered industrial use land. Although there are no exact figures on the breakdown of land classifications, it is estimated that over 75% of the area is covered by either buildings or pavement. The area within the shipyard where naval spent nuclear fuel would be stored has low visual sensitivity since the area is an industrial site. Improved grounds on the shipyard include the parade grounds, athletic fields and various lawns dispersed throughout. Semi-improved grounds include several small picnic areas on the shipyard, the Jamaica Island Family

Recreation area, and the isolated grassy areas on the fringe of the streets and sidewalks. The major areas of unimproved grounds (includes all other unpaved acreage not classified as improved or semi-improved) include the two freshwater ponds and the small beach front on what was once Jamaica Island. Because Admiralty Village is a housing facility, what little open space remained after development was utilized for recreational purposes (e.g., tennis courts) or landscaped to enhance aesthetic value.

4.1.3.6 Geology

4.1.3.6.1 General Geology. Portsmouth Naval Shipyard is located on Seavey Island in the Seaboard Lowland Section of the New England Province. This section has a low, undulating topography with low hills that are either bedrock with a light veneer of rocks or sediment left by glaciers, or marine clay.

The general area near Portsmouth Naval Shipyard is relatively flat, rising gradually to the foothills of the White Mountains and dissected by numerous streams and rivers that have, for example, carved gorges 20 to 100 feet deep in the granite hills of the Mount Agamenticus-Ogunquit area. What remains of the mountain range in the southern and western portions of the area are scattered and isolated, high, smooth, weathered rock hills.

The thickness of the overburden of loose materials varies from 0 to 200 feet over the region, with 80% of the area having less than 50 feet depth to bedrock. A predominant characteristic of the soil in the area is the presence of the groundwater table near or at the surface. (Navy 1984)

4.1.3.6.2 Geologic Resources. The physical geography of the general area near the Portsmouth Naval Shipyard is characterized by bedrock prominences surrounded by and dissected by inlets and stream courses of the Piscataqua River. Seavey Island, itself a rock knob, is one of these prominent bedrock outcrops. The bedrock of Seavey Island is almost entirely the Kittery formation, a fine-grained, lime-silicate material consisting of chalky sandstone formed under heat and pressure, siltstone, and gray sandstone shale from approximately 400 million years ago. (Navy 1984)

There are no economic geologic resources at the shipyard.

4.1.3.6.3 Seismic and Volcanic Hazards. Seismic risk related to structural damage may be represented in the United States by a relative scale of 0 through 4, with Zone 0 not expected to encounter damage and Zone 4 expected to encounter the greatest seismic risk. The shipyard is located in Zone 2A according to the "Uniform Building Code" (UBC 1991). No volcanic hazards exist. The Uniform Building Code seismic classification provides a means for a comparable assessment of the seismic hazard between the alternate sites. If the Record of Decision identifies this site for the interim storage of naval spent fuel, then a detailed seismic evaluation would be conducted. More detailed information regarding the design basis considerations for storage of naval spent nuclear fuel at the shipyard is provided in Attachment D.

Numerous small faults are to be seen in all rock units of the region. Quantitatively, their abundance appears to be related to the brittleness of the rock containing them. Most involve displacement of a few inches or feet. Only one was deemed to be sufficiently important to show on the geologic map. This is the Portsmouth fault which forms the Rye-Kittery contact for approximately 9 miles. There are so few outcrops of the fault zone, and these are poor, that no attempt was made to calculate the fault displacement. It is not known if the fault continues across the Piscataqua River and into Southeastern Maine. (Navy 1993b)

4.1.3.7 Air Resources

4.1.3.7.1 Climate and Meteorology. The overall climate in the Portsmouth region is characterized as variable. Weather conditions can change dramatically over short intervals. There are alternating frontal systems on a day-to-day basis, widely ranging daily and annual temperatures, and overall differences between the same seasons in different years.

Although this region is situated in the path of the prevailing westerly winds, the coastal area experiences a variety of air changes over the course of a year. These include: cold dry arctic air from the north, warm land air from the Gulf states, and cool, damp air from the Atlantic Ocean. It is the combinations of, or switches between, these conditions that generally cause the area's characteristic weather.

Weather conditions, especially temperature, in the Portsmouth general area are moderated by its maritime setting. The average daily temperature ranges from 80°F in July to 13°F in January and February. Temperatures can fluctuate outside this range, but they are not usually persistent.

Precipitation is fairly evenly distributed over the year, with 2.7 to 4.6 inches falling per month for a 42.6-inch annual total. On the average, there are about 130 days each year having more than a trace of precipitation. Most summer precipitation results from showers and, infrequently, thunderstorms. Winter precipitation is generally associated with stormy conditions caused by air masses moving up along the coast.

The cool Atlantic waters can produce extensive advection fog when warmer moist air is carried over the cool water. With any persistent eastern component in the wind direction, the fog that often lies just offshore during the summer can reach the coastline. This situation is increased during the summer by local sea breezes. All months of the year have a fairly consistent occurrence of fog. Localized and continuous fog was observed at the former Pease Air Force Base an average of 15% of the time and was dense enough to restrict visibility to 1.2 miles (2 kilometers) or less, about 35% of the time.

The predominant direction the wind blows from for the Portsmouth Harbor area is a combination of the western, southwestern, and southern sectors for a combined total of 36% of the time. Differences in wind characteristics occur on a seasonal basis with west-northwest winds dominating in the winter, and southwest-southeast winds increasing in frequency during spring and summer.

The wind speed averages 8.8 miles per hour in the Portsmouth Harbor area. Speeds greater than 40 miles per hour, however, can occur any time of the year. During the winter, increased wind speeds are normally caused by the northeast winds moving down the coast, while during the summer, high winds are more often associated with thunderstorms or squall lines moving through the area. (Navy 1991b)

4.1.3.7.2 Air Quality. A Reasonably Available Control Technology analysis was conducted in response to Maine Department of Environmental Protection (DEP) regulations requiring Reasonably Available Control Technology for Volatile Organic Compound (VOC) emission sources, such as the Portsmouth Naval Shipyard, which are located in ozone nonattainment areas. The Reasonably

Available Control Technology analysis was conducted for point and fugitive sources of VOC emissions at the shipyard.

The shipyard is a large industrial complex that emits VOC emissions from a variety of sources located throughout the site. Many of the sources of VOC are small and represent fugitive losses of emissions. VOC emissions from these operations are best controlled through the implementation of good housekeeping practices.

It has been determined that current VOC operations at the shipyard meet Reasonably Available Control Technology. Continuation of current practices will ensure that VOC emissions from the shipyard are maintained at or below Reasonably Available Control Technology levels. (Navy 1991b)

An area can be designated by the Environmental Protection Agency as having air quality that is better than defined by the National Ambient Air Quality Standards (attainment) or as exceeding one or more of those standards (nonattainment for one or more pollutants). The Code of Federal Regulations, Title 40, Part 81, states that the Air Quality Control Region for the shipyard is in moderate nonattainment for ozone and is better than national standards for total suspended particulate matter and SO₂. The area has no specific classification for carbon monoxide and NO₂. The nearest Class I Area to the shipyard is at the Presidential Range - Dry River Wilderness Area, approximately 120 kilometers (75 miles) from the shipyard.

4.1.3.7.3 Existing Radiological Conditions Radiological facilities at all naval shipyards are designed to ensure that there are no uncontrolled discharges of radioactivity in airborne exhausts. Radiological controls are exercised to preclude exposure of working personnel to airborne radioactivity exceeding federal limits. Air exhausted from radiological work facilities is passed through high-efficiency particulate air filters and monitored during discharges. The annual airborne radioactivity emissions from the shipyards do not result in any measurable radiation exposure to the general public. Calculations of site radioactive airborne emissions for 1992 have been performed as described in Attachment F. These calculations have shown that emissions of radionuclides from each shipyard result in an effective dose equivalent of less than 0.1 mrem per year to any member of the general public.

4.1.3.8 Water Resources

4.1.3.8.1 Surface Water. A large portion of York County's surface runoff from precipitation is drained by coastal basins reaching a short distance inland from the coast. The system of water drainage channels used by runoff waters, varying from very small brooks to larger rivers, generally are in a southeasterly direction towards the Atlantic Ocean, but tributaries naturally flow from all directions into the larger channels. The remainder of the area is drained by larger river drainage basins that reach further inland. The Saco River basin and the Piscataqua-Salmon Falls River basins are the largest drainage systems, the Mousam and Kennebunk Rivers being considerably smaller. In each of these drainage basins, surface water is held in swamps, ponds and lakes, both natural and man-made, and by dams for storage, water supply, and development of power.

The largest quantities of surface runoff occur during March, April, and May with the lowest occurring in August and September. On the average, runoff is approximately 22 inches of the 44 inches annual precipitation. The combination of spring rains and snow melt not only serve to greatly increase stream flow, but also tend to replenish groundwater supplies.

The Piscataqua River, formed by the confluence of the Cocheco River and the Salmon Falls River, flows southeasterly for 13 miles until it enters the ocean at Portsmouth Harbor. The entire 13 miles of the river is tidal. The river is one of the fastest flowing tidal waterways of any commercial port in the northeastern United States. Due to abrupt channel changes and the strengths of flood and ebb currents, hazardous cross-currents and eddies are found in the main channel passing north and east of Pierce and New Castle Island. The average current velocity at full strength in the main harbor varies from about 2.6 to 4.0 knots, whereas in the back channels, the velocity varies from less than 1 to 2 knots.

The tide at Portsmouth occurs twice daily. The average tidal range from Portsmouth Harbor is 8.4 feet. The average mean spring range is 9.7 feet and the average mean tide level is 4.2 feet.

New Hampshire and Maine have an agreement to maintain acceptable water quality in the Piscataqua River and both states regulate their effluent discharges into the river. The river is designated by the state of New Hampshire as a Class B segment and by the state of Maine as Class SB-1. New Hampshire Class B waters are acceptable for bathing, other recreational purposes, fish

habitat, and public water supply after adequate treatment. Maine Class SB-1 waters are suitable for all clean water usages including water contact recreation, fishing, shellfish harvesting and propagation, and fish and wildlife habitat. (Navy 1984)

The Flood Insurance Rate Map (FIRM COMMUNITY-PANEL No. 230171 0008D) shows that the Portsmouth Naval Shipyard is not in a 100 or 500 year floodplain.

4.1.3.8.2 Groundwater. Groundwater reserves constitute an important natural resource and are especially important to the more populated communities in the area. The majority of the public water supply in the area is taken from lakes and rivers, with groundwater providing the remainder of the requirements.

As much as 35% of the total area of York County is underlain by soils which are generally adapted to storage and yield of groundwater, but this figure is based only on surface data. In some localities, marine clays overlie deeper gravels and may represent excellent future sources. When favorable groundwater soils are measured to adequate depths, it is quite probable that the good groundwater yield areas will shrink to a few percent of the total land areas. (Navy 1984)

4.1.3.8.3 Existing Radiological Conditions. The normal activities associated with current naval nuclear operations at all naval shipyards do not result in the intentional discharge of any radioactive liquid effluent. However, there were occasions, primarily in the early 1960's, when measurable levels of radioactivity were discharged with liquid effluent. In all cases, effluent releases were less than permitted under the then current limits imposed by state and federal agencies.

The United States Environmental Protection Agency Office of Radiation Programs has performed monitoring of the water, plant life, aquatic life, and sediment in the vicinity of Portsmouth Naval Shipyard to confirm that the general public is not affected by operations of Portsmouth Naval Shipyard. "Radiological Survey of Portsmouth Naval Shipyard, Kittery, Maine and Environs" (Semler 1991) discusses the most recent Environmental Protection Agency monitoring data. Pertinent conclusions are as follows:

1. "No trace of Co-60 was detected in any samples at Portsmouth Naval Shipyard. All radioactivity detected in the 40 sediment samples is attributed to naturally occurring radionuclides or fallout from past nuclear weapons testing.
2. Results of core sampling did not indicate any previous deposit of Co-60 in the sediment.
3. The water samples contained no detectable levels of radioactivity.
4. All radioactivity detected in the biota samples is attributed to naturally occurring radionuclides or fallout.
5. External gamma ray measurements did not detect any increased radiation exposure to the public above natural background levels.
6. Based on the survey, it was concluded that current practices regarding nuclear-powered warship operations have resulted in no increases in radioactivity that would result in major exposure or contamination of the environment."

Environmental monitoring is conducted by the shipyard. The results of this monitoring program corroborate the Environmental Protection Agency's conclusions.

4.1.3.9 Ecological Resources

4.1.3.9.1 Terrestrial Ecology. Portsmouth Naval Shipyard is an isolated land mass that has been highly developed. There is almost no remaining natural habitat in the shipyard area, with the major exception being Clarks Island and the surrounding estuary. Even these areas are not unaffected by activities on the shipyard and nearby industry.

The estuary around the shipyard could be classified as an intertidal river system which supports a subtidal estuary community. The shoreline is characterized by steep, rocky banks and low-lying marshlands. The shipyard mass would probably be classified as a rock outcrop ecosystem, characterized by sparse vegetation of low-lying shrubs and herbs with scattered trees. The community would be classified as an acidic shoreline outcrop.

The vegetation of the shipyard is made up primarily of trees, shrubs, and grasses that have been planted for landscaping purposes. No naturally occurring species remain at this time. Because Clarks Island has remained undeveloped, there is much greater diversity. It supports a variety of herbaceous and shrub species including rushes, skunk cabbage, jewelweed, spike grass, swamp azalea, bittersweet, witch hazel, and dogwood. Several lowland tree species are also growing on the island, including red maple, sycamore, willow, and poplar.

The fringe marshes along the shore of Admiralty Village and along portions of Clarks Island are dominated by two species, cord grass (*Spartina alterniflora*) and salt hay (*Spartina patens*). These perennial grasses are year-round producers of vital organic matter that is distributed to the detrital food chain or deposited in the marsh as part of the underlying peat marsh.

Another important plant species present within the Piscataqua River and abundant around the shipyard is *Zostera marina*, commonly called eel grass. This submerged marine flowering plant is vital to the health and productivity of the estuary. It provides habitat essential to the life cycle of species such as crabs, fin fish, geese, and ducks. Eel grass beds are also preferred nursery habitat for lobsters. Other valuable functions of eel grass beds include: sediment trapping, bottom stabilization, and water filtration. This filtration ability also causes eel grass beds to be susceptible to algal blooms resulting from excessive wastewater and fertilizer nutrients. Thus, eel grass is essential to the health of the estuary and can also serve as an indicator of unhealthy conditions.

The limited amount of vegetation and the highly industrialized nature of the shipyard area severely limit the availability of suitable habitat for most terrestrial species. There are some mammals on the shipyard, primarily those species that tend to live in close association with man, including: mice, squirrels, raccoons, and rabbits. There are white-tailed deer and moose in close vicinity of the shipyard. However, there are no known resident species of deer or moose on the shipyard. The Navy's 1993 "Natural Resources Management Plan for Portsmouth Naval Shipyard" contains a complete listing of all mammals and reptiles found in the southeastern Maine-New Hampshire region (Navy 1993b).

One notable ecological feature of the shipyard is its avian population. Bird species are most abundant in the region during the months of April and September, coinciding with the migratory seasons. The most common species in the area are the herring gull, American black duck, doublecrested commorant, great blue heron, and American crow. The most abundant winter migrant

species are Canada geese, greater scaup, bufflehead, and common goldeye. Sea birds in general are the most abundant, and the year-round species include herring gulls and great black-backed gulls. The common tern can also be found in large numbers during the late spring and summer. Osprey have also been known to frequent the area and there is one known nesting pair in the Great Bay Estuary vicinity. Appendix V.A. of the Navy's Natural Resources Management Plan contains a complete list of bird species common to the coastal region (Navy 1993b).

Clarks Island serves as a safe haven for a multitude of birds. It is an optimum habitat for migratory species in that it has rocky shore, a small beach area, and an inland area of fairly dense wood and low-lying vegetation. It would not be unreasonable to expect that during the early spring and fall, Clarks Island would be utilized by a variety of songbird species along with the typical coastal species mentioned above. (Navy 1993b)

4.1.3.9.2 Wetlands. There are a few isolated marine wetlands in the vicinity of the shipyard and a small freshwater wetland on the shipyard. There are two freshwater ponds on the southern portion of the base, which have been characterized as palustrine, unconsolidated bottom, and permanently flooded. There is a small area on the banks of the larger pond which is characterized as palustrine, scrub shrub, broadleaf deciduous wetland. There are also two very minute areas southwest of the freshwater ponds which have been characterized as palustrine emergent, persistent, seasonally flooded wetlands. Two areas of estuarine wetlands are noted. Along the northeast shoreline, they are classified as intertidal, unconsolidated shore, mud bottom, and regularly flooded. This same classification has been given to the northern shoreline of Clarks Island. Finally, on the western side of Clarks Island and on the southwestern corner of the shipyard, there are areas of estuarine intertidal aquatic bed, algal, regularly flooded wetlands. It should be noted that these determinations were based on stereoscopic analysis of aerial photographs and cannot be considered completely accurate without ground truthing. (Navy 1993b)

Because natural drainage systems are limited, the shipyard has developed an extensive storm water collection system and a drainage system to control flooding of the freshwater ponds. This collection system eventually drains into the Piscataqua River, as does surface runoff. (Navy 1993b)

4.1.3.9.3 Aquatic Ecology. The waters surrounding the Portsmouth Naval Shipyard support a vast amount of marine life, from mammals to benthic organisms. Although the larger mammalian species, like whales and dolphin, are not common to the estuarine waters of the Piscataqua River,

harbor seals can be seen throughout the Great Bay region in winter and spring. The estuary also supports a number of commercially and recreationally important fin fish including smelt, winter flounder, Atlantic silversides, alewives, and striped bass. A more complete list can be found in Appendix V.A. of the Navy's Natural Resources Management Plan (Navy 1993b).

These fish species rely heavily on a healthy benthic invertebrate population for survival. Substrate type has a major impact on the number and variety of species that will be found in any particular area. The areas around the shipyard that have a rocky bottom will be populated by epibenthic organisms. Sandy or muddy bottoms can support both epibenthic and infaunal organisms. Some of the more common shellfish species include lobster, softshell clams, and blue muscles. A more detailed list of benthic infauna can be found in Appendix V.A. of the Navy's Natural Resources Management Plan (Navy 1993b).

The freshwater ponds on the shipyard also serve as a source of aquatic species. There is a healthy benthic community within this ecosystem as well, including a variety of polychaete worms. There is an abundance of vegetation in and around the ponds, which provides habitat for freshwater fish. The most abundant fish species at this time is the smallmouth bass (Micropterus dolomieu), which were stocked at one time. (Navy 1993b)

4.1.3.9.4 Endangered and Threatened Species. In the coastal area from Portland, Maine to Portsmouth, New Hampshire, the threatened or endangered species include the Piping Plover, Roseate Tern, Bald Eagle, Peregrine Falcon, Shortnose Sturgeon, and several species of whales and sea turtles.

Appendix V.A. of the Navy's Natural Resources Management Plan (Navy 1993b) includes a list of the threatened and endangered species of southeastern Maine and New Hampshire. Both Maine and New Hampshire officials were consulted and have determined that there is no evidence to suggest that any threatened or endangered species reside on the Portsmouth Naval Shipyard. Marine mammals are afforded full federal protection under the Marine Mammal Protection Act of 1972 (Navy 1993b).

4.1.3.10 Noise

Portsmouth Naval Shipyard is an existing industrial-type environment characterized by noise from truck and auto traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related compressors for those and other liquids. In addition, new construction of buildings, reconstruction and rehabilitation activities for streets, buildings, parking lots, and ships all contribute to a pervasively industrial environment.

4.1.3.11 Traffic and Transportation

The Kittery-Portsmouth area is very accessible to vehicular traffic due to the proximity of Interstate 95. The major cities of Boston, Massachusetts and Portland, Maine are approximately one hour away. U.S. Route 1, a primary road, runs parallel to I-95 in a north-south direction and provides good access to the local communities along the seacoast. Because of the shipyard's location on an island in the Piscataqua River, access is restricted to two federally owned bridges. The bridges provide access directly to the shipyard's northern boundary from residential streets in the town of Kittery. The majority of installation oriented traffic traverses five local secondary roadways: Walker Avenue, Wenworth Street, and Shapleigh, Whipple, and Rogers Roads. Walker Avenue is the primary access route to Bridge 1 and Whipple Road provides direct access to Bridge 2. Most shipyard generated traffic is funneled from the two major highways, I-95 and U.S. Route 1, through the local roadways and over the bridges.

Daily rail service, freight only, is provided to Portsmouth Naval Shipyard by the Boston and Maine Railroad. The railroad connects Portsmouth with Manchester, New Hampshire; Portland, Maine; and Boston, Massachusetts. Rail passenger service is available via AMTRAK connecting to Boston.

Limited air service is provided at small airports at Eliot and Sanford, Maine, and Hampton and Rochester, New Hampshire. Pease Airport provides the opportunity for commuter flights to Logan Airport in Boston, Massachusetts and to other cities. In addition, Portsmouth is within one hour travel time by car from major airports at Boston, Massachusetts and Portland, Maine.

The Portsmouth Harbor, about 3 nautical miles from deep water of the Atlantic Ocean, is accessible year round via the Piscataqua River channel. The river channel is 35 feet deep below mean low water and 400 feet wide. There are about 500 vessel trips each way through the channel each year. About 150 of these trips involve ships with drafts greater than 18 feet, and more than 200 trips are made by tankers. A Coast Guard Station is located at New Castle near the harbor entrance. (Navy 1984)

Spent naval nuclear fuel has been removed from Navy nuclear-powered ships and transported to the Idaho National Engineering Laboratory Expanded Core Facility (ECF) for examination and evaluation as a routine part of their operating cycle. Naval spent nuclear fuel shipments from Portsmouth Naval Shipyard to ECF were initiated in 1959. Since that time, 43 shipments of naval spent nuclear fuel originating at Portsmouth Naval Shipyard have been made to ECF. The naval spent nuclear fuel was shipped by rail. Attachment A provides a list of these shipments made to date by year. Attachment A also contains detailed descriptions of the shipping containers used for naval spent nuclear fuel shipments from shipyards.

4.1.3.12 Occupational and Public Health and Safety

4.1.3.12.1 Occupational Radiological Health and Safety. Portsmouth Naval Shipyard and the Admiralty Village housing area are physically located in York County, Kittery, Maine on government-owned land. The U.S. Government provides its own police and fire protection on the shipyard, while Kittery provides police and fire protection for the Admiralty Village Housing Area. (Navy 1984)

The Navy has well established and effective Occupational Safety, Health, and Occupational Medicine programs at all of its shipyards. In regard to radiological aspects of these programs, the Naval Nuclear Propulsion Program policy is to reduce to as low as reasonably achievable the external exposure to personnel from ionizing radiation associated with naval nuclear propulsion plants. These stringent controls on minimizing occupational radiation exposure have been successful. No civilian or military personnel at Navy sites have ever exceeded the federal accumulated radiation exposure limit which allows 5 rem exposure for each year of age beyond age 18. Since 1967, no person has exceeded the federal limit which allows up to 3 rem per quarter year and since 1980, no one has received more than 2 rem per year from radiation associated with naval nuclear propulsion plants.

The average occupational exposure of each person monitored at all shipyards is 0.26 rem per year. The average lifetime accumulated radiation exposure from radiation associated with naval nuclear propulsion plants for all shipyard personnel who were monitored is 1.2 rem. (NNPP 1993a) This corresponds to the likelihood of a cancer fatality of 1 in 2083.

The Navy's policy on occupational exposure from internal radioactivity is to prevent radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by federal regulations for radiation workers. As a result of this policy, no civilian or military personnel at shipyards have ever received more than one-tenth the federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with naval nuclear propulsion plants.

For work operations involving the potential for spreading radioactive contamination, containments are used to prevent personnel contamination or generation of airborne radioactivity. The controls for contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into radiological areas because the contamination control limits used in these areas were well below the levels of fallout and natural contamination occurring outside in the general public areas. A basic requirement of contamination control is monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves (i.e., frisk), and their performance is checked by radiological control personnel. Frisking of the entire body is required, normally using sensitive hand-held survey instruments. Major work facilities are equipped with portable monitors, which are used in lieu of hand-held friskers. These stringent controls to protect the workers and the public from contamination have proven effective in the past.

In 1991, researchers from Johns Hopkins University, Baltimore, Maryland, completed a very comprehensive epidemiological study of the health of workers at the six naval shipyards and two private shipyards that service the Navy's nuclear-powered ships (Matanoski 1991). This independent study evaluated a population of 70,730 civilian workers over a period from 1957, beginning with the first overhaul of the first nuclear-powered submarine, USS NAUTILUS, through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels of gamma radiation.

The Johns Hopkins study found no evidence to conclude that the health of people involved in work on U.S. naval nuclear-powered ships has been adversely affected by exposure to low levels of radiation incidental to this work. Additional studies are planned to investigate the observations and update the shipyard study with data beyond 1981.

The radiation exposure during normal operations at each shipyard for workers who have their radiation levels monitored is determined based on the annual radiation exposure of 0.26 mrem per worker for all shipyards based on Naval Nuclear Propulsion Program Report NT-93-2 (NNPP 1993a). The total number of shipyard personnel monitored for radiation exposure associated with the Naval Nuclear Propulsion Program has been about 164,000.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within DOE standards for occupationally exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.3.12.2 Occupational Non-radiological Health and Safety. In the non-radiological Occupational Safety, Health, and Occupational Medicine area, the Navy complies with the Occupational Safety and Health Administration Regulations. The Navy policy is to maintain a safe and healthful work environment at all Navy facilities. Due to the varied nature of work at these facilities, there is a potential for certain employees to be exposed to physical and chemical hazards. These employees are routinely monitored during work and receive medical surveillance for physical hazards such as exposure to high noise levels or heat stress. In addition, employees are monitored for their exposure to chemical hazards such as organic solvents, lead, asbestos, etc., and where appropriate are placed into medical surveillance programs for these chemical hazards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

4.1.3.12.3 Public Radiological Health and Safety. In order to quantify the exposures resulting from normal shipyard radiological releases to the general public, detailed analyses were performed based on very conservative estimates of radioisotopic releases since releases began. Attachment F provides detailed annual release values used in the analyses.

The GENII computer code (Napier et al. 1988) was used to calculate exposures to human beings due to the estimated radionuclide releases from normal operations at the shipyards.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from stored fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F.

The hypothetical exposures calculated in Attachment F for the period 1995 through 2035 were adjusted from an annual basis (1995) to the historical basis by multiplying by 38 years and by a factor of 1.7 to take into consideration variations in the number of ships and operations.

The calculated accumulated exposures through 1995 to the general population within 50 miles of the site (about 2.4 million people) are 0.65 person-rem. To provide perspective, the exposures received due to natural radiation sources through 1995 are approximately 28 million person-rem, based on 0.3 rem per person per year.

The results of environmental monitoring as described in Naval Nuclear Propulsion Program Report NT-93-1 show that Naval Nuclear Propulsion Program activities had no distinguishable effect on normal background radiation levels at site perimeters (NNPP 1993b).

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities.

All of the radiation exposures to the general population correspond to much less than one incident cancer, which means that it is unlikely that there has been any past health impacts to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.3.12.4 Public Non-radiological Health and Safety. The Naval Medical Clinic located on the shipyard is used by Navy personnel and dependents for their general medical care requirements. Medical problems that require treatment not available at the clinic are taken care of at hospitals located in York, Maine and Portsmouth, New Hampshire. (Navy 1984)

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.3.13 Utilities and Energy

Portsmouth Naval Shipyard has its own Security, Fire, Public Works, and Supply departments. Portsmouth Naval Shipyard obtains its electricity from Central Maine Power, but has a central power plant capable of producing all of the required steam and electricity. Potable water is furnished by the town of Kittery, Maine. (Navy 1984)

The 1993 electrical power usage at Portsmouth Naval Shipyard was 76,262 megawatt hours. The water usage at the shipyard was approximately 668 million gallons for 1993.

4.1.3.14 Materials and Waste Management

The shipyard's sewage is pumped to the town of Kittery's sewage treatment system. Disposition of solid waste is as follows: 58% is recycled, 38% is burned for energy recovery at the Maine Energy Recovery Incinerator, and 4% is landfilled at licensed off-site facilities. Bulk aqueous waste is collected and shipped for off-site licensed treatment/disposal. Containerized hazardous waste is collected, consolidated, characterized, and labeled at the shipyard's state-licensed Hazardous Waste Storage Facility prior to manifesting to off-site licensed treatment/disposal/energy recovery facilities. Oily waste is presently contracted for off-site disposal; however, an oily waste treatment system has been installed and should be on line in the near future. The effluent from treatment operations will be discharged to the sewer, and the separated waste oil will be sold through the Defense Logistics Agency.

Solid radioactive waste materials are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites licensed by the U.S. Nuclear Regulatory Commission or a State under agreement with the U.S. Nuclear Regulatory Commission. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites. During 1992, approximately 74 cubic yards of routine low-level radioactive waste containing 2 curies were shipped from Portsmouth Naval Shipyard for burial.

Waste which is both radioactive and chemically hazardous is regulated under both the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA) as "mixed waste." Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid combining radioactive and chemically hazardous substances so as to minimize the potential for generation of mixed waste. For example, these efforts include avoiding the use of acetone solvents, lead-based paints, lead shielding in disposal containers, and chemical paint removers. Radioactive wastes, including those containing chemically hazardous substances, are handled in accordance with long-standing Program radiological requirements. Such handling includes solidification to immobilize the radioactivity, separation of the radioactive and chemically hazardous substances, removal of liquids from solids, and other simple techniques. A determination is then made as to whether the resulting waste is hazardous. As a result of Program efforts to avoid the use of chemically hazardous substances in radiological work, Program activities typically generate only a few hundred cubic feet of mixed waste each year. This small amount of mixed waste, along with limited amounts of mixed waste from Program work conducted prior to 1987, will be stored pending the licensing of commercial treatment and disposal facilities.

4.1.4 PEARL HARBOR NAVAL SHIPYARD: PEARL HARBOR, HAWAII

4.1.4.1 Overview

The Pearl Harbor Naval Shipyard is located in the Southeast Loch of Pearl Harbor, Oahu, Hawaii (Figures 4.1.4-1 and 4.1.4-2). This shipyard consists of approximately 350 acres. The island of Oahu is the third largest (593 square miles) in the State of Hawaii and is the population center of the Hawaiian Islands. The 1990 Oahu population of approximately 820,000 residents comprised over 75% of the state's total, and the City and County of Honolulu are the fastest growing areas in the state, with the highest population densities. Honolulu is the state capital, largest city, and center of business and government.

Pearl Harbor is a principal harbor for U.S. Navy activities and is the base of Navy operations for the mid-Pacific. Figure 4.1.4-3 provides a Pearl Harbor site map. Its water surface area of about 8 square miles and its docks accommodate all classes of Navy vessels up to the largest aircraft carriers. Ship maintenance and repairs are performed for all types of vessels in Pearl Harbor Naval Shipyard's dry docks and docking areas. All of the docks are located in the Southeast Loch area with the exception of Dry Dock 4 which is adjacent to the Pearl Harbor main channel. (Navy 1991c)

4.1.4.2 Land Use

There are six major land use activities at Pearl Harbor. Commander Naval Base Pearl Harbor (NAVBASE) hosts various operational commands that include the Headquarters for the Pacific Fleet and the Headquarters of the Third Fleet.

Pearl Harbor Naval Shipyard provides the maintenance and repair services noted above. The Naval Supply Center provides fuel, ammunition, other supplies, and storage. The other primary land use activities are for: the Submarine Base; the Public Works Center; and the U.S. Naval Inactive Ship Maintenance Detachment.

Land use is designated as urban by the State of Hawaii, and military by the City and County of Honolulu. As can be seen in Figure 4.1.4-2, the Pearl Harbor Naval Shipyard is surrounded by

STATE OF HAWAII

Figure 4.1.4-1. Location of Pearl Harbor Naval Shipyard in Hawaii.

Figure 4.1.4-2. Pearl Harbor vicinity with average annual rainfall gradient.

Figure 4.1.4-3. Pearl Harbor Naval Shipyard site map.

military land with Hickam Air Force Base in the southern quadrant and naval installations occupying the remaining three quadrants. Other activities commonly occurring in the Pearl Harbor area are commercial fishing, tourism, and recreational facilities, along with a few retail complexes. (Navy 1990b)

4.1.4.3 Socioeconomics

Oahu has experienced a high rate of economic growth over the past decade due to its location in the Pacific, which benefits both military defense and visitor industries. These two industries have surpassed the two historical bases of the Hawaiian economy, which are pineapple and sugar cultivation and production.

Oahu's visitor industry continues to prosper. Visitor arrivals to the state are projected by the Department of Business and Economic Development to reach 7.8 million visitors by 2000, with Oahu capturing approximately half of the visitors. This would represent a visitor growth rate on Oahu of about 3.4 percent compounded annually.

Defense expenditures cushion Oahu's economy from the seasonal and cyclical fluctuations of tourism. The military is also a primary source of highly skilled employment opportunities for civilians. Pearl Harbor has the largest concentration of Department of Defense employment in the state, with about 7,700 shore-based Navy personnel and 10,900 civilians, for a total of 18,600 at the naval base. In 1993, shipyard employment accounted for about 5,000 of the total. The population distribution within 50 miles of Pearl Harbor Naval Shipyard is shown in Figure 4.1.4-4.

Unemployment figures in the state and for the island of Oahu are among the lowest in the nation. Oahu is at a 2.3 percent unemployment level as of October 1989, reflecting the strong local economy that prevailed in the latter half of the 1980s. With the outlook favorable for continued expansion, job growth is currently expected to equal or better the 2 to 3 percent historical annual increase in Oahu's work force. (Navy 1990b)

Miles	People	Cumulative People
0-5	214,516	214,516
5-10	217,692	486,208
10-20	325,980	812,188
20-30	4,975	817,163
30-40	0	817,163
40-50	222	817,385

Based on 1990 Census

Figure 4.1.4-4. Population distribution within 50 miles of Pearl Harbor Naval Shipyard.

The majority of the labor force that would be employed at the shipyard for construction and operation of the naval spent nuclear fuel area would be expected to reside on the island of Oahu. The calculated total population, labor force, and employment within this region for the base year (1995) are presented in Table 4.1.4-1. Projections of employment and population for the years beyond 1995 have not been presented because, as discussed in Section 5, the number of additional jobs that might be created at the shipyard under any alternative could be small.

Table 4.1.4-1. Regional employment factors at Pearl Harbor Naval Shipyard.

Regional Employment	Regional Labor Force	Regional Population
393,260	407,530	812,190

4.1.4.4 Cultural Resources

Pearl Harbor has been the site of several important historical events and changes, and is most noted for its role in the Pacific Theatre Defense during World War II. Physical sites near and in Pearl Harbor have been designated as historically significant, including several battleships sunk during the December 7, 1941 Japanese bombing of Pearl Harbor, as well as sites where planes were downed. Naval Base Pearl Harbor was designated as a National Historic Landmark in 1964, and in 1974, it was listed on the National Register of Historic Places.

The Pearl Harbor area has been heavily modified over the past 70 years. This includes extensive changes that were intended to stabilize the marshy shorelines. Most surface evidence of any pre-military occupation has long since been obliterated. Due to the historic nature of the shipyard, there might be areas of archaeological interest. However, there are no archaeological sites located within the boundary of the shipyard. Many native Hawaiian cultural resources exist on the Hawaiian Islands. There are three Hawaiian fish ponds located outside the boundary, in West Loch and in East Loch, that have been recommended for preservation. (Navy 1990b)

4.1.4.5 Aesthetic and Scenic Resources

The Pearl Harbor viewshed is dominated by the sweeping mountain to sea vistas characteristic of nearshore areas on Oahu. The City and County of Honolulu's *Coastal View Study* (1987) states

that the "flat terrain and the built up military facilities surrounding Pearl Harbor provide very little public viewing opportunities into this bay." (Navy 1990b) The shipyard area, itself, is an industrial setting. The area within the shipyard where naval spent nuclear fuel would be stored has low visual sensitivity since the area is an industrial site.

4.1.4.6 Geology

4.1.4.6.1 General Geology. Oahu's topography consists of two parallel mountain ranges running in a northwest to southeast direction, separated by a plateau. A large, relatively level coastal plain borders the plateau at the south. The Pearl Harbor Naval Complex, for the most part, lies within this coastal plain.

Land near the waterfront areas is very flat, rising slightly inland from Kamehameha Highway. There are moderate slopes which exist around the rim of the Makalapa Crater.

4.1.4.6.2 Geologic Resources. There are several different soil associations within the Pearl Harbor basin. The majority of the U.S. Navy lands surrounding Pearl Harbor are comprised of the Lualualei - Fill Land - Ewa Soil Association. This association consists of well-drained, fine textured, and moderate fine textured soils on fans and in drainage ways on the southern and western coastal plains of Oahu. The soils are formed from sediment deposited by streams, and are nearly level to moderately sloping. This soil association makes up about 14 percent of the island of Oahu.

Pearl Harbor estuary occurs on the coastal sedimentary plain of southern Oahu. The harbor consists of three lochs which join to form a single channel entrance. Streams, springs, and ground-water flow into the harbor; the estuary was formed by freshwater flows that have eroded the coastal plain and retarded coral growth. Since their initial formation, the lochs have been altered by sea-level change, erosion, and silt. The west side of the harbor is composed mostly of limestone reef material known as the Ewa Plain. The east side of the harbor consists mainly of compacted volcanic ash. Hard, dense volcanic rock forms the bulk of the rock material to the north. Marine and terrestrial sediments occur around the perimeter of the harbor. (Navy 1990b)

Much of the land area in Pearl Harbor is fill land created by dredge spoils since 1930. A major dredging effort took place between 1940 and 1943, when dredged material was placed in the

Waipio Peninsula and adjacent to Kuahua Island (now Kuahua Peninsula). This landfill resulted in the present shoreline configuration. (Navy 1990b) There are no economic geologic resources at the shipyard.

4.1.4.6.3 Seismic and Volcanic Hazards. Seismic risk related to structural damage may be represented in the United States by a relative scale of 0 through 4, with Zone 0 not expected to encounter damage and Zone 4 expected to encounter the greatest seismic risk. The Pearl Harbor Naval Shipyard is located in Zone 1. (UBC 1991) Except for the island of Hawaii itself, the Hawaiian Islands are not a highly seismic area. Even on Hawaii, most of the earthquakes are of volcanic origin and do little or no damage, although a few have been quite severe. The Uniform Building Code seismic classification provides a means for a comparable assessment of the seismic hazard between the alternate sites. If the Record of Decision identifies this site for the interim storage of naval spent fuel, then a detailed seismic evaluation would be conducted. More detailed information regarding the design basis considerations for storage of naval spent nuclear fuel at the shipyard is provided in Attachment D.

From review of Tsunami Wave Runup Heights in Hawaii by Harold G. Loomis, Hawaii Institute of Geophysics, University of Hawaii, May 1976, past inundation levels from waves produced by seismic events have been about 3 feet above Mean Sea Level (msl). In addition, a memorandum from the U.S. Army Engineering Division, Pacific Ocean, dated 10 January 1986 indicated projected seismically induced wave elevations for the 10-year, 100-year, and 500-year event to be 0.8 feet, 2.0 feet, and 3.8 feet, respectively, for adjacent coastal areas. (Navy 1990b)

Pearl Harbor is fully protected from ocean waves and swells. Waves propagating through the 15,000-foot entrance channel are completely reduced. The normal tides in Hawaii occur twice daily, with pronounced daily inequalities. Maximum high, or spring tides, reach 2.5 feet above msl. Storm water level rise is caused by four components: astronomical tides, rise from atmospheric pressure reduction (pressure setup), wind setup, and wave setup. Based on information obtained from the Naval Western Oceanography Center, maximum hurricane storm water level rise from setup under the worst conditions foreseeable would be approximately 12 feet above the existing tide level. Thus, maximum total storm water level rise would be approximately 14.5 feet above msl. Under the maximum foreseeable conditions, any material stored in the dry dock area of Pearl Harbor Naval Shipyard, which is about 8 feet above msl, could be flooded to a level of about 6.5 feet.

In September 1992, the worst storm in Pacific history, Hurricane Iniki, hit Kauai with sustained 145-mile-per-hour winds and gusts to 175 miles per hour. Oahu, 80 miles to the east, received comparatively minor damage to that experienced on Kauai. The last hurricane to strike the state prior to Iniki was Iwa in 1982 but it did not cause nearly as much damage.

The Hawaiian Islands were formed by volcanic eruptions; however, the only active volcanic area is on the island of Hawaii. There are no volcanic hazards on the island of Oahu. (Doell and Dalrymple 1973).

4.1.4.7 Air Resources

4.1.4.7.1 Climate and Meteorology. With the exception of minor differences in temperature and rainfall at Red Hill and Camp Stover, all of the activities at Pearl Harbor lie within the same climatic zone and are subject to the same weather conditions.

The predominant winds are the northeast tradewinds, which prevail most of the year, particularly from February to November. Thus, the predominant winds would carry any airborne contaminant from the shipyard to the unpopulated ocean region adjacent to Pearl Harbor on the south. At certain times of the year, south to southwest winds and mild offshore breezes can be expected. Winds with speeds up to 49 miles per hour may occasionally strike from the north or northeast but rarely reach gale velocities. The south winds are usually accompanied by wet tropical air and frequent heavy showers. During the summer months, periods of no wind occur occasionally but do not persist for more than a day or two. During the winter months, winds tend to be less predictable, with longer periods of light and variable winds, and occurrences of strong southerly or "Kona" winds associated with weather fronts and storms.

The rainfall at Pearl Harbor is light and generally inadequate to sustain lawns and other vegetation for at least nine months of the year. Very heavy precipitation may occasionally fall during times of southerly winds, and this may cause local flooding because of the nature of the soils and the relatively low elevation. The mean annual rainfall for the naval base is between 20 and 30 inches, dependent upon the incidence of the occasional heavy southerly rains mentioned previously. The topography and meteorology of Oahu are responsible for the unusual annual rainfall gradient shown in Figure 4.1.4-2.

Temperatures vary by season as well as daily in the Pearl Harbor region. Highs of 87°F to 89°F are not uncommon during mid-afternoon in summer. Night temperatures during the same season fall between 72°F and 76°F. During the winter and early spring, daytime highs will reach between 76°F and 78°F, and nighttime lows may fall to the low 60's or high 50's. The lows are generally caused by a shallow blanket of cold air that pours down from the mountains and spreads out over the lowlands during periods of low-velocity tradewinds. The low temperatures are almost invariably accompanied by a heavy dewfall which is not normal to the region.

4.1.4.7.2 Air Quality. An area can be designated by the Environmental Protection Agency as having air quality that is better than defined by the National Ambient Air Quality Standards (attainment) or as exceeding one or more of those standards (nonattainment for one or more pollutants). The Code of Federal Regulations, Title 40, Part 81, states that the Air Quality Control Region for the shipyard is better than national standards for total suspended particulate matter and SO₂. The area has no specific classification for ozone, carbon monoxide, and NO₂.

Air quality on Oahu is primarily affected by the prevalence of the northeast tradewinds which prevail approximately 80 percent of the year, particularly from February to November. Air monitoring of the naval base area conducted in 1989 showed that there was no NAAQS violation. Thus, air quality was in attainment with federal standards. The state standards, which are more restrictive in many cases than federal requirements, were exceeded only at intersections having high traffic during peak rush hours. (Navy 1990b) The nearest Class I Area is Haleakala National Park 188 kilometers (117 miles) from the shipyard.

4.1.4.7.3 Existing Radiological Conditions. Radiological facilities at all naval shipyards are designed to ensure that there are no uncontrolled discharges of radioactivity in airborne exhausts. Radiological controls are exercised to preclude exposure of working personnel to airborne radioactivity exceeding federal limits. Air exhausted from radiological work facilities is passed through high-efficiency particulate air filters and monitored during discharges. The annual airborne radioactivity emissions from the shipyards do not result in any measurable radiation exposure to the general public. Calculations of site radioactive airborne emissions for 1992 have been performed as described in Attachment F. These calculations have shown that emissions of radionuclides from each shipyard result in an effective dose equivalent of less than 0.1 mrem per year to any member of the general public.

4.1.4.8 Water Resources

4.1.4.8.1 Surface Water. Pearl Harbor receives surface runoff from seven watersheds. The Waikele Watershed (54 square miles) is the largest of the seven, comprising nearly 40 percent of the Pearl Harbor Basin. It is drained primarily by Waikele Stream, which discharges the heaviest sediment load of any of the Pearl Harbor Basin streams.

The Waiawa Watershed (24.6 square miles) consists of forest, agricultural, and urban land. It is drained by Waiawa Stream and its tributaries into Middle Loch. The Waimalu Watershed (17.7 square miles) is drained by the Waimano, Waimalu, and Kalauao Streams, which discharge into the East Loch of Pearl Harbor. The watershed is primarily undeveloped forest land with established urban areas on the coastal plain and lower slopes. The Aiea and Halawa Watersheds are drained by the Aiea and Halawa Streams, respectively, which discharge into East Loch. They are similar in nature to the Waimalu Watershed. Honouliuli Stream drains the Honouliuli Watershed and discharges intermittently into West Loch. The watershed consists primarily of agricultural and forested land. Only 20 percent of the Ewa Beach Watershed drains into Pearl Harbor. Sediment discharges into Pearl Harbor from the flat lowland area adjacent to West Loch are negligible.

Of the eight streams discharging into Pearl Harbor, two are intermittent: Honouliuli Stream and Aiea Stream. The remaining are perennial streams (Waikele, Waiawa, Waimano, Waimalu, Kalauao, and Halawa), which have their headwaters in the high rainfall area of the Koolau Range. All streams drain the forested and agricultural lands and pass through urban areas before entering Pearl Harbor. Some flooding occurs along the major streams throughout much of the basin but is not a major problem on the Naval Complex, affecting only a narrow strip of land along Aiea stream. (Navy 1990b)

An assessment in 1988 by the State of Hawaii, Department of Health indicated that Pearl Harbor's large drainage basin in central Oahu and the abundant rainfall in headwaters of the eight streams that flow into the harbor are major contributors to the harbor's role as a catchment for nonpoint runoff from agricultural, urban, and military sources. Violations of water quality criteria were noted for nitrogen, phosphorus, turbidity, and fecal coliforms in the harbor water. (Navy 1990b)

The Flood Insurance Rate Map (FIRM) COMMUNITY-PANEL No. 150001 0110 C shows that the floodplain is "undetermined" for the Pearl Harbor Naval Shipyard. Based on FIRM maps and topographical maps of areas approximately 3 miles away, the conceptual interim storage location is in the 100-year floodplain. However, based on experience, the location considered for naval spent nuclear fuel is not in a high-hazard area (as defined by Title 10, Part 1022 of The Code of Federal Regulations for floodplains) which is an area where frequent flooding occurs.

4.1.4.8.2 Groundwater. The major source of potable water on Oahu is dependent on a hydrologic cycle that starts with evaporation of water from the ocean, condensation of that vapor into rain, and the capture of that rain by the Koolau Mountains. A portion of the rainwater percolates down into the porous ground to become groundwater. The groundwater is a limited resource found in three types of groundwater bodies, or aquifers: major basal aquifers, which consist of freshwater floating on heavier seawater sealed from the ocean by layers of dense, hard volcanic rock; perched aquifers in which rainfall is caught behind impermeable dikes at high elevations; and groundwater standing on impermeable beds of volcanic ash, thus creating springs. Naval Base Pearl Harbor receives most of its water from the Koolau Aquifer and a small portion from the Waianae Aquifer, which are basal aquifers located in south central Oahu, partially within the Pearl Harbor Water Management Area (PHWMA). As of 1990, the military had an allocation of 28.125 million gallons per day (mgd) from the PHWMA, of which 22.670 mgd was authorized for the Navy. Over 4 mgd of this allocation was not used in 1988. Approximately 3 mgd of this unused allocation is attributed to the Navy. The quality of groundwater from the above aquifers is good. (Navy 1990b)

4.1.4.8.3 Existing Radiological Conditions. The normal activities associated with current naval nuclear operations at all naval shipyards do not result in the intentional discharge of any radioactive liquid effluent. However, there were occasions, primarily in the early 1960's, when measurable levels of radioactivity were discharged with liquid effluent. In all cases, effluent releases were less than permitted under the then current limits imposed by state and federal agencies.

The United States Environmental Protection Agency Office of Radiation Programs has performed monitoring of the water, plant life, aquatic life, and sediment in the vicinity of Pearl Harbor Naval Shipyard to confirm that the general public is not affected by operations of Pearl Harbor Naval Shipyard. "Radiological Surveys of the Pearl Harbor Naval Shipyard and Environs" (Callis 1987) is the most recent Environmental Protection Agency report which discusses data taken in 1985. Pertinent conclusions from this report are as follows:

1. "Neither harbor water nor drinking water from surrounding areas contain detectable cobalt-60 or tritium radioactivity.
2. Very small quantities of cobalt-60 were found in sediment and in two aquatic vegetation samples from the harbor. No cobalt-60 was found in any of the aquatic life samples.
3. The levels of cobalt-60 in the harbor sediment have decreased greatly since the surveys of 1966 and 1968 and are consistent with those expected from the radioactive decay of the amounts found in the 1966 and 1968 surveys.
4. The current practice of restricting the release of radioactive material into the harbor to the minimum practical has been effective and should allow the cobalt-60 radioactivity remaining in harbor sediment to continue to decrease.
5. The levels and locations of radioactivity identified and the limited media in which it was found show that operations related to nuclear-powered warship activities resulted in no release of radionuclides having adverse effects on public health or the environment."

Environmental monitoring is conducted by the shipyard. The results of this monitoring program corroborate the Environmental Protection Agency's conclusion.

4.1.4.9 Ecological Resources

4.1.4.9.1 Terrestrial Ecology. Because the Pearl Harbor area has been disturbed extensively and for such a long period of time, the vegetation is dominated by introduced or alien species. Vegetation consists of maintained landscaped specimens or, on unmaintained areas, mangrove thickets and weedy scrub. The few native taxa which occur on these unmaintained areas such as 'uhaloa (Waltheria indica) and 'ilima (Sida fallax) occur throughout the Hawaiian Islands and the Pacific in similar environmental habitats. No plants considered threatened or endangered occur on this location.

Fauna in the Pearl Harbor area is also typically urban. In general, various feral and domestic cats and dogs, rodents, and exotic bird species are found in the area. No endemic land birds were recorded during the course of the field surveys completed in 1989. (Navy 1990b)

4.1.4.9.2 Wetlands. There are several wetland areas at Pearl Harbor identified in the East Loch, Middle Loch, and West Loch, as well as an area on the Waipio Peninsula. There is also a Pearl Harbor National Wildlife Refuge. These are habitats for endangered species of birds, principally the Hawaiian Coot and Hawaiian Stilt. A cooperative agreement established between the U.S. Navy, and the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the State of Hawaii, Department of Land and Natural Resources, protects these wetlands. (Navy 1990b)

4.1.4.9.3 Aquatic Ecology. Most of the Pearl Harbor marine community structure is characterized by four zones: sand-rubble zone, algal-mud zone, channel wall zone, and channel floor mud-silt zone. Sedimentation is the major factor determining the constituents of the Pearl Harbor marine community. Hence, stony corals, which are especially sensitive to high sediment loads, have not been observed. Predominant biota include the sea cucumber (Ophiodesoma spectabilis), a species commonly found in areas of high organic particulate input; benthic (bottom dwelling) algae; sponges; Sabellid (feather duster) worms; Serpulid worm tubes; and various benthic shrimps and crabs. (Navy 1990b)

4.1.4.9.4 Endangered and Threatened Species. Most of the land at Pearl Harbor Naval Shipyard has been urbanized, and the present vegetation consists almost exclusively of introduced plant species. Consequently, no federally or state listed threatened or endangered species or critical habitats are known to exist within the confines of Pearl Harbor Naval Shipyard. Because the area has been greatly disturbed and the native vegetation completely eliminated, there is little remaining terrestrial habitat of any consequence. Small tracts of weedy fields and isolated pockets of disturbed secondary vegetation within the station's boundaries provide limited habitat for introduced species of birds and rodents. Some migratory birds as well as endemic and indigenous waterfowl species may occasionally frequent the shoreline areas of Pearl Harbor Naval Shipyard, but none are considered residents of the activity. The mangrove stands and associated shoreline habitats act as nurseries to a variety of fish and wildlife and aid in shoreline stabilization and erosion control. (Navy 1989)

Marine mammals are afforded full Federal protection under the Marine Mammal Protection Act of 1972. As noted above, there are wetland areas in the Pearl Harbor Complex that include a

National Wildlife Refuge and provide habitats for endangered species of birds, principally the Hawaiian Coot (Fulica americana alai) and Hawaiian Stilt [Himantopus mexicanus (=himantopus) knudseni].

4.1.4.10 Noise

Noise sensitive locations in the Pearl Harbor area have been identified as the U.S.S. Arizona Memorial, U.S.S. Arizona Memorial Visitor Center, U.S.S. Bowfin Park, Marina Restaurant, Richardson Recreation Center, and existing or planned residential areas of Ford Island. Field noise measurements were taken at these locations on December 5, 1989; previous measurements also were taken at some of these locations. All appear to meet state and federal noise standards at present. Pearl Harbor Naval Shipyard is an existing industrial environment characterized by noise from truck and auto traffic, ship loading cranes and related diesel-powered equipment, and continuously operating transmission lines for steam, fuel, water, and related compressors for these and other liquids. In addition, new construction of buildings, reconstruction and rehabilitation activities for streets, buildings, parking lots, and ships all contribute to the noise associated with an industrial environment. (Navy 1990b)

4.1.4.11 Traffic and Transportation

The main portion of traffic into and out of the base is an aggregate of commuting traffic to work, residential related traffic, and service traffic related to the business of the base. Kamehameha Highway is the primary access route to the base from the Ewa/Pearl City/central Oahu direction. Both Kamehameha Highway and Interstate Highway H-1 provide access to the Naval Base from the Honolulu direction. (Navy 1990b)

The Honolulu International Airport provides scheduled passenger and cargo air service to major connecting hubs. In addition, Hickam Air Force Base services the military.

Naval spent nuclear fuel has been removed from Navy nuclear-powered ships and transported to the Idaho National Engineering Laboratory Expanded Core Facility (ECF) for examination and evaluation as a routine part of their operating cycle. Naval spent nuclear fuel shipments from Pearl Harbor Naval Shipyard to ECF were initiated in 1962. Since that time, 20 shipments of naval spent

nuclear fuel originating at Pearl Harbor Naval Shipyard have been made to ECF. The naval spent nuclear fuel containers were transported by ship to the Puget Sound Naval Shipyard where the containers were then transported to ECF by rail. Attachment A provides a list of these shipments made to date by year. Attachment A also contains detailed descriptions of the shipping containers used for naval spent nuclear fuel shipments from shipyards.

