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DOE/EA-1547F

Environmental Assessment

Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington

U.S. Department of Energy
Richland Operations Office
Richland, Washington 99352

March 2006

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GLOSSARY

Acronyms and Initialisms

ARARs	applicable or relevant and appropriate requirements
1995 EA	DOE/EA-0993, *Shutdown of the Fast Flux Test Facility*
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CY	Calendar Year
dBA	A-weighted decibel(s)
DHX	dump heat exchanger
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
EA	environmental assessment
EIS	environmental impact statement
ERDF	Environmental Restoration Disposal Facility
ERPG	Emergency Response Planning Guideline
ETF	Effluent Treatment Facility
FFTF	Fast Flux Test Facility
FONSI	Finding of No Significant Impact
FR	Federal Register
FSF	Fuel Storage Facility
FY	Fiscal Year
HCP EIS	Hanford Comprehensive Land-Use Plan EIS
IDS	Interim Decay Storage
IHX	intermediate heat exchanger
ISA	interim storage area
ISC	interim storage cask
LCF	latent cancer fatality
LDCV	Large Diameter Cleaning Vessel
LERF	Liquid Effluent Retention Facility
LMFBR	Liquid Metal Fast Breeder Reactor
LMR	Liquid Metal Reactor
MASF	Maintenance and Storage Facility
MEI	maximally exposed individual
NaK	sodium-potassium eutectic alloy
NaOH	sodium hydroxide
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission

PCB	polychlorinated biphenyl
PEIS	*Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*
PNNL	Pacific Northwest National Laboratory
PPA	property protected area
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
SALDS	State-Approved Land Disposal Site
SCFM	standard cubic feet per minute
SHPO	State Historic Preservation Officer
SRE	Sodium Reaction Experiment
SRF	Sodium Reaction Facility
SSF	Sodium Storage Facility
SSP	superheated steam process
TC&WM EIS	Tank Closure and Waste Management EIS
TSD	treatment, storage, and/or disposal
WAC	*Washington Administrative Code*

Definition of Terms

As Low As Reasonably Achievable. An approach to radiation and toxicological protection to control or manage exposures (both individual and collective to the workforce and general public) as low as social, technical, economic, practical, and public policy considerations permit.

Background radiation. That level of radioactivity from naturally occurring sources; principally radiation from cosmogenic and primordial radionuclides.

Deactivation (as defined by DOE Order 430.1B, "Real Property Asset Management"). Placing a facility in a stable and known condition including the removal of hazardous and radioactive materials to ensure adequate protection of workers, public health and safety, and the environment, thereby limiting the long-term cost of surveillance and maintenance. Actions include the removal of fuel, draining and/or de-energizing nonessential systems, removal of stored radioactive and hazardous materials, and related actions. Deactivation does not include all decontamination necessary for the dismantlement and demolition phase of decommissioning (e.g., removal of contamination remaining in the fixed structures and equipment after deactivation).

Decontamination (as defined by DOE Order 430.1B, "Real Property Asset Management"). The removal or reduction of residual chemical, biological, or radiological contaminant and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

Decommissioning (as defined by DOE Order 430.1B, "Real Property Asset Management"). The process of closing and securing a nuclear facility or nuclear materials storage facility to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment. It takes place after deactivation and includes surveillance, maintenance, decontamination, and/or dismantlement. These actions are taken at the end of the life of a facility to retire it from service with adequate regard for the health and safety of workers and the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or restricted use of the site.

Derived Air Concentrations. The airborne concentration that equals the annual limit on intake divided by the volume of air breathed by an average worker for a working year of 2,000 hours [assuming a breathing volume of 2,400 cubic meters (85,000 cubic feet)].

Derived Concentration Guide for Public Exposure. Those concentrations of radionuclides in air or water that would result in a maximum effective committed dose equivalent to 100 millirem per year using appropriate dose methodology under conditions of continuous exposure or use (i.e., continuously breathing or being immersed in contaminated air or exclusively drinking contaminated water).

Emergency Response Planning Guidelines No. 1 (ERPG-1). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

Emergency Response Planning Guidelines No. 2 (ERPG-2). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

Emergency Response Planning Guidelines No. 3 (ERPG-3). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Latent cancer fatalities. Deaths from cancer resulting from, and occurring some time after, exposure to ionizing radiation or other carcinogens.

Maximally exposed individual. A hypothetical member of the public residing near the Hanford Site who, by virtue of location and living habits, could receive the highest possible radiation dose from radioactive effluents released from the Hanford Site.

Millirad. A unit of radiation dose equivalent that is equal to one-one thousandth (1/1000) of a rad.

Millirem. A unit of radiation dose equivalent that is equal to one-one thousandth (1/1000) of a rem.

NaK. A sodium-potassium eutectic alloy, liquid at room temperature, typically used in instrumentation and cooling of auxiliary systems.

Person-rem. A population dose based on the number of exposed persons multiplied by the radiation dose each received.

Rad. The unit of absorbed dose. 1 rad = 0.01 Gray (gy).

Rem. A unit of dose equivalent that indicates the potential for impact on human cells.

Risk. The product of the probability of occurrence of an accident and the consequences of an accident.

Sievert (Sv). The international system (SI) unit for dose equivalent equal to 1 Joule/kilogram. 1 sievert = 100 rem.

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
inches	25.40	millimeters	millimeters	0.03937	inches
inches	2.54	centimeters	centimeters	0.393701	inches
feet	0.3048	meters	meters	3.28084	feet
yards	0.9144	meters	meters	1.0936	yards
miles (statute)	1.60934	kilometers	kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	square meters	10.7639	square feet
square yards	0.8361274	square meters	square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
acres	0.404687	hectares	hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.34952	grams	grams	0.035274	ounces (avoir)
pounds	0.45359237	kilograms	kilograms	2.204623	pounds (avoir)
tons (short)	0.9071847	tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	milliliters	milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	liters	liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	liters	liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	kilopascals	kilopascals	0.14504	pounds per square inch
torr	133.32	pascals	pascals	0.0075	torr

06/2001

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE., Third Ed., 1993, Professional Publications, Inc., Belmont, California.

Scientific Notation Conversion Chart

Multiplier	Equivalent
10^{-1}	0.1
10^{-2}	.01
10^{-3}	.001
10^{-4}	.0001
10^{-5}	.00001
10^{-6}	.000001
10^{-7}	.0000001
10^{-8}	.00000001

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Richland Operations Office (RL) is preparing this National Environmental Policy Act (NEPA) environmental assessment (EA) to analyze the potential environmental consequences of a proposed action. The proposed action, as described in subsection 1.2, involves first reacting (i.e, reducing the hazard of the metallic sodium by a chemical reaction) and then removing the radioactively contaminated sodium residuals associated with the Fast Flux Test Facility (FFTF) Project at the Hanford Site in Richland, Washington. In this EA, the proposed action would continue to support long-term, low cost surveillance and maintenance of the facility in a safer and still stable condition, with reduced risk to plant workers, the public, and the environment, prior to implementing a final FFTF decommissioning end state. The final end state would be defined through the Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) and Record of Decision (ROD). This proposed action would maintain the continuity and momentum of FFTF deactivation by using existing on-site experienced sodium-hazard staff, as described in DOE/EA-0993, *Shutdown of the Fast Flux Test Facility* (referred to as the 1995 EA). The 1995 EA addressed leaving the FFTF radioactively contaminated sodium residuals in-place and maintained under an inert gas atmosphere to prevent any chemical reactions during long-term surveillance and maintenance. This EA addresses a different approach to placing FFTF into long-term surveillance by applying technologies to react and remove the sodium residuals. Deactivation activities that would remove associated equipment and components to provide access to the hard-to-reach areas of sodium residuals are also examined. This EA also proposes how to remove, dispose of, and/or stabilize other miscellaneous hazards and waste streams that would be expected as a result of the residual removal activities.