Traffic circulation related to Naval Base Pearl Harbor is determined by the working and residential populations of the base, by the geometry of the existing roadways and intersections, and by the access gates into the base.

4.1.4.12 Occupational and Public Health and Safety

4.1.4.12.1 Occupational Radiological Health and Safety. The Navy has well established and effective Occupational Safety, Health, and Occupational Medicine programs at all of its shipyards. In regard to radiological aspects of these programs, the Naval Nuclear Propulsion Program policy is to reduce to as low as reasonably achievable the external exposure to personnel from ionizing radiation associated with naval nuclear propulsion plants. These stringent controls on minimizing occupational radiation exposure have been successful. No civilian or military personnel at Navy sites have ever exceeded the federal accumulated radiation exposure limit which allows 5 rem exposure for each year of age beyond age 18. Since 1967, no person has exceeded the federal limit which allows up to 3 rem per quarter year and since 1980, no one has received more than 2 rem per year from radiation associated with naval nuclear propulsion plants. The average occupational exposure of each person monitored at all shipyards is 0.26 rem per year. The average lifetime accumulated radiation exposure from radiation associated with naval nuclear propulsion plants for all shipyard personnel who were monitored is 1.2 rem. (NNPP 1993a) This corresponds to the likelihood of a cancer fatality of 1 in 2083.

The Navy's policy on occupational exposure from internal radioactivity is to prevent radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by federal regulations for radiation workers. As a result of this policy, no civilian or military personnel at shipyards have ever received more than one-tenth the federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with naval nuclear propulsion plants.

For work operations involving the potential for spreading radioactive contamination, containment-ments are used to prevent personnel contamination or generation of airborne radioactivity. The controls for contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into radiological areas because the contamination control limits used in these areas were well below the levels of fallout and natural contamination occurring outside in the general public areas. A basic requirement of contamination control is monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves (i.e., frisk), and their performance is checked by radiological control personnel. Frisking of the entire body is required, normally using sensitive hand-held survey instruments. Major work facilities are equipped with portable monitors, which are used in lieu of hand-held friskers. These stringent controls to protect the workers and the public from contamination have proven effective in the past.

In 1991, researchers from Johns Hopkins University, Baltimore, Maryland, completed a very comprehensive epidemiological study of the health of workers at the six naval shipyards and two private shipyards that service the Navy's nuclear-powered ships (Matanoski 1991). This independent study evaluated a population of 70,730 civilian workers over a period from 1957, beginning with the first overhaul of the first nuclear-powered submarine, USS NAUTILUS, through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels of gamma radiation.

The Johns Hopkins study found no evidence to conclude that the health of people involved in work on U.S. naval nuclear-powered ships has been adversely affected by exposure to low levels of radiation incidental to this work. Additional studies are planned to investigate the observations and update the shipyard study with data beyond 1981.

The radiation exposure during normal operations at each shipyard for workers who have their radiation levels monitored is determined based on the annual radiation exposure of 0.26 mrem per worker for all shipyards based on Naval Nuclear Propulsion Program Report NT-93-2 (NNPP 1993a). The total number of shipyard personnel monitored for radiation exposure associated with the Naval Nuclear Propulsion Program has been about 164,000.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to

transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within DOE standards for occupationally exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.4.12.2 Occupational Non-radiological Health and Safety. In the non-radiological Occupational Safety, Health, and Occupational Medicine area, the Navy complies with the Occupational Safety and Health Administration Regulations. The Navy's policy is to maintain a safe and healthful work environment at all naval facilities. Due to the varied nature of work at these facilities, there is a potential for certain employees to be exposed to physical and chemical hazards. These employees are routinely monitored during work and receive medical surveillance for physical hazards such as exposure to high noise levels or heat stress. In addition, employees are monitored for their exposure to chemical hazards such as organic solvents, lead, asbestos, etc., and where appropriate are placed into medical surveillance programs for these chemical hazards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

4.1.4.12.3 Public Radiological Health and Safety. In order to quantify the exposures resulting from normal shipyard radiological releases to the general public, detailed analyses were performed based on very conservative estimates of radioisotopic releases from 1961 through 1992. Attachment F provides detailed annual release values used in the analyses.

The GENII computer code (Napier et al. 1988) was used to calculate exposures to human beings due to the estimated radionuclide releases from normal operations at the shipyards.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from stored fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F.

The hypothetical exposures calculated in Attachment F for the period 1995 through 2035 were adjusted from an annual basis (1995) to the historical basis by multiplying by 38 years and by a factor of 1.7 to take into consideration variations in the number of ships and operations.

The calculated accumulated exposures through 1995 to the general population within 50 miles of the site (about 0.8 million people) are 1.9 person-rem. To provide perspective, the exposures received due to natural radiation sources through 1995 are approximately 9.3 million person-rem, based on 0.3 rem per person per year.

The results of environmental monitoring as described in Naval Nuclear Propulsion Program Report NT-93-1 show that Naval Nuclear Propulsion Program activities had no distinguishable effect on normal background radiation levels at site perimeters (NNPP 1993b).

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities.

All of the radiation exposures to the general population correspond to much less than one incident cancer, which means that it is unlikely that there has been any past health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.4.12.4 Public Non-radiological Health and Safety. The military is responsible for providing health care services for its personnel and dependents. Navy families receive both in-patient

and out-patient care at Tripler Army Medical Center. Services are also provided at on-base clinics and dispensaries. Active-duty personnel are required to use military health care facilities. In addition, military dependents have the option of going to private providers and being partially reimbursed for the cost.

The Oahu Civil Defense Agency is responsible for developing, preparing, and assisting in the implementation of civil defense plans and programs to protect the safety, health, and welfare of island residents during disasters and emergency situations. However, responsibility for military personnel and dependents on the base rests with the Navy.

Fire protection within Naval Base Pearl Harbor is provided by the Federal Fire Department. A Mutual Aid Pact between the federal (military) fire departments and the Honolulu Fire Department affords dual coverage in times of emergencies.

Naval Base Pearl Harbor is under federal jurisdiction; therefore, federal authorities are normally responsible for providing all needed police service. The City and County of Honolulu Police Department, however, is responsible for traffic control in areas around the base. The closest police station is located in Pearl City. (Navy 1990b)

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.4.13 Utilities and Energy

4.1.4.13.1 Water Consumption. Naval Base Pearl Harbor receives most of its water from the Koolau Aquifer and a small portion from the Waianae Aquifer, which are basal aquifers located in south central Oahu, partially within the Pearl Harbor Water Management Area (PHWMA). In early 1989, a Water Management Plan for the PHWMA was proposed by the Commission on Water and

Resource Management (CWRM) to preserve and manage the Koolau and Waianae basal aquifers and the Schofield high-level aquifer. One important portion of the Water Management Plan recommended that the sustainable yield for the PHWMA be revised downward from the then current 225 million gallons of water per day (mgd) to 195 mgd. The purpose of the revision was to eliminate possible shrinkage of the aquifer in the PHWMA from over-withdrawal. Actual use in 1989 totaled 198.298 mgd, of which the military portion was about 13 percent. The major water users in the PHWMA are the Board of Water Supply (87.5 mgd) and the Oahu Sugar Company (78.6 mgd). In the revised plan, water allocation to the military is not decreased. The stated management policy of the CWRM is that "total allocation of authorized use will not at any time exceed sustainable yield." As of 1990, the military had an allocation of 28.125 mgd from the PHWMA, of which 22.670 mgd was authorized for the Navy. Of the total allocation to the U.S. Navy, Koolau Aquifer provides 20.333 mgd, and Waianae Basal Aquifer provides 2.337 mgd. (Navy 1990b)

4.1.4.13.2 Electricity Consumption. The electrical power service for the Pearl Harbor Naval Complex is provided by the Hawaiian Electric Company. The Hawaiian Electric Company power grid on the island of Oahu consists of three power plants with a total capacity of 1,271 MW, plus two plants in planning or under construction totaling 390 MW. The peak island demand in 1989 was approximately 1,090 MW.

The power plants are located at Kahe, Waiau, and downtown Honolulu and are interconnected via 138-kV transmission and 46-kV sub-transmission circuits. The Pearl Harbor Naval Complex is served via three 46-kV feeders, each from a separate 80-MVA transformer at the Makalapa substation, which is part of the island's 138-kV grid. The feeders serve two Hawaiian Electric Company substations located on the base (Puuloa and Kuahua), which step the voltage down to 11.5 kV, and serve two normally separated 11.5-kV networks.

One of the 46-kV feeders serves only the Puuloa substation. The second serves only the Kuahua substation. The third serves both substations. Any one feeder has the capacity to carry the entire Pearl Harbor load or approximately 57 MVA. In addition to the three feeders from the Makalapa substation, there are two alternate 46-kV circuits, one a dedicated spare, from the Waiau power plant.

The Puuloa substation consists of two 20/33-MVA transformers located in the Pearl Harbor Naval Shipyard area and serves the Pearl Harbor Naval Shipyard, Naval Station Pearl Harbor, and

Ford Island. The Kuahua substation consists of two 15/20-MVA transformers located in the Submarine Base Pearl Harbor area and serves the Submarine Base Pearl Harbor and Naval Supply Center Pearl Harbor areas.

4.1.4.13.3 Fuel Consumption. One major type of energy use is vehicular fuel consumption. No estimates are available to differentiate vehicle fuel use at Pearl Harbor from other areas. The ferry system consumed 152,088 gallons of diesel fuel in 1988. An occupancy rate of 1.5 persons per vehicle was used, so the ratio of fuel consumed per person per trip was 0.144 gallon of diesel fuel per person crossing. The second major source of energy consumption originates in buildings. The analysis of building energy use is based on standards for energy consumption per unit of designated building floor area by type of building and the geographical location.

4.1.4.13.4 Wastewater Systems and Discharges. Sewage at the Pearl Harbor Naval Complex is collected and treated in several separate systems. Most of the sewage generated by U.S. Navy shore activities and family housing areas receives secondary treatment at Navy-operated sewage treatment plants. The largest volume is treated at the Fort Kamehameha Sewage Treatment Plant which serves the Naval Station Pearl Harbor, Pearl Harbor Naval Shipyard, Naval Supply Center Pearl Harbor Complexes, Camp Smith, Navy and Air Force housing areas, Hickam Air Force Base, and other adjacent military areas.

4.1.4.13.5 Energy Conservation. To minimize the use of fossil fuels and conserve energy, the military has adopted conservation criteria for new construction and major renovation projects. The policies used under the conservation criteria focus on meeting design energy targets, based on Btu/per square foot/per year (Btu/sf/yr). Guidelines are provided for ventilation, insulation, and energy life cycle cost of structures. (Navy 1990b)

4.1.4.14 Materials and Waste Management

The City and County of Honolulu's HPOWER (Honolulu Program of Waste Energy Recovery) "garbage-to-energy" facility at Campbell Industrial Park is currently in full operation and burning roughly 1,500 to 1,800 tons per day, which is most of the combustible rubbish generated on the island of Oahu. Approximately 20 percent (by weight) of the refuse handled by the HPOWER facility is reduced to ash and other residue which requires landfill disposal.

There are two city and county landfills: the Kapaa Landfill in Kailua (Windward Oahu) and the Waimanalo Gulch Landfill in Nanakuli (Leeward Oahu). The Kapaa Landfill has reached full capacity, and plans are underway to locate a new site in Windward Oahu. The Nanakuli facility, which opened in September 1989, is programmed for 1,000 tons per day for seven to eight years. According to the city, the facility should be able to accommodate projected needs for at least 15 years and maybe longer. (Navy 1990b)

Solid radioactive waste materials are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites licensed by the U.S. Nuclear Regulatory Commission or a State under agreement with the U.S. Nuclear Regulatory Commission. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites. During 1992, approximately 110 cubic yards of routine low-level radioactive waste containing a total of 1 curie were shipped from the shipyard for burial.

Waste which is both radioactive and chemically hazardous is regulated under both the Atomic Energy Act and the Resource Conservation and Recovery Act as "mixed waste." Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid commingling radioactive and chemically hazardous substances so as to minimize the potential for generation of mixed waste. For example, these efforts include avoiding the use of acetone solvents, lead-based paints, lead shielding in disposal containers, and chemical paint removers. Radioactive wastes, including those containing chemically hazardous substances, are handled in accordance with long-standing Program radiological requirements. Such handling includes solidification to immobilize the radioactivity, separation of the radioactive and chemically hazardous substances, removal of liquids from solids, and other simple techniques. A determination is then made as to whether the resulting waste is hazardous. As a result of Program efforts to avoid the use of chemically hazardous substances in radiological work, Program activities typically generate only a few hundred cubic feet of mixed waste each year. This small amount of mixed waste, along with limited amounts of mixed waste from Program work conducted prior to 1987, will be stored pending the licensing of commercial treatment and disposal facilities.

4.1.5 KENNETH A. KESSELRING SITE: WEST MILTON, NEW YORK

4.1.5.1 Overview

The Kenneth A. Kesselring Site of the Knolls Atomic Power Laboratory (KAPL) is located in the mid-eastern sector of New York State as shown on Figure 4.1.5-1. The Site is located near West Milton in Saratoga County, New York at 43°2'28" north latitude and 73°57'13" west longitude. This United States Government owned reservation consists of over 3900 acres centered about 15 miles north of the city of Schenectady and about 8 miles west of Saratoga Springs. The Site includes three operating naval nuclear propulsion prototype plants and support facilities. The Site also includes one prototype plant that is in the process of being permanently shut down; one of the three operating plants is currently scheduled to be shut down in 1996. All the operating facilities are located in a secure area near the center of the reservation (see Figure 4.1.5-2). A more detailed illustration of the site is provided in Figure 4.1.5-3.

4.1.5.2 Land Use

All the land within the Site perimeter is owned by the Department of Energy (DOE). There are no permanent residents within this area. The surrounding region, within 50 miles of the Site, contains a population of about 1,150,000 as obtained from the 1990 census.

Most of the land surrounding the Site is either wooded or is used for farming. Both dairy farms and agricultural farms are located in the immediate vicinity of the reservation.

The West Milton area is located within the undulating transition zone between the Adirondack Highlands and the Hudson-Mohawk Lowlands physiographic provinces. The area is characterized by a series of irregular northwest-southwest trending topographic steps that descend from the highlands southeasterly towards the lowlands.

A map of New York State with major cities labeled: BUFFALO, ROCHESTER, SYRACUSE, SCHENECTADY, ALBANY, and NEW YORK CITY. Albany is highlighted with a circle and two dots inside, and a large black arrow points from it towards the bottom left corner of the map.

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Figure 4.1.5-2. Kesselring Site location map.

Figure 4.1.5-3. Kesseling Site map.

Ground elevations in the vicinity of the reservation range from 400 to 900 feet above mean sea level. The Glowegee Creek, its various tributaries, and the Crook Brook drain the reservation. The developed portion of the reservation, which contains the prototype plants, consists of approximately 50 acres (see Figure 4.1.5-2). The terrain surrounding the Site forms a partial bowl having a bottom diameter of about 2000 feet and a maximum height of 150 feet. The Site is essentially flat-lying with ground elevations ranging from 480 to 490 feet. The western half of the Site is surrounded by elliptical hills approximately 600 feet in elevation. Drainage from the Site is eastward, to the Glowegee Creek.

4.1.5.3 Socioeconomics

As of 1993, the Kesselring Site employed about 1,450 civilian workers, and about 1,250 naval personnel worked at the Site.

The only industry within 4 miles of the Site is the Cottrell Paper Company, located in Rock City Falls, about 3 miles from the Site.

The region surrounding the Site, within 50 miles, contains a population of about 1,150,000 as obtained from the 1990 census. Figure 4.1.5-4 provides a population distribution rose centered on the Site and lists the total population within concentric rings covering a 50-mile radius from the Site.

The majority of the labor force that would be employed at the Site for construction and operation of the naval spent nuclear fuel area would be expected to reside within about 20 miles from the Site. The calculated total population, labor force, and employment within this region for the base year (1995) are presented in Table 4.1.5-1. Projections of employment and population for the years beyond 1995 have not been presented because, as discussed in Section 5, the number of additional jobs that might be created at the Site under any alternative could be small.

Table 4.1.5-1. Regional employment factors at the Kesselring Site.

Regional Employment	Regional Labor Force	Regional Population
165,830	176,600	373,970

Miles	People	Cumulative People
0-5	10,290	10,290
5-10	56,786	67,076
10-20	306,898	373,974
20-30	464,323	838,297
30-40	166,939	1,005,236
40-50	143,351	1,148,587

Based on 1990 Census

Figure 4.1.5-4. 50-mile population distribution around the Kesselring Site.

4.1.5.4 Cultural Resources

Historically, the Kesselring Site reservation was used for agricultural purposes. Although old farmhouse foundations, grove sites, stone walls, and land fences exist on the Kesselring Reservation, there are no known archaeological, cultural, or Native American sites in the secure area of the Kesselring Site (WASH 1972). There are no historic structures on the Site that are potentially eligible for or are listed on the National Register of Historic Places (NPS 1991).

4.1.5.5 Aesthetic and Scenic Resources

The Kesselring Site is located in an area of moderately undulating topography at the northern edge of the Hudson-Mohawk Lowlands. Most of the Site facilities including the prototype reactor plants are located within a fenced security area. This security area and adjacent parking lots are located near the center of the Government reservation. (UE&C 1973) Since the balance of the reservation consists of wooded lands, there is very little public viewing opportunity of the Site facilities from the boundaries of the Government reservation. The area within the Site fenced security region where naval spent nuclear fuel would be stored has low visual sensitivity since the area is an industrial site.

4.1.5.6 Geology

4.1.5.6.1 General Geology. In 1973, a Site evaluation and foundation engineering investigation were conducted for the Kesselring Site (UE&C 1973) to establish suitable parameters for the analysis and design of the S8G prototype structures. A prior evaluation of the Site was conducted for the Modifications and Addition to Reactor Facilities. In both investigations, the local and regional geology and seismicity of the West Milton area were examined through a literature search, a detailed subsurface investigation, and a geophysical survey involving refraction and cross-hole velocity measurements. Major soil boring, sampling, and laboratory testing for the S8G Site evaluation were reported in various documents (UE&C 1973; EDCE 1974a; EDCE 1974b). Additional boring information and a geophysical field investigation performed for the Modifications and Addition to Reactor Facilities project were also utilized in the S8G Site evaluation. A 1974 Site geology evaluation was also conducted and a report issued (DGC 1974).

4.1.5.6.2 Geologic Resources. At Kesselring, unconsolidated materials, primarily of glacial origin, overlie bedrock. The thickness of these materials or overburden sequence is variable, ranging from 0 to several hundred feet. The overburden sequence, in ascending order, consists of three basic kinds of depositional units: glacier debris, lake, and ice-contact/outwash deposits. Deposits from glaciers overlie much of the bedrock and form the elliptical hills (drumlins) throughout most of the reservation. The glacier deposits are a dense and poorly sorted mixture of clay, silt, sand, gravel, and boulders. Thinly stratified lake clay and silt deposits are mapped over the reservation's southeastern quadrant. The ice-contact/outwash deposits mostly consist of stratified sands and gravels. The ice contact/outwash deposits, characterized by low clay and silt content, have better aquifer potential than the silt-and-clay-rich glacier and lake deposits.

Bedrock geology is also variable at the reservation and consists of crystalline rocks, Potsdam Sandstone, Galway Formation (dolomites and sandstones), Gailor Dolomite, Trenton/Amsterdam/ Lowville Limestones, and Canajoharie Shale. The Canajoharie Shale underlies the majority of the reservation. This black shale generally is considered a poor aquifer and its productivity is dependent on the presence or absence of fractures. Also, its water may contain naturally occurring hydrogen sulfide.

At the Site, approximately 20 to 30 feet of overburden deposits overlie the Canajoharie Shale. These deposits consist of layers of deposits from glaciers and lakes. Locally, these deposits have been altered as the result of facility construction. Generally, groundwater exists from 5 to 10 feet below the ground surface. Groundwater flows easterly, toward the nearby Glowegee Creek.

There are no economic geologic resources at the Site.

4.1.5.6.3 Seismic and Volcanic Hazards. In 1973, a seismicity evaluation of the Kesselring Site was conducted (UE&C 1973). An additional investigation was conducted in 1981 (EDCE 1981). The following is a summary of their findings.

Three branch faults exist in the vicinity of the Site: The West Galway, the East Galway, and the Rock City Falls faults. These branch faults are the lines of demarcation between the various bedrock formations in the immediate area. The East Galway branch lies approximately 3500 feet northwest of the Site and is believed to be the predominant influence on the earthquake loading for Site facilities. The two Galway faults are end branches of the Hoffman's Ferry fault.

Although the West Milton area is an area of faulting, it is only moderately active with respect to seismic events. Seismic risk related to structural damage may be represented in the United States by a relative scale of 0 through 4, with Zone 0 not expected to encounter damage and Zone 4 expected to encounter the greatest seismic risk. The United States Coast and Geodetic Survey places the Site in a Zone 2 (moderate damage) area adjacent to a Zone 1 (minor damage) area to the south and a Zone 3 (major damage) area to the north. The Zone 3 area is in the St. Lawrence Rift region, long known as a relatively active seismic area. The Uniform Building Code seismic classification provides a means for a comparable assessment of the seismic hazard between the alternate sites. If the Record of Decision identifies this site for the interim storage of naval spent fuel, then a detailed seismic evaluation would be conducted. More detailed information regarding the design basis considerations for storage of naval spent nuclear fuel at the Site is provided in Attachment D.

Data accumulated indicate that the maximum intensity earthquake for the region within a 100-mile radius of the Site had a value of VII. The most recent earthquake of that intensity occurred at Lake George, New York, on April 30, 1931. It is postulated that this event had an epicenter at the point where the Rock City Falls fault meets the Hoffman's Ferry fault. Since the West Galway and East Galway branch faults are extensions of the Hoffman's Ferry fault, an earthquake of similar intensity might occur anywhere along the East Galway fault within the lifetime of the Site structures.

Several earthquakes having an intensity VIII or greater have occurred at distances greater than 100 miles from the Site. However, due to attenuation effects, the ground motion at the Site associated with these earthquakes has not been greater than that equivalent to an intensity VI. The most recent event occurred in 1983 at Newcomb, New York (about 75 miles northwest of the Site) and was of intensity VI.

Details regarding the seismic characteristics of the area and the design bases seismic evaluations performed for the Kesselring Site are provided in the "Site Geology Evaluation Report - S8G for Kesselring Site" (UE&C 1973) and in "Geotechnical Site Investigation, Kesselring Site, West Milton, New York" (EDCE 1981).

There are no volcanic hazards in the vicinity of the Site.

4.1.5.7 Air Resources

4.1.5.7.1 Climate and Meteorology. The east-central part of New York State, in which the West Milton area is located, is situated at the northern end of the Hudson River Valley and is approximately 150 miles inland from the Atlantic coastline and about 200 miles south of the Canadian border. The climate of the region is primarily continental in character, but is subjected to some modification by the Atlantic Ocean. The moderating effect on temperatures is more pronounced during the warmer months than in winter when outbursts of cold air sweep down from Canada. In the warmer seasons, temperatures rise rapidly in the daytime, but also fall rapidly after sunset so that the nights are relatively cool. Occasionally, there are extended periods of oppressive heat up to a week or more in duration.

During the winter months, winds are generally from the west or northwest. During the warmer months, the winds are from the south. Wind velocities are moderate, and generally average less than 10 mph. Destructive winds (i.e., winds in excess of 80 mph) occur infrequently and tornadoes are rare. Tornadoes are rare in the region served by the Albany, New York weather station.

The mean monthly temperature of the region is about 50°F. Daily extremes can range from -30°F in the winter months to 100°F in the summer. On an annual basis, the mean daytime relative humidity values range from 50 to 80 percent. During the summer months, relative humidity values frequently approach 100 percent during the night.

Total yearly precipitation averages about 36 inches. The average yearly snowfall is about 58 inches and the maximum snowfall in 24 hours is about 22 inches. On the average, a frost depth of about 3 feet can be expected.

For weather reporting purposes, the West Milton area of northeastern New York is included in the National Weather Service Zone Forecast for Saratoga County. The principal weather recording location is at the Albany, New York airport. Its elevation is 275 feet above mean sea level. Because of the proximity of West Milton to Albany, temperature data for the Site should differ little from the Albany data. The two locations are generally within one or two degrees of each other, with West Milton tending to have lower temperatures.

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4.1.5.7.2 Air Quality. The principal sources of industrial gaseous effluents from the Kesselring Site are two 21-million, one 30-million, and one 110-million Btu/hr steam generating boilers. The number 2 fuel oil that is used to fire all of the boilers contains less than 0.5 weight percent sulfur. Combustion gases from the boilers are released through three elevated exhaust stacks. Operations such as ozalid reproduction, carpenter shops, welding hoods, paint shop, and industrial cleaning processes constitute other permitted point sources of airborne effluents. All point source emissions conform to the applicable state and federal clean air standards. Sulfur emitted from all boiler units is monitored via analysis of fuel sulfur content and reported to the Environmental Protection Agency (EPA) on a quarterly basis in compliance with the EPA's New Source Performance Standards (40CFR60). Sulfur emissions from the boilers are well within the EPA's New Source Performance Standards emission standard for stationary combustion installations. All other industrial emission sources at the Kesselring Site do not require monitoring under terms of the current New York State permits due to the very low levels of the emissions.

An area can be designated by the Environmental Protection Agency as having air quality that is better than defined by the National Ambient Air Quality Standards (attainment) or as exceeding one or more of those standards (nonattainment for one or more pollutants). The Code of Federal Regulations, Title 40, Part 81, states that the Air Quality Control Region for this site is in marginal nonattainment for ozone and is better than national standards for total suspended particulate matter and SO₂. The area has no specific classification for carbon monoxide and NO₂.

The nearest Class I area is at Lye Brook Wilderness, Suarderland, Vermont, which is 46 miles from the Site.

4.1.5.7.3 Existing Radiological Conditions. Radiological facilities at the Kesselring Site are designed to ensure that there are no discharges of radioactivity in airborne exhausts in excess of prescribed operational limits. Radiological controls are exercised to preclude exposure of working personnel to airborne radioactivity exceeding federal limits. Air exhausted from radiological work facilities is passed through high-efficiency particulate air filters and monitored during discharges. The annual airborne radioactive emissions from Kesselring Site do not result in any measurable radiation exposure to the general public. As described in the "Knolls Atomic Power Laboratory Environmental Monitoring Report for Calendar Year 1992" (KAPL 1992), the estimated 1992 radiation exposure to off-site individuals attributed to radioactive air emissions from Kesselring Site operations was less than 1 percent of the Nuclear Regulatory Commission's guide given in 40CFR61 (CFR 1989). In

order to quantify the risk of normal (non-accident) Kesselring Site radiological airborne releases to the general public, detailed analyses were performed based on conservative estimates of radioisotopic releases in the exhaust air. In 1992, the airborne radioactivity emissions from the Kesselring Site totaled about 2 curies (KAPL 1992).

4.1.5.7.4 Existing Non-radiological Conditions. New York State emission standards for all permitted emission sources at the Kesselring Site, with the exception of the site boilers, are stipulated in the individual permits for these sources. State regulations provide specific guidance on what types of emissions require a permit. Compliance with the operating permit is the responsibility of the permit holder under the condition that all planned changes in operating permit conditions require prior review and approval by the New York State Department of Environmental Conservation (NYSDEC). In addition, all operating permits are reviewed and renewed at least every 5 years.

Stationary combustion sources such as the Site's boilers are not specifically regulated by NYSDEC, but fall under the federal New Source Performance Standards (40CFR60). Compliance with the 40CFR60 standards is accomplished by utilization of number 2 fuel oil certified by the vendor that it contains less than 0.5 percent sulfur. Reports documenting fuel use and sulfur content are provided to the EPA Region II office on a quarterly basis.

4.1.5.8 Water Resources

The hydrology information contained herein was extracted from two independent evaluations. One was performed by the U. S. Geological Survey in November 1951. The second survey was performed in 1955. Additional hydrological surveys were performed in 1975 (Moody 1975; DGC 1975), and 1985 and 1986 (DGC 1986).

4.1.5.8.1 Surface Water. Most of the Site is drained by the Glowegee Creek, which meanders through rolling farmlands and woodlands to a junction with Kayaderosseras Creek at a point approximately 1 mile east of West Milton. The quality of the water in Kayaderosseras Creek and Glowegee Creek is satisfactory for public water supply and most industrial purposes, although Glowegee Creek is not used for these purposes. The average stream flow measured at the U. S. Coast and Geodetic Survey gaging station 0.5 mile downstream of the Site is 41 cfs. The range of elevation for Glowegee Creek is approximately 580 feet above mean sea level at the western entry to

the Site to about 380 feet above mean sea level at its junction with the Kayaderosseras Creek. Swamp area and natural surface storage in the basin are small, but the soils and the unconsolidated materials below the soils can hold a considerable volume of groundwater. A number of perennial springs exist in the area. There are no records indicating flooding of the Site.

The Kayaderosseras Creek empties into Saratoga Lake and ultimately, by way of Fish Creek, into the Hudson River. Kayaderosseras Creek rises in the Kayaderosseras Range on the southern edge of the Adirondack Mountains. The basin above West Milton ranges approximately 1600 feet in elevation and contains a sizeable aggregate area of swamps.

The Flood Insurance Rate Map (FIRM COMMUNITY-PANEL No. 360 722 B) shows that the Kesselring Site is not in a 100 or 500 year floodplain.

4.1.5.8.2 Groundwater. At the Site, the overburden sequence, consisting of glacier and lake deposits, and the underlying Canajoharie Shale generally form poor aquifer systems. In the West Milton area, neither of these systems are designated as sole source aquifers by the EPA or as primary/principal aquifers by New York State.

The dense glacial deposits and fine-grained lake deposits have characteristically low permeabilities in comparison to ice-contact/outwash deposits. Historically, both the glacier and lake deposits produce very low volumes of groundwater. At the Site, shallow water table mapping shows that the groundwater gradient is low. This low gradient combined with the low permeability of the glacial deposits indicates that the groundwater flow rate is very low, on the order of 5 to 10 feet/year. Also, water table mapping indicates that the Glowegee Creek, approximately 200 to 1000 feet east of the operating facilities boundary, forms an aquifer boundary.

The source of potable water is a well field, located on the far eastern side of the Site, and is composed of six wells which draw water from both deep and shallow aquifers. Monitoring of groundwater from the Site service water well field has shown that all chemical constituents measured are within the New York State drinking water standards (KAPL 1992). This well field, which is adjacent to the Kayaderosseras Creek, is underlain by two sand and gravel aquifers. The uppermost aquifer exists under water-table conditions and extends to a depth of approximately 30 feet below ground surface. The lowermost aquifer exists under artesian head pressure with the potentiometric surface rising several feet above the static water-table surface. The depth of the artesian aquifer is

approximately 55 to 100 feet below the ground surface. Recharge to the water-table aquifer during simultaneous water withdrawal comes primarily from the Kayaderosseras Creek, and to a lesser degree from Crook Brook. (DGC 1986)

There are 19 monitoring wells within the operating area. These recently installed wells are used to provide depth-to-groundwater information, related water table mapping, and water quality assessment. Test borings on the reservation have generally showed the water table to be within 5 to 10 feet of the ground surface. The test boring data also indicate that the configuration of the water table is, for the most part, a replica of the configuration of the surface topography, but at a lower elevation and somewhat softened in relief.

4.1.5.8.3 Existing Radiological Conditions. The liquid effluent environmental monitoring program at the Kesselring Site consists of radiological monitoring of the Gloweggee Creek water, aquatic life, and sediment in the vicinity of the Site to confirm that the general public is not affected by operations at the Site. There is no detectable radioactivity present in the Gloweggee Creek sediment due to Site operations (KAPL 1992). The concentrations of chemical constituents in liquid effluent from the Kesselring Site resulted in no adverse effect on the quality of Gloweggee Creek aquatic life. This is substantiated by results of fish and aquatic life surveys that confirmed the existence of a diverse and healthy aquatic community in the creek water. Only naturally occurring radionuclides were detected in the Gloweggee Creek water samples. The results of analysis for fish collected from Gloweggee Creek show no radioactivity attributable to Site operations.

Currently, Kesselring Site does not discharge radioactive liquid effluent to the environment. Since the beginning of prototype operations, the release of radioactivity into Gloweggee Creek has been small (about 15 curies) and has had no measurable effect on the natural background radioactivity in the sediment. Over 98 percent of the radioactivity discharged to the creek was tritium but included traces of other radionuclides such as cobalt-60, iron-55, nickel-63, and antimony-125 (KAPL 1992). The amount of tritium released was greatly decreased when water reuse was started by the prototype plants. In addition, the average concentration of tritium discharged to Gloweggee Creek was over 1000 times lower than allowed by federal regulations. In over three decades of operation, there has been no measurable impact from Kesselring Site operations on the environment or adverse effect on the community or the public.

4.1.5.9 Ecological Resources

4.1.5.9.1 Terrestrial Ecology. The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the Site and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present.

4.1.5.9.2 Wetlands. There are 13 areas located on the Kesselring Site classified as either Class II or III wetlands in accordance with the New York State Department of Environmental Conservation (NYCRR 1987). Current operations which include the secured area of the Site, parking lots, well field, and pumphouse area do not impact the listed wetlands. Access and perimeter roadways abut listed wetlands at four locations (within 100 feet); however, construction of these roadways predates all current regulatory requirements.

4.1.5.9.3 Aquatic Ecology. In accordance with the Environmental Statement for the S8G Prototype, Kesselring Site, West Milton, New York (WASH 1972), an expanded chemical and biological monitoring program was initiated in Glowegee Creek early in 1975. An important part of this monitoring program is an annual fish survey in Glowegee Creek upstream and downstream of Site discharges because Glowegee Creek is classified as a Class "C" trout stream by New York State. These surveys conducted by the New York State Department of Environmental Conservation and by environmental consultants from the Knolls Atomic Power Laboratory indicate that stocking downstream merely supplements the fish population that is removed by fishermen. The section of Glowegee Creek above the Site, although not stocked, contains a population of native trout which is maintained by natural spawning of the fish.

4.1.5.9.4 Endangered and Threatened Species. There are several endangered and threatened species listed by the New York State Department of Environmental Conservation located in the Saratoga County area. The endangered species are the karner blue butterfly, bald eagle, and peregrine falcon, and the threatened species is the red-shouldered hawk. To date, there have been no direct observations of these species documented on the Kesselring Site.

4.1.5.10 Noise

Plant operations and maintenance at the Kesselring Site generate noise equivalent to light industrial activity.

4.1.5.11 Traffic and Transportation

Two corridors, the Hudson-Champlain, 10 to 17 miles to the east, and the Mohawk-Hudson, 10 to 17 miles to the south and southwest, contain the major transportation systems and the relevant industrial complexes in the vicinity of the Site. The Cottrell Paper Company, located in Rock City Falls, 3 miles from the Site, is the only industry within a 5-mile radius.

Except for their use by Kesselring Site employees, the secondary routes bounding the Site are auxiliary commuting and delivery routes for small products and produce. State Route 29 runs 2 miles to the north, State Route 147 runs 4 miles to the west, and State Route 67 runs 4 miles to the south. State Route 50, 6 miles east, running from Saratoga Springs to Scotia, carries the only appreciable amount of truck and bus traffic. The majority of through traffic uses either Interstate I-87 or parallel route U.S. Highway 9, in the Hudson-Champlain corridor, 10 miles to the east.

Two lines of the Delaware and Hudson Railroad cross the region within 10 miles of the Site. The main north-south line runs through Ballston Spa, just over 5 miles to the east, and a trunkline runs just over 5 miles to the northeast into the central Adirondack area.

Commercial barge traffic occurs on the New York State Barge Canal, 12 miles southwest of the Site at its closest point, and on the less used Champlain Division, 17 miles east of the Site.

Saratoga County has the nearest airport, 4-1/2 miles east of the Site, followed by Schenectady and Albany airports, approximately 15 and 20 miles to the south-southeast. Data furnished by air traffic representatives for the three area airports indicate that regular flight patterns for military, commercial, and private aircraft, large and small, do not pass within a 5-mile radius of the Site. Only the instrument approach to the Saratoga County Airport, designated by the Federal Aviation Administration (FAA), has the potential for overflying the Site.

Albany County Airport, 22 miles south-southeast of the Site, is the nearest airport with scheduled flights by commercial jet aircraft. Schenectady County Airport, 15 miles south of the Site, is an auxiliary field with a low volume of traffic relative to size. No air carriers provide scheduled service out of Schenectady. The bulk of the airport's traffic is corporate and private aircraft, with the majority of the balance being military aircraft of the 109th New York Air National Guard.

Naval spent nuclear fuel has been removed from the prototypes and transported to the Idaho National Engineering Laboratory Expended Core Facility (ECF) for examination and evaluation as a matter of routine. Naval spent nuclear fuel shipments from the Kesselring Site to ECF were initiated in 1961. Since that time, 20 shipments of naval spent nuclear fuel originating at the Kesselring Site have been made to ECF. The shipping containers were transported by heavy-lift transporter to a nearby commercial rail line where the containers were then transported by rail. Attachment A provides a list of these shipments made to date by year. Attachment A also contains detailed descriptions of the shipping containers used for naval spent nuclear fuel shipments from shipyards.

The Site exclusion area boundary, which is the boundary of the Site, defines the restricted area. No activities unrelated to plant operation are permitted within the exclusion area. Access to the fenced-in security area containing the operating facilities (centered within the exclusion area boundary) is permitted only through one permanent gate facility which is manned by security guards on a 24-hour-per-day basis.

No public roads, highways, railways, or navigable waterways traverse the exclusion area.

4.1.5.12 Occupational and Public Health and Safety

4.1.5.12.1 Occupational Radiological Health and Safety. The Navy has well established and effective Occupational Safety, Health, and Occupational Medicine programs at all of its facilities. In regard to radiological aspects of these programs, the Naval Nuclear Propulsion Program policy is to reduce to as low as reasonably achievable the external exposure to personnel from ionizing radiation associated with naval nuclear propulsion plants. These stringent controls on minimizing occupational radiation exposure have been successful. No personnel at the Naval Reactors Department of Energy facilities have ever exceeded the applicable federal annual radiation exposure limit. The annual limit was 15 rem per year in 1958 and is currently 5 rem per year. No one has exceeded the Program's

limit of 5 rem per year since this limit was established in 1967 and since 1980, no one has received more than 2 rem per year from radiation associated with naval nuclear propulsion plants. The average occupational exposure of each person monitored at Naval Reactors DOE facilities is 0.12 rem per year. The average lifetime accumulated radiation exposure from radiation associated with the Naval Nuclear Propulsion Program for the 140,000 personnel who have been monitored at the DOE Naval Reactors facilities is about 0.35 rem (NNPP 1993c). This corresponds to the likelihood of a cancer fatality of 1 in 7142.

Naval Reactors policy on occupational exposure from ingested or inhaled radioactivity is to prevent significant radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by federal regulations for radiation workers. Since 1972 as a result of this policy, no one has received more than one-tenth the federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with work at the DOE Naval Reactors facilities.

For work operations involving the potential for spreading radioactive contamination, containments are used to prevent personnel contamination or generation of airborne radioactivity. The controls for contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into radiological areas because the contamination control limits used in these areas were well below the levels of fallout and natural contamination occurring outside in the general public areas. A basic requirement of contamination control is monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves (i.e., frisk), and their performance is checked by radiological control personnel. Frisking of the entire body is required, normally using sensitive hand-held survey instruments. Major work facilities are equipped with portable monitors, which are used in lieu of hand-held friskers. These stringent controls to protect the workers and the public from contamination have proven effective in the past.

In 1991, researchers from Johns Hopkins University, Baltimore, Maryland, completed a very comprehensive epidemiological study of the health of workers at the six naval shipyards and two private shipyards that service the Navy's nuclear-powered ships (Matanoski 1991). This independent study evaluated a population of 70,730 civilian workers over a period from 1957, beginning with the first overhaul of the first nuclear-powered submarine, USS NAUTILUS, through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels

of gamma radiation. This study is also of particular relevance to workers at the Naval Reactors prototypes because the type of radioactivity, level of exposure, and method of radiological controls at these shipyards are similar to the Naval Reactors prototypes.

The Johns Hopkins study found no evidence to conclude that the health of people involved in work on U.S. naval nuclear-powered ships has been adversely affected by exposure to low levels of radiation incidental to this work. The average annual radiation exposure for these shipyard workers is about two times higher than the exposure received by personnel assigned to Naval Reactors nuclear propulsion prototype sites. Additional studies are planned to investigate the observations and update the shipyard study with data beyond 1981.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within DOE standards for occupationally exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.5.12.2 Occupational Non-radiological Health and Safety. In the non-radiological Occupational Safety, Health and Occupational Medicine area, the Navy complies with the Occupational Safety and Health Administration Regulations. The Navy's policy is to maintain a safe and healthful work environment at all naval facilities. Engineered systems and administrative controls are the primary means employed for minimizing potential employee exposure to occupational hazards. If exposures cannot be controlled with engineering or administrative controls, personal protective equipment is used to provide additional protection. Due to the varied nature of work at these facilities, there is a potential for certain employees to be exposed to physical and chemical hazards. These employees are routinely monitored during work and receive medical surveillance for physical hazards such as exposure to high noise levels or heat stress. In addition, employees are monitored for

their exposure to chemical hazards such as organic solvents, lead, asbestos, etc., and where appropriate are placed into medical surveillance programs for these chemical hazards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

4.1.5.12.3 Public Radiological Health and Safety. The effluent and environmental monitoring results show that the radioactivity in liquid and gaseous effluents from 1992 operations at the Kesselring Site had no measurable effect on background radioactivity levels. Therefore, any radiation exposures from Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. In accordance with the "Knolls Atomic Power Laboratory Environmental Monitoring Report for Calendar Year 1992" (KAPL 1992), the following estimates were determined: (1) the radiation exposure to the maximally exposed individual in the vicinity of the Site was less than 0.1 mrem, (2) the average exposure to members of the public residing in the 80-kilometer (50-mile) radius assessment area surrounding the Site was less than 0.001 mrem, and (3) the collective exposure to the population residing within 50 miles of the Site was less than 0.1 person-rem.

The hypothetical exposures calculated in Attachment F for the period 1995 through 2035 were adjusted from an annual basis (1995) to the historical basis by multiplying by 40 years (to account for the period of site operations) and by a factor of 1.7 to take into consideration variations in the number of prototypes and operations.

The calculated accumulated exposures through 1995 to the general population within 50 miles of the site (about 1.15 million people) are 3.9 person-rem. To provide perspective, the exposures received due to natural radiation sources through 1995 are approximately 14 million person-rem, based on 0.3 rem per person per year.

The results show that the estimated exposures were less than 0.1 percent of that permitted by the radiation protection standards listed in DOE Order 5400.5 (DOE 1990), and that the estimated exposure to the population residing within 80 kilometers (50 miles) of the Site was less than 0.001 percent of the natural background radiation exposure to the population. In addition, the estimated exposures were less than 1 percent of that permitted by the numerical guide listed in 10CFR50, Appendix I (CFR 1986) for whole-body exposure, demonstrating that exposures are as low as is reasonably achievable. The exposure attributed to radioactive air emissions was less than 1 percent of the EPA standard given in 40CFR61 (CFR 1989).

The collective radiation exposure to the public along travel routes from Kesselring Site shipments of radioactive materials during 1992 was calculated using data given by the NRC in the "Final Environmental Statement of the Transportation of Material by Air and Other Modes" (NUREG 1977). Based on the type and number of shipments made, the collective annual radiation exposure to the public along the transportation routes, including transportation workers, was approximately 1 person-rem. This is less than 0.001 percent of the exposure received by the same population from natural background radiation.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities.

All of the radiation exposures to the general population correspond to much less than one incident cancer, which means that it is unlikely that there has been any past health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.5.12.4 Public Non-radiological Health and Safety. Liquid effluents from the Kesselring Site are derived from several sources: Site boiler blowdown, sewage treatment plant, cooling tower blowdown and overflow, retention basin discharges, storm water, and site service cooling water. Liquid effluents from the Kesselring Site enter Glowegee Creek through two surface channels (discharges 001 and 002), a submerged drain line from the sewage treatment plant (discharge 003), and a storm water runoff (discharge 004).

With the exception of the sewage treatment plant, intermittent cooling tower blowdowns, and once-through cooling systems that operate continuously, all effluents are released in batches. Control of effluent concentrations is achieved by the analysis of liquid collected from the continuous flow systems and from the collection tanks prior to each release from the batch systems.

A series of gates are located in discharge channels 001, 002, and the lagoon to provide a means to contain effluent if concentrations should ever exceed applicable discharge limits. In addition, continuous pH and temperature monitoring systems are installed in discharge channels 001, 002, and the lagoon. These systems automatically control the discharge gates and provide an alarm if there is ever an out-of-specification pH or temperature level. Periodic samples collected from the effluent channels are analyzed for chemical constituents, and demonstrate compliance with the Site's New York State Department of Environmental Conservation State Pollutant Discharge Elimination System permit.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.1.5.13 Utilities and Energy

4.1.5.13.1 Water Consumption. The Site Service Water System provides the Kesselring Site with water for operations, fire protection, sanitary, and potable use. The Site uses approximately 512 million gallons of well water per year. The Site is supplied by two pressurized mains from pumps located at the well field. Main and backup chlorination facilities are located at two of the pump locations. Five loops, on site, comprise the central distribution system which is capable of delivering up to 3,800 gallons per minute. Surge capacity for fire fighting and peak usage is provided by two elevated head tanks with a combined capacity of 500,000 gallons.

4.1.5.13.2 Electricity Consumption. The Kesselring Site is provided with two separate off-site commercial electrical power sources from the Niagara Mohawk Power Company. One source is the 115-kv Transmission Line No. 1 that runs between Spier Falls, New York and Rotterdam, New York. This line is approximately 40 miles long and is tapped at approximately the midpoint to provide service to the Site. The overhead line from the 115-kv tap on Line No. 1 to the Site is 2.4 miles long. The second physically independent commercial source feeding the Site is a 34.5-kv overhead transmission line supplied from a radial system fed from Ballston Spa, New York. The 34.5-kv line is approximately 9.6 miles long. The Site uses 47 thousand megawatt-hours of electricity annually for security, building lighting, and prototype plant support.

4.1.5.13.3 Fuel Consumption. There is no natural gas used on the Kesselring Site. Number 2 fuel oil is used to fire four Site steam generating boilers for Site heating for which the annual fuel oil consumption averages 640,000 gallons.

4.1.5.13.4 Wastewater Systems and Discharges. The sewage treatment facility for the Kesselring Site is a third-level treatment facility utilizing the extended aeration/contact stabilization of activated sludge and chemical precipitation of phosphorus followed by sand filtration. This facility meets all federal and New York State standards for sewage treatment. Discharges are controlled in conformance with the terms of a New York State Pollutant Discharge Elimination permit. Waste sludge is stored in a holding tank and is periodically removed by a licensed subcontractor for disposal at a state-approved, off-site disposal area. The treatment plant is automatic and operates unattended. Routine analysis and adjustments are made daily. Approximately 9.125 million gallons of sewage are processed by the Site Sewage Treatment Facility each year.

4.1.5.13.5 Energy Consumption. The following energy conservation initiatives for the Kesselring Site are scheduled for completion between now and the year 2000:

- (1) The shutdown of one prototype plant.
- (2) The conversion from fuel oil to natural gas for operating the Site steam heating boilers.
- (3) Replacing the existing building lights and windows with modern, more energy efficient systems.

- (4) Major building renovations including energy conservation upgrades to various administration and testing facilities.

4.1.5.14 Materials and Waste Management

Operation of the Kesselring Site results in the generation of various types of radioactive materials that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government-operated burial site. Radioactive materials that do not require disposal are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive materials from the Site to ensure that the material is properly identified, surveyed, and packaged in accordance with federal, state, and local requirements.

Low-level radioactive solid waste material that requires disposal includes filters, metal scrap, resin, rags, paper, and plastic. The volume of waste contaminated with radioactivity that is generated and shipped is minimized through the use of special work procedures that limit the amount of material that becomes contaminated during work on radioactive systems and reactor components. In addition, compressible wastes are compacted in order to further reduce the volume of waste to be buried. Radioactive liquids are solidified prior to shipment. All radioactive wastes are packaged to meet applicable regulations of the Department of Transportation given in 49CFR, Parts 171-175 and 177-178 (CFR 1985). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the burial sites. All shipments of low-level radioactive solid wastes were made by authorized common carriers to government-owned burial sites located outside of New York State. During 1992, approximately 215 cubic meters (281 cubic yards) of routine low-level radioactive waste containing 987 curies were shipped from the Site for burial.

Site operations produce a variety of industrial waste products including sewage treatment plant sludge and effluent, once-through cooling water, chemical wastes, boiler exhaust gases, and other such products typical of a large laboratory facility. All such waste products are controlled in accordance with various permits as required by federal and state laws. Chemically hazardous solids are controlled and disposed of in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA) in accordance with a permit held by the Site and administered by New York State.

All hazardous wastes are transported off-site for disposal at permitted, commercially available, facilities. No treatment (with the exception of exempt simple treatment and elementary neutralization) or disposal occurs at the Kesselring Site. In 1992, the Kesselring Site shipped approximately 15 tons of various hazardous wastes for off-site disposal. In accordance with RCRA, the Site has prepared a hazardous waste minimization plan. The plan requires specific actions to identify and minimize waste-producing operations, compare minimization efforts year to year to demonstrate progress, and establish waste minimization goals. This is accomplished by establishment of strict procurement procedures, substitution of non-hazardous materials where practical, and other similar measures.

Waste which is both radioactive and chemically hazardous is regulated under both the Atomic Energy Act and the RCRA as "mixed waste." Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid commingling radioactive and chemically hazardous substances so as to minimize the potential for generation of mixed waste. For example, these efforts include avoiding the use of acetone solvents, lead-based paints, lead shielding in disposal containers, and chemical paint removers. Radioactive wastes, including those containing chemically hazardous substances, are handled in accordance with long-standing Program radiological requirements. Such handling includes solidification to immobilize the radioactivity, separation of the radioactive and chemically hazardous substances, removal of liquids from solids, and other simple techniques. A determination is then made as to whether the resulting waste is hazardous. As a result of Program efforts to avoid the use of chemically hazardous substances in radiological work, Program activities typically generate only a few hundred cubic feet of mixed waste each year. This small amount of mixed waste, along with limited amounts of mixed waste from Program work conducted prior to 1987, will be stored pending the licensing of commercial treatment and disposal facilities.

Sanitary wastewater is processed at a conventional extended aeration treatment plant at the southeast corner of the fenced security area. The treatment train consists of equipment to break down large solids, aeration tanks in which air is bubbled through the waste to provide mixing with activated sludge to reduce biochemical oxygen demand, and a clarifier for the separation of liquids and solids. The treatment plant is effective in reducing biochemical oxygen demand and suspended solids by over 90 percent in the effluent. Discharges are controlled in conformance with the terms of a New York State Pollutant Discharge Elimination System permit held by the Kesselring Site. As the need arises, accumulated sludge is removed from the plant by a New York State licensed subcontractor and disposed of at an approved off-site disposal facility also licensed by New York State.

Non-hazardous wastes are reused and recycled or disposed of off-site. Sanitary wastes such as cafeteria waste, scrap paper, and the like are also disposed of at a licensed off-site facility. No hazardous wastes are being buried in the landfill. Most metal solid waste is accumulated and sold to a scrap salvage vendor.

4.2 IDAHO NATIONAL ENGINEERING LABORATORY

4.2.1 Overview

There are three naval reactor prototype plants at the Idaho National Engineering Laboratory (INEL) at the Naval Reactors Facility (NRF). These plants contain nuclear reactor plants, but they have reached the end of their usefulness and are being placed in layup and safe storage. Dismantlement of each of the prototype plants will be accomplished in the future; however, no specific time has yet been set for this work. Appropriate documentation under the National Environmental Policy Act (NEPA) will be prepared for prototype dismantlement when a specific proposal for these actions has been developed.

Also located at the Naval Reactors Facility is the Expanded Core Facility (ECF) to which naval spent nuclear fuel has been shipped for examination since 1957. After examination at the ECF, the spent nuclear fuel is transferred to the Idaho Chemical Processing Plant, also at INEL, for storage. This section provides a brief summary of the INEL affected environment. A detailed description of the affected environment at the INEL is provided in Volume 1, Appendix B and Volume 2, Section 4. The reader should refer to the applicable sections therein for additional information.

4.2.2 Land Use

The INEL site (which has been designated a National Environmental Research Park) occupies approximately 2300 square kilometers (about 890 square miles) of dry, cool desert in southeastern Idaho. Land at the INEL site is currently used for industrial and support operations associated with energy research and waste management activities, grazing, infrastructure, recreational uses, and environmental research. Only about 2 percent of the land is used for facilities and operations. Public access to most facility areas is restricted. Land surrounding the INEL site is primarily used for grazing, mineral and energy production, wildlife management, range land, and recreational uses.

4.2.3 Socioeconomics

INEL plays a substantial role in the regional economy. For fiscal year 1990, INEL directly employed approximately 11,100 personnel, or nearly 12 percent of the total regional employment. The population directly supported by INEL employment was approximately 38,000 persons, or 17 percent of the total regional population. Over 97 percent of INEL employees reside in the region of influence affected by the INEL. The INEL region of influence includes the seven counties surrounding and including the INEL: Bingham, Bonneville, Butte, Clark, Jefferson, Bannock, and Madison counties. Employment in this region experienced an annual average growth rate of approximately 1.3 percent from 1980 to 1991 while the population growth in the same region between 1980 and 1990 was about 0.6 percent per year. Volume 1, Appendix B provides a complete description of the affected environment at the INEL in this category.

4.2.4 Cultural Resources

Approximately 4 percent of the INEL has been surveyed for archaeological resources. Over 1500 sites have been identified; however, none are currently on the National Register of Historic Places, but may be placed there after formal evaluation. One structure on the INEL related to nuclear research and development, the Experimental Breeder Reactor I, is on the National Register of Historic Places and is a National Historic Landmark while a number of other reactors and associated buildings are eligible for inclusion. The entire INEL site is culturally important to Native Americans, since they believe the land is sacred.

4.2.5 Aesthetic and Scenic Resources

The INEL site is bordered on the north and west by the Bitterroot, Lemhi, and Lost River mountain ranges. Volcanic buttes near the southern boundary of the INEL can be seen from most locations on the site. Most of the area within the INEL site consists of open, undeveloped land. Although many of the site facilities are visible to the public, most facilities are located over 0.5 mile from public roads. The reader should refer to the detailed description of the affected environment in this category at the INEL in Volume 1, Appendix B.

4.2.6 Geology

The INEL site is located on the Eastern Snake River Plain which extends in a broad arc from the Idaho-Oregon border in the west to the Yellowstone Plateau in the east. The resources found within the site are sand, gravel, and pumice.

The Eastern Snake River Plain has low seismicity but is surrounded by an area of high seismicity. A summary of the seismicity at the ECF site is provided in Attachment B. There are no active volcanic sources known to exist near the ECF site (Rizzo 1994).