This document was prepared in compliance with the requirements of the Council on Environmental Quality (CEQ) Regulations for Implementing the *National Environmental Policy Act* (NEPA) *of 1969* [40 Code of Federal Regulations (CFR) Parts 1500-1508]; and the DOE Regulations for implementing NEPA (10 CFR Part 1021). NEPA requires the assessment of environmental consequences of Federal actions that may affect the quality of the human environment. Based on the potential for impacts analyzed in this EA, DOE would either publish under NEPA a Finding of No Significant Impact (FONSI) decision or prepare an EIS.

1.1 Background

The FFTF is a DOE-owned, formerly-operating, 400-megawatt (thermal) liquid-metal cooled (sodium) research and test reactor located in the 400 Area of DOE's Hanford Site near the City of Richland, Washington (Figures 1 and 2). A detailed description of the FFTF Complex is provided in *Technical Information Document for the Fast Flux Test Facility Closure Project Environmental Impact Statement* (FFTF-18346).

The original purpose of the facility was to develop and test advanced fuels and materials for the Liquid Metal Fast Breeder Reactor (LMFBR) Program [the FFTF is a Liquid Metal Reactor (LMR)] and to serve as a prototype facility for future LMFBR facilities; other missions were subsequently pursued. Initial criticality was achieved on February 9, 1980, and full power was initially achieved on December 21, 1980. Following an additional year of extensive acceptance testing, FFTF operated safely and successfully from 1982 to 1992 and provided the nuclear industry with significant advances in fuel performance, medical isotope production, materials performance and passive and active safety system testing. In December 1993, DOE decided not to further operate FFTF because of a lack of economically viable missions at that time. DOE issued a shutdown order for FFTF.

In May, 1995, DOE prepared the 1995 EA, evaluating the potential impacts associated with actions necessary to place the FFTF in radiologically safe and industrially safe permanent shutdown and deactivation condition (Phase I), suitable for a long-term surveillance and maintenance (Phase II) prior to decommissioning (Phase III). The 1995 EA did not evaluate Phase III. DOE determined that an EIS was not required for the permanent shutdown and deactivation of the FFTF, and issued a FONSI in May 1995.

In January 1997, DOE decided to maintain FFTF in standby pending an evaluation of a future role in DOE's national tritium production strategy. In December 1998, DOE decided FFTF should not play a role in production of the nation's tritium stockpile. Facility deactivation work continued under the 1995 EA, limited to activities that would not preclude reactor restart.

In December 2000, DOE published the *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (NI-PEIS, DOE/EIS-0310F) This NI-PEIS evaluated the role of FFTF as an alternative nuclear irradiation services facility to accomplish civilian nuclear energy research and development, medical and industrial radioisotope production, and production of plutonium-238 to support future National Aeronautics and Space Administration space exploration missions. Also evaluated was an alternative to permanently deactivate the FFTF. Based on the NI-PEIS, DOE decided in the Record of Decision (ROD) [66 Federal Register (FR) 7877, January 26, 2001], that the permanent deactivation of FFTF was to be resumed, with no new missions. Since that time, deactivation has continued, consistent with the 1995 EA and FONSI and the 2000 NI-PEIS and 2001 ROD.

The total Hanford Site radioactively contaminated sodium inventory is estimated to be 1,136,000 liters (300,000 gallons). Approximately 874,000 liters (231,000 gallons) of 984,000 liters (260,000 gallons) of bulk radioactively contaminated sodium has been drained from the FFTF reactor vessel (RV), three primary and three secondary heat transport system loops, and Fuel Storage Facility (FSF), and transferred to the Sodium Storage Facility (SSF, adjacent to FFTF). Additional bulk radioactively contaminated sodium inventory remains stored in the Hanford Site 200 West Area in 5 Hallam tanks [128,700 liters (34,000 gallons)] and in 158 55-gallon storage drums of Sodium Reactor Experiment (SRE) sodium [26,000 liters (7,000 gallons)]. Associated trace heat systems have been de-energized. Approximately 79,000 liters (21,000 gallons) of bulk FFTF sodium remains in the FFTF Interim Decay Storage (IDS) vessel and associated auxiliary systems. The IDS sodium will be drained and transferred to SSF in Calendar Year 2006. The FFTF sodium residuals (i.e., material that remains on the walls of piping and components, or remains in pumps or vessels and other locations not readily drained) are being maintained in an inert environment (under an argon cover gas).