4.2.7 Air Resources

The Eastern Snake River Plain climate exhibits low relative humidity, wide daily temperature swings, and large variations in annual precipitation. The average seasonal temperatures at the INEL site range from -7.3 degrees C (18.8 degrees F) in winter to 18.2 degrees C (64.8 degrees F) in summer. Annual precipitation is light, averaging 22.1 centimeters (8.7 inches). The average annual snowfall is 70.1 centimeters (27.6 inches). Other than thunderstorms, severe weather is uncommon.

The air quality on the INEL site and off-site is generally good and within applicable guidelines. Details of the non-radiological air quality and the radiological air quality are provided in Appendix B of Volume 1.

4.2.8 Water Resources

Surface water features near the INEL site are the Big Lost River, Little Lost River, Birch Creek, and on-site man-made ponds. Water in the rivers does not exceed the applicable drinking water quality standards. The potential for flooding has been assessed. Details on the INEL flood plains can be found in Appendix B and Volume 2.

Groundwater in the area is contained in the Snake River Plain Aquifer. Subsurface water quality is affected by natural water chemistry and contaminants originating at the site. Previous waste discharges to unlined ponds and deep wells have introduced radionuclides, non-radioactive metals, inorganic salts, and organic compounds into the subsurface water. For a complete description of the affected environment in this category, the reader should refer to Volume 1, Appendix B.

4.2.9 Ecological Resources

Vegetation on the INEL site is primarily shrub-steppe vegetation, with sagebrush being the dominant plant. The INEL supports animal communities typical of shrub-steppe vegetation and habitats. Over 270 vertebrate species have been observed on the site. A more thorough treatment of the topic of ecological resources at the INEL is provided in Volume 1, Appendix B. Also presented therein is a description of the threatened and endangered species which include the bald eagle and the peregrine falcon.

4.2.10 Noise

The major sources of noise at the INEL occur primarily in developed operational areas and include various facilities, equipment, and machines. Existing INEL-related noises which might affect the public are those from transporting people and materials to and from the INEL and in-town facilities via buses, trucks, private vehicles, helicopters, and freight trains. In addition, air cargo and business travel of INEL personnel via commercial air transport represent an appreciable fraction of all such travel in and out of regional airports.

4.2.11 Traffic and Transportation

The INEL is surrounded by a system of interstate highways, U.S. highways, state highways, railroads, and airports. The regional railroads include main and branch Union Pacific lines in Southeastern Idaho. The two major airports in Idaho Falls and Pocatello provide passenger and cargo service.

The INEL transportation infrastructure consists of an on-site road system and rail service. There are about 140 kilometers (87 miles) of paved roads, of which 29 kilometers (18 miles) are considered service roads and are closed to the public. The Union Pacific Railroad crosses the southern portion of the INEL and provides rail service to the site. Rail shipments are limited to bulk commodities, spent nuclear fuel, and radioactive materials.

4.2.12 Occupational and Public Health and Safety

4.2.12.1 Occupational Radiological Health and Safety. Radiation exposures to workers at ECF in recent years have averaged approximately 100 millirem per year, compared to the limit of 5000 millirem per year specified by federal regulations (10CFR20). The total radiation exposure to workers at ECF makes up about 30% of the occupational exposure to radiation experienced by workers at NRF. Approximately 280 workers at ECF work in radiological areas and are monitored for occupational radiation exposure. The average lifetime accumulated radiation exposure from radiation associated with naval nuclear propulsion plants for the 140,000 personnel who have been monitored at the DOE Naval Reactors facilities including ECF, is about 0.35 rem (NNPP 1993c). This corresponds to the likelihood of a cancer fatality of 1 in 7142.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to transportation workers for all historical shipments is 16.5 rem, which statistically corresponds to 0.0066 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since the workers are closer to the shipment for a longer time than any member of the general population. Under the limiting assumption that the same worker is associated with every shipment for the entire historical period, this person would receive a total exposure of 7.5 rem over the approximately 40-year period, or about 0.19 rem per year, which is within Department of Energy (DOE) standards for occupationally exposed individuals. The radiation exposures to workers correspond to much less than one incident cancer, which means that it is unlikely that there have been any past health impacts due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.2.12.2 Occupational Non-radiological Health and Safety. Operations at ECF have resulted in fewer than 210 days of work lost to injuries in the seven years between 1987 and 1993 out of 736

total lost days of work at NRF during that period. Recordable injuries at ECF represented about 12 percent of the total number of such injuries at NRF during the same period.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. Approximately 0.028 fatalities are estimated as a result of non-radiological sources (vehicle emissions) associated with all historical shipments of spent nuclear fuel. This number includes both the workers and the general public. Since this number is much less than one, it is unlikely that there has been any non-radiological health impact due to the historical shipment of naval spent nuclear fuel over the entire history of such shipments.

Limited quantities of some materials classified as hazardous chemicals are handled at ECF, but the precautions used during the work prevent exposure of the workers to these materials.

4.2.12.3 Public Radiological Health and Safety. The Naval Reactors Facility has from its beginning monitored potential sources of releases of radioactivity to the environment from the NRF site in liquid and airborne effluents. Releases of water containing low levels of radioactivity to various disposal basins, leaching pits, and retention basins were made principally in the 1950s and 1960s. This practice was discontinued in 1979 and the residual activity in the soil from this practice is estimated to be approximately 150 curies, consisting primarily of cesium-137, strontium-90, and cobalt-60. The Naval Reactors Facility maintains a program to monitor these areas to provide assurance that they continue to not present a hazard to the public. Operations at NRF, including ECF, have had no effect on the groundwater of the Snake River Plain Aquifer. Monitoring of the aquifer on the NRF site indicates radioactivity is at or near natural background levels. The comprehensive INEL site radiation monitoring program (Hoff et al. 1992) shows that radiation exposure to persons off-site as a result of all NRF operations is too small to be measured.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. The radiation exposure to the general population for all historical shipments is 1.92 rem, which statistically corresponds to 0.00096 cancer fatalities. The maximum exposed individual (MEI) is a transportation worker, since these workers are closer to the shipment for a longer time than any member of the general population. The maximum exposure to an individual of the general population is 0.06 rem over the entire historical

period, which statistically corresponds to 0.000044 estimated health detriments and 0.00003 cancer fatalities.

4.2.12.4 Public Non-radiological Health and Safety. Since operations began, NRF has monitored site water and air released from operations at the site to ensure that they meet the requirements of applicable federal and state environmental standards. Results of all effluent monitoring confirm that the operation of NRF has no discernible impact on the environment (WECNRF 1993). Operations at NRF have not caused degradation of the quality of the groundwater of the Snake River Plain Aquifer. Monitoring results indicate no detectable toxic chemicals, solvents, or laboratory chemicals in the groundwater in the vicinity of NRF. Low levels of sodium and chloride (like table salt) used to soften site water and nitrates (which leaked through cracks in the sewage lagoon liners) and discharges to the industrial waste ditch are detectable in the immediate vicinity of NRF at levels below the applicable drinking water standards. No constituent measured in groundwater exceeds applicable drinking water standards.

Attachment A provides a discussion of the calculation of past health impacts associated with all transportation of naval spent nuclear fuel and test specimens. As stated in Section 4.2.12.2, it is unlikely that there has been any non-radiological health impact to the public due to all historical shipments of naval spent nuclear fuel over the entire history of such shipments.

4.2.13 Utilities and Energy

The following discussion briefly describes the current utility and energy usage at INEL. For more detailed information, refer to Volume 1, Appendix B.

Commercial electrical power is supplied to the INEL site by the Idaho Power Company. The water supply for INEL is provided by a system of wells, pumps, and storage tanks which are administered by the DOE. Because of the distance between site facility areas, the water supply systems for each facility are independent of each other. Wastewater systems at most on-site facility areas consist primarily of septic tanks and drain fields, although two areas also have wastewater treatment facilities. The fuels consumed at the site (fuel oil, gasoline, diesel, kerosene, coal, and liquid petroleum gas) are transported to the site by various distributors for storage and use.

4.2.14 Materials and Waste Management

The following discussion briefly describes the current waste disposal practices at the INEL. For more detailed information, refer to Volume 1, Appendix B.

High-level waste is currently in storage at the INEL Idaho Chemical Processing Plant. Liquid waste is blended and then treated by calcination to produce a granular calcine solid.

Transuranic waste is kept in retrievable storage at the Radioactive Waste Management Complex. Although there is no currently available disposal facility, all transuranic wastes are intended to ultimately be retrieved, repackaged, certified, and shipped to the Waste Isolation Pilot Plant for final disposal.

Low-level waste has been stored and disposed of at the Radioactive Waste Management Complex. Most low-level waste is reduced in volume before disposal through incineration, compaction, and sizing at the Waste Experimental Reduction Facility; however, this treatment has been curtailed since 1991 awaiting an operating permit from the State of Idaho. Low-level waste awaiting treatment is stored on asphalt/concrete pads at the Waste Experimental Reduction Facility and in radioactive waste storage containers at the generating facilities.

Most of the mixed low-level waste currently stored at the INEL is alpha-contaminated low-level mixed waste shipped to the INEL for storage and treatment from off-site generators. Currently, only low-level mixed waste from INEL contractors is accepted at INEL for treatment and disposal. All low-level mixed waste generated at INEL is stored at interim storage facilities until treatment systems become available or operational.

Hazardous waste generated at the INEL is not treated or permanently stored at the INEL. It is collected and temporarily stored at the Hazardous Waste Storage Facility, or at temporary accumulation areas, and shipped off-site to permitted treatment, storage, or disposal facilities.

The industrial/commercial solid waste generated at the INEL is disposed of in the INEL Landfill Complex located at the Central Facilities Area. Waste segregation takes place at each INEL facility so recyclable materials do not enter the solid waste stream.

4.3 SAVANNAH RIVER SITE

4.3.1 Overview

As mentioned previously, naval spent nuclear fuel has been shipped to the Expanded Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) for examination since 1957. One of the alternatives under consideration is to create a facility similar to ECF at or adjacent to the DOE-owned Savannah River Site (SRS) in South Carolina. A detailed description of the environment at the SRS is provided in Volume 1, Appendix C. This section provides a summary of some of the highlights from Volume 1, Appendix C. Therefore, specific source references for information contained in this section are omitted here but can be found in Volume 1, Appendix C.

Two sites have been identified as possible locations for the construction of a full-capability Expanded Core Facility. One location for the Savannah River ECF is just to the east of the geographic center of the complex (see Site A on Figure 4.3-1). The other location (Site B) is the unused Barnwell Nuclear Fuel Plant located just outside of the eastern boundary of the present SRS complex. In either case, a separate security area would be established specifically to enclose the Savannah River ECF, with all access controlled by the Naval Reactors Program as has always been the case at the INEL-ECF.

4.3.2 Land Use

The SRS (which has been designated a National Environmental Research Park) occupies an area of approximately 800 square kilometers (310 square miles) in western South Carolina in a generally rural area about 40 kilometers (25 miles) southeast of Augusta, Georgia. Land use on the Savannah River Site can be grouped into three major categories: forest/undeveloped, water/wetlands, and developed facilities. Land use bordering SRS is primarily forest and agricultural. There is also a large amount of open water and non-forested wetlands along the Savannah River Valley. The SRS does not contain any public recreation facilities and only about 5 percent of the land is occupied by constructed facilities.

Figure 4.3-1. Candidate sites for an Expanded Core Facility.

4.3.3 Socioeconomics

Approximately 90 percent of the SRS work force lives within the region of influence affected by the SRS. The SRS region of influence includes Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. Employment in this region experienced an annual average growth rate of approximately 5 percent between 1980 and 1990. Over this same time period, the labor force in the six-county region of influence grew approximately 39 percent. Personal income in the region of influence is about \$7 billion. Population in the region of influence increased 13 percent from 376,058 in 1980 to 425,607 in 1990. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.4 Cultural Resources

Cultural resources on the SRS can be summarized by stating that approximately 60 percent of the SRS area has been examined by the South Carolina Institute of Archaeology, University of South Carolina, in consultation with the South Carolina State Historic Preservation Officer, and more than 850 archaeological sites have been identified. These range in age from Clovis Paleoindian to 1950s farms. Most structures were demolished during initial establishment of the SRS. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.5 Aesthetic and Scenic Resources

The dominant aesthetic setting in the vicinity of the SRS consists mainly of agricultural land and forest, with some limited residential and industrial areas. Because of the distance to the site boundary, the rolling terrain, normally hazy atmospheric conditions, and heavy vegetation, SRS facilities are not generally visible from off the Site. The land on the SRS is heavily wooded, and developed areas occupy only approximately 5 percent of the total land area.

4.3.6 Geology

The SRS is on the Upper Atlantic Coastal Plain of South Carolina, which consists of approximately 200 to 400 meters of sands, clays, and limestones formed millions of years ago. These sediments are underlain by sandstones of Triassic age and older metamorphic and igneous rocks.

There are no known capable faults as defined by the Nuclear Regulatory Commission regulatory guidelines in the SRS region. Therefore, earthquakes capable of producing structural damage are not likely in the vicinity of SRS. Two notable earthquakes have occurred within 320 kilometers (200 miles) of the SRS. The first was a major earthquake in 1886 centered in the Charleston area with an estimated Richter magnitude of 6.8. The second earthquake was the Union County, South Carolina, earthquake of 1913, which had an estimated Richter magnitude of 6.0 and occurred about 160 kilometers (100 miles) from the SRS. Two earthquakes have occurred on the SRS during recent years. One on June 8, 1985, with a local magnitude of 2.6, and the other on August 5, 1988, with a local magnitude of 2.0. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.7 Air Resources

The annual average temperature at the SRS is 17.8 degrees C (64 degrees F); monthly averages range from 7.2 degrees C (45 degrees F) in January to 27.2 degrees C (81 degrees F) in July. Relative humidity readings taken four times per day range from 36 percent in April to 98 percent in August. The average annual precipitation at the SRS is approximately 122 centimeters (48 inches). Precipitation distribution is fairly even throughout the year, with the highest precipitation in the summer and the lowest in autumn. Winter storms in the SRS area occasionally bring strong and gusty surface winds with speeds as high as 32 meters per second (72 miles per hour).

The SRS is in a Class II area in attainment with National Ambient Air Quality Standards (NAAQS) for pollutants, which include sulfur dioxide, nitrogen oxides, particulate matter, lead, ozone (as volatile compounds), and carbon monoxide. The SRS has demonstrated its compliance with the South Carolina Department of Health and Environmental Control regulation R.61-62.5, Standard 8, "Toxic Air Pollutants," which regulates the emission of 257 toxic substances. Appendix C of Volume 1 provides a more detailed description of the affected environment in this category.

4.3.8 Water Resources

The Savannah River bounds the SRS on its southern border for about 32 kilometers (20 miles), approximately 260 kilometers (160 miles) from the Atlantic Ocean. At the SRS, Savannah River flow averages about 283 cubic meters (10,000 cubic feet) per second. Five principal tributaries to the Savannah River are on the SRS: Upper Three Runs Creek, Four Mile Branch Creek, Pen Branch Creek, Steel Creek, and Lower Three Runs Creek. Neither of the sites identified for the Savannah River ECF is located on the 100-year floodplain. Further discussion on the creeks in the SRS as well as the 100-year floodplain is available in Volume 1, Appendix C. Approximately 200 Carolina Bays are scattered across the SRS. Carolina Bays are naturally occurring closed depressions that often hold water. The quality of the water in the Savannah River and the SRS streams is such that on April 24, 1992, the South Carolina Department of Health and Environmental Control changed the classification of these waterways from "Class B waters" to "Freshwaters." This action imposes a more stringent set of water quality standards.

Excellent quality groundwater is abundant in this region of South Carolina from many local aquifers. The main source of recharge to the groundwater is rainfall and the direction of flow in the vadose zone is predominantly downward. In general, the vadose zone thickness ranges from approximately 40 meters (130 feet) in the northernmost part of the SRS to 0 meter where the water table intersects wetlands, streams, or creeks. The groundwater beneath 5 to 10 percent of the SRS has been contaminated by industrial solvents, metals, tritium, or other constituents used or generated on the Site. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.9 Ecological Resources

At the time of acquisition by the U.S. Government, the SRS was approximately two-thirds forested and one-third cropland and pasture. At present, more than 90 percent is forested and an extensive forest management program is conducted by the Savannah River Forest Station. The SRS is an important contributor to the biodiversity of Georgia and South Carolina. Carolina Bays, the Savannah River Swamp, and several relatively intact longleaf pine-wiregrass communities provide important contributions to the diversity of biota of the SRS and of the entire region.

The removal of all human inhabitants in 1951 and the restoration of forest cover since then have provided the wildlife associated with the wetlands of the Savannah River and the pine-dominated sand hills of coastal South Carolina found on the SRS with excellent wildlife habitat. A more thorough treatment of the topic of ecological resources at the SRS is provided in Volume 1, Appendix C. Also presented therein is a description of threatened, endangered, and candidate plant and animal species known to occur or that might occur on the SRS.

4.3.10 Noise

The major noise sources at SRS occur primarily in developed operational areas and include various facilities, equipment, and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Major noise sources outside the operational areas consist primarily of vehicles and railroad operations. Existing SRS-related noise sources of importance to the public are those resulting from the transportation of people and materials to and from the Site. These sources include trucks, private vehicles, helicopters, and freight trains. In addition, a portion of the air cargo and business travel using commercial air transport through the airports at Augusta, Georgia, and Columbia, South Carolina, are attributable to SRS operations. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.11 Traffic and Transportation

The SRS is surrounded by a system of interstate highways, U.S. highways, state highways, and railroads. The regional transportation networks service the four South Carolina counties and two Georgia counties that generate about 90 percent of SRS commuter traffic.

The SRS transportation infrastructure consists of more than 230 kilometers (143 miles) of primary roads, 1,931 kilometers (1,200 miles) of unpaved secondary roads, and 103 kilometers (64 miles) of railroad track. These roads and railroads provide connections among the various SRS facilities and to off-site transportation linkages.

4.3.12 Occupational and Public Health and Safety

The sources of radiation exposure to individuals consist of natural background radiation from cosmic, terrestrial, and internal body sources; radiation from medical diagnostic and therapeutic practices; and radiation from man-made sources, including consumer products, industrial products, and nuclear facilities. Programs are in place at the Savannah River Site to protect workers from radiological and non-radiological hazards. These programs help to maintain the doses to workers well below the regulatory dose limit of 5 rem/year and the DOE Administrative Control Level of 2 rem/year. Appendix C of Volume 1 provides a complete description of the affected environment at the SRS in this category.

4.3.13 Utilities and Energy

The principal source of water for SRS facilities is the Savannah River, with the remainder supplemented by groundwater wells. The Savannah River Site has its own electric-generating facility, although it purchases much of the power it uses from the South Carolina Electric and Gas Company.

4.3.14 Materials and Waste Management

The SRS generates high-level radioactive waste, transuranic waste, low-level radioactive waste, hazardous waste, mixed waste, and sanitary waste. DOE treats and stores waste generated from on-site operations at the SRS in waste management facilities. This includes approximately 20,000 cubic meters (700,000 cubic feet) of low-level waste generated annually. SRS packages low-level waste for disposal on the site in accordance with the waste category and its estimated surface dose rate.

Mixed low-level waste contains low-level radioactive materials and hazardous wastes. The SRS mixed waste program consists primarily of providing safe storage until treatment and disposal facilities are available. Appendix C of Volume 1 provides a complete description of the affected environment for this category.

4.4 HANFORD SITE

4.4.1 Overview

As mentioned previously, naval spent nuclear fuel has been shipped to the Expanded Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) for examination since 1957. An alternative under consideration to performing spent naval nuclear fuel inspections at the INEL-ECF is to construct a facility providing similar capabilities at the Hanford Site. Two options for relocating an alternate ECF at the Hanford Site are to: (1) construct a new ECF between the 200 East and 200 West Areas adjacent to the proposed spent nuclear fuel storage facility, or (2) modify the currently unused Fuels and Materials Examination Facility (FMEF), located in the 400 Area, to perform ECF operations (see Figure 4.4-1).

This section provides a brief summary of the affected environment at Hanford. A detailed discussion of the Hanford Site affected environment is contained in Volume 1, Appendix A. The reader should refer to the applicable sections therein for additional information.

4.4.2 Land Use

The Hanford Site (which has been designated a National Environmental Research Park) encompasses approximately 1450 square kilometers (560 square miles) and includes several Department of Energy (DOE) operational areas. Most of the site is open, vacant land with only about 6 percent of the land occupied by constructed facilities. Land uses in the surrounding area include urban and industrial development, irrigated and dry-land farming, and grazing.

The Hanford Site includes some land-use resources that Native Americans have expressed an interest in, regarding the Treaty of 1855. DOE is assisting them in this effort. Details are provided in Volume 1, Appendix A.

Figure 4.4-1. Hanford Site map.

4.4.3 Socioeconomics

The Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities (Richland, Pasco, and Kennewick) and other parts of Benton and Franklin counties. Approximately 380,000 people live within an 80-kilometer (50-mile) radius of the site. The agricultural community also represents a sizeable part of the local economy. Any major changes in Hanford activity would potentially most affect the Tri-Cities and other areas of Benton and Franklin counties. These areas in particular, but generally the 10 counties surrounding the Hanford Site, constitute the designated region of influence (Volume 1, Appendix A).

Hanford employment accounted for nearly one-quarter of the total non-agricultural jobs in Benton and Franklin counties in 1991. Approximately 93 percent of the direct employment at Hanford consists of residents of Benton and Franklin counties; approximately 81 percent reside in the Tri-Cities area. Population in the two counties increased by about 4 percent from 1980 to 1990.

4.4.4 Cultural Resources

The Hanford Site is rich in cultural resources. It contains numerous, well-preserved archaeological sites representing both the prehistoric and historical periods and is still thought of as a homeland by many Native American people. Two single sites and seven archaeological districts are included in the National Register of Historic Places. Management of Hanford's cultural resources follows the Hanford Cultural Management Plan and is conducted by the Hanford Cultural Resources Laboratory of Pacific Northwest Laboratory. DOE is assisting Native Americans who have expressed an interest in renewing their use of some Hanford land-use resources, in accordance with the Treaty of 1855. Details are provided in Volume 1, Appendix A.

4.4.5 Aesthetic and Scenic Resources

The land in the vicinity of the Hanford Site is generally flat. Rattlesnake Mountain forms the western boundary of the Site, and Gable Mountain and Gable Butte are the highest land forms within the Site. Both the Columbia River, flowing across the northern part of the Site and forming the eastern boundary, and the spring-blooming desert flowers provide a source of visual enjoyment to

people. The White Bluffs, steep bluffs above the northern boundary of the river in this region, are a striking feature of the landscape.

4.4.6 Geology

The Hanford Site is located within the central part of the Pasco Basin of the Columbia Plateau. Its surface features were formed by catastrophic floods and have undergone little modification since, with the exception of more recently formed sand dunes. The elevation of the Site varies from about 105 meters (345 feet) above mean sea level in the southeast corner to about 245 meters (803 feet) in the northwest. Much of the Hanford Site is underlain by sand, gravel, and cobble deposits which could have economic value. The major geologic units and a description of them can be found in Volume 1, Appendix A.

Seismicity of the Columbia Plateau is relatively low when compared to other regions of the Pacific Northwest. There are several major volcanoes in the Cascade Range west of the Hanford Site. The nearest is Mount Adams which is about 165 kilometers (102 miles) from the Site. The most active volcano is Mount St. Helens which is about 220 kilometers (136 miles) west-southwest from Hanford.

4.4.7 Air Resources

The Hanford Site is located in a semi-arid region where the climate is mild and dry, with occasional periods of high winds. The summers are generally hot and dry; the winters are relatively cool and mild. Average monthly temperatures at the Hanford Site range from -1.5 degrees C (29.3 degrees F) in January to 24.7 degrees C (76.5 degrees F) in July. The annual average relative humidity is 54 percent and is usually highest in winter (approximately 75 percent) and lower in summer (about 35 percent). The Cascade Mountains west of the Hanford Site greatly influence the local climate by acting as a natural barrier to Pacific Ocean storm systems. This contributes to the Site's relatively low average annual precipitation of 16 centimeters (6.3 inches). This range also serves as a source of cold air drainage which has a considerable effect on the wind regime on the Hanford Site.

Air quality is within federal standards. Details of the non-radiological air quality and the radiological air quality are provided in Appendix A of Volume 1.

Information on severe weather, precipitation extremes, and air dispersion/stagnation characteristics is provided in Volume 1, Appendix A for the Hanford Site. The source of meteorological information used in analytical calculations is provided in Attachment F.

4.4.8 Water Resources

The major surface water features near the Hanford Site are the Columbia and Yakima Rivers. The Columbia River flows through the northern part of the Site at an average annual flow rate of about 3400 cubic meters per second (120,000 cubic feet per second). The Yakima River, which has a low annual flow rate compared to the Columbia River, flows along the southern portion of the Hanford Site at an average annual rate of 104 cubic meters per second (3673 cubic feet per second). The Hanford ECF site or the modified FMEF site would not be affected by a 500-year flood of the Columbia River. Details are provided in Volume 1, Appendix A.

The State of Washington Department of Ecology classifies the Columbia River as Class A (excellent) from the Grand Coulee Dam, past the Hanford Site, to the mouth of the river at the Pacific Ocean. The Hanford Reach of the Columbia River is the last free-flowing portion of the river in the United States. Radiological monitoring shows low levels of radionuclides in the Columbia River. Hydrogen-3 (tritium), iodine-129, and uranium are found in slightly higher concentrations downstream of the Hanford Site than upstream, but are well below concentration guidelines established by the DOE and the U.S. Environmental Protection Agency (EPA) drinking water standards.

Groundwater quality on the Hanford Site has been affected by defense-related activities to produce nuclear materials. While most of the Site does not have contaminated groundwater, large underlying areas of the Site do have elevated levels of both radiological and non-radiological constituents. The liquid effluents, discharged into the ground, have carried with them certain radionuclides and chemicals which move through the soil column at varying rates, eventually entering the groundwater forming plumes of contamination. Groundwater monitoring is conducted on an annual basis. Results indicate that concentrations of various radionuclides in some wells in or near operating areas exceeded drinking water standards. Tritium continues to slowly migrate with the groundwater flow

where it enters the Columbia River. Nitrate concentrations also exceeded drinking water standards at various locations around the Hanford Site. More information on groundwater quality can be found in Volume 1, Appendix A.

4.4.9 Ecological Resources

The Hanford Site is a relatively large, undisturbed area of shrub-steppe vegetation that contains numerous plant and animal species adapted to the region's semi-arid environment. The vegetation at the Hanford Site consists of 10 major kinds of plant communities, with cheatgrass the dominant plant on fields. More than 300 species of insects, 12 species of amphibians and reptiles, and about 39 species of mammals are found on the Hanford Site. The horned-lark and western meadowlark are the most abundant nesting birds. A more thorough treatment of the topic of ecological resources at the Hanford Site is provided in Volume 1, Appendix A. Also presented therein is a description of threatened and endangered species. These include four species of plants, six species of birds, and one species each of mammals and insects.

4.4.10 Noise

Hanford measurements of the propagation of noise have been concerned primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most Hanford activities. Most industrial facilities on the Hanford Site are located far enough away from the site boundary that noise levels at the boundary are not measurable or are barely distinguishable from background noise levels. Some field activities, such as well drilling and sampling, have the potential for producing noise in the field apart from major permanent facilities that could be disruptive to wildlife.

4.4.11 Traffic and Transportation

The area is serviced by a system of interstate highways and state roads. Personnel and most material shipments are transported by road. Bulk materials or large items are shipped by barge. Rail transportation is used to move irradiated fuel and certain high-level radioactive solid wastes and to transport equipment and materials.

Hanford's on-site road network consists of rural arterial routes. Only 65 of the 288 miles of paved roads at Hanford are accessible to the public. On-site rail transport is provided by a short-line railroad owned and operated by the DOE. This line connects just south of the Yakima River with the Union Pacific, which in turn interchanges with the Washington Central and Burlington Northern Railroads at Kennewick. The Hanford Site infrequently uses the Port of Benton dock facilities on the Columbia River for off-loading large shipments. Overland trailers are then used to transport those shipments to the Site.

4.4.12 Occupational and Public Health and Safety

Programs are in place at the Hanford Site to protect workers from radiological and non-radiological hazards. In 1989, about 9000 individuals were monitored at the Hanford Site, of which 6000 received a measurable radiation dose equivalent to an average annual dose of 0.1 rem per person. This is well below the regulatory dose limit of 5 rem per year and the DOE administrative control level of 2 rem per year.

Doses and exposures to the public from airborne releases at the Hanford Site are calculated and reported annually. It is calculated that the maximally exposed off-site individual would receive an exposure of 0.02 millirem per year of radioactive emissions, while the average exposure to the public would be 0.002 millirem per year.

4.4.13 Utilities and Energy

The principal source of water in the Tri-Cities and at the Hanford Site is the Columbia River. Electrical power for the Hanford Site is purchased wholesale from the Bonneville Power Administration, a federal power marketing agency. Hydropower, and to a lesser extent coal and nuclear power, are used to generate the region's electricity.

4.4.14 Materials and Waste Management

The Hanford Site contains several waste areas associated with nuclear defense-related materials. These areas are scheduled for remediation in accordance with the Hanford Federal Facility Agreement and Consent Order.

The following discussion briefly describes the current waste disposal practices at the Hanford Site. For more detailed information, and information on historical waste disposal practices, refer to Volume 1, Appendix A.

Wastes at the Hanford Site are generated by both facility operations and environmental restoration activities. Non-dangerous solid waste is disposed of at the Solid Waste Landfill located in the 200 Area. The existing capacity of this landfill will be expended by the mid to late 1990s. Newly generated non-radioactive hazardous waste is shipped off-site for treatment, recycling, recovery, and/or disposal.

Low-level mixed waste contains low-level radioactive materials and hazardous wastes. These wastes are either stored until technology is modified or verified to allow treatment or are evaporated through an evaporator. Solid low-level radioactive waste is placed in unlined, shallow trenches at the 200 Area Low-Level Waste Burial Grounds. Hanford also receives low-level waste from off-site generators for disposal. High-level wastes are being stored in single-shell and double-shell tanks until a treatment facility is constructed to allow treatment and disposal of the waste.

Transuranic waste is stored in above-ground storage facilities in the Hanford Central Waste Complex and Transuranic Waste Storage and Assay Facility. This waste is planned to be shipped to the Waste Isolation Pilot Plant in New Mexico for final disposal.

4.5 OAK RIDGE RESERVATION

4.5.1 Overview

As mentioned previously, naval spent nuclear fuel has been shipped to the Expended Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) for examination since 1957. An alternative to continuing naval spent nuclear fuel operations at the ECF at INEL is to construct a facility providing similar capabilities at the Oak Ridge Reservation (ORR). The new ECF would be sited near the K-25 Site which is located on the western portion of the ORR (see Figure 4.5-1). A separate security area would be established specifically to enclose the ECF at ORR, with all access controlled by the Naval Reactors Program as has always been the case at the ECF at INEL.

This section provides a brief summary of the affected environment at the Oak Ridge Reservation. A detailed discussion of the ORR affected environment is contained in Volume 1, Appendix F. The reader should refer to the applicable sections of that appendix for additional information and for information source references.

4.5.2 Land Use

The ORR is located on approximately 54 square miles (140 square kilometers) of federal land within Anderson and Roane Counties, Tennessee, with Knox and Loudon Counties to the south. Most of the ORR is located within the corporate limits of the city of Oak Ridge. Knoxville is located approximately 30 miles (48 kilometers) southeast of Oak Ridge and is the largest city in the area. The ORR includes three intensively developed industrial areas at the Y-12 Plant, the Oak Ridge National Laboratory (ORNL), and the K-25 Site separated by mostly undeveloped forest land. Surrounding land uses include residential, commercial, public, and industrial areas in the city of Oak Ridge and rural areas characterized by residences, small farms, forest, and pastures. Approximately 21 square miles (54 square kilometers) of undeveloped ORR land have been designated as a National Environmental Research Park.

Figure 4.5-1. Oak Ridge Reservation site map.

4.5.3 Socioeconomics

Socioeconomic parameters are defined in this Environmental Impact Statement (EIS) for a region of influence encompassing Anderson, Knox, Roane, and Loudon Counties, Tennessee. About 92 percent of ORR employees presently live in this region of influence. The employment level at the ORR in 1990 was 17,082 persons. The 1990 population of 489,230 in the region of influence is expected to increase at less than 1 percent annually through the year 2004, to 538,820 people. The housing stock, with a 1990 vacancy rate of 1.5 percent, is expected to grow in proportion to the population.

4.5.4 Cultural Resources

A cultural resources survey conducted in 1975 did not identify any cultural resources on the proposed Oak Ridge ECF site. Therefore, no prehistoric or historic resources are expected to be located on the proposed Oak Ridge ECF site. There are no known Native American resources on the proposed site of the Oak Ridge ECF. Further discussion is provided in Appendix F of Volume 1.

4.5.5 Aesthetic and Scenic Resources

The view on and near the ORR consists mainly of rural land. Views are limited by hilly terrain, forest cover, and frequent haziness. The three main developed areas at the Y-12 Plant, ORNL, and K-25 Site have low vulnerability to visual impacts (visual sensitivity); undeveloped ORR lands range from low to moderate visual sensitivity.

4.5.6 Geology

The ORR lies within the western portion of the Valley and Ridge Province, near the boundary with the Cumberland Plateau. The Valley and Ridge Province is characterized by numerous linear ridges and valleys which extend northeast-southwest. Local geology is characterized by sedimentary rocks of Cambrian and Ordovician age. Areas of the ORR underlain by limestones and dolomites

contain sinkholes and caves ("karst" geology). Soils generally belong to the Ultisol order, characterized as moderately acidic soils that exhibit severe mineral weathering with precipitation of iron oxides. No prime or unique farmlands are located on the ORR.

From 1811 to 1975, five earthquakes or earthquake series with Modified Mercalli Intensity (MMI) of V to VI have affected the ORR area. No MMI VII earthquakes have been recorded in the ORR during this period. An MMI VII earthquake does not typically cause severe damage, but rather causes breaking of weak chimneys at the roof line, cracks in masonry, and the falling of plaster, loose bricks, and stones. MMI VII earthquakes generally occur one order of magnitude less frequently than MMI V to VI earthquakes. Seismic records indicate that the ORR is located in a region of moderate seismic activity having an average of one to two earthquakes per year with seismic activity occurring in bursts followed by long periods of no activity. No deformation of recent surface deposits has been detected, and seismic shocks from the surrounding, more seismically active areas are dissipated by distance from the epicenter. The ORR is located in Uniform Building Code Zone 2A.

4.5.7 Air Resources

Climate at the ORR is characterized by moderate temperatures (low daily average of 36.7°F in January and high daily average of 76.6°F in July), ample precipitation (annual average of 54.0 inches), and frequent summer thunderstorms. Although infrequently subjected to tornadoes, the ORR did experience a tornado from a severe thunderstorm in February 1993. The tornado passed the Y-12 Plant and ended just north of Knoxville. Wind speeds along the tornado path ranged from 40 miles per hour (18 meters per second) to nearly 130 miles per hour (58 meters per second). As of 1991, the areas within the Air Quality Control Region which includes the ORR were designated as in attainment with respect to all National Ambient Air Quality Standards. Great Smoky Mountains National Park, a Prevention of Significant Deterioration Class I area, is located roughly 30 miles to the southeast. The estimated 50-year effective dose equivalent to any member of the public due to airborne radiological emissions from the ORR is approximately 3.3 millirem. This level is well under regulatory limits.

4.5.8 Water Resources

The ORR is drained by the Clinch River and its network of tributaries. The Clinch River, a tributary of the Tennessee River, extends roughly 350 miles and drains roughly 4,410 square miles. The section of the river bordering the ORR is impounded by Melton Hill Dam and is a navigable component of the inland waterway system. The average discharge from Melton Hill Dam between 1963 and 1979 was 150 cubic meters (5,300 cubic feet) per second. The Clinch River is the principal source of water withdrawn to meet operational demands on the ORR. The only groundwater beneath the ORR suitable for withdrawal is found in the Knox Aquifer, but withdrawals are few due to the abundance of surface water. Concentrations of radiological and non-radiological contaminants above applicable water standards have been observed at a number of groundwater monitoring wells within the ORR. Such concentrations are probably a result of past waste disposal practices (such as the discharge of radioactive material to ponds and impoundments). However, data indicate that generally the contamination remains close to the source. Further discussion concerning the water quality at ORR is provided in Appendix F of Volume 1.

4.5.9 Ecological Resources

Most undeveloped land on the ORR supports forest, including naturally established second growth forest and pine plantations that have been established on former agricultural lands. Aquatic habitats on the ORR include tailwaters, impoundments, reservoir embayments, large streams, small perennial streams, and wetlands. Wetlands on the ORR include shallow embayments on the Clinch River impoundments, narrow strips of forested wetlands along groundwater seeps and creeks, and abandoned farm ponds. Twenty-five plant and animal species known to be present on the ORR are listed by the Tennessee Department of Environment and Conservation as either endangered, threatened, or of special concern.

4.5.10 Noise

Noise from the operation of industrial facilities and equipment on the ORR is primarily limited to the developed areas at the Y-12 Plant, ORNL, and K-25 Site. Noise from other parts of

the ORR is generally limited to vehicular and rail traffic. Noise at the ORR boundary is generally indistinguishable from background noise.

4.5.11 Traffic and Transportation

Segments of some arterial roads in the vicinity of the ORR operate close to design capacity at certain times. Several arterial roads that are open to the public traverse ORR lands. The Clinch River is a navigable component of the inland waterway system but primarily serves only recreational boaters. Airports in the vicinity of the ORR include the McGhee Tyson Airport in Knoxville and numerous smaller private airfields.

4.5.12 Occupational and Public Health and Safety

Health impacts to the public are minimal due to administrative and design controls at ORR facilities that keep releases of radioactive or otherwise hazardous materials to the environment in compliance with applicable regulatory standards. Occupational doses to persons working at ORR facilities also fall within regulatory limits. Refer to Appendix F of this volume for detailed information in this area.

4.5.13 Utilities and Energy

The Clinch River and Melton Hill Reservoirs provide all water resources to the ORR and the city of Oak Ridge through two pumping stations. The ORR uses an average of 69.3 million liters (18.3 million gallons) per day. Total potable water capacity available to the ORR is 152 million liters (40.2 million gallons) per day, obtained through the K-25 and Y-12 treatment plants. Electric power is provided to the ORR by the Tennessee Valley Authority. The current ORR power demand is approximately 115 megawatts, while the connected capacity of ORR facilities is approximately 920 megawatts. The average usage of natural gas at the ORR in 1994 was 3.6 billion Btu per day, compared to a contractual capacity of 7.6 billion Btu per day.

4.5.14 Materials and Waste Management

Each of the three main areas of the ORR is responsible for its own air and wastewater discharges and the associated treatment facilities. Non-radioactive hazardous wastes are also handled by each area, typically by shipment to off-site commercial treatment or disposal enterprises. Facilities for managing radioactive wastes, radioactive mixed wastes, and sanitary and industrial wastes generally involve more than one of the areas or involve land/facilities outside the area boundaries. Solid sanitary and industrial wastes are disposed of on the ORR. Most radioactive and mixed wastes are stored on-site pending future disposal actions. The Toxic Substance Control Act Incinerator, located at the K-25 Site, is used to incinerate uranium-contaminated polychlorinated biphenyl wastes and other mixed wastes.

4.6 NEVADA TEST SITE

4.6.1 Overview

As mentioned previously, naval spent nuclear fuel has been shipped to the Expanded Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) for examination since 1957. Two of the alternatives under consideration result in the creation of a facility similar to ECF at the DOE-owned Nevada Test Site (NTS) in Nevada. A detailed description of the environment at the NTS is provided in Volume 1, Appendix F. This section provides a summary of some of the highlights from that volume. Therefore, specific source references for information contained in this section are omitted here but can be found in Volume 1, Appendix F.

A site has been identified as a possible location for the construction of a full-capability ECF at the Nevada Test Site. The potential location for the Nevada ECF is in Area 5 in the southeast section of the NTS, adjacent to Mercury Highway and south of the NFS High Explosive Assembly/Disassembly Unit (see Figure 4.6-1). A separate security area would be established specifically to enclose the Nevada Test Site ECF, with all access controlled by the Naval Reactors Program as has always been the case at the Idaho ECF. This would place the Nevada ECF in close proximity to the location being proposed under one of the Centralization alternatives for construction and operation of an interim spent nuclear fuel storage facility.

4.6.2 Land Use

The NTS occupies an area of approximately 3,500 square kilometers (1,350 square miles) in southern Nevada in a remote area about 104 kilometers (65 miles) northwest of Las Vegas, Nevada. The southern two-thirds of the NTS is dominated by three large valleys or basins: Yucca, Frenchman, and Jackass flats. Mountain ridges and hills rise above gradually sloping stream-deposited soil fans, enclosing these basins. The northern and northwestern sections of the NTS are dominated by Pahute Mesa and Ranier Mesa. The NTS does not contain any public recreation facilities and only a very small percentage of the land is occupied by constructed facilities. The NTS is almost entirely surrounded by other federally owned lands which buffer it from lands open to the public. The NTS is

Figure 4.6-1. Candidate site for an Expanded Core Facility at the Nevada Test Site.

bordered by the Nellis Air Force Range on the north, east, and west, and by the Bureau of Land Management on the south and southwest.

4.6.3 Socioeconomics

Socioeconomic parameters defined in this Environmental Impact Statement (EIS) are for a two-county region of influence encompassing Clark and Nye Counties, Nevada. Ninety-eight percent of NTS employees live in Clark County (88 percent) or Nye County (10 percent). Economic conditions have continued to improve in Southern Nevada since the mid-1980s. Economic growth has been accelerated relative to the national trends because of the expansion in hotel and gaming markets. Appendix F of Volume 1 provides a complete description of the affected environment at the NTS in this category.

4.6.4 Cultural Resources

People have inhabited the NTS site for approximately 12,000 years. The area of the NTS was inhabited by Shoshone and Southern Paiute Native American tribes prior to European settlement. These tribes are known to be affiliated with sites located in the northern portions of the NTS including the Pahute and Rainier Mesas. No prehistoric or historic resources are expected to be located on the proposed site for the ECF facilities. Also, there are no areas contained in the site that are subject to Native American Treaty rights. Appendix F of Volume 1 provides a complete description of the affected environment at the NTS in this category.

4.6.5 Aesthetic and Scenic Resources

The view across the NTS comprises a mixture of open desert, mountain ranges, and industrial features. Areas on and surrounding the NTS are generally of low to moderate vulnerability to visual impact (visual sensitivity). Appendix F of Volume 1 provides a more complete description of the affected environment at the NTS in this category.

4.6.6 Geology

The NTS lies in the southern part of the Great Basin Section of the Basin and Range Physiographic Province. Local geology is characterized by sediment-filled topographically closed valleys surrounded by ranges composed of sedimentary rocks and compacted volcanic ash and lava. Appendix F of Volume 1 provides a complete description of the affected environment at the NTS in this category.

4.6.7 Air Resources

The climate at lower elevations at the NTS is characterized by bright sunlight, limited precipitation, low relative humidity, and large daily temperature ranges. Climatological parameters change markedly at higher elevations. In Pahute Mesa at an elevation of 2,000 meters (6,560 feet) above mean sea level, the average daily maximum/minimum temperatures are 4.4°C/2.2°C (40°F/28°F) in January and 26.7°C/16.7°C (80°F/62°F) in July. At Yucca Flat, at an elevation of 1,200 meters (3,920 feet) above mean sea level, the average daily maximum/minimum temperatures are 10.6°C/-6.1°C (51°F/21°F) in January and 35.6°C/13.9°C (96°F/57°F) in July.

The NTS is located in an attainment area for all criteria pollutants, and air quality in the region presently meets all applicable federal and Nevada regulations. For all activities on the NTS, the estimated effective dose equivalent to any member of the public from all airborne radionuclide emissions is approximately 0.01 millirem per year, which is well under regulatory limits.

4.6.8 Water Resources

Perennial surface water in the vicinity of the NTS is mostly limited to widely scattered springs, short river reaches, and playas (seasonally inundated lakes). Intermittent surface water bodies include ephemeral streams which briefly flow following heavy rainfall and playa lakes which contain standing water for brief periods following storms. Localized flash floods following rare heavy rainfalls can be destructive. Aquifers underlying the NTS are generally deep and between 660 and 1640 feet. Due to the scarcity of surface water, groundwater is the principal water source for NTS activities and surrounding communities. Appendix F of Volume 1 provides a complete

description of the affected environment at the NTS in the general category of water resources, including both surface water and groundwater.

4.6.9 Ecological Resources

The NTS lies in an ecological transition area between the Mojave and Great Basin deserts. Terrestrial habitats on the NTS comprise desert scrub-shrub plant communities and a mountain, hill, and mesa community dominated by pinion pine and juniper. Aquatic habitats and wetlands on the NTS are limited to widely scattered springs, ephemeral stream channels, and playa lakes. Twenty-five federally and state listed threatened, endangered, or other special status species have been identified on or near the NTS. Of particular concern is the federally listed (threatened) desert tortoise, which is vulnerable to physical injury from construction and human activities, and the federally listed (endangered) Devils Hole pupfish, which is vulnerable to declining water levels.

4.6.10 Noise

Major noise sources at the NTS occur primarily in developed operational areas and include various facilities, equipment, and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles), aircraft operations, and testing. No NTS environmental noise survey data are available. At the boundary, away from most facilities, noise from most sources is barely distinguishable from background noise levels.

4.6.11 Traffic and Transportation

Arterial roads in the vicinity of the NTS, including Nevada Route 375 and U.S. Route 95, generally support free flow of traffic. Airports in the vicinity of the NTS include McCarran International Airport in Las Vegas and numerous smaller private airports. Additional information in this category can be found in Volume 1, Appendix F.

4.6.12 Occupational and Public Health and Safety

Health impacts to the public are minimal due to administrative and design controls at the NTS facilities that keep releases of radioactive or other hazardous materials to the environment in compliance with applicable regulatory standards. Occupational doses to persons working at NTS facilities also fall within regulatory limits. Appendix F of Volume 1 provides a complete description of the affected environment at the NTS in this category.

4.6.13 Utilities and Energy

Water is presently supplied to NTS facilities at a rate of 6139 gallons per minute by 12 active wells that tap underlying groundwater (aquifers). Between 40 and 45 megawatts of electrical power is presently available to the NTS from the Nevada Power Company. Proposed expansion will bring capacity to approximately 200 megawatts.

4.6.14 Materials and Waste Management

Numerous surface and subsurface contamination sites from previously conducted nuclear tests and ancillary operations have been identified on the NTS. Non-radiological contamination on the NTS is minimal because there have been no industrial-type production operations on the NTS.

A "Mixed Waste Management Unit" is located just north of the Radioactive Waste Management Station and will be part of routine disposal operations in the near future. In May 1990, mixed waste disposal operations ceased due to Environmental Protection Agency issuance of the Land Disposal Restrictions of the Resource Conservation and Recovery Act for the Third Thirds Wastes. Active mixed waste disposal operations will commence upon completion of a National Environmental Policy Act documentation and issuance of a State of Nevada Part B permit.

Appendix F of Volume 1 provides additional documentation on materials and waste management practices at the Nevada Test Site.

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5. ENVIRONMENTAL CONSEQUENCES

5.1 NAVY AND PROTOTYPE SITES FOR NAVAL SPENT NUCLEAR FUEL

5.1.1 PUGET SOUND NAVAL SHIPYARD: BREMERTON, WASHINGTON

5.1.1.1 Overview of Environmental Impacts

The following sections discuss the major differences in potential environmental consequences associated with the choice of alternatives that include storage of naval spent nuclear fuel and inspection of high priority naval spent nuclear fuel at Puget Sound Naval Shipyard. The environmental consequences associated with storage of naval spent nuclear fuel at Puget Sound Naval Shipyard are based on the estimates of naval spent nuclear fuel that would be stored at Puget Sound Naval Shipyard through the year 2035 and current knowledge of the design features associated with spent fuel storage systems. The review of the environmental consequences associated with these alternatives has shown that the impact on the environment associated with these activities would be very small. There would be no impact to the Puget Sound Naval Shipyard regional environment associated with any alternatives that do not involve the Puget Sound Naval Shipyard.

5.1.1.2 Land Use

Construction of a storage area at Puget Sound Naval Shipyard for temporary naval spent nuclear fuel storage would require a modest change in the current land in use by the shipyard. A description of the alternate storage containers and water pools and approximate storage locations is provided in Attachment D. Attachment C provides a comparison of spent nuclear fuel storage in new water pools versus dry container storage. The shipyard area is already an industrial site; therefore, there would be no impact on land use. No additional land outside the naval complex would be required. The alternative of storing naval spent nuclear fuel in water pools would require that a water

pool facility be constructed in the vicinity of the area that is designated for dry container storage or modification of the existing water pool to provide additional space. The water pool would have sufficient capacity to accommodate storage of all spent nuclear fuel expected to be stored at the shipyard.

In addition to the alternative involving storage at naval facilities of spent nuclear fuel generated in the future, the existing water pool facility would be used for the alternative where inspections of high priority naval spent nuclear fuel would be conducted at Puget Sound Naval Shipyard. A description of the Puget Sound Naval Shipyard water pool facility and the inspection operations under the alternative of inspecting high priority spent nuclear fuel at Puget Sound Naval Shipyard are also provided in Attachment D.

Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.1.1.3 Socioeconomics

The calculated number of direct construction and operating jobs that would be required for the 10-year period between 1995 and 2004 for each storage alternative at the shipyard is provided in Table 5.1.1-1. Since there would be no naval spent nuclear fuel storage or inspection activities at the shipyard under the 1992/1993 Planning Basis and Centralization alternatives, no additional jobs would be required at the shipyard under these alternatives.

Table 5.1.1-1. Number of construction and operating jobs created at Puget Sound Naval Shipyard for each alternative.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Railcar ⁽¹⁾	1	1	8	1	1	1	1	1	1	1
Immobile Containers on Pads ⁽²⁾	1	1	1	1	2	6	8	8	8	8
Shipping Containers on Pads ⁽³⁾	1	1	1	1	2	6	2	2	2	2
Water Pool Storage ⁽²⁾	16	16	73	113	138	99	106	40	40	40
Water Pool Inspection ⁽³⁾	0	0	82	123	142	60	60	60	60	60

(1) Storage mode under the No Action and Decentralization alternatives.

(2) Storage mode under the Decentralization alternative.

(3) Inspection at Puget Sound would occur under the Decentralization B alternative.

The only discernible socioeconomic consequence of storing naval spent nuclear fuel at Puget Sound Naval Shipyard is that a relatively small number of construction workers (ranging from a few to a maximum of several hundred) would be required for construction of the storage area. The work force would consist of skilled craftsmen and unskilled laborers. This work force would be needed during the storage facility expansion and water pool modification and would be available from within the area.

The operation of the spent fuel storage area using dry storage containers would require additional workers to secure the fuel in the storage area and to support surveillance and monitoring activities. For the alternative involving storing fuel in immobile dry storage containers, about 20 workers would be required to handle the spent nuclear fuel when it is placed into the storage containers. This work force would normally only be needed when fuel is being inserted into the containers. For the alternative involving shipping containers, fewer workers would be needed to handle and secure the containers in the storage area. The operation of a water pool facility for the alternative involving storing naval spent nuclear fuel in a water pool would require approximately 40 additional workers. The operation of a water pool facility for the alternative involving inspection of

spent nuclear fuel would require approximately 60 workers. The number required for any of the shipyard and prototype site storage alternatives would be small and is expected to be supplied from either within the existing shipyard work force or from the local work force. Considering that the Department of Defense employs approximately 10,200 civilians at the shipyard, the addition of workers to support the alternatives would have no discernible impact on the local socioeconomic conditions of the Puget Sound Naval Shipyard site and Bremerton area.

For the alternatives where dry storage containers would be manufactured, some additional jobs would be created in the locations where the containers are made. The process of selecting the container manufacturer is subject to federal procurement requirements and would be initiated after the Record of Decision. Consequently, the specific socioeconomic impacts from container fabrication cannot be specified. The net effect of container fabrication would be to create additional jobs and bolster the local economy of the area(s) where containers are made. It is considered unlikely that the selection of the contractor would depend on the alternative storage site selected, so the jobs associated with construction of casks provide no basis for selection of a storage site.

5.1.1.4 Cultural Resources

The action considered would not affect any site that is listed on the National Register of Historic Places (NPS 1991), any known archaeological areas, or any other cultural resources. Therefore, there would be no impacts to cultural resources associated with the alternative of storing or inspecting naval spent nuclear fuel at this location.

None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.1.1.5 Aesthetic and Scenic Resources

The naval spent nuclear fuel storage area would be located within the Puget Sound Naval Shipyard and would not affect the visual quality of the area since it is compatible with the landscape character of the site. Physical changes to the site resulting from the expansion of a spent nuclear fuel storage area would not alter this industrial setting. There are no particulate air emissions associated

with storage of naval spent nuclear fuel and thus no visibility impacts are expected. No aesthetic or scenic resources in the vicinity of the shipyard would be affected by the construction and operation of the storage facility.

5.1.1.6 Geology

The expansion and operation of the naval spent nuclear fuel storage facility at this location is not expected to affect the geologic character or resources of the region. If an alternative were selected which required the storage area to be constructed, the ground would be excavated as necessary to prepare the surface. This would not affect the geologic characteristics of the underlying layers nor the characteristics of the aquifer or vadose zone.

5.1.1.7 Air Resources

5.1.1.7.1 Radiological Consequences. If the alternative where naval spent fuel would be stored in dry storage containers were to be selected, no airborne radioactivity releases would be expected to occur as a result of normal storage operations. The fuel would be contained such that at least two barriers exist to prevent fission products from becoming airborne. These barriers would retain the spent nuclear fuel in an air-tight containment until it is moved to a permanent storage site and there would be no airborne radioactive material released from routine operations for this method of storage. The only radiation exposure would be direct radiation from the array of filled storage containers. The filled storage containers would be fenced off and shielded if necessary such that there would be no distinguishable effect on the current radiation readings at the site perimeter.

For the alternatives where naval spent nuclear fuel would be stored in a water pool and the alternative where fuel would be inspected in the Puget Sound Naval Shipyard water pool, airborne radioactivity would be emitted beyond current emissions. The airborne releases are expected to be less than the emissions from the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) because the water pool size and the number of inspections performed would be smaller at the shipyard and the shipyard would not conduct the shielded cell operations that are performed at ECF. To conservatively estimate the radiological consequences, airborne releases based on ECF releases from 1991 are used. The radiological source term used and the detailed calculations performed to determine expected normal releases are provided in Attachment F.

The radiation exposures to human beings due to estimated radionuclide releases to the atmosphere plus direct radiation from the stored spent nuclear fuel at the shipyards for both the alternative involving water pool storage and the alternative involving dry storage were calculated as described in Attachment F. Postulated releases were calculated for wet storage of spent nuclear fuel in a water pool plus inspection of naval spent nuclear fuel.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from the stored spent fuel. The population data used to calculate population doses were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F. Estimated exposures to workers were also calculated.

The hypothetical exposures calculated are based on an exposure to the estimated average effluents and the direct radiation exposure for one year from the naval spent nuclear fuel stored at the shipyard. The calculations include the external effective exposure equivalent from the ground deposition, deposition to surface water, and air immersion pathways and the 50-year committed effective exposure equivalent from internal exposure through the ingestion and inhalation pathways. All pathways were considered for persons potentially exposed, except that the ingestion pathway was omitted for the workers because they do not grow their food on-site. Solubilities which would produce the highest calculated exposures were chosen for internal exposure factors. Values for human dietary consumption patterns were taken from "Age Dependent Values of Dietary Intake for Assessing Human Exposures to Environmental Pollutants" (Rupp 1980). The hypothetical exposures calculated can be converted into a risk of fatal cancer or a risk of non-fatal health detriments (e.g., non-fatal cancers, hereditary defects) based on recommendations of the International Commission on Radiological Protection (ICRP 1991).

Attachment F summarizes the calculated exposures and fatal cancers to the worker, maximally exposed off-site individual (MOI), nearest public access (NPA), and the population from releases of radioactivity and direct radiation exposure in one year for each location and storage mode. Section 3.7 provides a comparison of the annual number of fatal cancers calculated for the general population for each location and alternative.

The number of fatal cancers calculated is so small that there would be essentially no fatal cancers resulting from the storage of naval spent nuclear fuel during the time it could reasonably be expected to continue to be stored. Putting this into perspective, it could be stated that one member of the population might experience a fatal cancer due to incident-free storage of naval spent nuclear fuel at the Puget Sound Naval Shipyard if operations continued for 15,400 years.

5.1.1.7.2 Non-radiological Consequences. As noted in Attachment F, no increase in non-radioactive airborne emissions would be expected to result from spent nuclear fuel storage or examination facility operations. Storage and examination facility operations would not involve use of carcinogenic toxins, criteria pollutants, or other hazardous or toxic chemicals except that small quantities of industrial cleaning agents and paint thinner may be used for housekeeping and cleanliness control and these would be the same as those already used at the shipyard. Consequently, there would be no impact on ambient air quality as a result of implementing any of the alternatives at the shipyard.

If an alternative were to be selected that required a storage facility to be constructed or renovated, fugitive dust emissions would be expected to result from excavation operations. The quantity of dust generated would be small, consistent with typical excavation activities, and controlled within local requirements for dust control.

5.1.1.8 Water Resources

5.1.1.8.1 Radiological Consequences. Spent nuclear fuel storage and inspection operations at the shipyard would not result in discharges of radioactivity in liquid effluents during routine operation regardless of the alternative selected for storage or inspection of spent nuclear fuel. The health effect due to fallout of nuclides released to the air onto the surface water is included in the analysis results discussed in Section 5.1.1.7. The air fallout impact is so small that there would be no distinguishable radiation levels in the water.

Puget Sound Naval Shipyard does not reside in the 100 or 500 year floodplain. Consequently, the floodplain would not be impacted by spent naval nuclear fuel storage and examination activities at the shipyard.

5.1.1.8.2 Non-radiological Consequences. Other than chemicals used to maintain the storage area, no hazardous wastes would be generated by the storage of naval spent nuclear fuel at the shipyard. Any hazardous liquid effluents that may be generated at the storage area would be disposed of at an Environmental Protection Agency approved disposal site.

The only source for liquid discharges from the naval spent nuclear fuel storage operations to the environment consists of storm water runoff which would be consistent with the type of discharges associated with common light industrial facilities and related activities. It can be concluded that there would be no impact to the human environment due to runoff water from the naval spent nuclear fuel storage area.

The increased water usage associated with any alternative would be negligible compared to the existing shipyard demand.

5.1.1.9 Ecological Resources

Construction and operation of a spent fuel storage area would not impact any known habitats for threatened or endangered species and no major changes to the industrial environment are planned. Therefore, no major ecological impacts to the region would result from selection of any of the alternatives.

The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the shipyard and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present. Therefore, there would be no ecological impacts associated with construction or operation of a spent nuclear fuel storage area at this location. The radiological controls that are in effect at the shipyard ensure that the radiation levels in the vicinity of the shipyard are maintained at or near natural background. Since these same controls would be applied to spent nuclear fuel activities, no ecological effects due to radioactive material would be expected to occur.

5.1.1.10 Noise

Puget Sound Naval Shipyard is an existing industrial-type environment characterized by noise from truck and automobile traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related pumping systems for those and other liquids. No ambient noise level increases are expected to occur as a result of any of the alternatives. Therefore, no noise impacts would be expected to occur.

5.1.1.11 Traffic and Transportation

Shipments of radioactive materials in the Naval Nuclear Propulsion Program are required to be made in accordance with applicable regulations of the U.S. Department of Transportation, U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments and provide requirements for the container design, certification, and identification as applicable for the specific quantity, type, and form of radioactive material being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and qualification of workers who construct containers, and quality control inspections during fabrication to ensure that the containers will meet their design requirements. A detailed description of the shipping containers used for naval spent nuclear fuel shipments is provided in Attachment A. A description of the impacts associated with normal and accident conditions associated with transportation of naval spent nuclear fuel is provided in Attachment A.

5.1.1.11.1 Regional Infrastructure. The alternatives under consideration are described in Section 3. The No Action alternative or the first variation of the Decentralization alternative would store the naval spent nuclear fuel on-site. This alternative would reduce the number of rail shipments from the shipyard or prototype site compared to the past practice of transporting all naval spent nuclear fuel to INEL. The second variation of the Decentralization alternative would ship about 10 percent of the naval spent nuclear fuel to Puget Sound. This would have some transportation impact, but not as much as transporting all naval spent nuclear fuel off-site. The third Decentralization alternative ships all naval spent nuclear fuel to INEL, examines it, and returns it to the original shipyard or prototype

site. This alternative involves more transportation than the previous practice of transporting naval spent nuclear fuel to INEL, since the naval spent nuclear fuel is not returned from INEL to the original site. The 1992/1993 Planning Basis alternative, the Regionalization at INEL alternative, or the Centralization at INEL alternative would involve the same transportation as has been required in the past, namely transportation to INEL and retention there. The Centralization alternative at the Hanford Site would result in more transportation impact than any of the previous alternatives, due to the distances and population distribution between Hanford and the shipyards and prototypes. The Centralization alternative at the Savannah River Site would result in the most transportation impact of naval spent nuclear fuel of any of the alternatives.

5.1.1.11.2 Site Infrastructure. The alternatives associated with naval spent nuclear fuel storage and inspection at Puget Sound Naval Shipyard would create some small amount of additional site highway traffic because any additional employees needed to operate the water pool facility under the inspection or storage alternatives would need to travel to and from work. This impact is expected to be very small considering the total number of employees at the Puget Sound Naval Shipyard and the fact that the additional workers might be provided from the existing work force. Spent fuel storage and inspection activities would increase the internal traffic in the shipyard in the short-term; however, the total impact on shipyard traffic would not be detectable.

5.1.1.12 Occupational and Public Health and Safety

Detailed analyses of incident-free naval spent nuclear fuel transportation and storage and handling impacts on worker and public health are described in Attachment A (transportation) and Attachment F (storage and inspection). The transportation analysis results, and the storage and handling analysis are summarized separately in the following subsections.

5.1.1.12.1 Incident-free Transportation Occupational and Public Health and Safety. The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.1.12.2 Incident-free Occupational and Public Health and Safety During Naval Spent Nuclear Fuel Storage and Handling. The public health and safety impacts of radioactivity releases and direct radiation from storage of naval spent nuclear fuel were analyzed as discussed in Section 5.1.1.7 and Attachment F. Attachment F summarizes the results of the analysis of radioactivity releases and direct radiation from stored naval spent nuclear fuel. This analysis shows that the exposure to the workers, maximally exposed off-site individual, and nearest public access from stored naval spent nuclear fuel would result in far less than one fatality per year. For perspective, it could be stated that one member of these population groups might experience a fatal cancer due to storage of naval spent nuclear fuel at Puget Sound Naval Shipyard if operations continued for 15,400 years.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

No public or occupational radiological health and safety impacts would be expected to result from naval spent nuclear fuel storage area construction activities since the construction would not involve radioactive work.

Attachment F also discusses toxic chemical issues for naval spent nuclear fuel handling and storage. Attachment F concludes that there would be no additional types or volumes of chemicals required at the shipyards or prototype site for naval spent nuclear fuel storage. Therefore, there is no incident-free non-radiological impact resulting from storage of naval spent nuclear fuel at the shipyards or prototype site.

5.1.1.13 Utilities and Energy

If an alternative associated with storage of spent nuclear fuel at Puget Sound Naval Shipyard were to be selected, construction and operation of the storage area would not be expected to require a large expenditure of utilities and energy resources. Construction activities would require quantities of water and electricity typical of any small to medium size construction project. Operation of a dry

container spent fuel storage facility would likely require only minimal electricity for security lighting and to support industrial equipment necessary to move spent fuel.

Alternatives associated with water pool storage and inspection would require heating, ventilation, water, and electrical systems suitable for a work environment and to properly filter and exhaust the airborne discharges to the atmosphere. The utility and energy demands and impact would be less than that identified in Section 5.2.13 for operation of ECF (10,000 MWh per year) since the water pool facility at Puget is smaller and the scope of operations would be less.

The amount of utilities and energy expected to be consumed would be a small incremental increase in the total amount of utilities and energy used at the shipyard and would not result in any discernible environmental consequence.

5.1.1.14 Facility and Transportation Accidents

5.1.1.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of abnormal occurrence limits on exposures as defined by the U.S. Nuclear Regulatory Commission. A description of potential accidents considered and a summary of the accident analyses that were conducted with regard to the inspection and storage of naval spent nuclear fuel are contained in Attachment F.

5.1.1.14.1.1 Radiological Accidents. Section 3.7.3 provides a summary of the impacts due to the most severe accidents considered for each site. The facility accident with the greatest potential impact at Puget Sound Naval Shipyard involves accidental drainage of the water pool. An accident of this magnitude would result in less than one fatal cancer to the general population over 50 years, as described in Attachment F. The likelihood of such an accident occurring is 1×10^{-5} , which is very small. For perspective, an accident such as this would not be expected to occur unless the facility operated for about 100,000 years.

5.1.1.14.1.2 Non-radiological Accidents. As discussed in detail in Attachment F, the limiting hypothetical non-radiological accident for naval spent nuclear fuel storage in a water pool at a shipyard or prototype location would be a diesel fuel spill and fire. A catastrophic failure of a diesel

fuel storage tank that might be used for an emergency diesel generator to provide backup electrical power was postulated to occur, resulting in the spilling of the entire quantity of diesel fuel with a subsequent fire. The fire would generate the following toxic chemicals:

- Carbon monoxide
- Oxides of nitrogen (90% nitric oxide and 10% nitrogen dioxide)
- Lead
- Sulfur dioxide.

Measures would be taken to reduce the health impacts of potential releases of toxic materials. These measures would involve controls to protect both workers and the general public. The naval shipyard and prototype sites have emergency planning, emergency preparedness, and emergency response programs in place to protect both workers and the public, and involve established resources such as warning communications, fire departments, and emergency command centers.

The airborne concentrations of the combustion products listed above, resulting from the fire, were calculated at the locations of the on-site individuals, an individual at the site boundary, and the general population within a 50-mile radius of the facility. Detailed results are presented in Attachment F. If the accidental fire that has been hypothesized were to actually occur, the safety measures that would be in place would ensure no adverse health impacts to the general public and minimal health impacts to the workers.

5.1.1.14.2 Transportation Accidents. Shipments of radioactive materials associated with naval spent nuclear fuel have never resulted in any measurable release of radioactivity to the environment (NNPP 1993a). There have never been any significant accidents involving release of radioactive material during shipment since the Naval Nuclear Propulsion Program began. The effects of potential transportation accidents during the various stages of transportation of naval spent nuclear fuel are presented in Attachment A.

The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are

much less than one fatal cancer for each alternative. Details of the transportation analysis are provided in Attachment A.

5.1.1.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that an area ranging from about 8 acres extending approximately a quarter mile (for an inadvertent criticality accident) to about 110 acres extending approximately 0.9 mile (for a large airplane crashing into a dry storage container) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure. It should be noted that all of the affected area within approximately a half mile from the spent nuclear fuel facility would be inside the boundaries of the federally owned site.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area impacted would only vary slightly among the alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on plant and animal species in the area would also be small for all alternatives considered. Similarly, since the areas

which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. There are no endangered or threatened species unique to the area surrounding the federally owned site, so an accident would not be expected to result in destruction of any species for any of the alternatives considered. The effects of accidents related to any of the alternatives and any associated cleanup which might be performed would be localized in a small area which extends only a short distance beyond the boundaries of the federally owned site and thus would not be expected to appreciably affect the potential for survival of any species in the area. Based on these considerations, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.1.1.15 Waste Management

The alternative in which naval spent nuclear fuel is stored at Puget Sound Naval Shipyard would produce limited amounts of solid municipal waste, solid low-level radioactive wastes, and hazardous wastes. In addition, no transuranic or high-level radioactive wastes would be generated by spent nuclear fuel activities at the site under any alternative. The quantity of industrial wastes generated would be small and most likely consist of industrial cleaning agents of the type normally encountered at the site. Small quantities of sanitary wastes would result from the additional work force but this volume would be small. The wastes produced from the storage of naval spent nuclear fuel would be controlled and minimized in accordance with the existing waste management programs at the shipyard. The amount of additional wastes generated would be minimal compared to the existing baseline and would not cause any adverse impacts to public health and safety and the environment in the vicinity of the shipyard.

5.1.1.16 Cumulative Impacts

5.1.1.16.1 Radiological Cumulative Impacts. Spent nuclear fuel storage and examination at Puget Sound would not result in discharges of radioactivity in liquid effluents during routine operations regardless of the alternative selected. Therefore, there would be no incremental addition of radioactivity to surface or ground water as a result of normal operations for any alternative. For alternatives involving the storage of spent nuclear fuel in dry storage and shipping containers, no airborne radioactivity emissions are expected, so there would be no cumulative air quality impacts

associated with these storage methods. Consequently, the only radiological cumulative impacts that would result from dry storage alternatives would be due to direct radiation exposure from the stored containers of spent nuclear fuel.

For alternatives involving the storage and examination at Puget Sound of naval spent nuclear fuel in water pools, there would be no discernible direct radiation exposure to the public from the fuel elements due to the shielding provided by the water in the pool. Therefore, any cumulative impacts which would result from water pool storage (and examination at Puget Sound) would be primarily due to airborne emissions, and the addition of these emissions would cause an indiscernible change in the emissions in the area (see Section 5.1.1.7). Current operations at the site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

A summary of the cumulative radiological impacts is provided in the following section.

An overview of the historical radiological impacts from naval nuclear operations at the Puget Sound Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section 4.1.1.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at Puget Sound Naval Shipyard are very small and are described in Section 5.1.1.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent

nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the population in the vicinity of the Puget Sound Naval Shipyard from all of the alternatives considered would be approximately 5.30 person-rem. This means that there would be much less than one fatal cancer from these operations over the entire 40-year period evaluated. The total exposure to a theoretical maximally exposed off-site individual living at the shipyard boundary for the entire 40-year period would be 7.0×10^{-3} rem due to the alternative resulting in the largest exposure. This maximally exposed off-site individual would have a 3.5×10^{-6} risk of contracting a fatal cancer during his or her lifetime due to storage of spent nuclear fuel. When existing site radiological impacts due to naval nuclear operations are added to the impacts of the most limiting spent nuclear fuel alternative, the exposure to the population would be 6.1 person-rem and to the maximally exposed off-site individual would be 7.6×10^{-3} rem. This still results in much less than one fatal cancer in the population and the risk of the maximally exposed off-site individual contracting a fatal cancer during his or her lifetime is 3.8×10^{-6} .

The total exposure related to naval spent nuclear fuel activities to a worker assumed to be working continually 100 meters from the spent nuclear fuel under the alternative resulting in the largest exposure is 0.22 rem accumulated over 40 years. That corresponds to a fatal cancer risk of 8.8×10^{-5} during the worker's lifetime. The exposure to the same worker when existing site radiological impacts due to naval nuclear operations are added to the spent nuclear fuel exposure is 0.222 rem over 40 years which corresponds to a fatal cancer risk of 8.9×10^{-5} during the worker's lifetime. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

Sections 4.1.1.14 and 5.1.1.15 describe the management of low-level radioactive waste and mixed waste at the site. The volume of low-level radioactive wastes which would be generated under the alternatives has not been calculated. However, considering the nature of radiological work that

would be associated with spent nuclear fuel storage (and examination) activities, the amount of low-level radioactive waste produced during spent nuclear fuel activities would be much less than 20 percent of the current site generation rate (651 m³ per year). This additional radioactive waste would not introduce any changes to the site's waste management practices. The small amount of additional material involved would not impose any discernible additional stress on the capacity of the radioactive waste burial ground. Therefore, any cumulative impacts associated with the generation and disposal of additional low-level wastes would be very small.

Since no mixed, transuranic, or high-level radioactive wastes would be generated by spent nuclear fuel activities at this site under any alternative, there would be no cumulative impacts associated with these materials.

5.1.1.16.2 Non-radiological Cumulative Impacts. An overview of the historical non-radiological impacts from naval nuclear operations at the Puget Sound Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section 4.1.1.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no non-radiological cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The non-radiological impacts associated with the alternative where naval spent nuclear fuel would be inspected or stored at Puget Sound Naval Shipyard are described in Section 5.1.1.12, with the detailed results of analyses provided in Attachment F. As summarized in Section 5.1.1.12, there would be no additional chemicals required at the shipyard for naval spent nuclear fuel storage and therefore no non-radiological impacts from normal operations. Consequently, no cumulative impacts to air quality or water resources would result since the incremental addition of chemicals at the shipyard that might result from naval spent fuel activities would be very small. There are no current environmental problems associated with these materials.

The non-radiological cumulative transportation impacts for the population from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A. The non-radiological

impacts associated with the transportation and storage of naval spent nuclear fuel for all of the alternatives considered would be low.

No cumulative land use impacts would be expected to occur as a result of spent nuclear fuel storage and examination at Puget Sound. The land that would be dedicated for this purpose is on existing federal property and situated in an industrial setting which has already been disturbed from its natural state (approximately 327 acres are developed land). The conversion of this space for storage of spent nuclear fuel would not result in the need to disturb undeveloped land or for additional land to be added to the federally owned property in the foreseeable future.

From a socioeconomic perspective, the introduction of naval spent nuclear fuel activities at the site would create a small number of additional jobs and could have a very small cumulative socioeconomic impact. The site currently employs approximately 10,200 civilian personnel. No shipyard employment has been associated with spent nuclear fuel activities in the past since spent nuclear fuel activities have not been conducted at the site. An average of approximately 1 to 100 additional jobs might be added as a result of possible spent nuclear fuel activities in the future. The peak number of additional jobs created at the site in any given year would be approximately 280, which is associated with construction and operation of a water pool facility for storage of spent nuclear fuel and modification of the existing water pool for limited examination of fuel. Considering that the regional labor force consists of approximately 527,000 workers, the additional number of added jobs under any alternative would have little or no discernible socioeconomic impact. These jobs would be filled either from within the existing site work force or from the available regional labor force without discernible effect. There are no foreseeable future projects planned at the site and no known projects planned in the region that would cause the small number of workers involved in naval spent nuclear fuel activities to become an important impact.

The cumulative impacts associated with non-radiological waste management are likewise expected to be small. As stated previously, any industrial wastes generated from naval spent nuclear fuel storage and examination at Puget Sound would be small and limited to industrial cleaning agents of the type normally encountered at the site. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of additional non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste

disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of waste.

5.1.1.17 Unavoidable Adverse Effects

There are no discernible unavoidable adverse effects associated with the implementation of any of the alternatives and none which would help to choose among the alternatives. The alternative in which naval spent nuclear fuel is inspected or stored at the Puget Sound Naval Shipyard would cause the public to be exposed to small amounts of radiation, described in Section 5.1.1.12, and would result in less than one health effect in the entire population surrounding the shipyard. Similarly, continued operation of the storage facility would produce limited amounts of solid municipal waste and solid low-level radioactive waste. These amounts of waste would not produce any major impacts in the vicinity of the Puget Sound Naval Shipyard. There will be no changes to the ecological, cultural, geological, and aesthetic resources due to the implementation of any of the alternatives. There will also be no impact on ambient noise levels.

5.1.1.18 Irreversible and Irretrievable Commitments of Resources

The only irreversible and irretrievable commitment of resources that results from the alternative in which naval spent nuclear fuel would be stored at the shipyard would be the money which would be spent by the federal government to construct the necessary facilities. The total cost of storing spent naval nuclear fuel at the shipyards and prototype ranges from approximately \$1.5 billion to \$5.7 billion. This cost represents the total cumulative cost over the 40-year period for all of the shipyards and prototype. This cost includes construction costs of the new storage facilities, and, depending on the alternative selected, the operation of a limited examination facility at Puget Sound Naval Shipyard combined with the costs associated with shutting down ECF, or the operational costs of the INEL-ECF. The major expense in the highest cost alternatives is the procurement of shipping containers. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

5.1.2 NORFOLK NAVAL SHIPYARD: PORTSMOUTH, VIRGINIA

5.1.2.1 Overview of Environmental Impacts

The following sections discuss the major differences in potential environmental consequences associated with the choice of alternatives that include storage of naval spent nuclear fuel at Norfolk Naval Shipyard. The environmental consequences associated with storage of naval spent nuclear fuel at Norfolk Naval Shipyard are based on the estimates of naval spent nuclear fuel that would be stored at Norfolk Naval Shipyard through the year 2035 and current knowledge of the design features associated with spent fuel storage containers. The review of the environmental consequences associated with these alternatives has shown that the impact on the environment at Norfolk Naval Shipyard associated with all activities is very small. There would be no impact to the Norfolk Naval Shipyard regional environment associated with any alternatives that do not involve the Norfolk Naval Shipyard.

5.1.2.2 Land Use

Norfolk Naval Shipyard has identified a centrally located area within the controlled industrial area as a potential site for spent nuclear fuel storage. The site is located approximately 1500 feet from the southern branch of the Elizabeth River. Public access to the 900 feet of river nearest the site evaluated is restricted. There are no known existing adverse environmental conditions at this site. The area is already an industrial site; therefore, there would be no impact on land use. The area identified should be sufficient depending on the type of storage mode ultimately chosen. A description of storage containers and water pools and their approximate storage locations is provided in Attachment D. Attachment C provides a comparison of spent nuclear fuel storage in new water pools versus dry container storage.

The alternative of storing naval spent nuclear fuel in water pools would require that a water pool facility be constructed in the vicinity of the area that is designated for dry container storage. The water pool would have sufficient capacity to accommodate storage of all spent nuclear fuel expected to be stored at the shipyard.

No additional land use outside the shipyard would be required.

Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.1.2.3 Socioeconomics

The calculated number of direct construction and operating jobs that would be required for the 10-year period between 1995 and 2004 for each storage alternative at the shipyard is provided in Table 5.1.2-1. Since there would be no naval spent nuclear fuel storage or inspection activities at the shipyard under the 1992/1993 Planning Basis and Centralization alternatives, no additional jobs would be required at the shipyard under these alternatives.

Table 5.1.2-1. Number of construction and operating jobs created at Norfolk Naval Shipyard for each alternative.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Railcar ⁽¹⁾	1	1	8	1	1	1	1	1	1	1
Immobile Containers on Pads ⁽²⁾	1	1	1	1	2	6	8	8	8	8
Shipping Containers on Pads ⁽²⁾	1	1	1	1	2	6	2	2	2	2
Water Pools ⁽²⁾	16	16	70	107	132	94	103	40	40	40

(1) Storage mode under the No Action and Decentralization alternatives.

(2) Storage mode under the Decentralization alternative.

The only discernible socioeconomic consequence of storing naval spent nuclear fuel at Norfolk Naval Shipyard is that a relatively small number of construction workers (ranging from a few to a maximum of several hundred would be required for construction of the storage area). The work force would consist of skilled craftsmen and unskilled laborers. This work force would be needed during the storage facility construction and would be available from within the area.

The operation of the spent fuel storage area using dry storage containers would require additional workers to support surveillance and monitoring activities. For the alternative involving storing fuel in immobile dry storage containers, about 20 workers would be required to handle the spent nuclear fuel when it is placed into the storage containers. This work force would normally only be needed when fuel is being inserted into the containers. For the alternative involving shipping containers, fewer workers would be needed to handle and secure the containers in the storage area. The operation of a water pool facility for the alternative involving storing naval spent nuclear fuel in a water pool would require approximately 40 additional workers. The number required for any of the shipyard and prototype site storage alternatives would be small and is expected to be supplied from either within the existing shipyard work force or from the local work force. Considering that the Department of Defense employs approximately 8,500 civilians at the shipyard, the addition of workers to support the alternatives would have no discernible impact on the local socioeconomic conditions of the Norfolk Naval Shipyard site.

For the alternatives where dry storage containers would be manufactured, some additional jobs would be created in the locations where the containers are made. The process of selecting the container manufacturer is subject to federal procurement requirements and would be initiated after the Record of Decision. Consequently, the specific socioeconomic impacts from container fabrication cannot be specified. The net effect of container fabrication would be to create additional jobs and bolster the local economy of the area(s) where containers are made. It is considered unlikely that the selection of the contractor would depend on the alternative storage site selected, so the jobs associated with construction of casks provide no basis for selection of a storage site.

5.1.2.4 Cultural Resources

The action considered would not affect any site that is listed on the National Register of Historic Places (NPS 1991), any known archaeological areas, or any other cultural resources. Therefore, there would be no impacts to cultural resources associated with the alternative of storing naval spent nuclear fuel at this location.

None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.1.2.5 Aesthetic and Scenic Resources

The naval spent nuclear fuel storage area would be located within the Norfolk Naval Shipyard which is an existing industrial setting and would not affect the visual quality of the area since it is compatible with the landscape character of the site. Physical changes to the site resulting from the construction of a spent nuclear fuel storage area would not alter this setting. There are no particulate air emissions associated with storage of naval spent nuclear fuel and thus no visibility impacts are expected. No aesthetic or scenic resources in the vicinity of the shipyard would be affected by the construction and operation of the storage facility.

5.1.2.6 Geology

The construction and operation of the naval spent nuclear fuel storage facility at the Norfolk Naval Shipyard is not expected to affect the geologic character or resources of the region. If an alternative were selected which required a storage facility to be constructed, the ground would only be excavated as necessary to prepare the surface. This would not affect the geological characteristics of the underlying layers nor the characteristics of the aquifer or vadose zone. For the alternative of storing fuel in a water pool facility, the ground surface would need to be excavated to a depth of approximately 40 feet. This excavation would not affect the geological characteristics of the area. Since the Columbia aquifer is at a depth of 3 to 5 feet throughout the shipyard, the hydraulic considerations make a water pool facility more difficult and expensive than an above-ground storage facility. However, if water pools were selected, all precautions necessary to protect the aquifer would be taken.

5.1.2.7 Air Resources

5.1.2.7.1 Radiological Consequences. If the alternative where naval spent fuel would be stored in dry storage containers were to be selected, no airborne radioactivity releases would be expected to occur as a result of normal storage operations. The fuel would be contained such that at least two barriers exist to prevent fission products from becoming airborne. These barriers would retain the spent nuclear fuel in an air-tight containment until it is moved to a permanent storage site and there would be no airborne radioactive material released from routine operations for this method of storage.

The only radiation exposure would be direct radiation from the array of filled storage containers. The filled storage containers would be fenced off and shielded if necessary such that there would be no distinguishable effect on the current radiation readings at the site perimeter.

For the alternative where naval spent nuclear fuel would be stored in a water pool, airborne radioactivity would be emitted beyond current emissions. The airborne releases for this alternative are expected to be less than the emissions from the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) because the water pool size and the number of inspections performed would be smaller at the shipyard and the shipyard would not conduct the shielded cell operations that are performed at ECF. To conservatively estimate the radiological consequences, airborne releases based on ECF releases from 1991 are used. The radiological source term used and the detailed calculations performed to determine expected normal releases are provided in Attachment F.

The radiation exposures to human beings due to estimated radionuclide releases to the atmosphere plus direct radiation from the stored spent nuclear fuel at the shipyards for both the alternative involving water pool storage and the alternative involving dry storage were calculated as described in Attachment F. Postulated releases were calculated for wet storage of spent nuclear fuel in a water pool plus inspection of naval spent nuclear fuel.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from the stored spent fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F. Estimated exposures to workers were also calculated.

The hypothetical exposures calculated are based on an exposure to the estimated average effluents and the direct radiation exposure for one year from the naval spent nuclear fuel stored at the shipyard. The calculations include the external effective exposure equivalent from the ground deposition, deposition to surface water, and air immersion pathways and the 50-year committed effective exposure equivalent from internal exposure through the ingestion and inhalation pathways. All pathways were considered for persons potentially exposed, except that the ingestion pathway was omitted for the workers because they do not grow their food on-site. Solubilities which would produce the highest calculated exposures were chosen for internal exposure factors. Values for

human dietary consumption patterns were taken from "Age Dependent Values of Dietary Intake for Assessing Human Exposures to Environmental Pollutants" (Rupp 1980). The hypothetical exposures calculated can be converted into a risk of fatal cancer or a risk of non-fatal health detriments (e.g., non-fatal cancers, hereditary defects) based on recommendations of the International Commission on Radiological Protection (ICRP 1991).

Attachment F summarizes the calculated exposures and fatal cancers to the worker, maximally exposed off-site individual (MOI), nearest public access (NPA), and the population from airborne releases of radioactivity and direct radiation exposure in one year for each location and storage mode. Section 3.7 provides a comparison of the annual number of fatal cancers calculated for the general population for each location and alternative.

The number of fatal cancers calculated is so small that there would be essentially no fatal cancers resulting from the storage of naval spent nuclear fuel during the time it could reasonably be expected to continue to be stored. Putting this into perspective, it could be stated that one member of the population might experience a fatal cancer due to incident-free storage of naval spent nuclear fuel at the Norfolk Naval Shipyard if operations continued for 7,100 years.

If a water pool facility would be constructed at the Norfolk Naval Shipyard and used for storage of spent nuclear fuel, the airborne emissions from the facility would be less than that identified for the Puget Sound Naval Shipyard because no spent nuclear fuel inspection operations beyond visual examinations would be conducted in the water pools.

5.1.2.7.2 Non-radiological Consequences. As noted in Attachment F, no increase in non-radioactive airborne emissions would be expected to result from spent nuclear fuel storage facility operations. Storage facility operations would not involve use of carcinogenic toxins, criteria pollutants, or other hazardous or toxic chemicals except for small quantities of industrial cleaning agents and paint thinner that may be used for housekeeping and cleanliness control and these would be the same as those already used at the shipyard. Consequently, there would be no impact on ambient air quality as a result of implementing any of the alternatives at the shipyard.

If an alternative were to be selected that required a storage facility to be constructed or renovated, fugitive dust emissions would be expected to result from excavation operations. The

quantity of dust generated would be small, consistent with typical excavation activities, and controlled within local requirements for dust control.

5.1.2.8 Water Resources

5.1.2.8.1 Radiological Consequences. Spent nuclear fuel storage operations at the shipyard would not result in discharges of radioactivity in liquid effluents during routine operation regardless of the particular alternative chosen for storage of spent nuclear fuel. The health effect due to fallout of nuclides released to the air onto the surface water is included in the analysis results discussed in Section 5.1.2.7. The air fallout impact is so small that there would be no distinguishable radiation levels in the water.

Most of the Norfolk Naval Shipyard, including the location considered for the interim storage of naval spent nuclear fuel, is in the 100-year floodplain. However, the location considered for naval spent nuclear fuel is not in a high-hazard area (as defined by Title 10, Part 1022 of The Code of Federal Regulations for floodplains) which is an area where frequent flooding occurs. Since the majority of the shipyard is already developed and covered with impervious material, construction and operation of a naval spent nuclear fuel storage facility at the shipyard would produce no discernible impacts on the floodplain.

Flooding in the area where shipping and immobile dry storage containers are stored would not result in any adverse environmental consequences. These containers are completely sealed such that no radioactivity would be released from the interior even if they were completely submerged. In addition, the massive nature of these containers prevents them from floating or moving during a flood.

Since the shipyard resides in a floodplain, the design of the facility and equipment would minimize the potential for flooding and damage to the facility. However, in the event a water pool facility would be flooded, the exchange of pool water with the flood waters could occur. As discussed in Attachment F, Section F.1.4.2.1.6.2, the radioactivity concentration in the ECF water pool is below the Nuclear Regulatory Commission limits specified in Title 10, Part 20 of The Code of Federal Regulations for liquid effluent except for Co-60 which is slightly higher (water pools used for

storage or examination of naval spent nuclear fuel would be maintained to comparable concentrations). Any release of radioactivity would have to result from the exchange of floodwater with the pool water. This exchange would reduce the level of radioactivity even further. Consequently, no adverse environmental impacts would result from flooding of water pools at naval spent nuclear fuel storage sites.

5.1.2.8.2 Non-radiological Consequences. Other than chemicals used to maintain the storage area, no hazardous wastes would be generated by the storage of naval spent nuclear fuel at Norfolk Naval Shipyard. Any hazardous liquid effluents that may be generated at the storage area would be disposed of at an Environmental Protection Agency approved disposal site.

The only source for liquid discharges from the naval spent nuclear fuel storage operations to the environment consists of storm water runoff which would be consistent with the type of discharges associated with common light industrial facilities and related activities. It can be concluded that there would be no impact to the human environment due to runoff water from the naval spent nuclear fuel storage area.

The increased water usage under any of the alternatives would be negligible compared to the existing shipyard demand.

5.1.2.9 Ecological Resources

There are no threatened or endangered species known to exist within the shipyard and no major changes to the industrial environment are planned. Therefore, no major ecological impacts to the region would result from selection of any of the alternatives.

The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the shipyard and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present. Therefore, there would be no ecological impacts associated with construction or operation of a spent nuclear fuel storage area at this location. The radiological controls that are in effect at the shipyard ensure that the radiation levels in

the vicinity of the shipyard are maintained at or near natural background. Since these same controls would be applied to spent nuclear fuel activities, no ecological effects due to radioactive material would be expected to occur.

5.1.2.10 Noise

Norfolk Naval Shipyard is an existing industrial-type environment characterized by noise from truck and automobile traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related pumping systems for those and other liquids. No ambient noise level increases are expected to occur as a result of any of the alternatives. Therefore, no noise impacts would be expected to occur.

5.1.2.11 Traffic and Transportation

Shipments of radioactive materials in the Naval Nuclear Propulsion Program are required to be made in accordance with applicable regulations of the U.S. Department of Transportation, U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments and provide requirements for the container design, certification, and identification as applicable for the specific quantity, type, and form of radioactive material being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and qualification of workers who construct containers, and quality control inspections during fabrication to ensure that the containers will meet their design requirements. A detailed description of the shipping containers used for naval spent nuclear fuel shipments is provided in Attachment A. A description of the impacts associated with normal and accident conditions associated with transportation of naval spent nuclear fuel is provided in Attachment A.

5.1.2.11.1 Regional Infrastructure. The alternatives under consideration are described in Section 3. The No Action alternative or the first variation of the Decentralization alternative would store the naval spent nuclear fuel on-site. This alternative would reduce the number of rail shipments from the shipyard or prototype site compared to the past practice of transporting all naval spent nuclear fuel to

INEL. The second variation of the Decentralization alternative would ship about 10 percent of the naval spent nuclear fuel to Puget Sound. This would have some transportation impact, but not as much as transporting all naval spent nuclear fuel off-site. The third Decentralization alternative ships all naval spent nuclear fuel to INEL, examines it, and returns it to the original shipyard or prototype site. This alternative involves more transportation than the previous practice of transporting naval spent nuclear fuel to INEL, since the naval spent nuclear fuel is not returned from INEL to the original site. The 1992/1993 Planning Basis alternative, the Regionalization at INEL alternative, or the Centralization at INEL alternative would involve the same transportation as has been required in the past, namely transportation to INEL and retention there. The Centralization alternative at the Hanford Site would result in more transportation impact than any of the previous alternatives, due to the distances and population distribution between Hanford and the shipyards and prototypes. The Centralization alternative at the Savannah River Site would result in the most transportation impact of naval spent nuclear fuel of any of the alternatives.

5.1.2.11.2 Site Infrastructure. If the alternative of storing naval spent nuclear fuel at Norfolk Naval Shipyard were to be selected, operation of a naval spent nuclear fuel storage facility would not noticeably affect site highway traffic because any increase in the work force would represent a very small incremental increase in overall traffic to and from the shipyard. Internal traffic in the Norfolk Naval Shipyard would increase in the short-term; however, the total impact on shipyard and surrounding area traffic would be very small.

5.1.2.12 Occupational and Public Health and Safety

Detailed analyses of incident-free naval spent nuclear fuel transportation and storage and handling impacts on worker and public health are described in Attachment A (transportation) and Attachment F (storage and inspection). The transportation analysis results, and the storage and handling analysis are summarized separately in the following subsections.

5.1.2.12.1 Incident-free Transportation Occupational and Public Health and Safety. The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel

and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.2.12.2 Incident-free Occupational and Public Health and Safety During Naval Spent Nuclear Fuel Storage and Handling. The public health and safety impacts of radioactivity releases and direct radiation from storage of naval spent nuclear fuel were analyzed as discussed in Section 5.1.2.7 and Attachment F. Attachment F summarizes the results of the analysis of radioactivity releases and direct radiation from stored naval spent nuclear fuel. This analysis shows that the exposure to the worker, maximally exposed off-site individual, and nearest public access from stored naval spent nuclear fuel would result in far less than one fatality per year. For perspective, it could be stated that one member of these population groups might experience a fatal cancer due to storage of naval spent nuclear fuel at Norfolk Naval Shipyard if operations continued for 7,100 years.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

No public or occupational radiological health and safety impacts would be expected to result from naval spent nuclear fuel storage area construction activities since the construction would not involve radioactive work.

Attachment F also discusses toxic chemical issues for naval spent nuclear fuel handling and storage. Attachment F concludes that there would be no additional types or volumes of chemicals required at the shipyards or prototype site for naval spent nuclear fuel storage. Therefore, there is no incident-free non-radiological impact resulting from storage of naval spent nuclear fuel at the shipyards or prototype site.

5.1.2.13 Utilities and Energy

If an alternative associated with storage of spent nuclear fuel at Norfolk Naval Shipyard were to be selected, construction and operation of the storage facility would not be expected to require a large expenditure of utilities and energy resources. Construction activities would require quantities of water and electricity typical of any small to medium size construction project. Operation of a dry container spent fuel storage facility would likely require only a small amount of electricity for lighting and to support industrial equipment necessary to move spent nuclear fuel. Alternatives associated with water pool storage would require heating, ventilation, water, and electrical systems suitable for a work environment and to properly filter and exhaust the airborne discharges to the atmosphere. The utility and energy demands would be less than those required to operate ECF (10,000 MWh per year) (Section 5.2.13) since the water pool used for spent fuel storage would be smaller and no spent fuel operations beyond visual examinations would be conducted in the water pool.

The amount of utilities and energy expected to be consumed would be a small incremental increase in the total amount of utilities and energy used at the shipyard and would not result in any discernible environmental consequence.

5.1.2.14 Facility and Transportation Accidents

5.1.2.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of abnormal occurrence limits on exposures as defined by the U.S. Nuclear Regulatory Commission. A description of potential accidents considered and a summary of the accident analyses that were conducted with regards to the storage of naval spent nuclear fuel are contained in Attachment F.

5.1.2.14.1.1 Radiological Accidents. Section 3.7.3 provides a summary of the impacts due to the most severe accidents considered for each site. The facility accident with the greatest potential impact at Norfolk Naval Shipyard involves an airplane crash. An accident of this magnitude would result in a calculated 16 fatal cancers to the general population over 50 years, as described in Attachment F. The likelihood of such an accident occurring is 1×10^{-6} , which is very small. For

perspective, an accident such as this would not be expected to occur unless the facility operated for about 1,000,000 years.

5.1.2.14.1.2 Non-radiological Accidents. As discussed in detail in Attachment F, the limiting hypothetical non-radiological accident for naval spent nuclear fuel storage in a water pool at a shipyard or prototype location would be a diesel fuel spill and fire. A catastrophic failure of a diesel fuel storage tank that might be used for an emergency diesel generator to provide backup electrical power was postulated to occur, resulting in the spilling of the entire quantity of diesel fuel with a subsequent fire. The fire would generate the following toxic chemicals:

- Carbon monoxide
- Oxides of nitrogen (90% nitric oxide and 10% nitrogen dioxide)
- Lead
- Sulfur dioxide.

Measures would be taken to reduce the health impacts of potential releases of toxic materials. These measures would involve controls to protect both workers and the general public. The naval shipyard and prototype sites have emergency planning, emergency preparedness, and emergency response programs in place to protect both workers and the public, and involve established resources such as warning communications, fire departments, and emergency command centers.

The airborne concentrations of the combustion products listed above, resulting from the fire, were calculated at the locations of the on-site individuals, an individual at the site boundary, and the general population within a 50-mile radius of the facility. Detailed results are presented in Attachment F. If the accidental fire that has been hypothesized were to actually occur, the safety measures that would be in place would ensure no adverse health impacts to the general public and minimal health impacts to the workers.

5.1.2.14.2 Transportation Accidents. Shipments of radioactive materials associated with naval spent nuclear fuel have never resulted in any measurable release of radioactivity to the environment (NNPP 1993a). There have never been any significant accidents involving release of radioactive material during shipment since the Naval Nuclear Propulsion Program began. The effects of potential transportation accidents during the various stages of transportation of naval spent nuclear fuel are presented in Attachment A.

The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. Details of the transportation analysis are provided in Attachment A.

5.1.2.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that an area ranging from about 8 acres extending approximately a quarter mile (for an inadvertent criticality accident) to about 110 acres extending approximately 0.9 mile (for a large airplane crashing into a dry storage container) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure. It should be noted that all of the affected area within about a quarter of a mile from the spent nuclear fuel facility would be inside the boundaries of the federally owned site.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources, partially because the area involved would be small and partly because the remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area impacted would vary only slightly among the alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological

resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. There are no endangered or threatened species unique to the area surrounding the federally owned site and an accident would not be expected to result in destruction of any species for any of the alternatives considered. The effects of accidents related to any of the alternatives and any associated cleanup which might be performed would be localized in a small area extending only a short distance beyond the boundaries of the federally owned site and would not be expected to appreciably affect threatened or endangered species in the area. Based on these considerations, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.1.2.15 Waste Management

The alternative in which naval spent nuclear fuel is stored at Norfolk Naval Shipyard would produce limited amounts of solid municipal waste, solid low-level radioactive wastes, and hazardous wastes. In addition, no transuranic or high-level radioactive wastes would be generated by spent nuclear fuel activities at the site under any alternative. The quantity of industrial wastes generated would be small and most likely consist of industrial cleaning agents of the type normally encountered at the site. Small quantities of sanitary wastes would result from the additional work force but this volume would be small. The wastes produced from the storage of naval spent nuclear fuel would be controlled and minimized in accordance with the existing waste management programs at the shipyard. The amount of additional wastes generated would be minimal compared to the existing baseline and would not cause any adverse impacts to public health and safety and the environment in the vicinity of the shipyard.

5.1.2.16 Cumulative Impacts

5.1.2.16.1 Radiological Cumulative Impacts. Spent nuclear fuel storage at the site would not result in discharges of radioactivity in liquid effluents during routine operations regardless of the alternative selected. Therefore, there would be no incremental addition of radioactivity to surface or

ground water as a result of normal operations for any alternative. For alternatives involving the storage of spent nuclear fuel in dry storage and shipping containers, no airborne radioactivity emissions are expected, so there would be no cumulative air quality impacts associated with these storage methods. Consequently, the only radiological cumulative impacts that would result from dry storage alternatives would be due to direct radiation exposure from the stored containers of spent nuclear fuel.

For alternatives involving the storage of naval spent nuclear fuel in water pools, there would be no discernible direct radiation exposure to the public from the fuel elements due to the shielding provided by the water in the pool. Therefore, any cumulative impacts which would result from water pool storage would be primarily due to airborne emissions, and the addition of these emissions would cause an indiscernible change in the emissions in the area (see Section 5.1.2.7). Current operations at the site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

A summary of the cumulative radiological impacts is provided in the following section.

An overview of the historical radiological impacts from naval nuclear operations at the Norfolk Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section 4.1.2.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The radiological impacts associated with the alternatives where naval spent nuclear fuel would be stored at Norfolk Naval Shipyard are very small and are described in Section 5.1.2.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the population in the vicinity of the Norfolk Naval Shipyard from all of the alternatives considered would be approximately 11.2 person-rem. This means that there would be much less than one fatal cancer from these operations over the entire 40-year period evaluated. The total exposure to a theoretical maximally exposed off-site individual living at the shipyard boundary for the entire 40-year period would be 0.12 rem due to the alternative resulting in the largest exposure. This maximally exposed off-site individual would have a 6.0×10^{-5} risk of contracting a fatal cancer during his or her lifetime due to storage of spent nuclear fuel. When existing site radiological impacts due to naval nuclear operations are added to the impacts of the most limiting spent nuclear fuel alternative, the exposure to the population would be 13.6 person-rem and to the maximally exposed off-site individual would remain at 0.12 rem. This still results in much less than one fatal cancer in the population and the risk of the maximally exposed off-site individual contracting a fatal cancer during his or her lifetime is essentially unchanged.

The total exposure related to naval spent nuclear fuel activities to a worker assumed to be working continually 100 meters from the spent nuclear fuel under the alternative resulting in the largest exposure is 0.23 rem accumulated over 40 years. That corresponds to a fatal cancer risk of 9.2×10^{-5} during the worker's lifetime. The exposure to the same worker when existing site radiological impacts due to naval nuclear operations are added to the spent nuclear fuel exposure is 0.232 rem over 40 years which corresponds to a fatal cancer risk of 9.3×10^{-5} during the worker's lifetime. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

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Sections 4.1.2.14 and 5.1.2.15 describe the management of low-level radioactive waste and mixed waste at the site. The volume of low-level radioactive wastes which would be generated under the alternatives has not been calculated. However, considering the nature of radiological work that would be associated with spent nuclear fuel storage activities, the amount of low-level radioactive waste produced during spent nuclear fuel activities would be much less than 20 percent of the current site generation rate (1019 m³ per year). This additional radioactive waste would not introduce any changes to the site's waste management practices. The small amount of additional material involved would not impose any discernible additional stress on the capacity of the radioactive waste burial ground. Therefore, any cumulative impacts associated with the generation and disposal of additional low-level wastes would be very small.

Since no mixed, transuranic, or high-level radioactive wastes would be generated by spent nuclear fuel activities at this site under any alternative, there would be no cumulative impacts associated with these materials.

5.1.2.16.2 Non-radiological Cumulative Impacts. An overview of the historical non-radiological impacts from naval nuclear operations at the Norfolk Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section 4.1.2.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no non-radiological cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The non-radiological impacts associated with the alternative where naval spent nuclear fuel would be inspected or stored at Norfolk Naval Shipyard are described in Section 5.1.2.12, with the detailed results of analyses provided in Attachment F. As summarized in Section 5.1.2.12, there would be no additional chemicals required at the shipyard for naval spent nuclear fuel storage and therefore no non-radiological impacts from normal operations. Consequently, no cumulative impacts to air quality or water resources would result since the incremental addition of chemicals at the shipyard that might result from naval spent fuel activities would be very small. There are no current environmental problems associated with these materials.

The non-radiological cumulative transportation impacts for the population from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program

also have been calculated. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A. The non-radiological impacts associated with the transportation and storage of naval spent nuclear fuel for all of the alternatives considered would be low.

No cumulative land use impacts would be expected to occur as a result of spent nuclear fuel storage. The land that would be dedicated for this purpose is on existing federal property and situated in an industrial setting which has already been disturbed from its natural state (over 1100 acres are developed land). The conversion of this space for storage of spent nuclear fuel would not result in the need to disturb undeveloped land or for additional land to be added to the federally owned property in the foreseeable future.

From a socioeconomic perspective, the introduction of naval spent nuclear fuel activities at the site would create a small number of additional jobs and could have a very small cumulative socioeconomic impact. The site currently employs approximately 8500 civilian personnel. No shipyard employment has been associated with spent nuclear fuel activities in the past since spent nuclear fuel activities have not been conducted at the site. An average of approximately 1 to 40 additional jobs might be added as a result of possible spent nuclear fuel activities in the future. The peak number of additional jobs created at the site in any given year would be approximately 132, which is associated with construction and operation of a water pool facility for storage of spent nuclear fuel. Considering that the regional labor force consists of approximately 533,000 workers, the additional number of added jobs under any alternative would have little or no discernible socioeconomic impact. These jobs would be filled either from within the existing site work force or from the available regional labor force without discernible effect. There are no foreseeable future projects planned at the site and no known projects planned in the region that would cause the small number of workers involved in naval spent nuclear fuel activities to become an important impact.

The cumulative impacts associated with non-radiological waste management are likewise expected to be small. As stated previously, any industrial wastes generated from naval spent nuclear fuel storage would be small and limited to industrial cleaning agents of the type normally encountered at the site. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of additional non-radiological wastes generated would

not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of waste.

5.1.2.17 Unavoidable Adverse Effects

There are no discernible unavoidable adverse effects associated with the implementation of any of the alternatives and none which would help to choose among the alternatives. The alternative in which naval spent nuclear fuel is stored at the Norfolk Naval Shipyard would cause the public to be exposed to small amounts of radiation, described in Section 5.1.2.12, and would result in less than one health effect in the entire population surrounding the shipyard. Similarly, continued operation of the storage facility would produce limited amounts of solid municipal waste and solid low-level radioactive waste. These amounts of waste would not produce any major impacts in the vicinity of the shipyard. There will be no changes to the ecological, cultural, geological, and aesthetic resources due to the implementation of any of the alternatives. There would also be no expected impact on ambient noise levels.

5.1.2.18 Irreversible and Irretrievable Commitments of Resources

The only irreversible and irretrievable commitment of resources that results from the alternative in which naval spent nuclear fuel would be stored at the Norfolk Naval Shipyard would be the money which would be spent by the federal government to construct the necessary facilities. The total cost of storing spent naval nuclear fuel at the shipyards and prototype ranges from approximately \$1.5 billion to \$5.7 billion. This cost represents the total cumulative cost over the 40-year period for all of the shipyards and prototype. This cost includes construction costs of the new storage facilities, and, depending on the alternative selected, the operation of a limited examination facility at Puget Sound Naval Shipyard combined with the costs associated with shutting down ECF, or the operational costs of the INEL-ECF. The major expense in the highest cost alternatives is the procurement of shipping containers. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

5.1.3 PORTSMOUTH NAVAL SHIPYARD: KITTERY, MAINE

5.1.3.1 Overview of Environmental Impacts

The following sections discuss the major differences in potential environmental consequences associated with the choice of alternatives that include storage of naval spent nuclear fuel at Portsmouth Naval Shipyard. The environmental consequences associated with storage of naval spent nuclear fuel at Portsmouth Naval Shipyard are based on the estimates of naval spent nuclear fuel that will be stored at Portsmouth Naval Shipyard through the year 2035 and current knowledge of the design features associated with spent fuel shipping containers, immobile storage containers, and storage systems. The review of the environmental consequences associated with each of these alternatives has shown that the associated impact on the environment is very small. There would be no impact to the Portsmouth Naval Shipyard regional environment associated with any alternatives that do not involve the Portsmouth Naval Shipyard.

5.1.3.2 Land Use

Construction of a storage area at Portsmouth Naval Shipyard would require a modest change in the current land use by the shipyard. A description of the alternative storage containers and their approximate storage locations is provided in Attachment D. Attachment C provides a comparison of spent nuclear fuel storage in new water pools versus dry container storage.

The alternative of storing naval spent nuclear fuel in water pools would require that a water pool facility be constructed in the vicinity of the area that is designated for dry container storage. The water pool would have sufficient capacity to accommodate storage of all naval spent nuclear fuel expected to be stored at the shipyard.

No additional land outside the shipyard would be required.

Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.1.3.3 Socioeconomics

The calculated number of direct construction and operating jobs that would be required for the 10-year period between 1995 and 2004 for each storage alternative at the shipyard is provided in Table 5.1.3-1. Since there would be no naval spent nuclear fuel storage or inspection activities at the shipyard under the 1992/1993 Planning Basis and Centralization alternatives, no additional jobs would be required at the shipyard under these alternatives.

Table 5.1.3-1. Number of construction and operating jobs created at Portsmouth Naval Shipyard for each alternative.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Railcar ⁽¹⁾	1	1	6	1	1	1	1	1	1	1
Immobile Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	4	4	4	4
Shipping Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	1	1	1	1
Water Pools ⁽²⁾	16	16	47	72	89	63	77	35	35	35

(1) Storage mode under the No Action and Decentralization alternatives.

(2) Storage mode under the Decentralization alternative.

(3) The construction jobs would last less than one year.

The only discernible socioeconomic consequence of storing naval spent nuclear fuel at Portsmouth Naval Shipyard is that a relatively small number of construction workers (ranging from a few to a maximum of several hundred would be required for construction of the area). The work force would consist of skilled craftsmen and unskilled laborers. This work force would be needed during the storage facility construction and would be available from within the area.

The operation of the spent fuel storage area using dry storage containers would require additional workers to secure the fuel in the storage area and to support surveillance and monitoring activities. For the alternative involving storing fuel in immobile dry storage containers, about 20 workers would be required to handle the spent nuclear fuel when it is placed into the storage

containers. This work force would normally only be needed when fuel is being inserted into the containers. For the alternative involving shipping containers, fewer workers would be needed to handle and secure the containers in the storage area. The operation of a water pool facility for the alternative involving storing naval spent nuclear fuel in a water pool would require approximately 40 additional workers. The number required for any of the shipyard and prototype site storage alternatives would be small and is expected to be supplied from either within the existing shipyard work force or from the local work force. Considering that the shipyard employs approximately 5000 naval and civilian personnel, the addition of workers to support the alternatives would have no discernible impact on the local socioeconomic conditions of the Portsmouth Naval Shipyard site.

For the alternatives where dry storage containers would be manufactured, some additional jobs would be created in the locations where the containers are made. The process of selecting the container manufacturer is subject to federal procurement requirements and would be initiated after the Record of Decision. Consequently, the specific socioeconomic impacts from container fabrication cannot be specified. The net effect of container fabrication would be to create additional jobs and bolster the local economy of the area(s) where containers are made. It is considered unlikely that the selection of the contractor would depend on the alternative storage site selected, so the jobs associated with construction of casks provide no basis for selection of a storage site.

5.1.3.4 Cultural Resources

All construction contracts for the shipyard contain a clause such that if artifacts are uncovered, appropriate measures must be taken to ensure the safe recovery of such items. In most cases, these items are then placed in the shipyard museum.

The shipyard's historic district is considered a valued cultural resource and many buildings are listed on the historic register. The implementation of storage alternatives will not affect any site that is listed on the National Register of Historic Places (NPS 1991), any known archaeological areas, or any other cultural resources. Therefore, there would be no impacts to cultural resources associated with the alternative of storing naval spent nuclear fuel at the shipyard.

None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.1.3.5 Aesthetic and Scenic Resources

The naval spent nuclear fuel storage area would be located within the Portsmouth Naval Shipyard which is an existing industrial setting and would not affect the visual quality of the area since it is compatible with the landscape character of the site. Physical changes to the site resulting from the construction of a naval spent nuclear fuel storage facility will not alter this setting. There are no particulate air emissions associated with storage of naval spent nuclear fuel and thus no visibility impacts are expected. No aesthetic or scenic resources in the vicinity of the shipyard would be affected by the construction and operation of the storage facility.

5.1.3.6 Geology

If an alternative were to be selected which required naval spent nuclear fuel to be stored at Portsmouth Naval Shipyard, the construction and operation of the naval spent nuclear fuel storage facility would not be expected to affect the geologic character or resources of the region. During the storage facility construction phase, the ground would need to be excavated as necessary to prepare the surface. This would not affect the geological characteristics of the underlying layers. For the alternative of storing naval spent nuclear fuel in a storage pool facility, the ground surface would need to be excavated to a depth of approximately 40 feet. This excavation would not affect the geological characteristics of the area.

5.1.3.7 Air Resources

5.1.3.7.1 Radiological Consequences. No airborne radionuclide releases from normal operations are expected to occur as a result of the alternatives involving naval spent nuclear fuel being stored in dry storage containers. The fuel would be contained such that at least two barriers exist to prevent fission products from becoming airborne. These barriers would retain the spent nuclear fuel in an air-tight containment until moved to a permanent storage site and there would be no airborne

radioactive material released from routine operations for this method of storage. The only radiation exposure would be direct radiation from the array of filled storage containers. The filled storage containers would be fenced off and shielded if necessary such that there would be no distinguishable effect on the current radiation readings at the site perimeter.

For the alternative where naval spent nuclear fuel would be stored in a water pool, airborne radionuclide releases are expected to be less than the emissions from the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) because the water pool size and number of inspections performed would be smaller at the shipyard and the shipyard would not conduct the shielded cell operations that are performed at ECF. To conservatively estimate the radiological consequences, airborne releases based on ECF releases from 1991 are used. The radiological source term used and the detailed calculations performed to determine expected normal releases are provided in Attachment F.

The radiation exposures to human beings due to estimated radionuclide releases to the atmosphere plus direct radiation from the stored spent nuclear fuel at the shipyards for both the alternative involving water pool storage and the alternative involving dry storage were calculated as described in Attachment F.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from the stored fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F. Estimated exposures to workers were also calculated.

The hypothetical exposures calculated are based on an exposure to the estimated average effluents and the direct radiation exposure for one year from the fuel stored at the shipyard. The calculations include the external effective equivalent exposure from the ground deposition, deposition to surface water, and air immersion pathways and the 50-year committed effective equivalent exposure from internal exposure through the ingestion and inhalation pathways. All pathways were considered for persons potentially exposed, except that the ingestion pathway was omitted for the workers because they do not grow their food on-site. Solubilities which would produce the highest calculated exposures were chosen for internal exposure factors. Values for human dietary consumption patterns were taken from "Age Dependent Values of Dietary Intake for Assessing Human

Exposures to Environmental Pollutants" (Rupp 1980). The hypothetical exposures calculated can be converted into a risk of fatal cancer or a risk of non-fatal health detriments (e.g., non-fatal cancers, hereditary defects) based on the "1990 Recommendations of the International Commission on Radiological Protection" (ICRP 1991).

Attachment F summarizes the calculated exposures and fatal cancers to the worker, maximally exposed off-site individual (MOI), nearest public access (NPA), and the population from releases of radioactivity and direct radiation exposure in one year for each location and storage mode. Section 3.7 provides a comparison of the annual number of fatal cancers calculated for the general population for each location and alternative.

The number of fatal cancers calculated is so small that there would be essentially no fatal cancers resulting from the storage of naval spent nuclear fuel during the time it could reasonably be expected to continue to be stored. Putting this into perspective, it could be stated that one member of the population might experience a fatal cancer due to incident-free storage of naval spent nuclear fuel at the Portsmouth Naval Shipyard if operations continued for 43,500 years.

If a water pool facility would be constructed at the Portsmouth Naval Shipyard and used for storage of naval spent nuclear fuel, the airborne emissions from the facility would be less than that identified for the Puget Sound Naval Shipyard because no naval spent nuclear fuel inspection operations beyond visual examination would be conducted in the water pool facility.

5.1.3.7.2 Non-radiological Consequences. As noted in Attachment F, no increase in non-radioactive airborne emissions would be expected to result from spent nuclear fuel storage facility operations. Storage facility operations would not involve use of carcinogenic toxins, criteria pollutants, or other hazardous or toxic chemicals except that small quantities of industrial cleaning agents and paint thinner may be used for housekeeping and cleanliness control and these would be the same as those already used at the shipyard. Consequently, there would be no impact on ambient air quality as a result of implementing any of the alternatives at the shipyard.

If an alternative were to be selected that required a storage facility to be constructed or renovated, fugitive dust emissions would be expected to result from excavation operations. The quantity of dust generated would be small, consistent with typical excavation activities, and controlled within local requirements for dust control.

5.1.3.8 Water Resources

5.1.3.8.1 Radiological Consequences. Spent nuclear fuel storage at the shipyard would not result in discharges of radioactivity to liquid effluents during routine operation regardless of the alternative selected for storage of spent nuclear fuel. The health effect due to fallout of nuclides released to the air onto the surface water is included in the analysis results discussed in Section 5.1.3.7. The air fallout impact is so small that there would be no distinguishable radiation levels in the water.

Portsmouth Naval Shipyard does not reside in the 100 or 500 year floodplain. Consequently, the floodplain would not be impacted by spent naval nuclear fuel storage and examination activities at the shipyard.

5.1.3.8.2 Non-radiological Consequences. Other than chemicals used to maintain the storage area, no hazardous wastes would be generated by the storage of naval spent nuclear fuel at Portsmouth Naval Shipyard. Any hazardous liquid effluents that may be generated at the storage area would be disposed of at an Environmental Protection Agency approved disposal site.

The only source for liquid discharges from the naval spent nuclear fuel storage operations to the environment consists of storm water runoff which would be consistent with the type of discharges associated with common light industrial facilities and related activities. It can be concluded that there would be no impact to the human environment due to runoff water from the proposed naval spent nuclear fuel storage area.

The increased water usage under any alternative would be negligible compared to the existing shipyard demand.

5.1.3.9 Ecological Resources

Both Maine and New Hampshire officials were consulted and have determined that there is no evidence to suggest that any threatened or endangered species reside on the Portsmouth Naval Shipyard (Appendix V.B. of the Navy's Natural Resources Management Plan (Navy 1993a)). No major changes to the industrial environment are planned. None of the alternatives would affect the

areas surrounding the shipyard. Therefore, no major ecological impacts to the region would result from selection of any of the alternatives.

The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the shipyard and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present. Therefore, there would be no ecological impacts associated with construction or operation of a spent nuclear fuel storage area at this location. The radiological controls that are in effect at the shipyard ensure that the radiation levels in the vicinity of the shipyard are maintained at or near natural background. Since these same controls would be applied to spent nuclear fuel activities, no ecological effects due to radioactive material would be expected to occur.

5.1.3.10 Noise

Portsmouth Naval Shipyard is an existing industrial-type environment characterized by noise from truck and automobile traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related pumping systems for those and other liquids. No ambient noise level increases are expected to occur as a result of any of the alternatives. Therefore, no noise impacts would be expected to occur.

5.1.3.11 Traffic and Transportation

Shipments of radioactive materials in the Naval Nuclear Propulsion Program are required to be made in accordance with applicable regulations of the U.S. Department of Transportation, U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments and provide requirements for the container design, certification, and identification as applicable for the specific quantity, type, and form of radioactive material being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and

qualification of workers who construct containers, and quality control inspections during fabrication to ensure that the containers will meet their design requirements. A detailed description of the shipping containers used for naval spent nuclear fuel shipments is provided in Attachment A. A description of the impacts associated with normal and accident conditions associated with transportation of naval spent nuclear fuel is provided in Attachment A.

5.1.3.11.1 Regional Infrastructure. The alternatives under consideration are described in Section 3. The No Action alternative or the first variation of the Decentralization alternative would store the spent nuclear fuel on-site. This alternative would reduce the number of rail shipments from the shipyard or prototype site compared to the past practice of transporting all spent nuclear fuel to INEL. The second variation of the Decentralization alternative would ship about 10 percent of the spent nuclear fuel to Puget Sound. This would have some transportation impact, but not as much as transporting all spent nuclear fuel off-site. The third Decentralization alternative ships all spent nuclear fuel to INEL, examines it, and returns it to the original shipyard or prototype site. This alternative involves more transportation than the previous practice of transporting spent nuclear fuel to INEL, since the spent nuclear fuel is not returned from INEL to the original site. The 1992/1993 Planning Basis alternative, the Regionalization at INEL alternative, or the Centralization at INEL alternative would involve the same transportation as has been required in the past, namely transportation to INEL and retention there. The Centralization alternative at the Hanford Site would result in more transportation impact than any of the previous alternatives, due to the distances and population distribution between Hanford and the shipyards and prototypes. The Centralization alternative at the Savannah River Site would result in the most transportation impact of spent nuclear fuel of any of the alternatives.

5.1.3.11.2 Site Infrastructure. The alternative associated with naval spent nuclear fuel storage at Portsmouth Naval Shipyard would not noticeably affect site highway traffic because any increase in the work force would represent a very small incremental increase in overall traffic to and from the shipyard. There would be no noticeable change in the internal traffic in the shipyard because fuel is held temporarily even when it is transported off-site.

5.1.3.12 Occupational and Public Health and Safety

Detailed analyses of incident-free spent nuclear fuel transportation and storage and handling impacts on worker and public health are described in Attachment A (transportation) and Attachment F (storage and inspection). The transportation analysis results, and the storage and handling analysis are summarized separately in the following subsections.

5.1.3.12.1 Incident-free Transportation Occupational and Public Health and Safety. The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.3.12.2 Incident-free Occupational and Public Health and Safety During Spent Nuclear Fuel Storage and Handling. The public health and safety impacts of radioactivity releases and direct radiation from storage of spent nuclear fuel were analyzed as discussed in Section 5.1.3.7 and Attachment F. Attachment F summarizes the results of the analysis of radioactivity releases and direct radiation from stored spent nuclear fuel. This analysis shows that the exposure to the worker, maximally exposed off-site individual, and nearest public access from stored naval spent nuclear fuel would result in far less than one fatality per year. For perspective, it could be stated that one member of these population groups might experience a fatal cancer due to storage of naval spent nuclear fuel at Portsmouth Naval Shipyard if operations continued for 43,500 years.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

No public or occupational radiological health and safety impacts would be expected to result from naval spent nuclear fuel storage area construction activities since the construction would not involve radioactive work.

Attachment F also discusses toxic chemical issues for spent nuclear fuel handling and storage. Attachment F concludes that there would be no additional types or volumes of chemicals required at the shipyards or prototype site for spent nuclear fuel storage. Therefore, there is no incident-free non-radiological impact resulting from storage of spent nuclear fuel at the shipyards or prototype site.

5.1.3.13 Utilities and Energy

If an alternative associated with the storage of naval spent nuclear fuel at Portsmouth Naval Shipyard were to be selected, construction and operation of the storage area would not be expected to require a large expenditure of utilities and energy resources. Construction activities will require quantities of water and electricity typical of any small to medium size construction project. Operation of the dry container naval spent nuclear fuel storage facility will likely require only a small amount of electricity for security lighting and to support industrial equipment necessary to move naval spent nuclear fuel (cranes, etc). Alternatives associated with water pool storage would require heating, ventilation, water, and electrical systems suitable for a work environment and to properly filter and exhaust the airborne discharges to the atmosphere. The utility and energy demands would be less than those required to operate ECF (10,000 MWh per year) (Section 5.2.13) since the water pool used for naval spent nuclear fuel storage would be smaller and no spent fuel operations beyond visual examinations would be conducted in the water pool.

The amount of utilities and energy expected to be consumed would be a small incremental increase in the total amount of utilities and energy used at the Portsmouth Naval Shipyard and will not result in any discernible environmental consequence.

5.1.3.14 Facility and Transportation Accidents

5.1.3.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of abnormal occurrence limits on exposures

as defined by the U.S. Nuclear Regulatory Commission. A description of potential accidents considered and a summary of the accident analyses that were conducted with regards to the storage of naval spent nuclear fuel are contained in Attachment F.

5.1.3.14.1.1 Radiological Accidents. Section 3.7.3 provides a summary of the impacts due to the most severe accidents considered for each site. The facility accident with the greatest potential impact at Portsmouth Naval Shipyard involves an airplane crash. An accident of this magnitude would result in 9 fatal cancers to the general population over 50 years, as described in Attachment F. The likelihood of an airplane crash is 1×10^{-7} . The facility accident with the greatest risk involves accidental drainage of the water pool. The drained water pool accident would result in less than one fatality over 50 years, but the likelihood of occurrence is 1×10^{-5} .

5.1.3.14.1.2 Non-radiological Accidents. As discussed in detail in Attachment F, the limiting hypothetical non-radiological accident for spent nuclear fuel storage in a water pool at a shipyard or prototype location would be a diesel fuel spill and fire. A catastrophic failure of a diesel fuel storage tank that might be used for an emergency diesel generator to provide backup electrical power was postulated to occur, resulting in the spilling of the entire quantity of diesel fuel with a subsequent fire. The fire would generate the following toxic chemicals:

- Carbon monoxide
- Oxides of nitrogen (90% nitric oxide and 10% nitrogen dioxide)
- Lead
- Sulfur dioxide.

Measures would be taken to reduce the health impacts of potential releases of toxic materials. These measures would involve controls to protect both workers and the general public. The naval shipyard and prototype sites have emergency planning, emergency preparedness, and emergency response programs in place to protect both workers and the public and involve established resources such as warning communications, fire departments, and emergency command centers.

The airborne concentrations of the combustion products listed above, resulting from the fire, were calculated at the locations of the on-site individuals, an individual at the site boundary, and the general population within a 50-mile radius of the facility. Detailed results are presented in Attachment F. If the accidental fire that has been hypothesized were to actually occur, the safety measures

that would be in place would ensure no adverse health impacts to the general public and minimal health impacts to the workers.

5.1.3.14.2 Transportation Accidents. Shipments of radioactive materials associated with naval spent nuclear fuel have never resulted in any measurable release of radioactivity to the environment (NNPP 1993a). There have never been any significant accidents involving the release of radioactive material during shipment since the Naval Nuclear Propulsion Program began. The effects of potential transportation accidents during the various stages of transportation of naval spent nuclear fuel are presented in Attachment A.

The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.3.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that an area ranging from about 8 acres extending approximately a quarter mile (for an inadvertent criticality accident) to about 110 acres extending approximately 0.9 mile (for a large airplane crashing into a dry storage container) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure. It should be noted that all of the affected area within about a quarter mile from the spent nuclear fuel facility would be inside the boundaries of the federally owned site.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources, partially because the area would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area impacted would vary only slightly among the alternatives considered. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. There are no endangered or threatened species unique to the area surrounding the federally owned site, so an accident would not be expected to result in destruction of any species for any of the alternatives considered. The effects of accidents related to any of the alternatives and any associated cleanup which might be performed would be localized in a small area extending only a short distance beyond the boundaries of the federally owned site and thus would not be expected to appreciably affect the potential for survival of endangered or threatened species in southeastern Maine or New Hampshire. Based on these considerations, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.1.3.15 Waste Management

The alternative in which naval spent nuclear fuel is stored at Portsmouth Naval Shipyard would produce limited amounts of solid municipal waste, solid low-level radioactive wastes, and hazardous wastes. In addition, no transuranic or high-level radioactive wastes would be generated by spent nuclear fuel activities at the site under any alternative. The quantity of industrial wastes generated would be small and most likely consist of industrial cleaning agents of the type normally

encountered at the site. Small quantities of sanitary wastes would result from the additional work force but this volume would be small. The wastes produced from the storage of naval spent nuclear fuel would be controlled and minimized in accordance with the existing waste management programs at the Portsmouth Naval Shipyard. The amount of additional wastes generated would be minimal compared to the existing baseline and would not cause any adverse impacts to public health and safety and the environment in the vicinity of the Portsmouth Naval Shipyard.

5.1.3.16 Cumulative Impacts

5.1.3.16.1 Radiological Cumulative Impacts. Spent nuclear fuel storage at the site would not result in discharges of radioactivity in liquid effluents during routine operations regardless of the alternative selected. Therefore, there would be no incremental addition of radioactivity to surface or ground water as a result of normal operations for any alternative. For alternatives involving the storage of spent nuclear fuel in dry storage and shipping containers, no airborne radioactivity emissions are expected, so there would be no cumulative air quality impacts associated with these storage methods. Consequently, the only radiological cumulative impacts that would result from dry storage alternatives would be due to direct radiation exposure from the stored containers of spent nuclear fuel.

For alternatives involving the storage of naval spent nuclear fuel in water pools, there would be no discernible direct radiation exposure to the public from the fuel elements due to the shielding provided by the water in the pool. Therefore, any cumulative impacts which would result from water pool storage would be primarily due to airborne emissions, and the addition of these emissions would cause an indiscernible change in the emissions in the area (see Section 5.1.3.7). Current operations at the site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

A summary of the cumulative radiological impacts is provided in the following section.

An overview of the historical radiological impacts from naval nuclear operations at the Portsmouth Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section

4.1.3.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The radiological impacts associated with the alternatives where naval spent nuclear fuel would be stored at Portsmouth Naval Shipyard are very small and are described in Section 5.1.3.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the population in the vicinity of the Portsmouth Naval Shipyard from all of the alternatives considered would be approximately 1.8 person-rem. This means that there would be much less than one fatal cancer from these operations over the entire 40-year period evaluated. The total exposure to a theoretical maximally exposed off-site individual living at the shipyard boundary for the entire 40-year period would be 2.2×10^{-3} rem due to the alternative resulting in the largest exposure. This maximally exposed off-site individual would have a 1.1×10^{-6} risk of contracting a fatal cancer during his or her lifetime due to storage of spent nuclear fuel. When existing site radiological impacts due to naval nuclear operations are added to the impacts of the most limiting spent nuclear fuel alternative, the exposure to the population would be 2.2 person-rem and to the maximally exposed off-site individual would be 2.5×10^{-3} rem. This still results in much less than one fatal cancer in the population and the risk of the maximally exposed off-site individual contracting a fatal cancer during his or her lifetime is 1.3×10^{-6} .

The total exposure related to naval spent nuclear fuel activities to a worker assumed to be working continually 100 meters from the spent nuclear fuel under the alternative resulting in the

largest exposure is 0.11 rem accumulated over 40 years. That corresponds to a fatal cancer risk of 4.4×10^{-5} during the worker's lifetime. The exposure to the same worker when existing site radiological impacts due to naval nuclear operations are added to the spent nuclear fuel exposure is essentially the same over 40 years. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

Sections 4.1.3.14 and 5.1.3.15 describe the management of low-level radioactive waste and mixed waste at the site. The volume of low-level radioactive wastes which would be generated under the alternatives has not been calculated. However, considering the nature of radiological work that would be associated with spent nuclear fuel storage activities, the amount of low-level radioactive waste produced during spent nuclear fuel activities would be much less than 20 percent of the current site generation rate (57 m³ per year). This additional radioactive waste would not introduce any changes to the site's waste management practices. The small amount of additional material involved would not impose any discernible additional stress on the capacity of the radioactive waste burial ground. Therefore, any cumulative impacts associated with the generation and disposal of additional low-level wastes would be very small.

Since no mixed, transuranic, or high-level radioactive wastes would be generated by spent nuclear fuel activities at this site under any alternative, there would be no cumulative impacts associated with these materials.

5.1.3.16.2 Non-radiological Cumulative Impacts. An overview of the historical non-radiological impacts from naval nuclear operations at the Portsmouth Naval Shipyard and from transportation of naval spent nuclear fuel is provided in Section 4.1.3.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no non-radiological cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The non-radiological impacts associated with the alternative where naval spent nuclear fuel would be inspected or stored at Portsmouth Naval Shipyard are described in Section 5.1.3.12, with the detailed results of analyses provided in Attachment F. As summarized in Section 5.1.3.12, there would be no additional chemicals required at the shipyard for naval spent nuclear fuel storage and therefore no non-radiological impacts from normal operations. Consequently, no cumulative impacts to air quality or water resources would result since the incremental addition of chemicals at the shipyard that might result from naval spent fuel activities would be very small. There are no current environmental problems associated with these materials.

The non-radiological cumulative transportation impacts for the population from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A. The non-radiological impacts associated with the transportation and storage of naval spent nuclear fuel for all of the alternatives considered would be low.

No cumulative land use impacts would be expected to occur as a result of spent nuclear fuel storage. The land that would be dedicated for this purpose is on existing federal property and situated in an industrial setting which has already been disturbed from its natural state (approximately 227 acres are developed land). The conversion of this space for storage of spent nuclear fuel would not result in the need to disturb undeveloped land or for additional land to be added to the federally owned property in the foreseeable future.

From a socioeconomic perspective, the introduction of naval spent nuclear fuel activities at the site would create a small number of additional jobs and could have a very small cumulative socioeconomic impact. The site currently employs approximately 4900 civilian personnel. No shipyard employment has been associated with spent nuclear fuel activities in the past since spent nuclear fuel activities have not been conducted at the site. An average of approximately 1 to 35 additional jobs might be added as a result of possible spent nuclear fuel activities in the future. The peak number of additional jobs created at the site in any given year would be approximately 89, which is associated with construction and operation of a water pool facility for storage of spent nuclear fuel. Considering that the regional labor force consists of approximately 121,550 workers, the additional number of added jobs under any alternative would have little or no discernible

socioeconomic impact. These jobs would be filled either from within the existing site work force or from the available regional labor force without discernible effect. There are no foreseeable future projects planned at the site and no known projects planned in the region that would cause the small number of workers involved in naval spent nuclear fuel activities to become an important impact.

The cumulative impacts associated with non-radiological waste management are likewise expected to be small. As stated previously, any industrial wastes generated from naval spent nuclear fuel storage would be small and limited to industrial cleaning agents of the type normally encountered at the site. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of additional non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of waste.

5.1.3.17 Unavoidable Adverse Effects

There are no discernible unavoidable adverse effects associated with the implementation of any of the alternatives and none which would help to choose among the alternatives. The alternative in which naval spent nuclear fuel is stored at the Portsmouth Naval Shipyard would cause the public to be exposed to small amounts of radiation, described in Section 5.1.3.12, and would result in less than one health effect in the entire population surrounding the shipyard. Similarly, continued operation of the storage facility would produce limited amounts of solid municipal waste and solid low-level radioactive waste. These amounts of waste would not produce any major impacts in the vicinity of the shipyard. There will be no changes to the ecological, cultural, geological, and aesthetic resources due to the implementation of any of the alternatives. There will also be no impact on ambient noise levels.

5.1.3.18 Irreversible and Irretrievable Commitments of Resources

The only irreversible and irretrievable commitment of resources that results from the alternative in which naval spent nuclear fuel would be stored at the Portsmouth Naval Shipyard would

be the money which would be spent by the federal government to construct the necessary facilities. The total cost of storing spent naval nuclear fuel at the shipyards and prototype ranges from approximately \$1.5 billion to \$5.7 billion. This cost represents the total cumulative cost over the 40-year period for all of the shipyards and prototype. This cost includes construction costs of the new storage facilities, and, depending on the alternative selected, the operation of a limited examination facility at Puget Sound Naval Shipyard combined with the costs associated with shutting down ECF, or the operational costs of the INEL-ECF. The major expense in the highest cost alternatives is the procurement of shipping containers. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

5.1.4 PEARL HARBOR NAVAL SHIPYARD: PEARL HARBOR, HAWAII

5.1.4.1 Overview of Environmental Impacts

The following sections discuss the major differences in potential environmental consequences associated with the choice of alternatives that include storage of naval spent nuclear fuel at Pearl Harbor Naval Shipyard (hereafter referred to as Pearl Harbor). The environmental consequences associated with storage of naval spent nuclear fuel at Pearl Harbor are based on the estimates of naval spent nuclear fuel that will be stored at Pearl Harbor through the year 2035 and the current knowledge of the design features associated with spent fuel storage systems. The review of the environmental consequences associated with these alternatives has shown that the impact on the environment at Pearl Harbor associated with all activities is very small. There would be no impact to the environment in the vicinity of Pearl Harbor associated with any alternatives that do not involve Pearl Harbor.

5.1.4.2 Land Use

Construction of a storage area at Pearl Harbor for temporary naval spent nuclear fuel storage would require a modest change in the current land in use by the shipyard. A description of the alternate storage containers and water pools and their approximate storage locations is provided in Attachment D. Attachment C provides a comparison of naval spent nuclear fuel storage in water pools versus dry container storage. The area is already an industrial site; therefore, there will be no impact on land use.

The alternative of storing naval spent nuclear fuel in water pools would require that a water pool facility be constructed in the vicinity of the area that is designated for dry container storage. The water pool would have sufficient capacity to accommodate storage of all naval spent nuclear fuel expected to be stored at the shipyard.

No additional land use outside the shipyard would be required.

Native Hawaiian rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.1.4.3 Socioeconomics

The calculated number of direct construction and operating jobs that would be required for the 10-year period between 1995 and 2004 for each storage alternative at the shipyard is provided in Table 5.1.4-1. Since there would be no naval spent nuclear fuel storage or inspection activities at the shipyard under the 1992/1993 Planning Basis and Centralization alternatives, no additional jobs would be required at the shipyard under these alternatives.

Table 5.1.4-1. Number of construction and operating jobs created at Pearl Harbor Naval Shipyard for each alternative.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Railcar ⁽¹⁾	1	1	6	1	1	1	1	1	1	1
Immobile Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	4	4	4	4
Shipping Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	1	1	1	1
Water Pools ⁽²⁾	16	16	46	71	88	62	77	35	35	35

(1) Storage mode under the No Action and Decentralization alternatives.

(2) Storage mode under the Decentralization alternative.

(3) The construction jobs would last less than one year.

The only discernible socioeconomic consequence from the alternative of storing naval spent nuclear fuel at Pearl Harbor is that a relatively small number of construction workers (ranging from a few to a maximum of several hundred would be required for construction of the storage area). The work force would consist of skilled craftsmen and unskilled laborers. This work force would be needed during the storage facility construction and would be provided from within the area.

The operation of the naval spent nuclear fuel storage area using dry storage containers would require additional workers to secure the fuel in the storage area and to support surveillance and monitoring activities. For the alternative involving storing fuel in immobile dry storage containers, about 20 workers would be required to handle the naval spent nuclear fuel when it is placed into the storage containers. This work force would normally only be needed when fuel is being inserted into the containers. For the alternative involving shipping containers, fewer workers would be needed to handle and secure the containers in the storage area. The operation of a water pool facility for the alternative involving storing naval spent nuclear fuel in a water pool would require approximately 40 additional workers. The number required for any of the shipyard and prototype site storage alternatives would be small and would be expected to be supplied from either within the existing shipyard work force or the local work force. Considering that the Department of Defense employs approximately 10,900 civilians at the Pearl Harbor naval base, the addition of workers to support the alternatives would have no discernible impact on the local socioeconomic conditions of the Pearl Harbor site.

For the alternatives where dry storage containers would be manufactured, some additional jobs would be created in the locations where the containers are made. The process of selecting the container manufacturer is subject to federal procurement requirements and would be initiated after the Record of Decision. Consequently, the specific socioeconomic impacts from container fabrication cannot be specified. The net effect of container fabrication would be to create additional jobs and bolster the local economy of the area(s) where containers are made. It is considered unlikely that the selection of the contractor would depend on the alternative storage site selected, so the jobs associated with construction of casks provide no basis for selection of a storage site.

5.1.4.4 Cultural Resources

The action considered will not affect any site that is listed on the National Register of Historic Places (NPS 1991), any known archaeological areas, or any other cultural resources. Therefore, there would be no impacts to cultural resources associated with the alternative of storing naval spent nuclear fuel at this location.

None of the alternatives considered would impact known archaeological or Native Hawaiian sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.1.4.5 Aesthetic and Scenic Resources

The naval spent nuclear fuel storage area would be located within the Pearl Harbor site which is an existing industrial setting and would not affect the visual quality of the area since it is compatible with the landscape character of the site. Physical changes to the Pearl Harbor site resulting from storage area construction will not alter this setting. There are no particulate air emissions associated with storage of naval spent nuclear fuel and thus no visibility impacts are expected. No aesthetic or scenic resources in the vicinity of the shipyard would be affected by the construction and operation of the storage facility.

5.1.4.6 Geology

The construction and operation of the naval spent nuclear fuel storage facility at Pearl Harbor is not expected to affect the geologic character or resources of the region. If an alternative were selected which required a storage area to be constructed, the ground surface would be excavated as necessary to prepare the surface. This would not affect the geological characteristics of the underlying layers nor the characteristics of the Koolou and Wainae aquifers or vadose zone. For the alternative of storing fuel in a water pool facility, the ground surface would need to be excavated to a depth of approximately 40 feet. This excavation would not affect the geological characteristics of the area.

5.1.4.7 Air Resources

5.1.4.7.1 Radiological Consequences. No airborne radionuclide releases from normal operations are expected to occur as a result of naval spent nuclear fuel being stored in dry storage containers. The fuel would be contained such that at least two barriers exist to prevent fission products from becoming airborne. These barriers would retain the naval spent nuclear fuel in an air-tight containment until it is moved to a permanent storage site and there would be no airborne

radioactive material released from routine operations for this method of storage. The only radiation exposure would be direct radiation from the array of filled storage containers. The filled storage containers would be fenced off and shielded if necessary such that there would be no distinguishable effect on normal background radiation levels at the site perimeter.

For the alternative where naval spent nuclear fuel would be stored in a water pool, airborne radionuclide releases are expected to be less than the emissions from the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) because the water pool size would be smaller, no naval spent nuclear fuel inspection operations beyond visual examinations would be conducted, and no shielded cell operations would be conducted at Pearl Harbor. To conservatively estimate the radiological consequences, airborne releases based on ECF releases from 1991 are used. The radiological source term used and the detailed calculations performed to determine expected normal releases are provided in Attachment F.

The radiation exposures to human beings due to estimated radionuclide releases to the atmosphere plus direct radiation from the stored naval spent nuclear fuel at the shipyards for both the alternative involving water pool storage and the alternative involving dry storage were calculated as described in Attachment F.

A person on the shipyard boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from the stored naval spent nuclear fuel. The population data used to calculate population exposures were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F. Estimated exposures to workers were also calculated.

The hypothetical exposures calculated are based on an exposure to the estimated average effluents and the direct radiation exposure for one year from the naval spent nuclear fuel stored at the shipyard. The calculations include the external effective equivalent exposure from the ground deposition, deposition to surface water, and air immersion pathways and the 50-year committed effective equivalent exposure from internal exposure through the ingestion and inhalation pathways. All pathways were considered for persons potentially exposed, except that the ingestion pathway was omitted for the workers because they do not grow their food on-site. Solubilities which would produce the highest calculated exposures were chosen for internal exposure factors. Values for

human dietary consumption patterns were taken from "Age Dependent Values of Dietary Intake for Assessing Human Exposures to Environmental Pollutants" (Rupp 1980). The hypothetical exposures calculated can be converted into a risk of fatal cancer or a risk of non-fatal health detriments (e.g., non-fatal cancers, hereditary defects) based on recommendations of the International Commission on Radiological Protection (ICRP 1991).

Attachment F summarizes the calculated exposures and fatal cancers to the worker, the maximally exposed off-site individual (MOI), nearest public access (NPA), and the population from releases of radioactivity and direct radiation exposure in one year for each location and storage mode. Section 3.7 provides a comparison of the annual number of fatal cancers calculated for the general population for each location and alternative.

The number of fatal cancers calculated is so small that there would be essentially no fatal cancers resulting from the storage of naval spent nuclear fuel during the time it could reasonably be expected to continue to be stored. Putting this into perspective, it could be stated that one member of the population might experience a fatal cancer due to incident-free storage of naval spent nuclear fuel at Pearl Harbor if operations continued for 14,300 years.

5.1.4.7.2 Non-radiological Consequences. As noted in Attachment F, no increase in non-radioactive airborne emissions would be expected to result from naval spent nuclear fuel storage facility operations. Storage facility operations would not involve use of carcinogenic toxins, criteria pollutants, or other hazardous or toxic chemicals except that small quantities of industrial cleaning agents and paint thinner may be used for housekeeping and cleanliness control and these would be the same as those already used at the shipyard. Consequently, there would be no impact on ambient air quality as a result of implementing any of the alternatives at the shipyard.

If an alternative were to be selected that required a storage facility to be constructed or renovated, fugitive dust emissions would be expected to result from excavation operations. The quantity of dust generated would be small, consistent with typical excavation activities, and controlled within local requirements for dust control.

5.1.4.8 Water Resources

5.1.4.8.1 Radiological Consequences. Naval spent nuclear fuel storage operations at Pearl Harbor would not result in discharges of radioactivity in liquid effluents during routine operation regardless of the alternative selected for storage of naval spent nuclear fuel. The health effect due to fallout of nuclides released to the air onto the surface water is included in the analysis results discussed in Section 5.1.4.7. The air fallout impact is so small that there would be no distinguishable radiation levels in the water.

Based on FIRM and topographical maps of areas approximately three miles away, the location considered for the interim storage of naval spent nuclear fuel is in the 100-year floodplain. However, the location considered for naval spent nuclear fuel is not in a high-hazard area (as defined by Title 10, Part 1022 of The Code of Federal Regulations for floodplains) which is an area where frequent flooding occurs. Since the majority of the shipyard is already developed and covered with impervious material, construction and operation of a naval spent nuclear fuel storage facility at the shipyard would produce no discernible impacts on the floodplain.

Flooding in the area where shipping and immobile dry storage containers are stored would not result in any adverse environmental consequences. These containers are completely sealed such that no radioactivity would be released from the interior even if they were completely submerged. In addition, the massive nature of these containers prevents them from floating or moving during a flood.

Since the shipyard resides in close proximity to a floodplain, the design of the facility and equipment would minimize the potential for flooding and damage to the facility. However, in the event a water pool facility would be flooded, the exchange of pool water with the flood waters could occur. As discussed in Attachment F, Section F.1.4.2.1.6.2, the radioactivity concentration in the ECF water pool is below the Nuclear Regulatory Commission limits specified in Title 10, Part 20 of The Code of Federal Regulations for liquid effluent except for Co-60 which is slightly higher (water pools used for storage or examination of naval spent nuclear fuel would be maintained to comparable concentrations). Any release of radioactivity would have to result from the exchange of floodwater with the pool water. This exchange would reduce the level of radioactivity even further.

Consequently, no adverse environmental impacts would result from flooding of water pools at naval spent nuclear fuel storage sites.

5.1.4.8.2 Non-radiological Consequences. Other than chemicals used to maintain the storage area, no hazardous wastes would be generated by the storage of naval spent nuclear fuel at Pearl Harbor. Any hazardous liquid effluents that may be generated at the storage area would be disposed of at an Environmental Protection Agency approved disposal site.

The only source for liquid discharges from the naval spent nuclear fuel storage operations to the environment consists of storm water runoff which would be consistent with the type of discharges associated with common light industrial facilities and related activities. It can be concluded that there would be no impact to the human environment due to runoff water from the naval spent nuclear fuel storage area.

The increased water usage under any of the alternatives would be negligible compared to the existing shipyard demand.

5.1.4.9 Ecological Resources

There are no threatened or endangered species known to exist within the Pearl Harbor shipyard and no major changes to the industrial environment are planned. Therefore, no major ecological impacts to the region would result from selection of any of the alternatives.

The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the shipyard and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present. Therefore, there would be no ecological impacts associated with construction or operation of a spent nuclear fuel storage area at this location. The radiological controls that are in effect at the shipyard ensure that the radiation levels in the vicinity of the shipyard are maintained at or near natural background. Since these same controls would be applied to spent nuclear fuel activities, no ecological effects due to radioactive material would be expected to occur.

5.1.4.10 Noise

Pearl Harbor is an existing industrial-type environment characterized by noise from truck and automobile traffic; ship loading cranes and related diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related pumping systems for those and other liquids. No ambient noise level increases are expected to occur as a result of any of the alternatives. Therefore, no noise impacts would be expected to occur.

5.1.4.11 Traffic and Transportation

Shipments of radioactive materials in the Naval Nuclear Propulsion Program are required to be made in accordance with applicable regulations of the U.S. Department of Transportation, U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments and provide requirements for the container design, certification, and identification as applicable for the specific quantity, type, and form of radioactive material being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and qualification of workers who construct containers, and quality control inspections during fabrication to ensure that the containers will meet their design requirements. A detailed description of the shipping containers used for naval spent nuclear fuel shipments is provided in Attachment A. A description of the impacts from normal and accident conditions associated with transportation of naval spent nuclear fuel is provided in Attachment A.

5.1.4.11.1 Regional Infrastructure. The alternatives under consideration are described in Section 3. The No Action alternative or the first variation of the Decentralization alternative would store the naval spent nuclear fuel on-site. This alternative would reduce the number of rail shipments from the shipyard or prototype site compared to the past practice of transporting all naval spent nuclear fuel to INEL. The second variation of the Decentralization alternative would ship about 10 percent of the naval spent nuclear fuel to Puget Sound. This would have some transportation impact, but not as much as transporting all naval spent nuclear fuel off-site. The third Decentralization alternative ships all naval spent nuclear fuel to INEL, examines it, and returns it to the original shipyard or prototype

site. This alternative involves more transportation than the previous practice of transporting naval spent nuclear fuel to INEL, since the naval spent nuclear fuel is not returned from INEL to the original site. The 1992/1993 Planning Basis alternative, the Regionalization at INEL alternative, or the Centralization at INEL alternative would involve the same transportation as has been required in the past, namely transportation to INEL and retention there. The Centralization alternative at the Hanford Site would result in more transportation impact than any of the previous alternatives, due to the distances and population distribution between Hanford and the shipyards and prototypes. The Centralization alternative at the Savannah River Site would result in the most transportation impact of naval spent nuclear fuel of any of the alternatives.

5.1.4.11.2 Site Infrastructure. The alternative associated with naval spent nuclear fuel storage at Pearl Harbor would not affect local highway traffic because any increase in the work force would represent a very small incremental increase in overall traffic to and from the shipyard. There would be no change in the internal traffic in the shipyard because naval spent nuclear fuel is held temporarily even when it is transported off-site.

5.1.4.12 Occupational and Public Health and Safety

Detailed analyses of incident-free naval spent nuclear fuel transportation and storage and handling impacts on worker and public health are described in Attachment A (transportation) and Attachment F (storage and inspection). The transportation analysis results, and the storage and handling analysis are summarized separately in the following subsections.

5.1.4.12.1 Incident-free Transportation Occupational and Public Health and Safety. The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.4.12.2 Incident-free Occupational and Public Health and Safety During Naval Spent Nuclear Fuel Storage and Handling. The public health and safety impacts of radioactivity releases

and direct radiation from storage of naval spent nuclear fuel were analyzed as discussed in Section 5.1.4.7 and Attachment F. Attachment F summarizes the results of the analysis of radioactivity releases and direct radiation from stored naval spent nuclear fuel. This analysis shows that the exposure to the worker, maximally exposed off-site individual, and nearest public access from stored naval spent nuclear fuel would result in far less than one fatality per year. For perspective, it could be stated that one member of these population groups might experience a fatal cancer due to storage of naval spent nuclear fuel at Pearl Harbor if operations continued for 14,300 years.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

No public or occupational radiological health and safety impacts would be expected to result from naval spent nuclear fuel storage area construction activities since the construction would not involve radioactive work.

Attachment F also discusses toxic chemical issues for naval spent nuclear fuel handling and storage. Attachment F concludes that there would be no additional types or volumes of chemicals required at the shipyards or prototype site for naval spent nuclear fuel storage. Therefore, there is no incident-free non-radiological impact resulting from storage of naval spent nuclear fuel at the shipyards or prototype site.

5.1.4.13 Utilities and Energy

If an alternative associated with the storage of naval spent nuclear fuel at Pearl Harbor were to be selected, construction and operation of the storage area would not be expected to require a large expenditure of utilities and energy resources. Construction activities would require quantities of water and electricity typical of any small to medium size construction project. Operation of the storage facility would likely require only small amounts of electricity for lighting and to support industrial equipment necessary to move spent nuclear fuel (e.g., cranes). Alternatives associated with water

pool storage would require heating, ventilation, water, and electrical systems suitable for a work environment and to properly filter and exhaust the airborne discharges to the atmosphere. The utility and energy demands would be less than those required to operate ECF (10,000 MWh per year) (Section 5.2.13) since the water pool used for spent fuel storage would be smaller and no spent fuel operations beyond visual examinations would be conducted in the water pool.

The amount of utilities and energy expected to be consumed would be a small incremental increase in the total amount of utilities and energy used at the shipyard and would not result in any discernible environmental consequence.

5.1.4.14 Facility and Transportation Accidents

5.1.4.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of abnormal occurrence limits on exposures as defined by the U.S. Nuclear Regulatory Commission. A description of potential accidents considered and a summary of the accident analyses that were conducted with regards to the storage of naval spent nuclear fuel is contained in Attachment F.

5.1.4.14.1.1 Radiological Accidents. Section 3.7.3 provides a summary of the impacts due to the most severe accidents considered for each site. The facility accident with the greatest potential impact at Pearl Harbor involves an airplane crash. An accident of this magnitude would result in a calculated 26 fatal cancers to the general population over 50 years, as described in Attachment F. The likelihood of such an accident occurring is 1×10^{-5} , which is very small. For perspective, an accident such as this would not be expected to occur unless the facility operated for about 100,000 years.

5.1.4.14.1.2 Non-radiological Accidents. As discussed in detail in Attachment F, the limiting hypothetical non-radiological accident for naval spent nuclear fuel storage in a water pool at a shipyard or prototype location would be a diesel fuel spill and fire. A catastrophic failure of a diesel fuel storage tank that might be used for an emergency diesel generator to provide backup electrical power was postulated to occur, resulting in the spilling of the entire quantity of diesel fuel with a subsequent fire. The fire would generate the following toxic chemicals:

- Carbon monoxide
- Oxides of nitrogen (90% nitric oxide and 10% nitrogen dioxide)
- Lead
- Sulfur dioxide.

Measures would be taken to reduce the health impacts of potential releases of toxic materials. These measures would involve controls to protect both workers and the general public. The naval shipyard and prototype sites have emergency planning, emergency preparedness, and emergency response programs in place to protect both workers and the public, and involve established resources such as warning communications, fire departments, and emergency command centers.

The airborne concentrations of the combustion products listed above, resulting from the fire, were calculated at the locations of the on-site individuals, an individual at the site boundary, and the general population within a 50-mile radius of the facility. Detailed results are presented in Attachment F. If the accidental fire that has been hypothesized were to actually occur, the safety measures that would be in place would ensure no adverse health impacts to the general public and minimal health impacts to the workers.

5.1.4.14.2 Transportation Accidents. Shipments of radioactive materials associated with naval spent nuclear fuel have never resulted in any measurable release of radioactivity to the environment (NNPP 1993a). There have never been any significant accidents involving release of radioactive material during shipment since the Naval Nuclear Propulsion Program began. The effects of potential transportation accidents during the various stages of transportation of naval spent nuclear fuel are presented in Attachment A.

The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.4.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects

such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that an area ranging from about 8 acres extending approximately a quarter mile (for an inadvertent criticality accident) to about 110 acres extending approximately 0.9 mile (for a large airplane crashing into a dry storage container) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure. It should be noted that all of the affected area within about three-quarters of a mile from the spent nuclear fuel facility would be within the boundaries of the federally owned site.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources or concerns such as Native Hawaiian rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area impacted would vary only slightly among the alternatives considered. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. There are no endangered or threatened species unique to the area surrounding the federally owned site, so an accident would not be expected to result in destruction of any species for any of the

alternatives considered. The effects of accidents related to any of the alternatives and any associated cleanup which might be performed would be localized in a small area extending only a short distance beyond the boundaries of the federally owned site and thus would not be expected to appreciably affect the potential for survival of any endangered or threatened species which might occupy wetlands or other habitat in the area. Based on these considerations, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.1.4.15 Waste Management

The alternative in which naval spent nuclear fuel is stored at Pearl Harbor would produce limited amounts of solid municipal waste, solid low-level radioactive wastes, and hazardous wastes. In addition, no transuranic or high-level radioactive wastes would be generated by spent nuclear fuel activities at the site under any alternative. The quantity of industrial wastes generated would be small and most likely consist of industrial cleaning agents of the type normally encountered at the site. Small quantities of sanitary wastes would result from the additional work force but this volume would be small. The wastes produced from the storage of naval spent nuclear fuel would be controlled and minimized in accordance with the existing waste management programs at Pearl Harbor. The amount of additional wastes generated would be minimal compared to the existing baseline and would not cause any adverse impacts to public health and safety and the environment in the vicinity of Pearl Harbor.

5.1.4.16 Cumulative Impacts

5.1.4.16.1 Radiological Cumulative Impacts. Spent nuclear fuel storage at the site would not result in discharges of radioactivity in liquid effluents during routine operations regardless of the alternative selected. Therefore, there would be no incremental addition of radioactivity to surface or ground water as a result of normal operations for any alternative. For alternatives involving the storage of spent nuclear fuel in dry storage and shipping containers, no airborne radioactivity emissions are expected, so there would be no cumulative air quality impacts associated with these storage methods. Consequently, the only radiological cumulative impacts that would result from dry storage alternatives would be due to direct radiation exposure from the stored containers of spent nuclear fuel.

For alternatives involving the storage of naval spent nuclear fuel in water pools, there would be no discernible direct radiation exposure to the public from the fuel elements due to the shielding provided by the water in the pool. Therefore, any cumulative impacts which would result from water pool storage would be primarily due to airborne emissions, and the addition of these emissions would cause an indiscernible change in the emissions in the area (see Section 5.1.4.7). Current operations at the site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

A summary of the cumulative radiological impacts is provided in the following section.

An overview of the historical radiological impacts from naval nuclear operations at Pearl Harbor and from transportation of naval spent nuclear fuel is provided in Section 4.1.4.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The radiological impacts associated with the alternative where naval spent nuclear fuel would be stored at Pearl Harbor are very small and are described in Section 5.1.4.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the population in the vicinity of Pearl Harbor from all of the alternatives considered would be approximately 5.6 person-rem. This means that there would be much less than one fatal cancer from these operations over the entire 40-year period evaluated. The total exposure to a theoretical maximally exposed off-site individual living at the shipyard boundary for the entire 40-year period would be 8.0×10^{-4} rem due to the alternative resulting in the largest exposure. This maximally exposed off-site individual would have a 4.0×10^{-7} risk of contracting a fatal cancer during his or her lifetime due to storage of spent nuclear fuel. When existing site radiological impacts due to naval nuclear operations are added to the impacts of the most limiting spent nuclear fuel alternative, the exposure to the population would be 6.8 person-rem and to the maximally exposed off-site individual would be 9.2×10^{-4} rem. This still results in much less than one fatal cancer in the population and the risk of the maximally exposed off-site individual contracting a fatal cancer during his or her lifetime is 4.6×10^{-7} .

The total exposure related to naval spent nuclear fuel activities to a worker assumed to be working continually 100 meters from the spent nuclear fuel under the alternative resulting in the largest exposure is 8.4×10^{-2} rem accumulated over 40 years. That corresponds to a fatal cancer risk of 3.4×10^{-5} during the worker's lifetime. The exposure to the same worker when existing site radiological impacts due to naval nuclear operations are added to the spent nuclear fuel exposure is essentially the same. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

Sections 4.1.4.14 and 5.1.4.15 describe the management of low-level radioactive waste and mixed waste at the site. The volume of low-level radioactive wastes which would be generated under the alternatives has not been calculated. However, considering the nature of radiological work that would be associated with spent nuclear fuel storage activities, the amount of low-level radioactive waste produced during spent nuclear fuel activities would be much less than 20 percent of the current site generation rate (84 m^3 per year). This additional radioactive waste would not introduce any changes to the site's waste management practices. The small amount of additional material involved would not impose any discernible additional stress on the capacity of the radioactive waste burial

ground. Therefore, any cumulative impacts associated with the generation and disposal of additional low-level wastes would be very small.

Since no mixed, transuranic, or high-level radioactive wastes would be generated by spent nuclear fuel activities at this site under any alternative, there would be no cumulative impacts associated with these materials.

5.1.4.16.2 Non-radiological Cumulative Impacts. An overview of the historical non-radiological impacts from naval nuclear operations at Pearl Harbor and from transportation of naval spent nuclear fuel is provided in Section 4.1.4.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no non-radiological cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The non-radiological impacts associated with the alternative where naval spent nuclear fuel would be inspected or stored at Pearl Harbor are described in Section 5.1.4.12, with the detailed results of analyses provided in Attachment F. As summarized in Section 5.1.4.12, there would be no additional chemicals required at the shipyard for naval spent nuclear fuel storage and therefore no non-radiological impacts from normal operations. Consequently, no cumulative impacts to air quality or water resources would result since the incremental addition of chemicals at the shipyard that might result from naval spent fuel activities would be very small. There are no current environmental problems associated with these materials.

The non-radiological cumulative transportation impacts for the population from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A. The non-radiological impacts associated with the transportation and storage of naval spent nuclear fuel for all of the alternatives considered would be low.

No cumulative land use impacts would be expected to occur as a result of spent nuclear fuel storage. The land that would be dedicated for this purpose is on existing federal property and situated

in an industrial setting which has already been disturbed from its natural state. The conversion of this space for storage of spent nuclear fuel would not result in the need to disturb undeveloped land or for additional land to be added to the federally owned property in the foreseeable future.

From a socioeconomic perspective, the introduction of naval spent nuclear fuel activities at the site would create a small number of additional jobs and could have a very small cumulative socioeconomic impact. The site currently employs approximately 5000 civilian personnel. No shipyard employment has been associated with spent nuclear fuel activities in the past since spent nuclear fuel activities have not been conducted at the site. An average of approximately 1 to 35 additional jobs might be added as a result of possible spent nuclear fuel activities in the future. The peak number of additional jobs created at the site in any given year would be approximately 88, which is associated with construction and operation of a water pool facility for storage of spent nuclear fuel. Considering that the regional labor force consists of approximately 407,530 workers, the additional number of added jobs under any alternative would have little or no discernible socioeconomic impact. These jobs would be filled either from within the existing site work force or from the available regional labor force without discernible effect. There are no foreseeable future projects planned at the site and no known projects planned in the region that would cause the small number of workers involved in naval spent nuclear fuel activities to become an important impact.

The cumulative impacts associated with non-radiological waste management are likewise expected to be small. As stated previously, any industrial wastes generated from naval spent nuclear fuel storage would be small and limited to industrial cleaning agents of the type normally encountered at the site. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of additional non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of waste.

5.1.4.17 Unavoidable Adverse Effects

There are no discernible unavoidable adverse effects associated with the implementation of any of the alternatives and none which would help to choose among the alternatives. The alternative in which naval spent nuclear fuel is stored at Pearl Harbor would cause the public to be exposed to small amounts of radiation, described in Section 5.1.4.12, and would result in less than one health effect in the entire population surrounding the shipyard. Similarly, continued operation of the storage facility would produce limited amounts of solid municipal waste and solid low-level radioactive waste. These amounts of waste would not produce any major impacts in the vicinity of the shipyard. There will be no changes to the ecological, cultural, geological, and aesthetic resources due to the implementation of any of the alternatives. There would also be no expected impact on ambient noise levels.

5.1.4.18 Irreversible and Irretrievable Commitments of Resources

The only irreversible and irretrievable commitment of resources that results from the alternative in which naval spent nuclear fuel would be stored at Pearl Harbor would be the money which would be spent by the federal government to construct the necessary facilities. The total cost of storing spent naval nuclear fuel at the shipyards and prototype ranges from approximately \$1.5 billion to \$5.7 billion. This cost represents the total cumulative cost over the 40-year period for all of the shipyards and prototype. This cost includes construction costs of the new storage facilities, and, depending on the alternative selected, the operation of a limited examination facility at Puget Sound Naval Shipyard combined with the costs associated with shutting down ECF, or the operational costs of the INEL-ECF. The major expense in the highest cost alternatives is the procurement of shipping containers. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

5.1.5 KENNETH A. KESSELRING SITE: WEST MILTON, NEW YORK

5.1.5.1 Overview of Environmental Impacts

The following sections discuss the major differences in potential environmental consequences associated with the choice of the alternatives that include storage of naval spent nuclear fuel at the Kenneth A. Kesselring Site. The environmental consequences associated with the storage of naval spent nuclear fuel at the Kesselring Site are based on the estimates of naval spent nuclear fuel that would be stored at the Kesselring Site through the year 2035 and current knowledge of the design features associated with spent fuel storage systems. The review of the environmental consequences associated with these alternatives has shown that the impact on the environment at the Kesselring Site associated with these activities is very small. There would be no impact to the environment in the vicinity of the Kesselring Site associated with any alternatives that do not involve the Kesselring Site.

5.1.5.2 Land Use

Construction of a storage area at the Kesselring Site for temporary storage of naval spent nuclear fuel would require little rearrangement of existing on-site facilities. The area is already an industrial site; therefore, there would be no impact on land use. A description of the alternate storage containers and water pools and their approximate locations is provided in Attachment D. Attachment C provides a comparison of naval spent nuclear fuel storage in water pools versus dry container storage.

No additional land within or outside the Kesselring Site would be required for fuel storage.

Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.1.5.3 Socioeconomics

The calculated number of direct construction and operating jobs that would be required for the 10-year period between 1995 and 2004 for each storage alternative at the Kesselring Site is provided

in Table 5.1.5-1. Since there would be no naval spent nuclear fuel storage or inspection activities at the Site under the 1992/1993 Planning Basis and Centralization alternatives, no additional jobs would be required at the Site under these alternatives.

Table 5.1.5-1. Number of construction and operating jobs created at the Kesselring Site for each alternative.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Railcar ⁽¹⁾	1	1	6	1	1	1	1	1	1	1
Immobile Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	3	3	3	3
Shipping Containers on Pads ⁽²⁾	1	1	1	1	2	6 ⁽³⁾	1	1	1	1
Water Pools ⁽²⁾	16	16	43	66	81	58	62	24	24	24

(1) Storage mode under the No Action and Decentralization alternatives.

(2) Storage mode under the Decentralization alternative.

(3) The construction jobs would last less than one year.

The only discernible socioeconomic consequence from the alternative of storing naval spent nuclear fuel at the Kesselring Site is that a relatively small number of construction workers (ranging from a few to a maximum of several hundred would be required for construction of the storage area). The work force would consist of skilled craftsmen and unskilled laborers. This work force would be needed during the storage facility construction and would be available from within the area.

The operation of the naval spent nuclear fuel storage area using dry storage containers would require additional workers. Personnel are required to secure fuel in the storage area and to support surveillance and monitoring activities associated with naval spent nuclear fuel storage operations. For the alternative involving storing fuel in immobile dry storage containers, about 20 workers would be required to handle the spent nuclear fuel when it is placed into the storage containers. This work force would normally only be needed when fuel is being inserted into the containers. For the alternative involving shipping containers, fewer workers would be needed to handle and secure the containers in the storage area. If the alternative of storing naval spent nuclear fuel in water pools

were selected, approximately 20 workers would be required. These workers would be expected to be supplied from either within the existing Kesselring Site work force or from the local work force. Considering that the Kesselring Site employs approximately 1450 workers, the addition of workers to support the alternatives would have no discernible impact on the local socioeconomic conditions of the Kesselring Site.

For the alternatives where dry storage containers would be manufactured, some additional jobs would be created in the locations where the containers are made. The process of selecting the container manufacturer is subject to federal procurement requirements and would be initiated after the Record of Decision. Consequently, the specific socioeconomic impacts from container fabrication cannot be specified. The net effect of container fabrication would be to create additional jobs and bolster the local economy of the area(s) where containers are made. It is considered unlikely that the selection of the contractor would depend on the alternative storage site selected, so the jobs associated with construction of casks provide no basis for selection of a storage site.

5.1.5.4 Cultural Resources

No site that is listed on the National Register of Historic Places (NPS 1991), any known archaeological areas, or any other cultural resources would be affected by the storage of naval spent nuclear fuel at the Kesselring Site. Therefore, there would be no impact to cultural resources from the alternative of storing naval spent nuclear fuel at the Kesselring Site.

None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.1.5.5 Aesthetic and Scenic Resources

The naval spent nuclear fuel storage area would be located in an existing area within the security perimeter of the Kesselring Site which is an existing light industrial setting. There would be minor changes to the Site resulting from the storage of spent fuel. No aesthetic or scenic resources in the vicinity of the Site or on the Site would be affected by the operation of the storage area because existing industrial use areas would be used to store the spent fuel. The visual quality of the area

would not be affected since the storage area would be compatible with the landscape character of the Kesselring Site. There are no particulate air emissions associated with storage of naval spent nuclear fuel and thus no visibility impacts are expected.

5.1.5.6 Geology

The operation of the naval spent nuclear fuel storage area at the Kesselring Site is not expected to affect the geologic character or resources of the region. If an alternative were selected that required a dry container storage area to be constructed, the ground would only be excavated as necessary to prepare the surface. This would not affect the geological characteristics of the underlying layers nor the characteristics of an aquifer or vadose zone. For the alternative of storing fuel in a water pool facility, the ground surface would need to be excavated to a depth of approximately 40 feet. This excavation would not affect the geological characteristics of the area.

5.1.5.7 Air Resources

5.1.5.7.1 Radiological Consequences. If the alternative where naval spent nuclear fuel would be stored in dry storage containers were to be selected, no airborne radioactivity releases would be expected to occur as a result of normal storage operations. The naval spent nuclear fuel would be contained such that at least two barriers exist to prevent fission products from becoming airborne. These barriers would retain the naval spent nuclear fuel in an air-tight containment until it is moved to a permanent storage site and there would be no airborne radioactive material released from routine operations for this method of storage. The only radiation exposure would be direct radiation from the array of filled storage containers. The filled storage containers would be fenced off and shielded if necessary such that there would be no distinguishable effect on the current radiation readings at the site perimeter.

For the alternative where naval spent nuclear fuel would be stored in a water pool, airborne radioactivity emissions are expected to be considerably less than that identified for the Idaho National Engineering Laboratory (INEL) Expanded Core Facility (ECF) because the water pool size would be smaller, no naval spent nuclear fuel inspection operations beyond visual examinations would be conducted, and no shielded cell operations would be conducted at the Kesselring Site. To conservatively estimate the radiological consequences, airborne releases based on ECF releases from

1991 are used. The radiological source term used and the detailed calculations performed to determine normal releases are provided in Attachment F.

The radiation exposures to human beings due to estimated radionuclide releases to the atmosphere and direct radiation from the stored naval spent nuclear fuel at the Kesselring Site for both the alternative involving water pool storage and the alternative involving dry storage were calculated as described in Attachment F.

A person on the Kesselring Site boundary at the location where the largest exposures would be received was used as the hypothetical maximally exposed off-site individual (MOI) for postulated releases of radioactive material from the stored naval spent nuclear fuel. The population data used to calculate population doses were taken from 1990 census data provided by the U.S. Census Bureau. Meteorology data were obtained as described in Attachment F. Estimated exposures to workers were also calculated.

The hypothetical exposures calculated are based on an exposure to the estimated average effluents and the direct radiation exposure for one year from the naval spent nuclear fuel stored at the Kesselring Site. The calculations include the external effective exposure equivalent from the ground deposition, deposition to surface water, and air immersion pathways and the 50-year committed effective exposure equivalent from internal exposure through the ingestion and inhalation pathways. All pathways were considered for the persons potentially exposed, except that the ingestion pathway was omitted for the workers at Kesselring because they do not grow their food on-site. Solubilities which would produce the highest calculated exposures were chosen for internal exposure factors. Values for human dietary consumption patterns were taken from "Age Dependent Values of Dietary Intake for Assessing Human Exposures to Environmental Pollutants" (Rupp 1980). The hypothetical exposures calculated can be converted into a risk of fatal cancer or a risk of non-fatal health detriments (e.g., non-fatal cancers, hereditary defects) based on recommendations of the International Commission on Radiological Protection (ICRP 1991).

Attachment F summarizes the calculated exposures and fatal cancers to the workers, the maximally exposed off-site individual (MOI), and the population from airborne releases of radioactivity and direct radiation exposure in one year for each location and storage mode. Section 3.7 provides a comparison of the annual number of fatal cancers calculated for the general population for each location and alternative.

The number of fatal cancers calculated is so small that there would be essentially no fatal cancers resulting from the storage of naval spent nuclear fuel during the time it could reasonably be expected to continue to be stored. Putting this into perspective, it could be stated that one member of the population might experience a fatal cancer due to incident-free storage of naval spent nuclear fuel at the Kesselring Site if operations continued for 24,400 years.

5.1.5.7.2 Non-radiological Consequences. As noted in Attachment F, no increase in non-radioactive airborne emissions would be expected to result from naval spent nuclear fuel storage area operations. Storage area operations would not involve use of carcinogenic toxins, criteria pollutants, or other hazardous toxic chemicals except for small quantities of industrial cleaning agents and paint thinner that may be used for housekeeping and cleanliness control and these would be the same as those already used at the Kesselring Site. Consequently, there would be no impact on ambient air quality as a result of implementing any of the alternatives at the Site.

If an alternative were to be selected that required a storage facility to be constructed or renovated, fugitive dust emissions would be expected to result from excavation operations. The quantity of dust generated would be small, consistent with typical excavation activities and controlled within local requirements for dust control.

5.1.5.8 Water Resources

5.1.5.8.1 Radiological Consequences. Naval spent nuclear fuel storage operations at the Kesselring Site would not result in discharges of radioactive liquid effluents during routine operation regardless of the alternative selected for storage of naval spent nuclear fuel. The health effect due to fallout of nuclides released to the air onto the surface water is included in the analysis results discussed in Section 5.1.5.7. The air fallout impact is so small that there would be no distinguishable radiation levels in the water.

The Kesselring Site does not reside in the 100 or 500 year floodplain. Consequently, the floodplain would not be impacted by spent naval nuclear fuel storage and examination activities at the Site.

5.1.5.8.2 Non-radiological Consequences. Other than chemicals used to maintain the storage area, no hazardous wastes would be generated by the storage of naval spent nuclear fuel at the Kesselring Site. Any hazardous liquid effluents that may be generated at the storage area would be disposed of at an Environmental Protection Agency approved disposal site.

The only source for liquid discharges from the naval spent nuclear fuel storage operations to the environment consists of storm water runoff which would be consistent with the type of discharges associated with common light industrial facilities and related activities. It can be concluded that there would be no impact to the human environment due to runoff water from the naval spent nuclear fuel storage area.

The increased water usage under any of the alternatives would be negligible compared to the existing Site demand.

5.1.5.9 Ecological Resources

There are no known habitats for threatened or endangered species within the Kesselring Site and no major changes to the industrial environment are planned. Therefore, no ecological impacts to the region would result from selection of any of the alternatives.

The conceptual location where naval spent nuclear fuel would be stored is illustrated in Attachment D. This location is within an existing industrial complex and is surrounded by buildings and paved areas. The industrial nature of the Kesselring Site and the fact that the land has already been disturbed from its natural state by earlier activities mean that plant or animal species sensitive to disturbance by human activities would not be expected to be present. Therefore, there would be no ecological impacts associated with construction or operation of a spent nuclear fuel storage area at this location. The radiological controls that are in effect at the Kesselring Site ensure that the radiation levels in the vicinity of the Site are maintained at or near natural background. Since these same controls would be applied to spent nuclear fuel activities, no ecological effects due to radioactive material would be expected to occur.

5.1.5.10 Noise

The Kesselring Site is an existing light industrial-type environment characterized by noise from truck and automobile traffic; diesel-powered equipment; and continuously operating transmission lines for steam, fuel, water, and related pumping systems for these and other liquids. There would be no increase in ambient noise associated with any of the alternatives. Therefore, no noise impacts would be expected to occur.

5.1.5.11 Traffic and Transportation

Shipments of radioactive materials in the Naval Nuclear Propulsion Program are required to be made in accordance with applicable regulations of the U.S. Department of Transportation, U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments and provide requirements for the container design, certification, and identification as applicable for the specific quantity, type, and form of radioactive material being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and qualification of workers who construct containers, and quality control inspections during fabrication to ensure that the containers will meet their design requirements. A detailed description of the shipping containers used for naval spent nuclear fuel shipments is provided in Attachment A. A description of the impacts from normal and accident conditions associated with transportation of naval spent nuclear fuel is provided in Attachment A.

5.1.5.11.1 Regional Infrastructure. The alternatives under consideration are described in Section 3. The No Action alternative or the first variation of the Decentralization alternative would store the naval spent nuclear fuel on-site. This alternative would reduce the number of rail shipments from the shipyard or prototype site compared to the past practice of transporting all naval spent nuclear fuel to INEL. The second variation of the Decentralization alternative would ship about 10 percent of the naval spent nuclear fuel to Puget Sound. This would have some transportation impact, but not as much as transporting all naval spent nuclear fuel off-site. The third Decentralization alternative ships all naval spent nuclear fuel to INEL, examines it, and returns it to the original shipyard or prototype

site. This alternative involves more transportation than the previous practice of transporting naval spent nuclear fuel to INEL, since the naval spent nuclear fuel is not returned from INEL to the original site. The 1992/1993 Planning Basis alternative, the Regionalization at INEL alternative, or the Centralization at INEL alternative would involve the same transportation as has been required in the past, namely transportation to INEL and retention there. The Centralization alternative at the Hanford Site would result in more transportation impact than any of the previous alternatives, due to the distances and population distribution between Hanford and the shipyards and prototypes. The Centralization alternative at the Savannah River Site would result in the most transportation impact of naval spent nuclear fuel of any of the alternatives.

5.1.5.11.2 Site Infrastructure. The alternatives associated with storage of naval spent nuclear fuel at the Kesselring Site would have no impact on local highway traffic because any increase in the work force would represent a very small incremental increase in overall traffic to and from the Site. There would be no change in the internal traffic at the Kesselring Site because naval spent nuclear fuel is temporarily held on-site even when it is transported off-site.

5.1.5.12 Occupational and Public Health and Safety

Detailed analyses of incident-free naval spent nuclear fuel transportation and storage and handling impacts on worker and public health are described in Attachment A (transportation) and Attachment F (storage and inspection). The transportation analysis results, and the storage and handling analysis are summarized separately in the following subsections.

5.1.5.12.1 Incident-free Transportation Occupational and Public Health and Safety. The radiological and non-radiological effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.5.12.2 Incident-free Occupational and Public Health and Safety During Naval Spent Nuclear Fuel Storage and Handling. The public health and safety impacts of radioactivity releases and direct radiation from storage of naval spent nuclear fuel were analyzed as discussed in Section 5.1.5.7 and Attachment F. Attachment F summarizes the results of the analysis of radioactivity releases and direct radiation from stored naval spent nuclear fuel. This analysis shows that the exposure to the worker and maximally exposed off-site individual from stored naval spent nuclear fuel would result in far less than one fatality per year. For perspective, it could be stated that one member of these population groups might experience a fatal cancer due to storage of naval spent nuclear fuel at the Kesselring Site if operations continued for 24,400 years.

Attachment F also discusses toxic chemical issues for naval spent nuclear fuel handling and storage. Attachment F concludes that there would be no additional types or volumes of chemicals required at the shipyards or prototype site for naval spent nuclear fuel storage. Therefore, there is no incident-free non-radiological impact resulting from storage of naval spent nuclear fuel at the shipyards or prototype site.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

No public or occupational radiological health and safety impacts would be expected to result from naval spent nuclear fuel storage area construction activities since the construction would not involve radioactive work.

5.1.5.13 Utilities and Energy

If an alternative associated with storage of naval spent nuclear fuel at the Kesselring Site were to be selected, construction and operation of a naval spent nuclear fuel storage facility would not be expected to require a large expenditure of utilities and energy resources. Operation of the storage facility would likely require only a small amount of electricity for lighting and to support industrial

equipment necessary to move spent nuclear fuel containers (cranes etc.). Construction activities would require quantities of water and electricity typical of any small to medium size construction project. Alternatives associated with water pool storage would require heating, ventilation, water, and electrical systems suitable for a work environment and to properly filter and exhaust the airborne discharges to the atmosphere. The utility and energy demands would be less than that required to operate ECF (10,000 MWh per year) (Section 5.2.13) since the water pool for naval spent nuclear fuel storage would be smaller and no inspections would be performed. The amount of utilities and energy expected to be consumed as a result of dry storage would be a small incremental increase in the total amount of utilities and energy used at the Kesselring Site and would not result in any discernible environmental consequences.

5.1.5.14 Facility and Transportation Accidents

5.1.5.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of abnormal occurrence limits on exposures as defined by the U.S. Nuclear Regulatory Commission. A description of potential accidents considered and a summary of the accident analyses that were conducted with regards to the storage of naval spent nuclear fuel are contained in Attachment F.

5.1.5.14.1.1 Radiological Accidents. Section 3.7.3 provides a summary of the impacts due to the most severe accidents considered for each site. The facility accident with the greatest potential impact at the Kesselring Site involves an airplane crash. An accident of this magnitude would result in 7.5 fatal cancers to the general population over 50 years, as described in Attachment F. The likelihood of an airplane crash is 1×10^{-7} . The facility accident with the greatest risk involves accidental drainage of the water pool. The drained water pool accident would result in less than one fatality over 50 years, but the likelihood of occurrence is 1×10^{-5} .

5.1.5.14.1.2 Non-radiological Accidents. As discussed in detail in Attachment F, the limiting hypothetical non-radiological accident for naval spent nuclear fuel storage in a water pool at a shipyard or prototype location would be a diesel fuel spill and fire. A catastrophic failure of a diesel fuel storage tank that might be used for an emergency diesel generator to provide backup electrical

power was postulated to occur, resulting in the spilling of the entire quantity of diesel fuel with a subsequent fire. The fire would generate the following toxic chemicals:

- Carbon monoxide
- Oxides of nitrogen (90% nitric oxide and 10% nitrogen dioxide)
- Lead
- Sulfur dioxide.

Measures would be taken to reduce the health impacts of potential releases of toxic materials. These measures would involve controls to protect both workers and the general public. The naval shipyard and prototype sites have emergency planning, emergency preparedness, and emergency response programs in place to protect both workers and the public, and involve established resources such as warning communications, fire departments, and emergency command centers.

The airborne concentrations of the combustion products listed above, resulting from the fire, were calculated at the locations of the on-site individuals, an individual at the site boundary, and the general population within a 50-mile radius of the facility. Detailed results are presented in Attachment F. If the accidental fire that has been hypothesized were to actually occur, the safety measures that would be in place would ensure no adverse health impacts to the general public and minimal health impacts to the workers.

5.1.5.14.2 Transportation Accidents. Shipments of radioactive materials associated with naval spent nuclear fuel have never resulted in any measurable release of radioactivity to the environment (NNPP 1993a). There have never been any significant accidents involving the release of radioactive material during shipment since the Naval Nuclear Propulsion Program began. The effects of potential transportation accidents during the various stages of transportation of naval spent nuclear fuel are presented in Attachment A.

The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.1.5.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that an area ranging from about 8 acres extending approximately a quarter mile (for an inadvertent criticality accident) to about 110 acres extending approximately 0.9 mile (for a large airplane crashing into a dry storage container) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure. It should be noted that all of the affected area within about three-quarters of a mile from the spent nuclear fuel facility would be inside the boundaries of the Kesselring Site.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area would vary only slightly among the alternatives considered. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. There are no endangered or threatened species unique to the area surrounding the federally

owned site, so an accident would not be expected to result in destruction of any species for any of the alternatives considered. The effects of any accident related to any of the alternatives and any cleanup which might be performed would be localized in a small area which extends only a short distance beyond the boundaries of the federally owned site and thus would not be expected to appreciably affect the potential for survival of endangered or threatened species which might occupy wetlands or other habitat in the Saratoga area. Consequently, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.1.5.15 Waste Management

The alternative in which naval spent nuclear fuel is stored at the Kesselring Site would produce limited amounts of solid municipal waste, solid low-level radioactive wastes, and hazardous wastes. In addition, no transuranic or high-level radioactive wastes would be generated by spent nuclear fuel activities at the Kesselring Site under any alternative. The quantity of industrial wastes generated would be small and most likely consist of industrial cleaning agents of the type normally encountered at the Site. Small quantities of sanitary wastes would result from the additional work force but this volume would be small. The wastes produced from the storage of naval spent nuclear fuel would be controlled and minimized in accordance with the existing waste management programs at the Kesselring Site. The amount of additional wastes generated would be minimal compared to the existing baseline and would not cause any adverse impacts to public health and safety and the environment in the vicinity of the Kesselring Site.

5.1.5.16 Cumulative Impacts

5.1.5.16.1 Radiological Cumulative Impacts. Spent nuclear fuel storage at the Kesselring Site would not result in discharges of radioactivity in liquid effluents during routine operations regardless of the alternative selected. Therefore, there would be no incremental addition of radioactivity to surface or ground water as a result of normal operations for any alternative. For alternatives involving the storage of spent nuclear fuel in dry storage and shipping containers, no airborne radioactivity emissions are expected, so there would be no cumulative air quality impacts associated with these storage methods. Consequently, the only radiological cumulative impacts that would result from dry storage alternatives would be due to direct radiation exposure from the stored containers of spent nuclear fuel.

For alternatives involving the storage of naval spent nuclear fuel in water pools, there would be no discernible direct radiation exposure to the public from the fuel elements due to the shielding provided by the water in the pool. Therefore, any cumulative impacts which would result from water pool storage would be primarily due to airborne emissions, and the addition of these emissions would cause an indiscernible change in the emissions in the area (see Section 5.1.5.7). Current operations at the site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

A summary of the cumulative radiological impacts is provided in the following section.

An overview of the historical radiological impacts from naval nuclear operations at the Kesselring Site and from transportation of naval spent nuclear fuel is provided in Section 4.1.5.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The radiological impacts associated with the alternatives where naval spent nuclear fuel would be stored at the Kesselring Site are very small and are described in Section 5.1.5.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the population in the vicinity of the Kesselring Site from all of the alternatives considered would be approximately 3.28 person-rem. This means that there would be much less than one fatal cancer from these operations over the entire 40-year period evaluated. The total exposure to a theoretical maximally exposed off-site individual living at the shipyard boundary for the entire 40-year period would be 2.7×10^{-4} rem due to the alternative resulting in the largest exposure. This maximally exposed off-site individual would have a 1.4×10^{-7} risk of contracting a fatal cancer during his or her lifetime due to storage of spent nuclear fuel. When existing site radiological impacts due to naval nuclear operations are added to the impacts of the most limiting spent nuclear fuel alternative, the exposure to the population would be 5.6 person-rem and to the maximally exposed off-site individual would be 4.8×10^{-4} rem. This still results in much less than one fatal cancer in the population and the risk of the maximally exposed off-site individual contracting a fatal cancer during his or her lifetime is 2.4×10^{-7} .

The total exposure related to naval spent nuclear fuel activities to a worker assumed to be working continually 100 meters from the spent nuclear fuel under the alternative resulting in the largest exposure is 2.4×10^{-2} rem accumulated over 40 years. That corresponds to a fatal cancer risk of 9.6×10^{-6} during the worker's lifetime. The exposure to the same worker when existing site radiological impacts due to naval nuclear operations are added to the spent nuclear fuel exposure is 2.6×10^{-2} rem over 40 years which corresponds to a fatal cancer risk of 1.1×10^{-5} during the worker's lifetime. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

Sections 4.1.5.14 and 5.1.5.15 describe the management of low-level radioactive waste and mixed waste at the site. The volume of low-level radioactive wastes which would be generated under the alternatives has not been calculated. However, considering the nature of radiological work that would be associated with spent nuclear fuel storage activities, the amount of low-level radioactive waste produced during spent nuclear fuel activities would be much less than 20 percent of the current site generation rate (215 m³ per year). This additional radioactive waste would not introduce any changes to the Site's waste management practices. The small amount of additional material involved

would not impose any discernible additional stress on the capacity of the radioactive waste burial ground. Therefore, any cumulative impacts associated with the generation and disposal of additional low-level wastes would be very small.

Since no mixed, transuranic, or high-level radioactive wastes would be generated by spent nuclear fuel activities at the Kesselring Site under any alternative, there would be no cumulative impacts associated with these materials.

5.1.5.16.2 Non-radiological Cumulative Impacts. An overview of the historical non-radiological impacts from naval nuclear operations at the Kesselring Site and from transportation of naval spent nuclear fuel is provided in Section 4.1.5.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no non-radiological cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The non-radiological impacts associated with the alternative where naval spent nuclear fuel would be inspected or stored at the Kesselring Site are described in Section 5.1.5.12, with the detailed results of analyses provided in Attachment F. As summarized in Section 5.1.5.12, there would be no additional chemicals required at the prototype site for naval spent nuclear fuel storage and therefore no non-radiological impacts from normal operations. Consequently, no cumulative impacts to air quality or water resources would result since the incremental addition of chemicals at the Site that might result from naval spent fuel activities would be very small. There are no current environmental problems associated with these materials.

The non-radiological cumulative transportation impacts for the population from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A. The non-radiological impacts associated with the transportation and storage of naval spent nuclear fuel for all of the alternatives considered would be low.

No cumulative land use impacts would be expected to occur as a result of spent nuclear fuel storage. The land that would be dedicated for this purpose is on existing federal property and situated in an industrial setting which has already been disturbed from its natural state (about 50 acres are developed land). The conversion of this space for storage of spent nuclear fuel would not result in the need to disturb undeveloped land or for additional land to be added to the federally owned property in the foreseeable future.

From a socioeconomic perspective, the introduction of naval spent nuclear fuel activities at the Kesselring Site would create a small number of additional jobs and could have a very small cumulative socioeconomic impact. The site currently employs approximately 1450 civilian personnel. No site employment has been associated with spent nuclear fuel activities in the past since spent nuclear fuel activities have not been conducted at the site. An average of approximately 1 to 24 additional jobs might be added as a result of possible spent nuclear fuel activities in the future. The peak number of additional jobs created at the site in any given year would be approximately 81, which is associated with construction and operation of a water pool facility for storage of spent nuclear fuel. Considering that the regional labor force consists of approximately 176,600 workers, the additional number of added jobs under any alternative would have little or no discernible socioeconomic impact. These jobs would be filled either from within the existing Site work force or from the available regional labor force without discernible effect. There are no foreseeable future projects planned at the Site and no known projects planned in the region that would cause the small number of workers involved in naval spent nuclear fuel activities to become an important impact.

The cumulative impacts associated with non-radiological waste management are likewise expected to be small. As stated previously, any industrial wastes generated from naval spent nuclear fuel storage would be small and limited to industrial cleaning agents of the type normally encountered at the Kesselring Site. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of additional non-radiological wastes generated would not introduce any changes to the Site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of waste.

5.1.5.17 Unavoidable Adverse Effects

There are no discernible unavoidable adverse effects associated with the implementation of any of the alternatives and none which would help to choose among the alternatives. The alternative in which naval spent nuclear fuel is stored at the Kesselring Site would cause the public to be exposed to small amounts of radiation, described in Section 5.1.5.12, and would result in less than one health effect in the entire population surrounding the Kesselring Site. Similarly, continued operation of the storage facility would produce limited amounts of solid municipal waste and solid low-level radioactive waste. These amounts of waste would not produce any major impacts in the vicinity of the Kesselring Site. There will be no changes to the ecological, cultural, geological, and aesthetic resources due to the implementation of any of the alternatives. There would also be no expected impact on ambient noise levels.

5.1.5.18 Irreversible and Irretrievable Commitments of Resources

The only irreversible and irretrievable commitment of resources that results from the alternative in which naval spent nuclear fuel would be stored at the Kesselring Site would be the money that would be spent by the federal government to construct the necessary facilities. The total cost of storing spent naval nuclear fuel at the shipyards and prototype ranges from approximately \$1.5 billion to \$5.7 billion. This cost represents the total cumulative cost over the 40-year period for all of the shipyards and prototype. This cost includes construction costs of the new storage facilities, and, depending on the alternative selected, the operation of a limited examination facility at Puget Sound Naval Shipyard combined with the costs associated with shutting down ECF, or the operational costs of the INEL-ECF. The major expense in the highest cost alternatives is the procurement of shipping containers. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

5.2 IDAHO NATIONAL ENGINEERING LABORATORY

5.2.1 Overview of Environmental Impacts

The following sections discuss the potential environmental consequences at the Idaho National Engineering Laboratory (INEL) associated with the choice of alternatives for naval spent nuclear fuel management at the Expended Core Facility (ECF). The environmental consequences are based on the fact that the ECF is currently in existence and operating within the perimeter of the Naval Reactors Facility (NRF) at INEL. Volume 1, Appendix B provides an assessment of the environmental impacts at INEL resulting from the full range of spent nuclear fuel activities. This includes the impacts resulting from "ECF-related" activities, which are discussed below (i.e., the impacts resulting from the transportation, receipt, handling, and examination of naval spent nuclear fuel), as well as the impacts associated with the spent nuclear fuel operations at the Idaho Chemical Processing Plant (i.e., the storage of both naval and non-naval spent nuclear fuel and other non-naval spent nuclear fuel operations).

Review of the environmental effects of operation of the Expended Core Facility at INEL for the receipt and examination of naval spent nuclear fuel has shown that the impact on the environment associated with this work is very small. The largest effect in the vicinity of INEL associated with the selection of any alternative for examination of naval fuel is the economic impact of the jobs which are retained or lost at ECF. The differences in all other impacts in the vicinity of INEL for the available alternatives are very small or non-existent.

5.2.2 Land Use

The plan for all three naval plant prototypes at NRF is that they will all be shut down, defueled, and placed in safe storage until they are decommissioned. Operations at the ECF could continue or cease, depending upon the alternative selected. None of the prototype plants or the ECF, if operations cease, is planned to be decommissioned during the next 10 years; therefore, this land will not be available for other uses in the near future. Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.2.3 Socioeconomics

Approximately 500 engineers, technicians, clerical, and maintenance personnel are employed in the receipt and examination of naval spent nuclear fuel at ECF or in direct support of these activities. Table 5.2-1 provides a summary of the direct jobs which would be associated with the ECF if an alternative is selected which closes ECF, while Table 5.2-2 provides a summary of the direct jobs associated with the continued operation of ECF. As shown in Table 5.2-1, there is an increase in workers in the first three years to handle the shipment of containers which had been in storage at the shipyards and prototype during the preparation of this Environmental Impact Statement. The number of workers then decreases steadily to a final caretaker work force of 10. The increase in work force in the first three years shown in Table 5.2-2 includes construction workers for the completion of the Dry Cell Facility in addition to the operations work force increase discussed above.

Table 5.2-1. Summary of direct jobs (closure of INEL-ECF).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	550	550	550	500	350	100	10	10	10	10

Table 5.2-2. Summary of direct jobs (operation of INEL-ECF).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	574	574	550	500	500	500	500	500	500	500

5.2.4 Cultural Resources

None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.2.5 Aesthetic and Scenic Resources

The entire Naval Reactors Facility is difficult to see from any point accessible to the public so aesthetic and scenic resources in the vicinity of INEL will not be affected by the alternative selected for receipt and handling of naval spent nuclear fuel at ECF. Even if NRF could be observed, the only action which would alter the landscape at NRF is the dry cell extension for spent fuel handling to ECF envisioned under the 1992/1993 Planning Basis alternative and this addition to the existing ECF building would be architecturally compatible with the NRF buildings.

5.2.6 Geology

The geology in the vicinity of the INEL will not be affected by the alternative selected for receipt and handling of naval spent nuclear fuel since no changes which could impact the geology would occur under any of the alternatives.

5.2.7 Air Resources

Small quantities of radioactivity are contained in the air released from ECF and prototype plant operations at NRF. The annual releases from ECF total approximately 1.1 curies, composed primarily of 0.30 curie of krypton-85, 0.70 curie of carbon-14, 0.094 curie of tritium, 0.000011 curie of combined strontium-90 and yttrium-90, and 0.0000048 curie of iodine-131. These releases at NRF would be reduced to near zero if an alternative which ends examination of naval spent nuclear fuel at ECF were selected. This reduction will occur approximately three years after the last fuel is received.

The principal sources of non-radioactive industrial gaseous effluents are air from offices, water vapor from cooling towers, and fuel combustion products from the three steam generating boilers used for heating. Since the boilers are used for generating steam for heating and it would be necessary to heat and maintain the ECF building whether naval spent nuclear fuel is shipped to INEL or not, the airborne effluents at NRF would be little affected by the alternative selected.

Asbestos-containing material is present at NRF, but, as a result of the well-controlled conditions with regard to asbestos at NRF, releases will be unaffected by the alternative selected.

5.2.8 Water Resources

No radioactive liquids are discharged to the environment at NRF. Consequently, the alternative selected would have no effect on releases of radioactive liquids at NRF.

Since the water released to the industrial waste ditch does not include any effluents from ECF, the discharges to the ditch would be unaffected by the choice of alternatives. Operation of ECF produces about 25% of the total NRF sewage discharge and the ECF discharge would be reduced to approximately zero if the people currently performing spent fuel examinations in that facility were no longer employed at NRF.

No hazardous wastes are disposed of at the NRF site and all solid and liquid hazardous wastes are transported by vendors to treatment, storage, and disposal facilities approved by the Environmental Protection Agency and operating under approvals or permits granted by state and federal regulatory agencies. The small amount of hazardous waste produced during ECF operation produces no effect on the environment in the vicinity of INEL, so the alternative selected would have no impact on water quality in this area.

Annual ECF water consumption is about 2.5 million gallons. The alternative selected would have no discernible effect on water usage, because the ground-water withdrawn for ECF operations is small in comparison to the total INEL water consumption. ECF operation has virtually no effect on surface waters.

A flood at ECF due to overflow of any surface water within the INEL boundaries is a low probability event. Flooding of the ECF building is possible should the Mackay Dam fail; however, there is adequate time following the dam break until the flood water reaches NRF to complete emergency procedure preparations. For more information refer to Attachment B.

5.2.9 Ecological Resources

Ecological resources (i.e., the terrestrial ecology, wetlands, aquatic ecology, and endangered and threatened species) in the vicinity of INEL will not be affected by any alternative selected since no additional land at the NRF site will be disturbed under any alternative.

5.2.10 Noise

The small amount of noise generated by work at ECF would cease several years after an alternative which stopped shipment of spent naval nuclear fuel were selected since ECF operations would cease. However, since this noise cannot be discerned beyond the site boundaries, the alternative selected would have no discernible impact on noise in the vicinity of INEL.

The similarly small amount of noise associated with railcar movement produced during shipment of the naval spent nuclear fuel from shipyards to ECF would cause the alternative selected to have no discernible impact on railcar noise generation. This is the case because the less than 50 railcars involved each year represent a minute fraction of the rail traffic in any area affected and the noise is indistinguishable from that produced by other rail traffic.

5.2.11 Traffic and Transportation

Traffic and transportation in the vicinity of INEL associated with naval spent nuclear fuel receipt, handling, and examination would essentially cease if an alternative which ended such operations at ECF were selected. This would cause approximately 400 truck deliveries per year to be eliminated. The reduction in personnel at ECF associated with cessation of these activities would cause approximately 22 fewer buses to be needed to transport them to and from the site each day. None of the alternatives considered would increase traffic or the need for transportation in the vicinity of INEL.

If the ECF operation continues at the INEL, routine shipments of naval spent nuclear fuel would be resumed to the site in certified shipping containers. Low-level waste generated at ECF and hazardous waste would continue to be moved from ECF to a disposal facility.

5.2.12 Occupational and Public Health and Safety

5.2.12.1 Occupational Health and Safety. Radiological and non-radiological impacts of ECF operations on occupational health and safety are assessed separately in terms of radiological and non-radiological effects.

Radiation exposures to workers at ECF have averaged approximately 100 millirem per year, compared to the limit of 5000 millirem per year specified by federal regulations (10CFR20). The total radiation exposure to workers at ECF makes up about 30% of the occupational exposure to radiation experienced by workers at NRF. Since only about 280 workers at ECF work in radiological areas and the health risk per worker is estimated to be approximately 0.00040 occurrences of fatal cancer per rem of exposure, less than one fatal cancer (approximately 0.45 fatal cancer estimated) could be expected among all ECF workers throughout the rest of their lives due to operation of ECF for an additional 40 years. This means that radiation effects on the health of INEL workers would be virtually unchanged by the alternative selected for examination of naval spent nuclear fuel.

Operations at ECF have resulted in fewer than 210 days of work lost to injuries in the seven years between 1987 and 1993 out of 736 total lost days of work at NRF during that period. Recordable injuries at ECF represented about 12% of the total number of such injuries at NRF during the same period. Consequently, selection of an alternative which ended operation of ECF at INEL might be expected to reduce injuries to workers at NRF by about 10% to 25% due to the reduction in work force. Operation of a replacement for ECF at another Department of Energy (DOE) site would likely result in roughly the same number of injuries to workers at that facility since the safety record at ECF is very good and similar safe working conditions could be established at the new facility.

Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

Limited quantities of some materials classified as hazardous chemicals are handled at ECF, but the precautions used during the work prevent exposure of the workers to these materials. Therefore, the alternative selected would not be expected to increase or decrease the exposure of INEL workers to potentially hazardous chemicals.

5.2.12.2 Public Health and Safety. The impact of NRF operations on public health and safety can also be assessed separately in terms of radiological and non-radiological effects.

The comprehensive INEL site radiation monitoring program (Hoff et al. 1992) shows that radiation exposure to persons who do not work at INEL resulting from all NRF operations is too small to be measured. In order to provide an estimate of the effects of radiation exposure which might be caused by INEL operations, calculations have been performed of the radiological exposures to the member of the general public who might receive the highest exposure (called the maximally exposed individual), to nearby (collocated) workers, to a worker at ECF located approximately 100 meters from the release point, and to the population surrounding the Idaho National Engineering Laboratory. These calculations include all types of radioactive particles or gases released into the atmosphere from the operation of all existing NRF facilities, including ECF. The calculation results and the analysis methods are provided in more detail in Attachment F.

The calculations indicate the risks are so small that there would be essentially no health effects resulting from radioactivity released by all operations at NRF, including ECF during the time it could reasonably be expected to operate. Putting the risk into perspective, it could be stated that one member of the population might experience a fatal cancer due to combined effects of operation of ECF if operations continued as in the past for 260 million years.

The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any health effects as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer or detrimental health effect for each alternative. The details of the transportation analysis are provided in Attachment A.

Results of all effluent monitoring confirm that the operation of NRF has no detectable impact on the environment from non-radiological releases (WECNRF 1993). Operations at NRF have had no effect on the groundwater of the Snake River Plain Aquifer, and monitoring results indicate no detectable toxic chemicals, solvents, or laboratory chemicals in the groundwater in the vicinity of NRF. No constituent measured in groundwater in the vicinity of NRF exceeds applicable drinking water standards. The alternative selected for examination of naval spent nuclear fuel would therefore have no effect on non-radiological public health and safety in the vicinity of INEL.

5.2.13 Utilities and Energy

Operations at ECF currently consume approximately 10,000 MWh of electricity each year. However, since the ECF building and associated facilities would have to be maintained during the period covered by this Environmental Impact Statement whether ECF is used for naval spent nuclear fuel examination or not and the spent fuel examinations do not consume particularly large amounts of energy, the consumption of electricity and other energy would not be appreciably affected by the alternative selected. None of the alternatives considered would increase the consumption of energy at INEL.

5.2.14 Facility and Transportation Accidents

5.2.14.1 Facility Accidents. There has never been an accident in the history of the Naval Nuclear Propulsion Program that resulted in a significant release of radioactivity to the environment or that resulted in radiation exposure to workers in excess of normal limits on exposure. Attachment F provides a description of radiological accidents which could occur during water pool and dry cell handling of naval spent nuclear fuel as well as accidents involving toxic chemicals used at ECF. The radiological accidents analyzed for ECF included: (1) an inadvertent criticality caused by an earthquake or similar event, (2) accidental loss of large amounts of water containing radioactive material from a water pool into the ground and then into water sources, and (3) severe damage of spent fuel if it were dropped from a crane during handling or had a heavy object dropped on it. The probability of an accident caused by an airplane crash was calculated for ECF and was determined to be less than 10^{-7} . Due to the low probability, no consequences were calculated for this accident. Calculations of the cancer fatalities which might occur as a result of all the postulated accidents are

provided in Attachment F. A comparison of the accident consequences for all alternatives is provided in Section 3.7.

The most limiting of the postulated accidents at ECF was water pool drainage, ultimately resulting in fuel overheating. The exposure to the entire population from this accident is calculated to cause 0.017 cancer fatalities over 50 years, as described in Attachment F.

The exposures to collocated workers following all accidents are well below the naval and DOE 5-rem standard for occupational exposure. However, exposures to the worker located at the ECF site 100 meters from the radiation release point would exceed this standard following an accident resulting in an inadvertent criticality.

Effects from accidents at ECF involving toxic chemicals were evaluated in Attachment F. Due to the amount and types of chemicals stored at ECF, toxic chemicals do not pose a risk to the public or the maximally exposed off-site individual following any of the postulated accidents. However, following the maximum foreseeable accident analyzed (a fire transient), a number of toxic chemicals would exceed Emergency Response Planning Guideline (ERPG) values for workers at ECF. For maximum off-site individuals at INEL, ERPG-1 values for the toxic chemicals are not exceeded under 50% or 95% meteorology conditions. The concentrations of toxic chemicals following the fire transient as well as a summary of the analysis methods are provided in Attachment F.

5.2.14.2 Transportation Accidents. The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and the hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any health effects as a result of naval spent nuclear fuel and test specimen shipments since the risk estimates are much less than one fatal cancer or detrimental health effect for each alternative. However, the most severe accident, with a likelihood of occurrence greater than 1×10^{-7} events per year, is estimated to result in a maximum of approximately 2 fatalities. The details of the transportation analysis are provided in Attachment A.

5.2.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives.

The analyses described in Attachment F showed that for the most severe hypothetical accidents, an area of approximately 8 to 11 acres, extending about 1/4 to 1/3 mile downwind, might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond this distance, exposures would be below 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who work at the federal facilities within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure.

The area affected by the hypothetical accidents would not extend beyond the boundaries of the INEL and, in fact, would not come close to approaching the boundaries. An accident might result in short-term restrictions on access to a relatively small area of the federally owned site, but it would not be expected to produce enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner and in full compliance with applicable laws and regulations. The area would vary only slightly among the alternatives considered. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. Similarly, since the areas which might be contaminated by chemicals or radioactive material to measurable levels during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. As previously stated, there are no endangered or threatened species unique to the area surrounding the Expanded Core Facility at INEL, so an accident would not be expected to result in destruction of any species for any of the alternatives considered. The effects of accidents associated with any of the alternatives and any cleanup which might be performed would be localized within a small area extending only a short distance from the Expanded Core Facility and thus would not be expected to appreciably affect the potential for survival of any species. Consequently, consideration of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.2.15 Waste Management

All non-hazardous solid wastes that cannot be recycled or used by other government agencies are transported to the INEL landfills at the Central Facilities Area. Operation of ECF makes little contribution to these wastes other than the trash associated with the approximately 500 persons who work at that facility. Therefore, the impact in this area at the INEL is little affected by the alternative selected.

The use of hazardous materials in essential applications at ECF results in the generation of some hazardous wastes, including photographic solutions, solutions containing heavy metals, organic solvents, paint-related wastes, and laboratory wastes. All hazardous wastes are transported by vendors to treatment, storage, and disposal facilities approved by the Environmental Protection Agency and operating under approvals or permits granted by state and federal regulatory agencies, and none are disposed of at INEL. When appropriate, wastes are recycled or provided to other federal agencies for use. The small amount of hazardous waste produced from ECF operation would be produced and managed in the same manner if the facility were constructed and operated at an alternate site, so the overall effect on the environment, including that in the vicinity of INEL, is essentially unchanged by the alternative selected.

Operations at ECF contribute approximately 425 cubic meters (15,000 cubic feet) of radioactive solid waste each year and this amount of solid radioactive waste would be reduced by approximately 75% after about three years if an alternative which stopped naval spent nuclear fuel examinations at INEL were selected. No high-level waste and almost no transuranic waste (less than 0.0001 cubic meter per year) are generated from current operations at ECF. None of the alternatives considered would increase the amount of radioactive waste at INEL resulting from naval spent nuclear fuel examinations. The radioactive waste from ECF examinations and related operations would be generated and managed in a similar manner if the facility were constructed and operated at an alternative site. Consequently, the overall effect on the environment is essentially unchanged by the alternative selected.

5.2.16 Cumulative Impacts

Up to this point, Section 5.2 has discussed the potential environmental consequences of operation of the ECF Project at INEL in terms of annual impacts (i.e., radiological exposures and health effects, accident risks, and quantities of wastes that would be generated during operation) based on the maximum annual capacity of the ECF Project. To determine the upper limit for the potential consequences of up to 40 years of future ECF operation (from 1995 to 2035), an evaluation of the accumulated environmental consequences and risks of operating ECF was performed.

5.2.16.1 Radiological Cumulative Impacts. Operation of the INEL-ECF does not result in discharges of radioactive liquids; therefore, there would be no changes to the surface or ground water as a result of normal operations for any alternative. There are small quantities of radioactivity in the air released from ECF which would contribute to the cumulative air quality impacts. For those alternatives where the ECF is shut down, the cumulative impacts would decrease by the amount of ECF radioactivity releases.

The radiation exposure to the general population since the beginning of operations associated with naval spent nuclear fuel is less than 2 rem, which corresponds to approximately 0.001 cancer fatality. An overview of the historical radiological impacts from naval nuclear operations at the INEL and from transportation of naval spent nuclear fuel is provided in Section 4.2.12 and detailed analyses are provided in Attachments F and A. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The annual radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at the ECF at INEL are very small and are described in Section 5.2.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the general public from transportation and from the alternatives considered involving continued operation of the ECF at INEL would be less than 3.5 person-rem. This means that there would be less than 0.0017 fatal cancers from these operations over the entire 40-year period evaluated. The exposure to the maximally exposed off-site individual is calculated to be approximately 0.01 millirem from 40 years of ECF operation. The corresponding risk of a cancer fatality to the maximally exposed off-site individual is 5.2×10^{-9} during his or her lifetime. A worker at the ECF site located 100 meters from the facility would receive less than 3 millirem over 40 years of ECF operation, which corresponds to a 1.1×10^{-6} risk of fatal cancer during the worker's lifetime. Analyses of hypothetical accidents which might occur as a result of these alternatives show that the risk of cancer fatalities is small. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

Cumulative impacts due to radioactive waste generation are expected to be minimal. Approximately 425 cubic meters of low-level waste are expected to be generated annually by ECF over the next 40 years. This is not expected to affect the INEL waste management program. Very little transuranic and mixed wastes and no high-level waste are generated from ECF operations.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

5.2.16.2 Non-radiological Cumulative Impacts. Cumulative socioeconomic impacts associated with continued operation of the ECF Project at the INEL are expected to be minor. The INEL currently employs approximately 11,000 people. The ECF operations work force of 500 people would continue to be employed over the long term at INEL if an alternative is selected which would continue naval spent nuclear fuel examination at INEL. If an alternative were selected which resulted

in naval fuel no longer being examined at INEL, the reduction in ECF work force would increase the predicted future reductions in work force at INEL by 500 jobs. Considering that the labor force in the region of influence consists of almost 105,000 people, the 500 ECF jobs would be expected to have only a minor impact in the INEL area.

Continued operation of the ECF Project at INEL is not expected to result in any appreciable impacts relative to cumulative non-radiological emissions. Current operations at INEL are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

As discussed in Section 5.2.8, the withdrawal of groundwater for continued ECF operation would be a small percentage of existing water withdrawals at INEL and well within the cumulative capabilities of the local water resources. ECF discharges of non-radioactive and non-hazardous liquid effluents at INEL would not affect water quality. The volume of ECF routine liquid effluents discharged at INEL would also not discernibly increase the impact to the local ecology.

Operation of the ECF has no effect on cumulative land use impacts. NRF occupies less than 0.02% of the approximately 571,000-acre INEL site and no additional land would be disturbed. Even for the options in which ECF is shut down, there would be no cumulative land use impacts since the site would need to be decommissioned and decontaminated before releasing it for other uses and this work would extend beyond the time frame of this study.

The cumulative impacts associated with non-radiological waste management are also small. The volume of hazardous, municipal, and sanitary wastes produced by ECF has not been calculated; however, considering the nature of the work associated with ECF and the number of workers, the amount of hazardous, municipal, and sanitary waste produced has a small effect on the cumulative impacts associated with this waste. For those options in which ECF is shut down, the effect of these wastes on the cumulative impacts is even smaller.

5.2.17 Unavoidable Adverse Effects

Small amounts of radioactivity, described in Section 5.2.12, would be released as a result of spent fuel operations at ECF, resulting in less than one health effect in the entire population surrounding INEL. The effects of these small releases, combined with the other factors described in Section 5.2.16, would produce no discernible cumulative effects. Similarly, continued operation of the facility would produce limited amounts of liquid sanitary waste and solid municipal waste and solid low-level radioactive waste. These amounts of waste would not differ from those produced in the past by operation of ECF and would not produce any major impacts in the vicinity of INEL.

The most important adverse effect in the vicinity of INEL would be the loss of jobs which would occur if an alternative which shut down the Expended Core Facility were chosen. As discussed in Section 5.2.3 above, approximately 500 people at INEL would lose their jobs if such an alternative were selected.

5.2.18 Irreversible and Irretrievable Commitments of Resources

There are few irreversible or irretrievable commitments of resources, other than costs, at INEL associated with the selection of any of the alternatives considered for naval spent nuclear fuel. The total cost of operating the INEL-ECF is approximately \$2.6 billion. This cost represents the total cumulative cost over the 40-year period and includes the operations costs for ECF as well as the construction costs for completing the Dry Cell Facility. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

In the event an alternative which resulted in ceasing operations at the Expended Core Facility were selected, decommissioning and decontamination of ECF would not occur immediately. Instead, the facility would be placed in a safe storage condition while the federal government decided on the proper disposition of the facility, planned the disposition, and programmed funds to carry out the disposition. Any disposition of the facility would be conducted in accordance with applicable federal and state regulations.

5.3 SAVANNAH RIVER SITE

5.3.1 Overview of Environmental Impacts

The following sections discuss the potential environmental consequences that would occur if a replacement for the Expanded Core Facility (ECF) were constructed and operated at the Department of Energy's Savannah River Site (SRS) or if the Barnwell Nuclear Fuel Plant (hereafter referred to as the Barnwell Plant) that is adjacent to and contiguous with the SRS were operated for this purpose. Both of these subalternatives will be referred to as the Savannah River ECF. The two proposed sites are depicted as Site A and Site B in Figure 4.3-1. Details of receipt, handling, and examination of naval spent nuclear fuel at the SRS and the modifications to the Barnwell Plant are described in Attachment E.

The environmental consequences of locating the ECF at the SRS are based on the same radiological source terms for normal and accidental releases and the estimated ECF atmospheric emissions, liquid effluents, and solid wastes discussed in Section 5.2. Consistent with the scope of a programmatic Environmental Impact Statement, the environmental effects due to normal and accidental releases were evaluated primarily for Site A. Some variations in the exposure to off-site individuals and workers at other SRS facilities would occur for the Barnwell Plant site. The environmental consequences of locating and operating the ECF at SRS would be similar to those for the ECF at the Idaho National Engineering Laboratory (INEL), and none would be large.

5.3.2 Land Use

Construction of a Savannah River ECF Project at Site A would directly affect about 30 acres of land. The Savannah River ECF site considered and its adjacent environs are relatively diverse and contain both pine stands and mixtures of hardwoods. Construction would not disturb any critical or sensitive ecological habitats, nor would it impact wetland areas. Compared to the INEL-ECF site, however, the Savannah River ECF site is considered more ecologically diverse.

The alternative location at the Barnwell Plant is approximately 6 miles from the Site A location. Forest removal at this site has already been completed, and any additional construction is not expected to have any effect on land use.

Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.3.3 Socioeconomics

The potential socioeconomic impacts associated with construction of the Savannah River ECF are expected to be equal to or less than those associated with the original ECF construction at the INEL because (1) a large movement of construction workers from other areas would not be expected for the Savannah River ECF construction due to the availability of construction craft workers within 70 miles of the SRS (Halliburton 1992); and (2) the six counties surrounding the SRS have a population much larger than the INEL area, which would provide a greater capability to absorb any temporary relocation of construction personnel.

Table 5.3-1 provides a summary of the direct jobs which would be required for the construction and operation of the Savannah River ECF during the 10-year period immediately after the Record of Decision. The greatest number of direct jobs would occur in 1999 during the peak of the construction phase. Estimates of the indirect jobs created as well as the effect on area population are included in Section 5.5.3 of Volume 1 as part of either the Regionalization or Centralization at the SRS alternatives.

Table 5.3-1. Summary of direct jobs due to the Savannah River ECF.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	20	20	476	825	1033	894	850	500	500	500

During the Savannah River ECF construction period, operations personnel would be hired so that at the end of the construction period, most of the operations workers would be employed. When fully staffed, ECF operation at the SRS would require approximately 500 people, the same number of operating and support personnel as at the INEL-ECF. This would represent less than 3 percent of the

total SRS work force. The six-county region of influence around the SRS had a 1990 population of 425,607 persons, or about twice that of the INEL. The larger population base associated with the SRS region would also provide a greater capability to absorb any personnel moving into the area during the construction period; however, the larger economic base of the SRS region (DOE 1988) would also have a greater tendency to diffuse potential economic benefits compared to the ECF Project at the INEL.

Given the small percentage increase in the number of jobs at the SRS attributable to Savannah River ECF operation, the impacts to local government services and community infrastructures are expected to be small. Volume 1 quantifies these effects. The economic benefits to the SRS region are expected to be similar to or less than those for the INEL region as the existing economic base of the SRS region is much greater and more diverse than the INEL region (DOE 1988).

5.3.4 Cultural Resources

None of the alternatives considered would impact known historical, archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.3.5 Aesthetic and Scenic Resources

The construction of the Savannah River ECF at Site A would directly affect 30 acres of land. As a result of its location and industrial characteristics, there is essentially no aesthetic or scenic impact, since the site would not be visible to the public.

No additional land would need to be cleared if the Barnwell Plant were used for an ECF. The building containing the existing water pool would need to be enlarged as part of the modifications discussed in Attachment E; however, the effect on the scenic resources would be minimal.

5.3.6 Geology

5.3.6.1 General Geology. The local geology of the SRS region determines the locations of the surface waters and groundwaters at the site described in "Reactor Operation Environmental Information Document, Volume I, Geology, Seismology and Subsurface Hydrology" (WSRC 1989). The geology of the SRS region has not been affected by operations conducted at SRS and is not expected to be affected by Savannah River ECF operations.

5.3.6.2 Geologic Resources. The geology of both sites considered has sufficient strength to support construction of the ECF structures, and operation of the Savannah River ECF is not expected to affect any geologic resources.

5.3.7 Air Resources

Toxic chemicals are used in the normal operations of an ECF. The use of these chemicals is controlled to limit the exposure of workers and the public. Airborne emissions from normal operations include the combustion gases from the boiler house, where fuel oil is burned to make steam from space heating. Emergency diesel generators, which are provided for safety, are operated periodically for test purposes and release exhaust fumes to the atmosphere. These emissions would not have any detectable environmental consequence.

The airborne releases of radioactivity for the Savannah River ECF would be the same as the INEL-ECF described in Section 5.2. The airborne release would result in no measurable exposure to on-site personnel or the general population. Details are provided in Attachment F.

5.3.8 Water Resources

5.3.8.1 Surface Water. Water required for construction of the facility would be withdrawn from the Savannah River. The small amount of water withdrawn from the Savannah River would be negligible in comparison to the approximately 4.5 million gallons-per-minute flow near the SRS. No new water intake structure would be required.

Expected surface water withdrawals of 2.5 million gallons per year from the Savannah River during Savannah River ECF operations represent small incremental increases in the amount of water currently being withdrawn by on-going SRS operations (23.2 billion gallons annually) and represent a negligible withdrawal in comparison to the average flow of the Savannah River. There would be no discharge of Savannah River ECF liquids to the Savannah River.

5.3.8.2 Groundwater. Sanitary effluents generated during construction would be treated through either the use of chemical toilets or a wastewater treatment facility. Solid waste generated during construction would be disposed of in the SRS sanitary landfill, which is operated in accordance with State of South Carolina guidelines. Mitigation and control measures for potential spills, fugitive dust, and erosion would be undertaken as part of construction activities.

Sanitary effluents generated as a result of Savannah River ECF operations would be discharged to a wastewater treatment plant. There would be no discharge of radioactive or hazardous liquid effluents to the ground at the Savannah River ECF site. Construction and operation of the Savannah River ECF is not expected to have an effect on the groundwater.

5.3.9 Ecological Resources

5.3.9.1 Terrestrial Ecology. During construction, plant and animal habitats associated with pine and hardwood vegetation communities would be lost or displaced from the construction site. Additionally, construction may have short-term impacts on wildlife beyond the immediate construction site (i.e., impact on area animals due to construction and traffic noise). However, because the affected land area is small compared to the entire SRS, the impacts on wildlife from construction are expected to be minor.

During construction and operation of the Savannah River ECF, all effluents and emissions would comply with regulatory standards. Due to the level of the emissions described in Attachment F, they are not expected to have an impact on the area wildlife. Operation of the Savannah River ECF should result in less noise and traffic than the construction phase, and no effects on terrestrial ecology are expected from Savannah River ECF operation.

5.3.9.2 Wetlands. The only wetlands located on the proposed Savannah River ECF sites are the Carolina Bays located at Site A. Because the Carolina Bays are located on the edge of the proposed site, they can be avoided during construction. Construction and operation of the Savannah River ECF would have no discernible impacts on other wetland areas and habitats at the SRS.

5.3.9.3 Aquatic Ecology. Experience has shown that SRS operations (e.g., reactor operation) can have an adverse effect on the receiving aquatic ecosystems (e.g., L-Lake, Steel Creek, Pen Branch, etc.). However, because there would be no discharge of radioactive or hazardous liquid effluents from Savannah River ECF operation, Savannah River ECF operation is expected to have no effect on the aquatic ecology.

5.3.9.4 Endangered and Threatened Species. The endangered and threatened species are described in Volume 1, Appendix C. The construction and operation of the Savannah River ECF are not expected to have any environmental impact on the endangered and threatened species found at the SRS.

5.3.10 Noise

The SRS is a large area of about 800 square kilometers (310 square miles). If the alternative involving construction of a new facility were selected, the construction of the Savannah River ECF would cause typical construction noises. There would be little or no noise accompanying normal operations of the Savannah River ECF.

5.3.11 Traffic and Transportation

Traffic and transportation would increase slightly in the SRS area if an ECF is constructed and operated at the SRS. The additional traffic would mainly be due to increased commuter traffic from construction workers and 500 operations workers as well as traffic from material shipments during the Savannah River ECF construction.

If the ECF Project were located at the SRS, routine shipments of naval spent nuclear fuel would be transported to the site in certified shipping containers. Low-level waste generated at the facility and transuranic waste would be moved from the facility to an SRS storage facility.

5.3.12 Occupational and Public Health and Safety

The health and safety assessment of normal operations at the Savannah River ECF was based on managing spent nuclear fuel for examination and storage by either of two approaches (i.e., handling in a water pool or in a dry cell). These are the same methods of spent nuclear fuel handling that have been employed or seriously considered for use at the INEL-ECF. The normal operational impacts associated with the Savannah River ECF would be similar to those for the INEL-ECF. The following sections describe the non-radiological and radiological impacts associated with the Savannah River ECF (refer to Section 5.2 for the INEL-ECF impacts).

5.3.12.1 Occupational Health and Safety. Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

During Savannah River ECF construction, workers are not expected to experience elevated background levels of radiation resulting from on-going SRS operations. The gamma radiation measured near the proposed Savannah River ECF site is similar to the radiation levels measured off-site in the SRS area (WSRC 1992). The potential exposure to a construction worker from inhalation of radionuclides released to the atmosphere from existing SRS operations is estimated to be less than 1 millirem per year, which is small compared to the external exposure. The very small exposure received by a construction worker would be well below the naval and Department of Energy (DOE) standard of 5000 millirem per year for occupationally related whole-body and internal exposures.

During operation of the Savannah River ECF, SRS personnel would be exposed to routine atmospheric emissions of radioactivity and might be exposed to potential emissions from accidents. Site A is located approximately 1 mile from the nearest SRS facility, while the Barnwell Plant is located approximately 5 miles from the nearest facility. As shown in Attachment F, no measurable exposure would be received by these collocated workers from normal Savannah River ECF operations. Exposures received by Savannah River ECF radiation workers from normal operations are

expected to be similar to the exposures currently received by workers from ECF operation at the INEL, discussed in Section 5.2.12.

5.3.12.2 Public Health and Safety. The impacts of normal operation of the Savannah River ECF would be similar to those for the INEL-ECF. Normal radiological releases to the atmosphere and the quantities of radioactive and hazardous wastes that would be generated would not differ from those previously discussed for the INEL. However, the location of the project relative to the surrounding SRS population and the distances to facilities that would be involved in routine shipments of material would result in differences in potential environmental consequences. Described below are the impacts to the public associated with operation of the Savannah River ECF (refer to Section 5.2.12 for the INEL-ECF impacts).

Assessment of the normal operations of the Savannah River ECF involved two options: fuel handling in a water pool and dry cell handling of fuel for examination and storage. For both options considered, the potential annual exposures were estimated for five different types of people: a worker at the Savannah River ECF site located 100 meters from the release point, the hypothetical maximally exposed collocated worker on the SRS site, the hypothetical maximally exposed off-site individual (MOI), an individual at the nearest public access (NPA), and the population within 80 kilometers (50 miles) of the Savannah River ECF site. Three pathways were included in the analysis: airborne, waterborne, and direct radiation, as applicable.

The results indicate that either the water pool or the dry cell option would be satisfactory for normal operations since the exposure is so low. The analysis shows that the exposure to all the individuals considered (workers, collocated workers, MOI, and NPA) from Savannah River ECF operations would be much less than 1 millirem per year. For perspective, it could be stated that one member of the entire population might experience a fatal cancer due to Savannah River ECF operations if operations continued for over 50,000 years. A description of the analysis methods and more detailed results are provided in Attachment F. The impacts from normal operations for all alternatives are summarized in Section 3.7.

The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of

naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.3.13 Utilities and Energy

Heating, ventilation, and electrical systems appropriate to the needs of the Savannah River ECF for suitable working environments and to properly filter and exhaust the airborne discharges to the atmosphere are estimated to require approximately 10,000 MWh per year for normal operations. Emergency diesel electrical generators would provide 350 kw for life support and crucial facility services during power outages. The amount of energy consumed would be a small fraction of the total energy used at SRS, and no discernible environmental consequence is expected.

5.3.14 Facility and Transportation Accidents

The differences in the potential consequences and risks of accidents of a Savannah River ECF compared to the INEL-ECF are related to the meteorological transport of released material, the population exposure, and the distance of transport. The following sections address the potential accident consequences and risks associated with locating an ECF at the SRS.

5.3.14.1 Facility Accidents. The accident scenarios for the Savannah River ECF are the same as those considered for the existing ECF at the INEL. These include radiological accidents which could occur during water pool and dry handling of spent nuclear fuel as well as accidents involving toxic chemicals used at ECF. The general types of radiological accidents analyzed included: (1) accidental criticality, (2) water pool drainage, (3) severe mechanical damage of spent fuel, (4) partial loss of shielding, and (5) an airplane crash into the ECF. Calculations of the cancer fatalities which might occur as a result of all the postulated accidents are provided in Attachment F. A comparison of the accident consequences for all alternatives is provided in Section 3.7.

The difference in the calculated consequences for accidents at the Savannah River ECF compared to the INEL-ECF is that the exposure received by the entire population would be greater at the Savannah River ECF due to the larger population within an 80-kilometer (50-mile) radius of the Savannah River ECF project site. Although the exposure received would be greater at the Savannah River ECF, the number of health effects which would result from any of the accidents considered

would be small. The most limiting of the postulated accidents for the Savannah River ECF was an airplane crash into a dry cell facility. If this accident were to occur, the exposure to the entire population from this accident is calculated to cause 4.8 cancer fatalities over 50 years, as described in Attachment F. The risk associated with the airplane crash is 0.0000096 fatal cancers per year.

The exposures to collocated workers following all accidents are below the naval and DOE 5-rem standard for occupational exposure under 50% meteorology conditions. However, exposures to the worker located at the Savannah River ECF site 100 meters from the radiation release point would exceed this standard following an accident resulting in an inadvertent criticality and following an airplane crash.

Effects from accidents at the Savannah River ECF involving toxic chemicals are similar to those described in Section 5.2.14 for the existing INEL-ECF. Due to the amount and types of chemicals stored at the ECF site, toxic chemicals do not pose a risk to the public following any of the postulated accidents. However, following the maximum foreseeable accident analyzed (a fire transient), a number of toxic chemicals would exceed Emergency Response Planning Guideline (ERPG) values for workers on the Savannah River ECF site as well as for collocated workers. For the MOI under either 50% or 95% meteorology conditions, toxic chemical levels do not exceed ERPG-2 values with the ECF at Site A and ERPG-3 values if the ECF is at the Barnwell Plant Site. The concentrations of toxic chemicals as well as a summary of the analysis methods are provided in Attachment F.

5.3.14.2 Transportation Accidents. The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any health effects as a result of naval spent nuclear fuel and test specimen shipments since the risk estimates are much less than one fatal cancer or health effect for each alternative. However, the most severe accident, with a likelihood of occurrence greater than 1×10^{-7} events per year, is estimated to result in a maximum of approximately 2 fatalities. The details of the transportation analysis are provided in Attachment A.

5.3.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been

estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that for the most severe hypothetical accidents, an area of between about 8 acres extending about 1/4 mile downwind (for an accidental criticality) and approximately 210 acres extending about 1 1/4 mile downwind (for a large airplane crash into the fuel examination facility) might be contaminated to the point where exposure could approach 100 millirem per year. Beyond these distances, exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. The area affected by the hypothetical facility accidents would not extend beyond the boundaries of the Savannah River Site. However, if the currently inactive Barnwell Nuclear Fuel Plant were the site of such an accident, the affected area could extend beyond the boundaries of federally owned property. Persons who live in this area might be evacuated or otherwise experience restrictions in their daily activities for a brief period, and those who work at locations within this area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure.

An accident might result in short-term restrictions on access to a relatively small area, but there would be no enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area impacted would vary only slightly among the alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with an Expanded Core Facility at the Savannah River Site would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for an alternative which would relocate the Expanded Core Facility to the Savannah River Site. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. As previously stated, there are no endangered or threatened species unique to the area surrounding the location considered for a replacement Expanded Core Facility at the Savannah River Site, so an

accident would not be expected to result in destruction of any species. The effects of accidents associated with these alternatives or any cleanup which might be performed would be localized in a small area extending only a relatively short distance from the Expanded Core Facility and thus would not be expected to appreciably affect the potential for survival of any endangered or threatened species in the Savannah River area. Consequently, consideration of impacts of accidents does not help to distinguish among alternatives.

5.3.15 Waste Management

During Savannah River ECF operation, non-radioactive and non-hazardous solid waste and hazardous solid waste would be generated in quantities similar to those for the INEL-ECF. Non-radioactive, non-hazardous wastes would be managed in a manner identical to that for the INEL-ECF (i.e., non-hazardous, non-radioactive solid wastes would be disposed of at a sanitary landfill). Hazardous wastes would be contained at their point of generation and stored at the SRS. Waste management practices for these wastes would produce no identifiable impact on public health and safety of the environment.

Operation of the ECF at the SRS would generate the same quantities of low-level waste, transuranic waste, and mixed wastes as the INEL-ECF. Low-level waste generated by the Savannah River ECF would be stored at the SRS. The 425 cubic meters of low-level waste generated annually by the ECF Project represents a small quantity when compared to the quantity of low-level waste disposed of at the SRS and would not impact planned disposal operations. No high-level waste would be generated.

Less than 0.0001 cubic meter of transuranic waste per year is generated by current ECF operations at the INEL. Any transuranic waste generated by the Savannah River ECF would be in addition to approximately 10,000 cubic meters currently held in storage at the SRS. Transuranic wastes generated at the Savannah River ECF would be a very small fraction of the SRS transuranic waste generated and would not impact planned SRS waste-handling operations.

Mixed wastes generated by Savannah River ECF operation would be stored at the SRS until treatment and disposal facilities are available. The amount of mixed waste generated would represent

a small quantity in relation to the quantities requiring storage or disposal from past and on-going SRS operations.

5.3.16 Cumulative Impacts

Up to this point, Section 5.3 has discussed the potential environmental consequences of constructing and operating the ECF Project at the SRS in terms of annual impacts (i.e., radiological doses and health effects, accident risks, and quantities of wastes that would be generated during operation) based on the maximum expected annual throughput of the ECF Project. To determine the potential consequences for 40 years of ECF operation (from 1995 to 2035), an evaluation of the accumulated environmental consequences and risks of constructing and operating the Savannah River ECF was performed.

5.3.16.1 Radiological Cumulative Impacts. The Savannah River Site has not been used for naval spent nuclear fuel operations in the past. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

Operation of the Savannah River ECF will not result in discharges of radioactive liquids; therefore, there would be no changes to the surface or ground water as a result of normal operations for any alternative. There will be small quantities of radioactivity in the air released from ECF which would contribute to the cumulative air quality impacts.

The annual radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at SRS are very small and are described in Section 5.3.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the general public from transportation and from Savannah River ECF operations would be less than 14 person-rem. This means that there would be less than 0.0067 fatal cancers from these operations over the entire 40-year period evaluated. The exposure to the maximally exposed off-site individual would be less than 0.2 millirem from 40 years of Savannah River ECF operation at either Site A or the Barnwell Plant. The corresponding risk of a cancer fatality to the maximally exposed off-site individual is 9.6×10^{-9} at Site A and 7.6×10^{-8} at the Barnwell Plant during his or her lifetime. A worker at the Savannah River ECF site located 100 meters from the facility would receive less than 4 millirem over 40 years of Savannah River ECF operation, which corresponds to a 1.4×10^{-6} risk of fatal cancer during the worker's lifetime. These exposures and cancer risks are as a result of ECF operations only. The exposures and risks corresponding to site-wide operations (including ECF) are discussed in Volume 1, Chapter 5. Analyses of hypothetical accidents which might occur as a result of these alternatives show that the risk of cancer fatalities is small. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

Cumulative impacts due to radioactive waste generation are expected to be minimal. Approximately 425 cubic meters of low-level waste are expected to be generated annually by the Savannah River ECF over the next 40 years. This is not expected to affect the SRS waste management program. Very little transuranic waste or mixed waste and no high-level waste will be generated from Savannah River ECF operations.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

5.3.16.2 Non-radiological Cumulative Impacts. Cumulative socioeconomic impacts associated with constructing and operating the ECF Project at the SRS are expected to be minor. The SRS currently employs over 20,000 people. In the past, no employment at the SRS has been associated with naval spent nuclear fuel operations. Savannah River ECF operations would provide long-term employment for 500 people at the SRS and would help offset predicted future reductions in the SRS work force (Halliburton 1992). The peak number of additional jobs created at the SRS in any given year would be approximately 1050, which includes both construction and operations workers during the peak of the Savannah River ECF construction effort. Considering that the labor force in the region of influence consists of 209,000 people, the additional number of jobs added from the construction and operation of the Savannah River ECF would be expected to have only a minor socioeconomic impact in the SRS area.

Construction and operation of the ECF Project at the SRS are not expected to result in any discernible impacts relative to cumulative non-radiological emissions. Construction of the ECF Project at either Site A or Site B is sufficiently remote and removed from the nearest SRS boundaries such that concentrations of fugitive emissions from construction would be well below applicable standards, as discussed in Section F.4 of Attachment F. Current operations at the SRS are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

As discussed in Section 5.3.8, the withdrawal of surface water for ECF construction and operation at the SRS would be a small percentage of existing withdrawals and well within the cumulative capabilities of the respective water resources. ECF discharges of non-radioactive and non-hazardous liquid effluents at the SRS would not affect water quality. The volume of ECF routine liquid effluents discharged at SRS would also have no measurable impact on aquatic biota or the wetland habitat.

Minimal cumulative land use impacts would be expected to occur as a result of the construction of a new ECF. The land that would be dedicated for this purpose is on existing federal property. The use of this land would not result in the need for additional land to be added to the federally owned property in the foreseeable future. The SRS occupies an area of approximately 800 square kilometers (310 square miles) with only about 5% of the land occupied by constructed facilities. No

land area at the Savannah River Site has been affected by past operations involving naval spent nuclear fuel. Construction of the Savannah River ECF would affect 30 acres of land. This is less than 0.02% of the total Savannah River Site land area.

The cumulative impacts associated with non-radiological waste management are also expected to be small. The volume of hazardous waste produced by ECF has not been calculated; however, considering the nature of the work associated with ECF, the amount of hazardous waste produced would have a small effect on the cumulative impacts associated with this waste. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of wastes.

5.3.17 Unavoidable Adverse Effects

The construction of the ECF Project at the SRS would directly impact about 30 acres of land area. An estimated 30 acres of stands of loblolly pine and mixtures of hardwoods would be cleared as part of construction activities for Site A. For the Barnwell Plant, no land would need to be cleared due to the limited amount of construction required for this site. During construction at Site A, plant and animal habitats associated with pine and hardwood vegetation communities would be lost or displaced.

Construction of the Savannah River ECF would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of a major industrial facility. All effluents and emissions would be below applicable environmental requirements and would not be expected to result in any major adverse impacts.

During Savannah River ECF operation, non-radioactive and non-hazardous solid waste and hazardous solid waste would be generated in quantities similar to those discussed for the INEL. Non-radioactive and non-hazardous solid waste would be disposed of in the SRS sanitary landfill and

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off-site in a commercial landfill. Hazardous wastes would be stored at the SRS in storage buildings or on storage pads. The Resource Conservation and Recovery Act regulates these wastes. The amount of hazardous waste generated by Savannah River ECF operation would be small in comparison to the amount of hazardous waste that is generated and currently in interim storage at the SRS. No discernible differences from normal hazardous waste management at the SRS would result from this strategy.

During Savannah River ECF operation, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials that would be minimal compared to criteria contained in the Environmental Protection Agency's 40CFR61 and DOE Order 5480.1B. Sanitary waste and service waste liquid discharges would be below applicable environmental standards. Solid wastes generated during operation, including transuranic, low-level, hazardous, and mixed wastes, would result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would result in a negligible increase in the risk of skin cancer; substitutes will be used when available.

In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would have a detectable effect on public health and safety. The difference in the impacts between the ECF alternative at SRS and the other DOE sites (INEL, Hanford, Oak Ridge, Nevada Test Site) is not discernible.

5.3.18 Irreversible and Irretrievable Commitments of Resources

During operation of the Savannah River ECF, additional fuel oil would be burned to supply steam for heat. The fuel is not in short supply. The water to be used for the Savannah River ECF would be withdrawn from the Savannah River and would be a negligible amount. No new water intake structure would be required, and no observed impacts have resulted from previous withdrawals. Total consumption of water attributable to water pool operations and consumption of potable water by operating personnel represent less than one-thousandth of a percent of the Savannah River average annual flow.

The total cost of locating a new ECF at Savannah River is approximately \$3.5 billion. This cost represents the total cumulative costs over the 40-year period and includes construction and

operations costs of the new ECF as well as the costs associated with shutting down the INEL-ECF. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives. This cost would be reduced if the Barnwell Plant were selected.

As is the case with the INEL-ECF, construction and operation of the Savannah River ECF would not require the use or consumption of scarce resources.

5.4 HANFORD SITE

5.4.1 Overview of Environmental Impacts

The following sections discuss the potential environmental consequences that would arise if a facility to replace the Idaho National Engineering Laboratory Expanded Core Facility (INEL-ECF) were to be constructed and operated at the Department of Energy (DOE) Hanford Site (Hanford ECF). Two options exist at Hanford: build a new ECF between the 200 West and the 200 East Areas, or modify the existing Fuels and Materials Examination Facility (FMEF) in the 400 Area (see Figure 4.4-1). Details of the receipt, handling, and examination of naval spent nuclear fuel at Hanford and the modifications to the FMEF are described in Attachment E. A detailed discussion of the potential environmental consequences of other actions and alternatives at Hanford is contained in Volume 1, Appendix A.

The environmental consequences of constructing and operating the Hanford ECF are based on the same radiological source terms for normal and accidental releases and the estimated atmospheric emissions, liquid effluents, and solid wastes for the INEL-ECF discussed in Section 4.2.

The environmental consequences for the Hanford ECF would be similar to those for the INEL-ECF (see Section 5.2), and none would be large.

5.4.2 Land Use

The Hanford ECF would use essentially the same land area as that which was affected by construction of the INEL-ECF. The structure itself would occupy approximately 5 acres, and the total affected land area would be approximately 30 acres. The higher elevation of the Hanford ECF location relative to a Probable Maximum Flood would reduce the amount of grading and the resulting atmospheric emissions from construction activities.

The land area that would be affected at the Hanford Site has been dedicated through previous operations as a nuclear materials handling area. The land area affected by construction is of the

sagebrush vegetation community typical of the arid Hanford Site region. Land areas disturbed by construction but not affected during operation would revert to the natural sagebrush community.

Native American rights and interests may be affected by construction or operations associated with alternatives that involve construction or modification of facilities at the Hanford Site. DOE is assisting Native Americans who have expressed an interest in renewing their use of some Hanford land-use resources, in accordance with the Treaty of 1855. Details are provided in Volume 1, Appendix A.

5.4.3 Socioeconomics

If the Hanford ECF were to be constructed, the potential socioeconomic impacts associated with construction of the facility are expected to be equal to or less than those that were associated with constructing the existing INEL-ECF because: (1) as at the INEL, a large migration of construction workers into the area would not be expected for constructing the project at the Hanford Site due to the availability of construction craft workers who were formerly involved in construction work at the Hanford Site; and (2) the existing population base within 80 kilometers (50 miles) of the Hanford Site is larger than that surrounding the INEL and would provide a larger capability to absorb the incoming construction workers. The estimates of the social and economic requirements of the operational work force expected to be employed during the construction period are small and similar to those estimated for the INEL. Details are available in Volume 1, Appendix A.

Table 5.4-1 provides a summary of the direct jobs which would be required for the construction and operation of the Hanford ECF during the 10-year period immediately after the Record of Decision. The greatest number of direct jobs would occur in 1999 during the peak of the construction phase. Estimates of the indirect jobs created as well as the effect on area population are included in Section 5.5.1 of Volume 1 as part of either the Regionalization or Centralization at Hanford alternatives.

Table 5.4-1. Summary of direct jobs due to the Hanford ECF.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	20	20	476	825	1033	894	850	500	500	500

During the construction period, operations personnel would be hired so that at the end of the construction period, most of the workers required for operation and support would be employed. When fully staffed, operation of the Hanford ECF would require approximately 500 people, the same number of operating and support personnel as operation of the INEL-ECF. The total operating work force would represent about 3 percent of the Hanford Site employment. The potential economic benefits to the area are expected to be similar to those for the INEL area. The benefits would result from the new jobs that would be created and the associated jobs that would become reinforced (DOE 1986a).

With the small percentage increase in the number of jobs at the Hanford Site attributable to Hanford ECF operations, the impacts to local government services and community infrastructures are expected to be small. Volume 1 quantifies these effects. The beneficial economic impacts to the region are expected to be similar to the economic benefits for the INEL region.

5.4.4 Cultural Resources

Construction at this site would neither impact any known archaeological and historic sites nor disturb any known habitats for rare or endangered species. None of the alternatives considered would impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.4.5 Aesthetic and Scenic Resources

The Hanford Site is in a semi-arid region of southeastern Washington. Since 1943, when the site was selected to become the facility for the production of plutonium for the Manhattan Project, the site has been devoted to research, development, and production activities. As a result of its isolated location, its industrial characteristics are not readily visible to the public. The architecture is compatible with the current industrial setting.

5.4.6 Geology

5.4.6.1 General Geology. The local geology of the Hanford region determines the locations of the surface waters and groundwaters at the site. The geology of the Hanford region is not expected to be affected by the Hanford ECF construction or operations.

5.4.6.2 Geologic Resources. Two geological resources are of particular relevance to the Hanford Site and to its utility as a location for the Hanford ECF. The water table is located several hundred feet beneath the site. The region between the surface and the water table is an unsaturated zone; it provides an effective barrier between the large aquifer in the groundwater below and the radiological work conducted above. No radiological or hazardous liquid effluent from the Hanford ECF would be discharged to the ground. The operation of the Hanford ECF is not expected to alter the character of the unsaturated zone or the aquifer under the Hanford Site.

5.4.7 Air Resources

The meteorology of the Hanford region is described in Section 4.4.7. There is no potential for the construction and operation of the Hanford ECF to have any impacts on the meteorology of the region.

Consideration of general weather parameters in the Hanford region indicates a high potential for air pollution due to frequent low rates of turbulence or mixing in the atmosphere. The lowest rates of mixing in an atmospheric layer are found in thermally stable layers. Thermally stable conditions occur at Hanford about 44 percent of the time, on the average. Neutral conditions (moderate mixing) occur about 31 percent of the time. The highest rates of mixing (thermally unstable) occur only about 25 percent of the time.

The stagnation that results from low mixing permits an abnormally high concentration of pollutants to accumulate from sources within the region. This applies to ordinary pollutants, such as smoke and other exhaust fumes from regional sources, as well as to airborne emissions from Hanford and a Hanford ECF. The normal emissions from a Hanford ECF would be low enough that the increase that might be accumulated during an inversion would not have any discernible environmental

consequence. Less than 1 percent of the total calculated number of fatal cancers in the 80-kilometer (50-mile) population would be due to the normal operations of a Hanford ECF.

Some of the chemicals that are used in the normal operations of an ECF are classified as toxic chemicals. The use of these chemicals is controlled to limit the exposure of workers and the public. Airborne emissions from normal operations include the combustion gases from the boiler house, where fuel is burned to make steam for space heating. Emergency diesel generators are provided for safety, are operated periodically for test purposes, and release exhaust fumes to the atmosphere.

The airborne release of radioactivity for the Hanford ECF would be the same as the INEL-ECF described in Section 5.2. The airborne releases would result in no measurable exposure to on-site personnel or the general public. Details are provided in Attachment F.

Experience with construction activities at Hanford indicates that fugitive dust concentrations at the nearest point of public access and at the site boundaries would be less than the Washington State limits. Standard control techniques such as applying water to the disturbed ground could be used to limit the dust emissions at the construction site.

5.4.8 Water Resources

5.4.8.1 Surface Water. Water required for construction would be withdrawn from the Columbia River. The amount of water withdrawn from the Columbia River would be negligible in comparison with the 3400 cubic meters per second (120,000 cubic feet per second) annual average flow rate of the river at the Hanford Site. No new water withdrawal intake structure would be required.

Expected surface water withdrawals from the Columbia River during Hanford ECF operations represent small incremental increases in the amount of water currently being withdrawn by on-going Hanford operations and represent a negligible withdrawal in comparison to the average flow of the Columbia River. There would be no discharge of liquids from the Hanford ECF to either the Columbia or Yakima River.

5.4.8.2 Groundwater. The groundwater at the potential Hanford ECF site is several hundred feet beneath the surface. This distance provides an ample buffer between the surface operations and the aquifer.

There would be no discharge of radioactive or hazardous liquid effluents from the Hanford ECF to the ground. The existence of contamination in the groundwater due to previous operations at the Hanford Site is discussed in Section 4.4.8.

Sanitary effluents generated during construction would be treated through the use of a septic tank and drain field. Solid non-radioactive and non-hazardous waste resulting from construction would be disposed of on-site at a sanitary landfill. Mitigative and control measures for potential spills and fugitive dust emissions would be undertaken as required.

Sanitary effluents generated as a result of Hanford ECF operations would be discharged to a septic tank located outside of the protected-area fence. Effluent from the septic tank would then be discharged to a sanitary tile field. Other liquid effluents, such as process steam condensate that would be within the limits of DOE and federal standards (DOE 1986b; CFR 1991; CFR 1992a), would be monitored and discharged to a tile field. Liquid effluents meeting these standards and requirements would not result in contamination of groundwater resources.

5.4.9 Ecological Resources

The largest impacts would result from the Centralization alternative. It requires the construction and operation of the Hanford ECF. It is expected that these impacts would be small and similar to those already experienced at Hanford from the construction and operation of other facilities of similar size and scope of operations. The expected impacts are discussed in the following subsections.

5.4.9.1 Terrestrial Ecology. Construction of the Hanford ECF would disturb approximately 30 acres of land, and would permanently occupy 5 acres of land. The remaining land would be revegetated with native grasses. There would be some adverse effect on animal populations, especially the less-mobile animals that might be destroyed during land clearing, but the larger ones would move to another location. The small quantities of radioactivity that would be released are

expected to have no effect on man, and are expected to have no effect on the terrestrial organisms. Further discussion is provided in Volume 1, Appendix A.

5.4.9.2 Wetlands. Due to the semi-arid nature of the Hanford environment, there are few affected wetland areas. They are found along the Columbia River and in local areas at the edges of ponds where the growth of various plants is enhanced. Hanford ECF operations would not have any adverse impact on these areas. Additional information is provided in Volume 1, Appendix A.

5.4.9.3 Aquatic Ecology. There are no aquatic habitats at the potential site for the Hanford ECF. Hence, there would be no impact on aquatic resources due to construction or operation of the Hanford ECF. Aquatic resources are discussed further in Volume 1, Appendix A. Experience has shown that Hanford operations have not adversely affected its aquatic ecology. The Hanford ECF alternatives are expected to have no adverse impact.

5.4.9.4 Endangered and Threatened Species. Construction and operation of the Hanford ECF would remove approximately 30 acres of sagebrush habitat until it was revegetated and reestablished after construction. This would impact some members of the species that nest and breed there. Similarly, there would be some impact on vegetation and less-mobile animals, but in general the impacts would be local and the affected animals would be expected to relocate to another suitable habitat on the site. Further discussion and mitigation measures are provided in Volume 1, Appendix A.

5.4.10 Noise

The Hanford Site is a very large area, about 1450 square kilometers (560 square miles), but only about 6 percent of the area is occupied by constructed facilities. Other than the normal noises associated with sparsely spaced industrial facilities and air, rail and road traffic, there is essentially no detectable noise on the site. Construction of the Hanford ECF would cause typical construction noises during the construction period. There would be little or no noise accompanying the normal operations of the Hanford ECF.

5.4.11 Traffic and Transportation

Traffic and transportation would increase slightly in the Hanford area if an ECF is constructed and operated at Hanford. The increased traffic would be mainly due to material shipments during Hanford ECF construction and additional commuter traffic from the construction workers and the operations workers.

The Hanford ECF site would be served by railway and roads. Naval spent nuclear fuel and any irradiated test specimens would be shipped by railway in shielded shipping containers from the shipyard, prototype, or test reactor to the Hanford ECF. There they would be examined and prepared for storage at a DOE facility. Stored fuel and scrap specimens would be stored until they would be shipped to a designated site for disposition. Solid, low-level waste from Hanford ECF handling would be transported by roadway to a Hanford shallow land burial site.

5.4.12 Occupational and Public Health and Safety

The health and safety assessment of normal operations at the Hanford ECF is based on handling spent nuclear fuel for examination and storage by either of two approaches: handling in a water pool or handling in a shielded dry cell. These are the same methods of spent nuclear fuel handling that have been used or were seriously considered for use at the INEL-ECF.

The normal operational impacts associated with the Hanford ECF would be similar to those for the INEL-ECF. The following sections describe the non-radiological and radiological impacts associated with the Hanford ECF (refer to Section 5.2 for the INEL-ECF impacts).

5.4.12.1 Occupational Health and Safety. Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

During construction of the Hanford ECF at the Hanford Site, construction personnel would be exposed to a slightly elevated background level of radioactivity resulting from ongoing Hanford Site operations. The maximum additional annual exposure from ongoing operations at the Hanford Site for a construction worker in the vicinity of the 200-East Area would be approximately 2 to 3 millirem if he or she spent 2000 hours per year (40 hours per week for 50 weeks per year) at the Site. This annual exposure of approximately 2 to 3 millirem to a construction worker at the Hanford Site would be well below the DOE standard of 5000 millirem per year for occupational exposure.

During operation of the Hanford ECF, other Hanford personnel would be exposed to routine atmospheric emissions of radioactivity and to potential emissions from accidents. The radiological exposure received by on-site personnel would be below the DOE standard for occupationally related external and internal exposure. Approximately 3000 workers are employed in the 200-East Area within a 1.6-kilometer (1-mile) radius of the Hanford ECF site. Fewer workers are employed near the 400 Area (alternative FMEF site for the Hanford ECF). As shown in Attachment F, the health effects due to exposures received by the collocated worker from normal Hanford ECF operation would be small. Exposures received by Hanford ECF workers are expected to be similar to the exposures that have been received by workers from recent ECF operations at the INEL, discussed in Section 5.2.12.

5.4.12.2 Public Health and Safety. Radiological releases to the atmosphere during normal operations and the quantities of radioactive and mixed wastes normally generated would be approximately the same as those previously discussed for the INEL. However, the location of the Hanford ECF relative to the surrounding Hanford Site population and the distances to other facilities that would be involved in routine shipments of material would result in small differences in potential environmental consequences.

Assessment of the normal operations of the Hanford ECF involved two options: fuel handling in a water pool or dry cell for examination and storage. For both options considered, the potential annual exposures were estimated for five different types of people: a worker at the Hanford ECF site located 100 meters from the release point, the hypothetical maximally exposed collocated worker on the Hanford Site, the hypothetical maximally exposed off-site individual (MOI), an individual at the nearest public access (NPA), and the population within 80 kilometers (50 miles) of the Hanford ECF site. Three pathways were included in the analysis: airborne, waterborne, and direct radiation, as applicable.

The results indicate that either the water pool or the dry cell option would be satisfactory for normal operations since the exposure is so low. The analysis shows that the exposure to all the individuals considered (workers, collocated workers, MOI, and NPA) from Hanford ECF operations would be much less than 1 millirem per year. For perspective, it could be stated that one member of the entire population might experience a fatal cancer due to Hanford ECF operations if operations continued for over 200,000 years. A description of the analysis methods and more detailed results are provided in Attachment F. The impacts from normal operations for all alternatives are summarized in Section 3.7.

The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.4.13 Utilities and Energy

Heating, ventilation, and electrical systems appropriate to the needs of the Hanford ECF for suitable working environments and to properly filter and exhaust the airborne discharges to the atmosphere are estimated to require approximately 10,000 MWh per year for normal operations. Emergency diesel electrical generators would provide 350 kw for life support and crucial facility services during power outages. The increase in electrical power needs might create the demand for additional capacity. The amount of energy consumed would be a small fraction of the total energy used at the Hanford Site, and no discernible environmental consequence is expected.

5.4.14 Facility and Transportation Accidents

The potential consequences and risks of accidents for the Hanford ECF compared to the INEL-ECF are related to the meteorological transport of released material, the population exposed, and (for the transport of naval spent nuclear fuel and any test specimens) the distance of transport. The following sections address the major potential accident consequences and risks associated with the Hanford ECF compared to the INEL-ECF.

5.4.14.1 Facility Accidents. The accident scenarios for the Hanford ECF are the same as those considered for the existing ECF at the INEL. These include radiological accidents which could occur during water pool and dry handling of spent nuclear fuel as well as accidents involving toxic chemicals used at ECF. The radiological accidents analyzed included: (1) an inadvertent criticality caused by an earthquake or similar catastrophic event, (2) accidental loss of large amounts of water containing radioactive material from a water pool into the ground and then into water sources, and (3) severe damage of spent fuel if it were dropped from a crane during handling or had a heavy object dropped on it. The probability of an accident caused by an airplane crash was calculated for the Hanford ECF and was determined to be less than 10^{-7} . Due to the low probability, no consequences were calculated for this accident. Calculations of the cancer fatalities which might occur as a result of all the postulated accidents are provided in Attachment F. A comparison of the accident consequences for all alternatives is provided in Section 3.7.

The difference in the calculated consequences for accidents at the Hanford ECF compared to the INEL-ECF is that the exposure received by the entire population tended to be greater at the Hanford ECF due to the larger population within an 80-kilometer (50-mile) radius of the Hanford ECF project site. Although the exposure received was greater at the Hanford ECF, it is unlikely that any health effects would result from any of the accidents considered. As was the case with the INEL-ECF, the most limiting of the postulated accidents for the Hanford ECF was water pool drainage, ultimately resulting in fuel overheating. The exposure to the entire population from this accident is calculated to cause 0.047 cancer fatalities over 50 years, as described in Attachment F. This amounts to an approximately 5-percent chance of one cancer fatality in 50 years from this potential accident.

The exposures to collocated workers following any accident are well below the naval and DOE 5-rem standard for occupational exposure. However, exposures to the worker located at the Hanford ECF site 100 meters from the radiation release point would exceed this standard following an accident resulting in an inadvertent criticality.

The effects from accidents involving the use of toxic chemicals at the Hanford ECF are similar to those described in Section 5.2.14 for the INEL-ECF. The same amount and types of chemicals stored and used at the INEL-ECF would be used at the Hanford ECF, so toxic chemicals would not pose a risk to the public following any of the postulated accidents. However, following the maximum foreseeable accident analyzed (a fire transient), a number of toxic chemicals would exceed

the Emergency Response Planning Guideline (ERPG) values for workers on the Hanford ECF site as well as collocated workers. For the maximum off-site individual (MOI), ERPG-1 values for the toxic chemicals are not exceeded under 50-percent or 95-percent meteorology conditions. The concentrations of toxic chemicals following the fire transient and a summary of the analysis methods are provided in Attachment F.

5.4.14.2 Transportation Accidents. The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancer as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. However, the most severe accident with a likelihood of occurrence greater than 1×10^{-7} events per year is estimated to result in a maximum of approximately 2 cancer fatalities. The details of the transportation analysis are provided in Attachment A.

5.4.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that for the most severe hypothetical accidents, an area of between about 8 acres extending about 1/4 mile downwind (for an accidental criticality) and approximately 210 acres extending about 1 1/4 mile downwind (for a large airplane crash into the fuel examination facility) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. Persons who work at locations within this area might be prevented from going to their jobs at the federally owned facilities until measures had been taken to reduce the potential for exposure.

The area affected by the hypothetical accidents would not extend beyond the boundaries of the federally owned Hanford Site. An accident might result in short-term restrictions on access to a relatively small area, but it would not be expected to produce any enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area would vary only

slightly among alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with an Expanded Core Facility at the Hanford Site would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for an alternative which would relocate the Expanded Core Facility to the Hanford Site. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, any effects on the ecology would be limited to small areas. As previously stated, there are no endangered or threatened species unique to the area surrounding the location considered for a replacement Expanded Core Facility at the Hanford Site, so an accident would not be expected to result in destruction of any species. The effects of accidents related to any of the alternatives and any cleanup which might be performed would be localized in a small area which would not extend beyond a relatively short distance from the Expanded Core Facility and thus would not be expected to appreciably affect the potential for survival of endangered or threatened species in the Hanford area. Based on these considerations, evaluation of impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.4.15 Waste Management

During Hanford ECF operations, non-radioactive and non-hazardous solid waste and hazardous solid waste would be generated in quantities similar to those for the INEL-ECF. These wastes would be managed in a manner identical to that for the INEL-ECF (that is, non-hazardous, non-radioactive solid wastes would be disposed of at a sanitary landfill, and hazardous wastes would be contained at their point of generation and transported off-site to an approved treatment, storage, and disposal facility). During normal waste management practices for these wastes, no identifiable impact on public health and safety or the environment would occur.

Operation of the Hanford ECF would generate essentially the same quantities of low-level waste, transuranic waste, and mixed wastes as discussed for the INEL. Additional information on materials and waste management at Hanford is provided in Volume 1, Appendix A.

5.4.16 Cumulative Impacts

The potential environmental consequences of constructing and operating the Hanford ECF are discussed above in terms of annual impacts (that is, radiological exposures and health effects, accident risks, and quantities of wastes that would be generated during operation) based on the evaluation of operating experiences at the INEL-ECF. This section provides a discussion of the potential consequences of up to 40 years of operation of the Hanford ECF (from 1995 to 2035).

5.4.16.1 Radiological Cumulative Impacts. Operation of the Hanford ECF would not result in discharges of radioactive liquids; therefore, there would be no changes to the surface or ground water as a result of normal operations for any alternative. There would be small quantities of radioactivity in the air released from the Hanford ECF which would contribute to the cumulative air quality impacts. The Hanford Site has not been used for naval spent nuclear fuel operations in the past. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The annual radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at Hanford Site are very small and are described in Section 5.4.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed.

The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the general public from transportation and from Hanford ECF operations would be about 5 person-rem. This means that there would be about 0.0025 fatal cancers from these operations over the entire 40-year period evaluated. The exposure to the maximally exposed off-site individual would be less than 0.02 millirem from 40 years of Hanford ECF operation at either the 200 Area or the FMEF. The corresponding risk of a cancer fatality to the maximally exposed off-site individual is 4.8×10^{-9} at the 200 Area and 8.8×10^{-9} at the FMEF during his or her lifetime. A worker at the Hanford ECF site located 100 meters from the facility would receive less than 4 millirem over 40 years of Hanford ECF operation, which corresponds to a 1.4×10^{-6} risk of fatal cancer during the worker's lifetime. These exposures and cancer risks are as a result of ECF operations only. The exposures and risks corresponding to site-wide operations (including ECF) are discussed in Volume 1, Chapter 5. Analyses of hypothetical accidents which might occur as a result of these alternatives show that the risk of cancer fatalities is small. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

Cumulative impacts due to radioactive waste generation are expected to be minimal. Approximately 425 cubic meters of low-level waste are expected to be generated annually by the Hanford ECF over the next 40 years. This is not expected to affect the Hanford waste management program. Very little transuranic waste or mixed waste and no high-level waste will be generated from Hanford ECF operations.

5.4.16.2 Non-radiological Cumulative Impacts. The cumulative socioeconomic impacts associated with constructing and operating the Hanford ECF are expected to be small. The Hanford Site currently employs over 18,000 people. In the past, no employment at the Hanford Site has been associated with naval spent nuclear fuel operations. Hanford ECF operations would provide long-term employment for 500 people at the Hanford Site. The peak number of additional jobs created at the Hanford Site in any given year would be approximately 1050, which includes both

construction and operations workers during the peak of the Hanford ECF construction effort. Considering that the labor force in the region of influence consists of approximately 88,000 people, the additional number of jobs added from the construction and operation of the Hanford ECF would be expected to have only a minor socioeconomic impact in the Hanford area.

Construction and operation of the Hanford ECF are not expected to result in any impacts from cumulative hazardous or toxic emissions. Construction would be sufficiently remote from the nearest site boundaries such that concentrations of any fugitive construction emissions would be well below applicable standards, as discussed in Section F.4 of Attachment F. Current operations at the Hanford Site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

As discussed in Section 5.4.8, the withdrawal of surface water for construction and operation of the Hanford ECF would be a small percentage of existing withdrawals and well within the cumulative capabilities of the respective water resources. Discharges of ECF non-radioactive and non-hazardous liquid effluents to tile fields at the Hanford Site are not expected to impact groundwater quality (that is, either of itself or on a cumulative basis).

Minimal cumulative land use impacts would be expected to occur as a result of the construction of a new ECF at Hanford. The land that would be dedicated for this purpose is on existing federal property. The use of this land would not result in the need for additional land to be added to the federally owned property in the foreseeable future. The Hanford Site occupies an area of approximately 1450 square kilometers (560 square miles) with only about 6% of the land occupied by constructed facilities. No land area at the Hanford Site has been affected by past operations involving naval spent nuclear fuel. Construction of the Hanford ECF would affect 30 acres of land. This is less than 0.01% of the total Hanford Site land area.

The cumulative impacts associated with non-radiological waste management are expected to be small. The volume of hazardous waste produced by ECF has not been calculated; however, considering the nature of the work associated with ECF, the amount of hazardous waste produced would have a small effect on the cumulative impacts associated with this waste. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to

the number of additional workers added, and this small incremental increase would not be discernible. The amount of non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of wastes.

5.4.17 Unavoidable Adverse Effects

Construction of the Hanford ECF would directly impact a total of about 120,000 square meters (30 acres) of land area previously dedicated to the handling of nuclear materials, and approximately 400,000 square meters (100 acres) outside the protected site area for the construction of a transmission line and tile field. During construction, plant and animal habitats associated with a sagebrush vegetation community would be lost or displaced from areas not previously disturbed. None of the land area outside the protected site area associated with the construction of the transmission line and less than half of the land area within the protected site area would be affected by operation; the rest would revert to a sagebrush vegetation community through natural plant succession. Modification of the FMEF would have lesser impacts because the construction work would be less extensive. Refer to Attachment E for details.

Construction of the Hanford ECF would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of a major industrial facility. All effluents and emissions would be below applicable environmental requirements and would not be expected to result in any adverse impact.

During operation of the Hanford ECF, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials that would be minimal compared to the criteria imposed by the "Environment, Safety, and Health Program for Department of Energy Operations" (DOE 1986b) and the "National Emission Standard for Hazardous Air Pollutants" (CFR 1992b). Sanitary and service waste liquid discharges that would eventually be discharged to the soil column through tile fields would all be below applicable environmental standards, including radioactivity standards for drinking water. Solid wastes generated during operation, including transuranic, low-level, hazardous, and mixed wastes, would

result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would be controlled, but might result in a negligible increase in the risk of skin cancer; substitutes would be used when available.

In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would affect public health and safety.

5.4.18 Irreversible and Irretrievable Commitments of Resources

During operation of the Hanford ECF, additional fuel would be burned to supply steam, similar to the levels experienced at the INEL-ECF. The water to be used for the Hanford ECF would be withdrawn from the Columbia River. The amount of water that would be withdrawn from the Columbia River would be negligible. No new water withdrawal intake structure would be required and no observed impacts have resulted from previous withdrawals. Total consumption of water attributable to water pool operations and consumption of potable water by operating personnel represent less than one-thousandth of a percent of the Columbia River average flow rate.

The total cost of locating a new ECF at Hanford would be approximately \$3.4 billion. This cost represents the total cumulative cost over the 40-year period and includes construction and operations costs of the new ECF as well as the cost associated with shutting down the INEL-ECF. If the FMEF were to be modified for use as the Hanford ECF, the cost would be less. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

Construction and operation of the Hanford ECF would not require the use or consumption of scarce resources. Expected withdrawals of surface water and groundwater during construction and operation would represent small incremental increases in the amounts of water being withdrawn by ongoing Hanford operations.

5.5 OAK RIDGE RESERVATION

5.5.1 Overview of Environmental Impacts

The following sections discuss the potential environmental consequences that would occur if a replacement for the Expanded Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) were constructed and operated at the Department of Energy's Oak Ridge Reservation (ORR). This replacement will be referred to as Oak Ridge ECF. The new ECF would be sited near the K-25 Site which is located on the western portion of the ORR (see Figure 4.5-1 of Section 4.5).

The environmental consequences of locating and operating the ECF at ORR are based on the same radiological source terms for normal and accidental releases and the estimated atmospheric emissions, liquid effluents, and solid wastes discussed in Section 5.2 for the ECF at INEL. The environmental consequences of locating and operating the ECF at ORR would be similar to those for the ECF at INEL, and none would be large.

5.5.2 Land Use

Construction of an ECF at ORR would directly affect about 30 acres of land near the already highly developed K-25 Site area. Site preparation for construction would disturb areas of natural vegetation cover which primarily include oak/hickory forest land. The direct loss of terrestrial habitat would be minimized to the extent practical. Following completion of construction, the grounds around the ECF would be landscaped with trees and shrubbery in a manner consistent with other facilities in the K-25 Site area. The affected land area is very small compared to the entire ORR. Native American rights and interests would not be modified by construction or operation of the Oak Ridge ECF.

5.5.3 Socioeconomics

The potential socioeconomic impacts associated with construction of the ECF at ORR are expected to be equal to or less than those associated with the original ECF construction at INEL because (1) a large movement of construction workers from other areas would not be expected for the

Oak Ridge ECF construction due to the availability of construction craft workers in the ORR region and (2) the existing population base within 80 kilometers (50 miles) of the ORR is larger than that surrounding the INEL area and would provide a greater capability to absorb the incoming construction personnel.

Table 5.5-1 provides a summary of the direct jobs which would be associated with construction and operation of the Oak Ridge ECF during the 10-year period immediately following the Record of Decision. The greatest number of direct jobs would occur in 1999 during the peak of the construction phase. Estimates of the indirect jobs created as well as the effect on area population are included in Chapter 5 of Volume 1 for Regionalization at the ORR and for Centralization at the ORR.

Table 5.5-1. Summary of direct jobs due to Oak Ridge ECF construction and operation.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	20	20	476	825	1033	894	850	500	500	500

During the Oak Ridge ECF construction period, operations workers would be hired so that at the end of the construction period, most of the 500 operations personnel would be employed. The percentage of operations workers expected to move into the area from other areas varies based on skill requirements. Overall, approximately 20 percent are estimated to move into the ORR area. The four-county region of influence around the ORR had a 1990 population of 489,230 persons, or more than twice that of the INEL.

ECF operations at the ORR would require essentially the same number of operations personnel as at the INEL. This would represent less than 3 percent of the total ORR work force. Given an average family size of 2.6 persons per household for operations personnel moving into the area, the expected population increase attributable to operations personnel would represent about 14 percent of the average annual growth rate from 1980 to 1990 in the ORR's four-county region of influence. This percentage of population increase attributable to Oak Ridge ECF operations in relation to normal population increases in the ORR region might have a short-term, minor impact on local government services and community infrastructures. The economic benefits to the ORR region are expected to be similar to or less than those for the INEL region since the existing economic base of the ORR region is greater and more diverse than that of the INEL region.

5.5.4 Cultural Resources

Construction or operation of the Oak Ridge ECF would not impact known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.5.5 Aesthetic and Scenic Resources

Construction of the Oak Ridge ECF would directly affect 30 acres of land. The proposed facility would be seen from Bear Creek Road as being completely surrounded by undeveloped areas. The forested ridges to the northwest and southeast of this area reduce its visibility from privately owned lands, so that impacts to aesthetic and scenic resources would be minor.

5.5.6 Geology

5.5.6.1 General Geology. Although some ripping or blasting of limestone, dolomite, or quartz layers could be necessary to construct the ECF, no unique geological features would be affected. There are no mining activities in this vicinity that could be impacted by ECF construction or operation. Previously disturbed areas would be regraded to accommodate the new ECF. Sediment runoff from such land disturbances would be minimized by implementation of soil erosion and sediment control measures.

5.5.6.2 Geologic Resources. Since no extensive or unique geologic or mineral resources are known to occur near the K-25 Site, impacts to such resources from ECF construction or operation would not be expected.

5.5.7 Air Resources

Minor short-term emissions of fugitive dust and exhaust from heavy equipment would be possible during Oak Ridge ECF construction. The use of toxic chemicals during ECF normal operations is controlled to limit the exposure of workers and the public. Airborne emissions from normal operations would include the combustion gases from the boiler house, where fuel would be

burned to make steam for space heating. Emergency diesel generators, which would be provided for safety, would be operated periodically for test purposes and release exhaust fumes to the atmosphere. The environmental impacts of these emissions would be negligible.

The airborne releases of radioactivity for the ECF at ORR would be the same as for the ECF at INEL described in Section 5.2. The airborne release would result in no measurable exposure to on-site personnel or the general population. Details are provided in Attachment F.

5.5.8 Water Resources

5.5.8.1 Surface Water. Water required for construction of the Oak Ridge ECF would be withdrawn from the Clinch River. The small amount of water withdrawn would be negligible in comparison to the approximately 1.29×10^{10} liters (3.40×10^9 gallons) per day flow at the Melton Hill Dam. No new water intake structure would be required.

The 2.5 million gallons per year additional surface water withdrawal from the Clinch River during Oak Ridge ECF operations would represent a very small increase in the 6.93×10^7 liters (1.83×10^7 gallons) per day currently being withdrawn by ongoing ORR operations and represent a negligible withdrawal in comparison to the average flow of the Clinch River.

Liquid discharges from the Oak Ridge ECF would be treated by a wastewater treatment plant which would be built to service the new DOE spent nuclear fuel facilities. Discharges of treated wastewater to area receiving waters would be in accordance with applicable National Pollutant Discharge Elimination System effluent limits. These discharges would have a negligible impact on the receiving water system. Design controls would render spills and leaks that could contaminate surface or groundwater unlikely.

The Oak Ridge ECF would not be located within the 500-year floodplain.

5.5.8.2 Groundwater. No groundwater would be used for construction and operation of the Oak Ridge ECF, given the plentiful surface water supplies. Therefore, no impact on groundwater levels or quantity is expected. Because there would be no direct discharge of process water to groundwater,

and because wastewater would be treated prior to a National Pollutant Discharge Elimination System-permitted discharge to surface waters, no impacts on groundwater are expected.

5.5.9 Ecological Resources

5.5.9.1 Terrestrial Ecology. Areas of natural vegetation cover which primarily include oak/hickory forest land would be disturbed for the Oak Ridge ECF. The loss of terrestrial habitats would be minimized to the extent practical. Construction and traffic noise might have a short-term, minor impact on wildlife beyond the immediate construction site.

During construction and operation of the Oak Ridge ECF, all effluents and emissions would comply with regulatory standards and are not expected to have an impact on the area wildlife. Operation of the Oak Ridge ECF should result in less noise and traffic than the construction phase, and no effects on terrestrial ecology are expected from Oak Ridge ECF operations.

5.5.9.2 Wetlands. Construction of the Oak Ridge ECF may displace forested wetlands adjacent to tributaries of Grassy Creek flowing near the proposed site. This displacement of wetlands would be accomplished in accordance with Corps of Engineers and Tennessee Water Quality Control Administration requirements.

5.5.9.3 Aquatic Ecology. Aquatic habitat would be affected by the rechanneling of tributaries to Grassy Creek during construction of the Oak Ridge ECF. Minor increases in water withdrawal from the Clinch River and water discharged to its tributaries would not greatly affect the aquatic ecology of these water bodies. All wastewater would be discharged in compliance with National Pollutant Discharge Elimination System permit limitations.

5.5.9.4 Endangered and Threatened Species. No known terrestrial or aquatic areas potentially providing habitat to federally listed or state listed threatened or endangered species are found in the construction area; consequently, impacts to threatened and endangered species are not expected to be a concern.

5.5.10 Noise

Noises generated on the ORR do not propagate off-site at levels that impact the general population. Noise increases outside the ORR due to the Oak Ridge ECF would be limited to those produced by truck, car, and train traffic on roads and railroads approaching the ORR. These increases would not be large enough to be objectionable to the communities bordering the roads and railroads.

5.5.11 Traffic and Transportation

Traffic and transportation would increase slightly in the ORR area if an ECF were constructed and operated at ORR. The additional traffic would mainly be due to increased commuter traffic from construction workers and 500 operations workers as well as traffic from material shipments during Oak Ridge ECF construction and operation.

If the Oak Ridge ECF were established, naval spent nuclear fuel would be routinely transported to the ORR in certified shipping containers. Various types of wastes generated at the ECF would be dispositioned on-site and off-site. Following examination, most of the spent nuclear fuel would be transferred to the spent fuel storage location at ORR until the time that permanent geologic storage becomes available.

5.5.12 Occupational and Public Health and Safety

The health and safety assessment of normal operations at the Oak Ridge ECF was based on handling and examination of naval spent nuclear fuel either in a water pool or in a dry cell. These are the same methods of spent nuclear fuel handling that have been employed or seriously considered for use at the ECF at INEL. The normal operational impacts associated with the ECF at ORR would be similar to those for the ECF at INEL. The following sections describe the non-radiological and radiological impacts associated with the ECF at ORR (refer to Section 5.2 for the ECF at INEL impacts).

5.5.12.1 Occupational Health and Safety. Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and

examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

During Oak Ridge ECF construction, workers are not expected to experience elevated background levels of radiation resulting from ongoing ORR operations. The potential exposure to a construction worker from inhalation of radionuclides released to the atmosphere from existing ORR operations is expected to be small compared to the external exposure. The exposure received by a construction worker would be well below the naval and Department of Energy (DOE) standard of 5000 millirem per year for occupationally related whole-body and internal exposures.

During operation of the Oak Ridge ECF, ORR personnel would be exposed to routine atmospheric emissions of radioactivity and might be exposed to potential emissions from accidents. The Oak Ridge ECF site is located approximately 1 mile from the nearest ORR facility. As shown in Attachment F, no measurable exposure would be received by these collocated workers from normal Oak Ridge ECF operations. Exposures received by radiation workers from normal operation of the ECF at ORR are expected to be similar to the exposures currently received by workers from normal operation of the ECF at INEL, discussed in Section 5.2.12.

Exposures, injuries, and potential fatalities to workers at the Oak Ridge ECF could also occur as a result of accidents during ECF operations. However, the safety record of the ECF at INEL is very good, and similar safe working conditions could be established at the new facility.

5.5.12.2 Public Health and Safety. The impacts of normal operation of the ECF at ORR would be similar to those for the ECF at INEL. Normal radiological releases to the atmosphere and the quantities of radioactive and hazardous wastes that would be generated would not differ from those previously discussed for the INEL. However, location of the ECF relative to the surrounding ORR population and the distances to facilities that would be involved in routine shipments of material would result in differences in potential environmental consequences. Described below are the impacts to the public associated with operation of the ECF at ORR (refer to Section 5.2.12 for the ECF at INEL impacts).

Assessment of normal operation of the Oak Ridge ECF involved handling and examination of spent fuel either in a water pool or in a dry cell. For both cases, the potential annual exposures were estimated for five different types of people: a worker at the Oak Ridge ECF site located 100 meters from the release point, the hypothetical maximally exposed collocated worker on the ORR site, the hypothetical maximally exposed off-site individual, an individual at the nearest public access, and the population within 80 kilometers (50 miles) of the Oak Ridge ECF site. Three pathways were included in the analysis: airborne, waterborne, and direct radiation, as applicable.

The results indicate that handling and examination of spent fuel either in a water pool or in a dry cell would be satisfactory for normal operations since the exposure is so low. The analysis shows that the exposure to all the individuals considered (workers, collocated workers, and off-site individuals) from Oak Ridge ECF operations would be much less than 1 millirem per year. For perspective, it could be stated that one member of the entire population might experience a fatal cancer due to Oak Ridge ECF operations if operations continued for 20,000 years. A description of the analysis methods and more detailed results are provided in Attachment F. The impacts from normal operations for all alternatives are summarized in Section 3.7.

The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.5.13 Utilities and Energy

Heating, ventilation, and electrical systems appropriate to the needs of the Oak Ridge ECF for suitable working environments and to properly filter and exhaust the airborne discharges to the atmosphere are estimated to require approximately 10,000 MWh per year for normal operations. Emergency diesel electrical generators would provide 350 kw for life support and crucial facility services during power outages. The amount of energy consumed would be a small fraction of the total energy used at ORR and no discernible environmental consequence is expected.

5.5.14 Facility and Transportation Accidents

The differences in the potential consequences and risks of accidents at the ECF at Oak Ridge compared to the ECF at INEL are related to the meteorological transport of released material, the population exposure, and the distance of transport. The following sections address the potential accident consequences and risks associated with locating an ECF at the ORR.

5.5.14.1 Facility Accidents. A number of hypothetical accidents were evaluated for the Oak Ridge ECF. These included radiological accidents involving naval spent nuclear fuel during water pool storage, dry storage, and dry cell operations as well as accidents involving toxic chemicals used at ECF. Calculations of the cancer fatalities which might occur as a result of all the postulated accidents are provided in Attachment F. A comparison of the accident consequences for all alternatives is provided in Section 3.7.

The difference in the calculated consequences for accidents at the ECF at ORR compared to the ECF at INEL is that the exposure received by the entire population would be greater at the Oak Ridge ECF due to the larger population within an 80-kilometer (50-mile) radius of the Oak Ridge ECF site. Although the exposure received was greater at the Oak Ridge ECF, the number of health effects which would result from any of the accidents considered would be small. The most limiting of the postulated accidents for the ECF at Oak Ridge would be an airplane crash into a dry cell facility. The exposure to the entire population from this accident is calculated to cause 8.4 cancer fatalities over 50 years, as described in Attachment F. The risk associated with the airplane crash would be approximately 0.000008 fatal cancers per year.

Effects from two accidents at the ECF at Oak Ridge involving toxic chemicals were evaluated in Attachment F. The first accident was a chemical spill and fire; the second was a fire involving diesel fuel. Both accidents could expose the public to various toxic chemicals at concentrations which exceed Emergency Response Planning Guidelines (ERPG) level 3 limits. Both accidents could also expose workers at the Oak Ridge ECF to various toxic chemicals at concentrations which exceed ERPG-3 limits. In both cases, however, it is expected that actual toxic chemical exposures would be much less due to the mitigative measures that would be implemented. A summary of the analysis methods, the toxic chemical concentrations, and a discussion of the mitigative measures for toxic chemicals are provided in Attachment F.

5.5.14.2 Transportation Accidents. The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any health effects as a result of naval spent nuclear fuel and test specimen shipments since the risk estimates are much less than one fatal cancer or health detriment for each alternative. However, the most severe accident, with a likelihood of occurrence greater than 1×10^{-7} events per year, is estimated to result in a maximum of 2.1 fatalities. The details of the transportation analysis are provided in Attachment A.

5.5.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that for the most severe hypothetical accidents, an area of between about 8 acres extending about 1/4 mile downwind (for an accidental criticality) and approximately 210 acres extending about 1 1/4 mile downwind (for a large airplane crash into the fuel examination facility) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. The area which might be affected by one of these hypothetical accidents could extend slightly beyond the boundaries of the Oak Ridge Reservation, so some people who live in the affected area might be evacuated or otherwise experience restrictions in their daily activities, and those who work at locations within the affected area might be prevented from going to their jobs until measures had been taken to reduce the potential for exposure.

An accident might result in short-term restrictions on access to a relatively small area, but it would not be expected to produce any enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full compliance with applicable laws and regulations. The area would vary only slightly among the alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with an Expanded Core Facility at the Oak Ridge Reservation would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for an alternative which would relocate the Expanded Core Facility to the Oak Ridge Reservation. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, effects on the ecology should be limited to small areas. As previously stated, there are no endangered or threatened species unique to the area surrounding the location considered for an Expanded Core Facility at the Oak Ridge Reservation, so an accident would not be expected to result in destruction of any species. The effects of accidents related to any of the alternatives and any cleanup which might be performed would be localized within a small area which would extend only a relatively short distance from the Expanded Core Facility and thus would not be expected to appreciably affect the potential for survival of endangered or threatened species in the vicinity. Based on these considerations, evaluation of the impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.5.15 Waste Management

During Oak Ridge ECF operations, non-radioactive and non-hazardous waste and hazardous waste would be generated in quantities similar to those for the ECF at INEL. Solid sanitary and industrial wastes would be disposed of at an on-site landfill. Hazardous solid wastes would be contained at their point of generation and transported off-site to an approved disposal facility. Waste management practices for these wastes would produce no identifiable impact on public health or safety of the environment.

Operation of the ECF at ORR would generate the same quantities of radioactive low-level waste, transuranic waste, and mixed wastes as the ECF at INEL. Low-level waste generated by the Oak Ridge ECF would be stored on-site pending a future disposal action. The 425 cubic meters (556

cubic yards) of low-level waste generated annually by the ECF at INEL represents a small fraction of the low-level waste managed at ORR. No high-level waste would be generated.

Less than 0.0001 cubic meter of transuranic waste per year is generated by current ECF operations at the INEL. Any transuranic waste generated by the Oak Ridge ECF would be a very small fraction of the transuranic waste at ORR and would not impact planned waste handling operations. Much of the newly generated and retrievably stored transuranic waste at ORR will be treated and certified for eventual disposal at the DOE Waste Isolation Pilot Project.

Any mixed waste generated by Oak Ridge ECF operations would be stored on-site pending a future disposal action. This would represent a very small fraction of the mixed waste at ORR from past and ongoing operations requiring disposition.

5.5.16 Cumulative Impacts

Up to this point, Section 5.5 has discussed the potential environmental consequences of constructing and operating the ECF at the ORR in terms of annual impacts (i.e., radiological doses and health effects, accident risks, and quantities of wastes that would be generated during operations) based on the maximum expected annual workload of the ECF. To determine the potential consequences for 40 years of ECF operation (from 1995 to 2035), an evaluation of the accumulated environmental consequences and risks of constructing and operating the Oak Ridge ECF was performed.

5.5.16.1 Radiological Cumulative Impacts. Operation of the Oak Ridge ECF would not result in discharges of radioactive liquids; therefore, there would be no changes to the surface or ground water as a result of normal ECF operations. There would be small quantities of radioactivity in the air released from ECF which would contribute to the cumulative air quality impacts.

The Oak Ridge Reservation has not been used for naval spent nuclear fuel operations in the past. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

The annual radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at ORR are very small and are described in Section 5.5.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure to the general public from transportation and from Oak Ridge ECF operations would be approximately 15 person-rem. This means that there might be 0.0075 fatal cancers from these operations over the entire 40-year period evaluated. The exposure to the maximally exposed off-site individual would be 4 millirem from 40 years of Oak Ridge ECF operation. The corresponding risk of a cancer fatality to the maximally exposed off-site individual is 2.0×10^{-6} during his or her lifetime. A worker at the Oak Ridge ECF site located 100 meters from the facility would receive less than 5 millirem over 40 years of Oak Ridge ECF operation, which corresponds to a 1.9×10^{-6} risk of fatal cancer during the worker's lifetime. These exposures and cancer risks are as a result of ECF operations only. The exposures and risks corresponding to site-wide operations (including ECF) are discussed in Volume 1, Chapter 5. Analyses of hypothetical accidents which might occur as a result of these alternatives show that the risk of cancer fatalities is small. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

Cumulative impacts due to radioactive waste generation are expected to be minimal. Approximately 425 cubic meters (556 cubic yards) of low-level waste are expected to be generated annually by the Oak Ridge ECF over the next 40 years. This is not expected to affect the ORR waste management program. Very little transuranic waste or mixed waste and no high-level waste will be generated from Oak Ridge ECF operations.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

5.5.16.2 Non-radiological Cumulative Impacts. The cumulative socioeconomic impacts associated with constructing and operating the Oak Ridge ECF are expected to be minor. The Oak Ridge Reservation employs over 17,000 people. In the past, no employment at the ORR has been associated with naval spent nuclear fuel operations. Oak Ridge ECF operations would provide long-term employment for 500 people at the ORR. The peak number of additional jobs created at the ORR in any given year would be approximately 1050, which includes both construction and operations workers during the peak of the Oak Ridge ECF construction effort. Considering that the labor force in the region of influence consists of over 292,000 people, the additional number of jobs added from the construction and operation of the Oak Ridge ECF would be expected to have only a minor socioeconomic impact in the Oak Ridge area.

Construction and operation of the Oak Ridge ECF are not expected to result in any discernible impacts relative to cumulative non-radiological emissions. Construction of the ECF is sufficiently remote and removed from the nearest ORR boundaries such that concentrations of fugitive emissions from construction would be well below applicable standards, as discussed in Section F.4 of Attachment F. Current operations at the Oak Ridge Reservation are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

The withdrawal of surface water for ECF construction and operation at the ORR would be a small percentage of existing withdrawals and well within the cumulative capabilities of the respective water resources. Discharges of ECF non-radioactive and non-hazardous liquid effluents at the ORR would have no measurable impact on water quality or aquatic ecology.

Minimal cumulative land use impacts would be expected to occur as a result of the construction of a new ECF. The land that would be dedicated for this purpose is on existing federal property. The use of this land would not result in the need for additional land to be added to the federally owned property in the foreseeable future. The Oak Ridge Reservation occupies an area of

approximately 140 square kilometers (54 square miles) with only about 8% of the land occupied by the Y-12 Plant, K-25 Site, and Oak Ridge National Laboratory. No land area at the Oak Ridge Reservation has been affected by past operations involving naval spent nuclear fuel. Construction of the Oak Ridge ECF would affect 30 acres of land. This is less than 0.09% of the total Oak Ridge Reservation land area.

The cumulative impacts associated with non-radiological waste management are also expected to be small. The volume of hazardous waste produced by ECF has not been calculated; however, considering the nature of the work associated with ECF, the amount of hazardous waste produced would have a small effect on the cumulative impacts associated with this waste. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of wastes.

5.5.17 Unavoidable Adverse Effects

Construction of an ECF at ORR would directly affect about 30 acres of land area. Site preparation for construction would disturb areas of natural vegetation cover which primarily include oak/hickory forest land. The direct loss of terrestrial habitat would be minimized to the extent practical.

Construction of the Oak Ridge ECF would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of a major industrial facility. All effluents and emissions would be below applicable environmental requirements and would not be expected to result in any major adverse impacts.

During Oak Ridge ECF operations, non-radioactive and non-hazardous waste and hazardous waste would be generated in quantities similar to those discussed for the INEL. Solid sanitary and industrial wastes would be disposed of in an ORR landfill. Hazardous wastes would be contained at

their point of generation and transported off-site to an approved disposal facility. The amount of hazardous waste generated by Oak Ridge ECF operations would be small in comparison to the amount of hazardous waste that is generated at the ORR. No discernible differences from normal hazardous waste management at the ORR would result from this strategy.

During Oak Ridge ECF operations, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials that would be small compared to criteria contained in 40CFR Part 61.92 and DOE Order 5480.1B. Sanitary waste and service waste liquid discharges would be below applicable environmental standards. Solid wastes generated during operations, including transuranic, low-level, hazardous, and mixed wastes, would result in small increases in potential exposures to radioactive and hazardous materials.

Construction and operation of the Oak Ridge ECF would not require the use or consumption of scarce resources. Expected surface water withdrawals during construction and operation would represent small incremental increases in the amount of water being withdrawn by ongoing ORR operations. In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would have a detectable effect on public health and safety. The difference in the impacts between the ECF alternative at ORR and the other DOE sites (INEL, Savannah River, Hanford, Nevada Test Site) is not discernible.

5.5.18 Irreversible and Irretrievable Commitments of Resources

During operation of the Oak Ridge ECF, additional fuel would be burned to supply steam for heat. The fuel is not in short supply. The water to be used for the Oak Ridge ECF would be withdrawn from the Clinch River and would be a small amount. No new water intake structure would be required, and no observed impacts have resulted from previous withdrawals. Total consumption of water attributable to water pool operations and consumption of potable water by operations personnel represent less than one-thousandth of a percent of the Clinch River average annual flow.

The total cost of locating a new ECF at Oak Ridge is approximately \$3.5 billion. This cost represents the total cumulative cost over the 40-year period and includes construction and operation

costs of the new ECF as well as the cost associated with shutting down the ECF at INEL. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

As is the case with the ECF at INEL, construction and operation of the ECF at ORR would not require the use or consumption of scarce resources.

5.6 NEVADA TEST SITE

5.6.1 Overview of Environmental Impacts

The following sections discuss the potential environmental consequences that would occur if a replacement for the Expanded Core Facility (ECF) at the Idaho National Engineering Laboratory (INEL) were constructed and operated at the Department of Energy's Nevada Test Site (NTS). This facility will be referred to as the Nevada ECF. The affected environment for the proposed site, depicted on Figure 4.6-1, is discussed briefly in Section 4.6 and in greater detail in Volume 1, Appendix F.

The environmental consequences of locating and operating the ECF at NTS are based on the same radiological source terms for normal and accidental releases and the estimated atmospheric emissions, liquid effluent, and solid wastes discussed in Section 5.2 for the ECF at INEL. The environmental consequences of locating and operating the Nevada ECF would be similar to those for the ECF at INEL, and none would be large.

5.6.2 Land Use

Over 40.5 square kilometers (10,000 acres) of land exists in the area being considered as a location for the proposed Nevada ECF. This is in the same general area being considered for the proposed spent nuclear fuel storage facility discussed in Volume 1, Appendix F. Construction of an ECF at NTS would directly affect about 30 acres of land. This would result in only a minimal reduction in the available land base of the NTS. Located next to Mercury Highway, the proposed area would support construction and maintenance of an ECF, railcar holding facilities, and necessary support facilities. The ECF facilities would be compatible with all existing and presently foreseeable NTS facilities. The affected land area is small compared to the entire NTS. Native American rights and interests would not be modified by construction or operations associated with any of the alternatives considered.

5.6.3 Socioeconomics

The potential socioeconomic impacts associated with construction of the Nevada ECF are expected to be equal to or less than those associated with the original ECF construction at the INEL because (1) a large movement of construction workers from other areas would not be expected for the Nevada ECF construction due to the availability of construction craft workers in the Las Vegas area; and (2) the counties surrounding the NTS have a population adequate to absorb any temporary relocation of construction personnel.

Table 5.6-1 provides a summary of the direct jobs which would be required for the construction and operation of the Nevada ECF during the 10-year period immediately after the Record of Decision. The greatest number of direct jobs would occur in 1999 during the peak of the construction phase. Estimates of the indirect jobs created as well as the effect on area population are included in Section 5.5.6 of Volume 1 as part of either the Regionalization or Centralization at the Nevada Test Site alternatives.

Table 5.6-1. Summary of direct jobs due to the Nevada ECF.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct Jobs	20	20	476	825	1033	894	850	500	500	500

During the Nevada ECF construction period, operations personnel would be hired so that at the end of the construction period, most of the operations workers would be employed. The percentage of operations workers expected to move into the area from other areas varies based on skill requirements. Overall, approximately 20 percent are estimated to move into the NTS area. The Las Vegas Metropolitan Service Area, which constitutes the major portion of the population in the region of influence, had a 1990 population of 735,000 and an estimated population of 900,000 as of August 1993.

The Nevada ECF operation would require essentially the same number of operations personnel (500) as at the INEL. This would represent a relatively small percentage of the total NTS work force. Given the 20-percent estimate for immigration and an average family size of 2.6 persons

per household for operations personnel moving into the area, the expected population increase attributable to the operating personnel would be 260 persons.

Given the small percentage of population increase attributable to Nevada ECF operations in relation to normal population increases in the NTS region, no major adverse impacts to local government services and community infrastructures are expected. The economic benefits to the NTS region are expected to be similar to those for the INEL region.

5.6.4 Cultural Resources

Construction at the site considered for the Nevada ECF would not impact any known archaeological or Native American sites. Procedures which comply with all applicable laws and regulations would be implemented to protect previously undetected archaeological and cultural sites.

5.6.5 Aesthetic and Scenic Resources

The construction of the Nevada ECF would directly affect approximately 30 acres of land. As a result of its location and industrial characteristics, there is essentially no aesthetic or scenic impact since the site would not be visible to the public.

5.6.6 Geology

5.6.6.1 General Geology. The local geology of the NTS region has been impacted as a result of past nuclear testing. This impact has been in the form of surface faulting. Because construction and operation of the Nevada ECF would not produce forces near the magnitude of those produced from past nuclear tests, it is highly unlikely that this activity would cause additional faulting.

5.6.6.2 Geologic Resources. Precious metals may exist in certain carbonate rocks and volcanic or sedimentary rocks at the NTS. The Nevada ECF would not be located within a mining district and the site will likely remain closed to mining operations so the impact to any precious metal deposits that may exist at the NTS will not change if the proposed facility is sited there.

5.6.7 Air Resources

Minor short-term emissions of fugitive dust and exhaust from heavy equipment would be possible during Nevada ECF construction. The use of toxic chemicals during ECF normal operations would be controlled such that the exposure levels of workers and the public would be negligible. Airborne emissions from normal operations would include the combustion gases from the boiler house, where fuel would be burned to make steam for space heating. Emergency diesel generators, which would be provided for safety, would be operated periodically for test purposes and release exhaust fumes to the atmosphere. These emissions would not have any detectable environmental consequence.

The airborne releases of radioactivity for the ECF at NTS would be the same as for the ECF at INEL described in Section 5.2. The airborne release would result in no measurable exposure to on-site personnel or the general population. Details of the analyses supporting this conclusion are provided in Attachment F.

5.6.8 Water Resources

5.6.8.1 Surface Water. As stated in Section 4.6.8, with the exception of short periods of runoff from spring discharges, there is no perennial surface water at the NTS. As such, the daily water supply required to operate the Nevada ECF could not be obtained from local surface waters. In fact, the NTS currently derives its complete water supply from the groundwater aquifers. Therefore, the construction and operation of the Nevada ECF would have no impact on the quantity and quality of surface water in the area.

There are no National Pollutant Discharge Elimination System permits for the NTS, as there are no wastewater discharges to on-site and off-site surface waters. NTS wastewaters are discharged to sewage lagoons. Therefore, all wastewaters associated with the construction and operation of the Nevada ECF would likely be discharged into the on-site lagoon system along with the other wastewaters generated at the NTS. Thus, surface water quantity and quality in the NTS area would not be expected to be impacted.

5.6.8.2 Groundwater. The NTS currently extracts groundwater from aquifers within two hydrographic subbasins: Alkali Flat-Furnace Creek Ranch and Ash Meadows. These subbasins, along with their specific hydrographic areas and NTS well locations, are described in Section 5.8 of Volume 1, Appendix F. The 2.5 million gallons per year additional withdrawal of water from these aquifers required for operation of an ECF represents less than a 3-percent increase over the present rate at which water is withdrawn for use in Area 6 and less than 0.5 percent of the total NTS usage rate.

5.6.9 Ecological Resources

5.6.9.1 Terrestrial Ecology. During construction and operation of the Nevada ECF, all effluent and emissions would comply with regulatory standards and are not expected to have an impact on the area wildlife. Operation of the Nevada ECF should result in less noise and traffic than the construction phase, and no effects on terrestrial ecology are expected from Nevada ECF operations.

5.6.9.2 Wetlands. National Wetland Inventory maps of the NTS have not been prepared, nor have wetlands been delineated on the site. However, available information indicates that wetlands on the NTS are limited in distribution and extent. Small areas of wetlands could be present in or on the margins of the surface drainages, playas, and reservoirs on the NTS. It is expected that construction and operation of the Nevada ECF would have negligible impact on any wetlands.

5.6.9.3 Aquatic Ecology. Because there would be no discharge of radioactive or hazardous liquid effluent from Nevada ECF operation, these operations are expected to have no effect on the aquatic ecology.

5.6.9.4 Endangered and Threatened Species. The endangered and threatened species are described in Section 4.6.9. The desert tortoise is the only federally listed species that could be affected by the construction of an ECF facility. Forty-five percent of the total known desert tortoise habitat is located in the Yucca Mountains. The area that could be affected directly by the proposed ECF are Frenchman Flat and the southern bajada of Control Point Hills.

Construction and maintenance of roads, utility and communication lines, buildings, water pipelines, sewage lagoons, and other facilities could result in harm or harassment of desert tortoises and loss of habitat. Tortoises could become injured by falling into open trenches or other temporary

construction excavations and might not be able to escape. They could become submerged in water storage ponds, wastewater lagoons, and other impoundments not fenced to exclude them.

5.6.10 Noise

Noises generated on the NTS do not propagate off-site at levels that impact the general population. Noise increases outside the NTS due to the Nevada ECF would be limited to those produced by truck, car, and train traffic on roads and railroads approaching the NTS. These increases would not be large enough to be objectionable to the areas bordering the roads and railroads.

5.6.11 Traffic and Transportation

Traffic and transportation would increase in the area if an ECF is constructed and operated at the NTS. The additional traffic would mainly be due to increased commuter traffic from construction workers and 500 operations workers as well as traffic from material shipments during the Nevada ECF construction.

If the Nevada ECF were established, naval spent nuclear fuel would be routinely transported to the site in certified shipping containers. Various types of wastes generated at the facility would be dispositioned on-site and off-site. Following examination, most of the naval spent nuclear fuel would be transferred to the spent fuel storage location on the NTS until the time that permanent geologic storage becomes available.

5.6.12 Occupational and Public Health and Safety

The health and safety assessment of normal operations at the Nevada ECF was based on handling and examination of spent nuclear fuel either in a water pool or in a dry cell. These are the same methods of spent nuclear fuel handling that have been employed or seriously considered for use at the ECF at INEL. The normal operational impacts associated with the Nevada ECF would be similar to those for the ECF at INEL. The following sections describe the non-radiological and radiological impacts associated with the ECF at NTS (refer to Section 5.2 for the ECF at INEL impacts).

5.6.12.1 Occupational Health and Safety. Projections of the number of occupational accidents that might occur during construction and operation of naval spent nuclear fuel storage and examination facilities have been made for each alternative. These projections are presented in Attachment F. Based on the results of these projections, it is concluded that the number of occupational fatalities and injuries or illnesses for construction activities and storage and examination operations would be very small for any alternative.

During Nevada ECF construction, workers are not expected to experience elevated background levels of radiation resulting from on-going NTS operations. The gamma radiation measured near the proposed Nevada ECF site is similar to the radiation levels measured off-site in the NTS area. The potential exposure to a construction worker from inhalation of radionuclides released to the atmosphere from previous and current NTS operations is expected to be small compared to the external exposure. The exposure received by a construction worker would be well below the naval and Department of Energy (DOE) standard of 5000 millirem per year for occupationally related whole-body and internal exposures.

During operation of the Nevada ECF, NTS personnel would be exposed to routine atmospheric emissions of radioactivity and might be exposed to potential emissions from accidents. The Nevada ECF site is located approximately 3 miles from the Radioactive Waste Management Facility, which is the nearest existing NTS facility. As shown in Attachment F, no measurable exposure would be received by these collocated workers from normal Nevada ECF operations. Exposures received by radiation workers from normal operation of the ECF at NTS are expected to be similar to the exposures currently received by workers from normal operation of the ECF at INEL, discussed in Section 5.2.12.

Exposures, injuries, and potential fatalities to workers at the Nevada ECF could also occur as a result of accidents during ECF operations. However, the safety record of the ECF at INEL is very good, and similar safe working conditions could be established at the new facility.

5.6.12.2 Public Health and Safety. The impacts of normal operation of the Nevada ECF would be similar to those for the ECF at INEL. Normal radiological releases to the atmosphere and the quantities of radioactive and hazardous wastes that would be generated would not differ from those previously discussed for the INEL. However, the location of the project relative to the surrounding NTS population and the distances to facilities that would be involved in routine shipments of material

would result in differences in potential environmental consequences. Described below are the impacts to the public associated with operation of the ECF at NTS (refer to Section 5.2.12 for the ECF at INEL impacts).

Assessment of the normal operations of the Nevada ECF involved handling and examination of spent fuel either in a water pool or in a dry cell. For both cases, the potential annual exposures were estimated for five different types of people: a worker at the Nevada ECF site located 100 meters from the release point, the hypothetical maximally exposed collocated worker on the NTS site, the hypothetical maximally exposed off-site individual, an individual at the nearest public access, and the population within 80 kilometers (50 miles) of the Nevada ECF site. Three pathways were included in the analysis: airborne, waterborne, and direct radiation, as applicable.

The results indicate that handling and examination of spent fuel either in a water pool or in a dry cell would be satisfactory for normal operations since the exposure is so low. The analysis shows that the exposure to all the individuals considered (workers, collocated workers, and off-site individuals) from Nevada ECF operations would be much less than one millirem per year. For perspective, it could be stated that one member of the entire population might experience a fatal cancer due to Nevada ECF operations if operations continued for over 11 million years. A description of the analysis methods and more detailed results are provided in Attachment F. The impacts from normal operations for all alternatives are summarized in Section 3.7.

The radiological and non-radiological health effects associated with the incident-free transportation of naval spent nuclear fuel and test specimens have been assessed for the general population, transportation workers, and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any fatal cancers as a result of naval spent nuclear fuel and test specimen shipments since the estimates are much less than one fatal cancer for each alternative. The details of the transportation analysis are provided in Attachment A.

5.6.13 Utilities and Energy

Heating, ventilation, and electrical systems appropriate to the needs of the Nevada ECF for suitable working environments and to properly filter and exhaust the airborne discharges to the atmosphere are estimated to require approximately 10,000 MWh per year for normal operations.

This would represent about a 4-percent increase in NTS electrical consumption and may require transmission line upgrades. Emergency diesel electrical generators would provide 350 kW for crucial facility services during power outages.

5.6.14 Facility and Transportation Accidents

The differences in the potential consequences and risks of accidents at the ECF at NTS compared to the ECF at INEL are related to the meteorological transport of released material, the population exposure, and the distance of transport. The following sections address the potential accident consequences and risks associated with locating an ECF at the NTS.

5.6.14.1 Facility Accidents. A number of hypothetical accidents were evaluated for the Nevada ECF. These included radiological accidents involving naval spent nuclear fuel during water pool storage, dry storage, and dry cell operations, as well as accidents involving toxic chemicals used at ECF. Calculations of the cancer fatalities which might occur as a result of all the postulated accidents are provided in Attachment F. A comparison of the accident consequences for all alternatives is provided in Section 3.7.

The difference in the calculated consequences for accidents at the Nevada ECF compared to the ECF at INEL is that the exposure received by the entire population would be less at the Nevada ECF due to a different population distribution within an 80-kilometer (50-mile) radius of the site. The most limiting of the postulated accidents for the Nevada ECF would be an airplane crash into a dry cell facility. The exposure to the entire population from this accident is calculated to cause 0.18 cancer fatalities over 50 years, as described in Attachment F.

The exposures to collocated workers following all accidents are well below the naval and DOE standard of 5 rem per year for occupational exposure. However, exposures to the worker located at a Nevada ECF site 100 meters from the radiation release point could exceed this standard following an accident resulting in an inadvertent criticality or an airplane crash into a dry cell.

Effects from accidents at the Nevada ECF involving toxic chemicals are similar to those described in Section 5.2.14 for the existing ECF at INEL. Due to the amount and types of chemicals stored at the ECF site, toxic chemicals do not pose a risk to the public following any of the postulated

accidents. However, following the maximum foreseeable accident analyzed (a fire transient), a number of toxic chemicals would exceed Emergency Response Planning Guideline (ERPG) values for workers on the Nevada ECF site. For the maximum off-site individual, ERPG-2 values for the toxic chemicals are not exceeded under either 50% meteorology or 95% meteorology conditions. The concentrations of toxic chemicals as well as a summary of the analysis methods are provided in Attachment F.

5.6.14.2 Transportation Accidents. The health effects associated with accidents during shipments of naval spent nuclear fuel and test specimens have been assessed for the general population and hypothetical maximum exposed individual for each alternative. As summarized in Section 3.7, it is unlikely that there will be any health effects as a result of naval spent nuclear fuel and test specimen shipments since the risk estimates are much less than one fatal cancer or detrimental health effect for each alternative. However, the most severe accident, with a likelihood of occurrence greater than 1×10^{-7} events per year, is estimated to result in a maximum of 2.1 fatalities. The details of the transportation analysis are provided in Attachment A.

5.6.14.3 Other Impacts of Accidents. In addition to the possible human health effects associated with facility or transportation accidents described in the preceding sections, other effects such as the impacts on socioeconomics and land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses described in Attachment F showed that for the most severe hypothetical accidents, an area of between about 8 acres extending about 1/4 mile downwind (for an accidental criticality) and approximately 210 acres extending about 1 1/4 mile downwind (for a large airplane crash into the fuel examination facility) might be contaminated to the point where exposure could exceed 100 millirem per year. Beyond these distances, the exposure would be less than 100 millirem, the Nuclear Regulatory Commission's standard for protection of the general population from radiation. The area affected by the hypothetical accidents would not extend beyond the boundaries of the Nevada Test Site. Persons who work at locations within this area might be prevented from going to their jobs at the federally owned facilities until measures had been taken to reduce the potential for exposure.

An accident might result in short-term restrictions on access to a relatively small area, but it would not be expected to produce any enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner in full

compliance with applicable laws and regulations. The area would vary only slightly among the alternatives. Overall, the risks are small so these considerations do not assist in distinguishing among alternatives.

Facility or transportation accidents associated with an Expanded Core Facility at the Nevada Test Site would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected, as described in earlier parts of this section. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life, but since human health effects for all the accidents analyzed are small and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for an alternative which would relocate the Expanded Core Facility to the Nevada Test Site. Similarly, since the areas which might be contaminated to measurable levels by chemicals or radioactive material during the hypothetical accidents would be relatively small, effects on the ecology should be limited to small areas. As previously stated, there are no endangered or threatened species unique to the area surrounding the location considered for an Expanded Core Facility at the Nevada Test Site, so an accident would not be expected to result in destruction of any species. The effects of accidents related to any of the alternatives and any cleanup which might be performed would be localized within a small area which would extend only a relatively short distance from the relocated Expanded Core Facility and thus would not be expected to appreciably affect the survival potential of endangered or threatened species in the vicinity. Based on these considerations, evaluation of the impacts of accidents on ecological resources does not help to distinguish among alternatives.

5.6.15 Waste Management

During Nevada ECF operation, non-radioactive and non-hazardous solid waste and hazardous solid waste would be generated in quantities similar to those for the ECF at INEL. These wastes would be managed in a manner identical to that for the ECF at INEL (i.e., non-hazardous, non-radioactive solid wastes would be disposed of at a sanitary landfill and hazardous solid wastes would be contained at their point of generation and transported off-site to an approved disposal facility). Waste management practices for these wastes would produce no identifiable impact on public health and safety of the environment.

Operation of the ECF at NTS would generate the same quantities of low-level waste, transuranic waste, and mixed wastes as the ECF at INEL. Low-level waste generated by Nevada ECF would be disposed of at the NTS. The 425 cubic meters (556 cubic yards) of low-level waste generated annually by the ECF at INEL represents a small fraction of the low-level waste managed at the NTS and would not impact planned disposal operations. No high-level waste would be generated.

Less than 0.0001 cubic meter of transuranic waste per year is generated by current ECF operations at the INEL. Any transuranic waste generated by the Nevada ECF would be added to the Nevada Test Site's transuranic waste storage cell, and would not impact planned waste handling operations. Any mixed wastes generated by Nevada ECF operation would be stored on-site pending a future disposal action.

5.6.16 Cumulative Impacts

Up to this point, Section 5.6 has discussed the potential environmental consequences of constructing and operating the ECF Project at the NTS in terms of annual impacts (i.e., radiological doses and health effects, accident risks, and quantities of wastes that would be generated during operations) based on the maximum expected annual workload of the ECF. To determine the potential consequences for 40 years of ECF operation (from 1995 to 2035), an evaluation of the accumulated environmental consequences and risks of constructing and operating the Nevada ECF was performed.

5.6.16.1 Radiological Cumulative Impacts. The Nevada Test Site has not been used for naval spent nuclear fuel operations in the past. Prior to this time, naval spent nuclear fuel inspections and storage operations have been conducted only at INEL. Therefore, no cumulative impacts have resulted from previous naval spent nuclear fuel inspection and storage operations at any alternate site except for INEL.

Operation of the Nevada ECF will not result in discharges of radioactive liquids; therefore, there would be no changes to the surface or ground water as a result of normal operations for any alternative. There will be small quantities of radioactivity in the air released from ECF which would contribute to the cumulative air quality impacts.

The annual radiological impacts associated with the alternatives where naval spent nuclear fuel would be inspected or stored at the NTS are very small and are described in Section 5.6.12, with the detailed results of analyses provided in Attachment F. In order to calculate cumulative impacts for the period between 1995 and 2035, the annual radiological impacts associated with each location and alternative were summed over 40 years. The results of this summation are tabulated in Tables 3-5 and 3-6 of Section 3.

The cumulative transportation impacts for the population groups from naval spent nuclear fuel transportation activities since the beginning of the Naval Nuclear Propulsion Program also have been calculated and are very small. In addition, the cumulative impacts from transportation of naval spent nuclear fuel over the 40-year period between 1995 and 2035 for each alternative have been assessed. The detailed results of these calculations are presented in Attachment A and summarized in Section 3.7.4.

The total exposure (from operations and transportation) to the general public from Nevada ECF operation would be approximately 6 person-rem. This means that there would be less than 3×10^{-3} fatal cancers from these operations over the entire 40-year period evaluated. The exposure to the maximally exposed off-site individual would be less than 1 millirem from 40 years of Nevada Test Site ECF operation. The corresponding risk of a cancer fatality to the maximally exposed off-site individual is 6.8×10^{-9} during his or her lifetime. A worker at the Nevada Test Site ECF located 100 meters from the facility would receive less than 2 millirem over 40 years of Nevada Test Site ECF operation, which corresponds to a 7.2×10^{-7} risk of fatal cancer during the worker's lifetime. These exposures and cancer risks are as a result of ECF operations only. The exposures and risks corresponding to site-wide operations (including ECF) are discussed in Volume 1, Chapter 5. Analyses of hypothetical accidents which might occur as a result of these alternatives show that the risk of cancer fatalities is small. The impacts associated with transportation of naval spent nuclear fuel for all of the alternatives considered would be similarly low.

Cumulative impacts due to radioactive waste generation are expected to be minimal. Approximately 425 cubic meters of low-level waste are expected to be generated annually by the Nevada ECF over the subject 40-year period. This is not expected to affect the NTS waste management program. Very little transuranic waste or mixed waste and no high-level waste will be generated from Nevada ECF operations.

No contribution to cumulative impacts from accidents involving naval spent nuclear fuel has been included in the analyses presented in this Environmental Impact Statement because there has never been a nuclear reactor accident, criticality accident, transportation accident, or any release of radioactivity which had a significant effect on the environment.

5.6.16.2 Non-radiological Cumulative Impacts. The cumulative socioeconomic impacts associated with constructing and operating the Nevada ECF are expected to be minor. The Nevada Test Site currently employs over 8,500 people. In the past, no employment at the NTS has been associated with naval spent nuclear fuel operations. Nevada Test Site ECF operations would provide long-term employment for 500 people at the NTS. The peak number of additional jobs created at the NTS in any given year would be approximately 1050, which includes both construction and operations workers during the peak of the Nevada Test Site ECF construction effort. Considering that the labor force in the region of influence is expected to reach 792,309 people by 2004, the additional number of jobs added from the construction and operation of the Nevada Test Site ECF would be expected to have only a minor socioeconomic impact in the NTS area.

Construction and operation of the Nevada ECF are not expected to result in any discernible impacts relative to cumulative non-radiological emissions. Construction of the ECF is sufficiently remote and removed from the nearest NTS boundaries such that concentrations of fugitive emissions from construction would be well below applicable standards, as discussed in Section F.4 of Attachment F. Current operations at the Nevada Test Site are in compliance with Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants." Cumulative air emissions would not threaten to exceed any applicable air quality requirement or regulation, either federal, state, or local in radiological and non-radiological categories.

Minimal cumulative land use impacts would be expected to occur as a result of the construction of a new ECF. The land that would be dedicated for this purpose is on existing federal property. The use of this land would not result in the need for additional land to be added to the federally owned property in the foreseeable future. The Nevada Test Site occupies an area of approximately 3,500 square kilometers (1,350 square miles) of which only about 0.55% is developed. No land area at the Nevada Test Site has been affected by past operations involving naval spent nuclear fuel. Construction of the Nevada Test Site ECF would affect 30 acres of land. This is less than 0.004% of the total Nevada Test Site land area.

The cumulative impacts associated with non-radiological waste management are also expected to be small. The volume of hazardous waste produced by ECF has not been calculated; however, considering the nature of the work associated with ECF, the amount of hazardous waste produced would have a small effect on the cumulative impacts associated with this waste. The volume of municipal solid wastes and sanitary wastes which would be generated is expected to be proportional to the number of additional workers added, and this small incremental increase would not be discernible. The amount of non-radiological wastes generated would not introduce any changes to the site's waste management practices and would not impose any additional stress on the capacity of on-site or off-site waste disposal or treatment facilities. Therefore, any cumulative impacts associated with the generation and disposal of additional wastes would be very small. There are no current environmental problems associated with these types of wastes.

5.6.17 Unavoidable Adverse Effects

Construction of an ECF at NTS would directly affect about 30 acres of land area. The direct loss of terrestrial habitat would be minimal.

Construction of the Nevada ECF would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of a major industrial facility. All effluents and emissions would be below applicable environmental requirements and would not be expected to result in any major adverse impacts.

During Nevada ECF operations, non-radioactive and non-hazardous solid waste and hazardous solid waste would be generated in quantities similar to those discussed for the INEL. Non-radioactive and non-hazardous solid waste would be disposed of in the NTS sanitary landfill. Hazardous wastes would be contained at their point of generation and transported off-site to an approved disposal facility. The amount of hazardous waste generated by Nevada ECF operation would be small in comparison to the amount of hazardous waste that is generated and currently in interim storage at the NTS. No discernible differences from normal hazardous waste management at the NTS would result from this strategy.

During Nevada ECF operations, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials

that would be minimal compared to criteria contained in 40CFR Part 61.92 and DOE Order 5480.1B. Sanitary waste and service waste liquid discharges would be below applicable environmental standards. Solid wastes generated during operations, including transuranic, low-level, hazardous, and mixed wastes, would result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would result in a negligible increase in the risk of skin cancer; substitutes will be used when available.

Construction and operation of the Nevada ECF would not require the use or consumption of scarce resources. Expected groundwater withdrawals during construction and operation would represent small incremental increases in the amount of water being withdrawn by ongoing NTS operations. In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would have a detectable effect on public health and safety. The difference in the impacts between the ECF alternative at the NTS and the other DOE sites (INEL, Savannah River, Hanford, Oak Ridge) is not discernible.

5.6.18 Irreversible and Irretrievable Commitments of Resources

During operation of the Nevada ECF, additional fuel would be burned to supply steam for heat. The fuel is not in short supply. The water to be used for the Nevada ECF would be withdrawn from the groundwater aquifers. No new water wells are expected to be required, and no observed impacts have resulted from previous withdrawals. Total consumption of water attributable to water pool operations and consumption of potable water by operating personnel would represent only a small percentage of the supply available by aquifer recharge.

The total cost of locating a new ECF at the Nevada Test Site is approximately \$3.5 billion. This cost represents the total cumulative cost over the 40-year period and includes construction and operation costs of the new ECF as well as the cost associated with shutting down the ECF at INEL. Refer to Section 3.7 for a comparison of the total cumulative costs among alternatives.

As is the case with the ECF at INEL, construction and operation of the Nevada ECF would not require the use or consumption of scarce resources.

5.7 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Implementation of any of the alternatives for the Navy will commit and utilize some environmental resources shortly after the implementation date. In general, up to an additional 30 acres of land could be committed to support naval spent nuclear fuel management activities; it should be noted however that the land at the Naval Reactors Facility at the Idaho National Engineering Laboratory is already committed to this purpose and implementation of the Preferred Alternative would not require the commitment of any additional land. The spent nuclear fuel management activities are expected to require up to 2.5 million gallons of water per year and up to 10,000 megawatt-hours of electrical energy per year depending on the alternative selected. As discussed throughout this Appendix, the normal operations associated with naval spent nuclear fuel management will result in some radioactive releases and releases of some toxic chemicals and other pollutants; however, due to the types of operations involved and the stringent controls that would be in place, these releases would be extremely small and would not affect long-term productivity of any site.

Commitment of these resources is necessary to support long-term safe handling, storage, and examination of naval spent nuclear fuel.

5.8 MITIGATION MEASURES

As stated earlier, all of the environmental impacts associated with implementation of any of the alternatives would be small. However, measures will be taken to reduce these small effects to the lowest possible levels. Consistent with existing Naval Nuclear Propulsion Program policies and historical practices, actions would be taken to prevent pollution, and to mitigate the impacts of naval spent nuclear fuel management facility construction, operations and potential accidents. These measures are summarized below; additional discussion is provided in Attachment F.

5.8.1 Pollution Prevention

Extensive environmental control programs and procedures are in place at all naval sites in order to minimize any environmental and public safety and health impacts that might result from radiological and non-radiological operations. A summary of some of these controls is provided in the following sections.

5.8.1.1 Radiological Pollution Prevention Actions. The policy of the U.S. Navy is to reduce to the minimum practicable the amounts of radioactivity released to the environment. This policy is implemented at shipyards and prototype sites through procedures that are consistent with the recommendations of the National Council on Radiation Protection and Measurements and the standards issued by the U.S. Environmental Protection Agency, International Commission on Radiation Protection, International Atomic Energy Agency, National Academy of Science - National Research Council, U.S. Nuclear Regulatory Commission, and U.S. Department of Energy.

The principal source of radioactivity in liquid effluents is trace amounts of corrosion and wear products from reactor plant metal surfaces in contact with reactor cooling water. Concentrations of radioactive fission products are normally not a consideration for waste disposal because these fission products remain within spent nuclear fuel elements, which are not handled as waste. Radioactive liquids that are generated at shipyard and prototype sites are collected in containers, processed to remove most of the radioactivity, and reused rather than intentionally discharged to the environment.

Radiological work facilities are designed to ensure that there are no appreciable discharges of radioactivity in airborne exhausts. Radiological controls are exercised in radiological work facilities

to preclude exposure of workers to airborne radioactivity exceeding limits specified in Title 10, Code of Federal Regulations, Chapter 20. These controls include performing work involving radioactive materials inside plastic bags or glove boxes which are completely sealed off from the environment. Air exhausted from radiological work facilities is passed through high efficiency particulate air filters which remove more than 99.9 percent of all particles from air, and is monitored during discharge to verify the effectiveness of the control measures.

Sources of radiation are controlled at shipyards and prototypes. Radiological work facilities are designed to minimize radiation exposure to personnel who perform work in the facility and to ensure that exposure to personnel outside the facility is negligible. Ambient radiation is measured with sensitive devices outside the boundaries of areas where radiological work is performed in order to confirm that radiological operations result in no measurable increase in exposure to the general public.

Shipyards and prototypes are not permitted to dispose of radioactive waste on their sites. All solid radioactive wastes are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites that are either licensed by the U.S. Nuclear Regulatory Commission or a state under agreement with the U.S. Nuclear Regulatory Commission or are authorized for radioactive waste disposal by the U.S. Department of Energy. The volume of waste that is generated and shipped is minimized through use of work procedures that limit the amount of material that becomes contaminated during work on radioactive systems and reactor components. Workers periodically receive training specifically intended to help them minimize the production of radioactive waste.

Personnel who work with radioactive materials receive specific training regarding the potential hazards associated with radioactive materials, the general and specific radiological aspects which he or she might encounter, and his or her responsibility to the Navy and the public for safe handling of radioactive materials. More details regarding the scope of this training are provided in Naval Nuclear Propulsion Program Reports NT-93-2 and NT-93-3 (NNPP 1993b and NNPP 1993c).

5.8.1.2 Non-radiological Pollution Prevention Actions. Naval shipyards and prototype sites follow applicable federal, state, and local requirements for the prevention of release of non-radiological pollutants to the environment. Procedures are in place at each location that ensure that operations at the shipyard or prototype comply with environmental requirements and that the operations do not have an adverse effect on the workers, the public, and the environment.

Shipyards and prototype sites are subject to regulation under the Clean Air Act. All sites follow Environmental Protection Agency, state, and local regulations regarding air pollution prevention. Permits are secured as required for operation of facilities which might emit criteria, toxic, or hazardous air pollutants. Equipment is designed and operated in order to comply with the National Emission Standards for Hazardous Air Pollutants and National Ambient Air Quality Standards for the region. Procedures are also in place at shipyard and prototype sites to ensure that the facilities comply with federal, state, and local requirements regarding asbestos emissions, open burning, vehicle emissions, and use of ozone depleting substances. When appropriate, air emissions are treated in order to achieve compliance with requirements and to ensure that the emissions will not degrade ambient air quality.

Shipyard and prototype sites also must comply with the requirements of the Clean Water Act. The Navy policy is to reduce or eliminate the need for wastewater treatment by minimizing or eliminating pollutants at the source. Permits are secured as required for all point source discharges to navigable waters and corrective measures are taken to comply with the terms of these permits. For cases where Publicly Owned Treatment Works are used for industrial wastewater discharges, measures are taken by the site to ensure that the discharges are in accordance with federal, state, and local requirements.

Each site has an active program for evaluating equipment and chemicals proposed for purchase to minimize or eliminate environmental, safety, and health hazards. These evaluations also help to minimize the amount of hazardous waste that is generated by ensuring that the types and quantities of hazardous materials procured are kept to a minimum. Each site has an active program to investigate the replacement of toxic or hazardous materials with other materials and, when possible, substitutions are made in order to avoid the use of chemicals that would result in the generation of hazardous waste. The procurement program includes approval by appropriate safety and health organizations at the site. Hazardous wastes and other toxic substances, such as polychlorinated biphenyls, are handled and disposed of in accordance with applicable Environmental Protection Agency, state, and local requirements. Personnel who handle hazardous materials, hazardous wastes, and other potentially hazardous substances receive training regarding the specific hazards of the materials that they are expected to handle and the methods for safely handling those materials. This training is conducted in accordance with applicable requirements such as those mandated by the Occupational Safety and Health Administration, the Department of Transportation, and the Environmental Protection Agency. Non-hazardous solid wastes are handled and disposed of in accordance

with applicable federal, state, and local requirements. When practicable and economically feasible, materials are recycled or recovered.

Naval designs also consider the effects of the life-cycle of components, including the ultimate disposal. For example, stainless steel fittings are frequently used in equipment in place of brass or bronze fittings, which contain lead, and which can allow lead to leach out of the metal alloys. Similarly, solvents chosen for naval work in recent years have been selected to avoid volatile substances and complex organic chemicals.

Contingency plans exist at shipyard and prototype sites to respond to all accidental discharges and hazardous substance (radiological and non-radiological) releases. These plans have been developed in accordance with the applicable federal, state, and local requirements and are intended to ensure that workers, the public, and the environment would be protected in the event of an accidental release.

5.8.1.3 Prevention of Mixed Wastes. Mixing of radioactive and chemically hazardous materials is avoided; compounding the intrinsic hazards of radioactivity with the chemical hazards of other materials creates a complex regulatory and occupational safety and health situation that impairs the execution of the work. For example, hazardous materials which could give rise to hazardous wastes listed under the Resource Conservation and Recovery Act (such as acetone) are precluded from use in radiological work. Other materials such as alcohol are used instead. The success of Program efforts in avoiding the creation of mixed radioactive and hazardous waste is reflected by the fact that in 1993, Program sites, naval shipyards, and Program DOE laboratories and prototypes produced less than 30 m³ of mixed waste and hold a current inventory of less than 100 m³.

5.8.2 Construction

In the event that implementation of an alternative requires construction of a new facility, the location will be selected to avoid impacts on the cultural, archaeological, aesthetic, or scenic resources of the area and to ensure that the rights and interests of Native American or Native Hawaiian groups are not infringed. Ecologically sensitive areas such as those in the vicinity of threatened or endangered species, and sites listed in the National Register of Historical Places would be avoided.

If upon implementation of an alternative, it is determined that construction of a naval spent nuclear fuel management facility would appreciably impact some resources, then actions to minimize those impacts would be taken. These actions could include, but would not be necessarily limited to, items such as: archaeological data collection prior to construction, education of workers about cultural resources and unauthorized artifact collection, involvement of Native Americans or Native Hawaiians in the selection of a mitigation strategy, and memorandums of agreement between the DOE and concerned parties. Preactivity surveys would be conducted to identify any plant or animal species that could be affected. As needed, mitigation measures and recovery plans would be developed; agencies such as the U.S. Fish and Wildlife Services and the Corps of Engineers would be consulted. The potential for soil erosion could be reduced through methods such as control of storm water runoff, including sediment catch basins. Fugitive dust emissions would be minimized by periodically wetting exposed soils. Traffic concerns could be controlled by widening of roads and traffic demand management. Workers in the construction environment would be protected by the use of hard hats and ear plugs and other safety equipment as needed.

5.8.3 Normal Operations

As has been the policy of the Naval Nuclear Propulsion Program, normal work practices at any naval spent nuclear fuel management facility would be designed to minimize releases and therefore mitigate the impacts on the environment. Releases as a result of normal operations would be minimized through a variety of measures, including: closely controlling the generation of contaminated waste, using total containment devices for certain work that could result in a radioactive release, filtering the ventilation exhaust from radiological facilities, and recycling and treating water used in contaminated systems. All radiological workers at naval facilities are trained in these mitigation principles and in other methods of minimizing radiation exposure. Mitigative measures for the use of toxic or hazardous materials make use of administrative controls, training, and safety equipment to provide personnel protection and emergency response. For personnel protection, controls involve safety review committees for planned activities that establish requirements, safe work permits and procedures, and the use of required clothing such as rubber boots, gloves, face shields, and eye protection that mitigate the effects associated with use of toxic or hazardous materials. Procedures may also require provisions for positioning mitigative devices such as eyewash stations and emergency showers before work is allowed to commence. All of the facilities being evaluated

would employ emergency response programs to mitigate impacts of potential toxic chemical accidents to workers and the public.

5.8.4 Accidents

Although a serious accident involving naval spent nuclear fuel is highly unlikely, emergency plans are in place at all nuclear naval facilities to mitigate the impacts of a facility or transportation accident. These plans include activation of emergency control organizations throughout the Naval Nuclear Propulsion Program to provide on-scene response as well as support for the on-scene response team. Realistic training exercises are conducted periodically to ensure that the response organizations maintain a high level of readiness, and to ensure that coordination and communication lines with local authorities and other federal and state agencies are effective. In addition, naval fuel is designed to resist corrosion and damage due to accident conditions; this rugged construction would also have an important mitigative effect on the impacts of an accident involving naval spent nuclear fuel.

Emergency response measures include provisions for immediate response to any emergency at any naval site, identification of the accident conditions, and communications with civil authorities providing radiological data and recommendations for any appropriate protective actions. In the event of an accident involving radioactive or toxic materials, workers in the vicinity of the accident would promptly evacuate the immediate area. This evacuation can typically be accomplished within minutes of the accident and would reduce the hazard to workers.

For members of the general public residing at the site boundary and beyond, action would be taken to prevent the public from exceeding certain limits on exposure to radiation or other hazards if needed. Individuals that reside or work on site, or those that may be traversing the site in a vehicle would be evacuated from the affected area within 2 hours. Security personnel and appropriate local officials at all locations would oversee the removal of residents, workers, and travelers in a safe and efficient manner. Periodic training and evaluation of the emergency response personnel is conducted to ensure that correct actions are taken during an actual casualty. Therefore, exposure of residents, workers, and travelers to any hazard, including the potential for ingestion and inhalation of contamination, would be limited, as much as possible. Upon stabilization of the situation, recovery and remediation actions would be implemented as soon as practicable.

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