In December 2003, DOE issued a final request for proposals to "clean up and take down" the FFTF Complex. On December 22, 2005, DOE cancelled the solicitation for the Hanford Site FFTF Closure Project. Cancellation of the solicitation was deemed necessary because of budget constraints and the need to support higher-risk/higher-priority Hanford Site cleanup projects. In February 2006, DOE announced its intention to prepare a Tank Closure and Waste Management (TC & WM) EIS for the Hanford Site (71 FR 5655). DOE decided to merge the scope of the FFTF EIS (69 FR 50176) to further coordinate resources and ensure a comprehensive look at environmental impacts at Hanford. In the TC & WM EIS, the potential decision for final decontamination and decommissioning of the FFTF would identify the final end state for the above-ground, below-ground, and ancillary support structures.

This EA is an interim action EA that examines the environmental consequences on an expanded deactivation workscope that was previously analyzed in the 1995 EA to evaluate a different approach to sodium residuals management. The 1995 EA provides the foundation for most of the analyses of environmental impacts included in this EA. This EA evaluates the any potential additional environmental

impacts. There have been relatively minor changes in environmental conditions at the 400 Area of the Hanford Site since 1995. The affected environment is described in Section 3.0, and updates the description provided in the 1995 EA (as documented in current 2005 reviews of Hanford Site environmental conditions). As such, this EA supplements or adds to the 1995 EA analysis of deactivation actions. Under the criteria of 40 CFR 1506.1, these actions would not be expected to have an adverse environmental impact or limit the choice of reasonable alternatives under consideration in the pending TC & WM EIS.

Metallic sodium is a strong reducing agent, and prone to exothermic reactions (sodium reacts vigorously with moisture under uncontrolled conditions to generate heat, hydrogen, and sodium oxide). The staff at FFTF has extensive expertise and corporate experience in the hazards of handling metallic sodium gained through startup, operations, maintenance, deactivation, and participation in national and international working groups.

1.2 Purpose and Need for Action

The 1995 EA addressed leaving and maintaining the FFTF radioactively contaminated sodium residuals under an inert gas atmosphere to prevent any chemical reactions during long-term surveillance and maintenance. The purpose of this proposed action is to continue to support long-term, low cost surveillance and maintenance (Phase II) of the facility in a safer and more stable condition with reduced risk to plant workers, the public, and the environment, prior to the final decommissioning end state of the FFTF. It would also maintain the continuity and momentum of FFTF deactivation activities using the advantage of existing knowledge and skills of current FFTF staff who have worked for many years within the confines of FFTF with the attendant sodium hazard (i.e., liquid-metal handling/cleaning expertise). The activities DOE now proposes to undertake include reaction and removal of radioactively contaminated sodium residuals, removal of associated equipment/components, as required, and removal/disposal/stabilization of the resulting miscellaneous hazards and waste streams. The proposed activities would be able to rely on existing staff with expertise in liquid metal handling/cleaning, minimizing risks to directly involved workers and other facility staff. Furthermore, it would eliminate having to maintain the inert cover gas system during the surveillance and maintenance phase, thus reducing costs.

1.3 Coordination with Activities under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980

Completion of the proposed deactivation workscope being evaluated in this EA would reduce a potential threat of release of hazardous substances into the environment. In parallel, DOE is preparing appropriate *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) *of 1980* documentation in order to implement the workscope described in this EA and to obtain a CERCLA decision document allowing waste streams generated from conducting the EA workscope to be disposed of at the existing 200 Area Environmental Restoration and Disposal Facility (ERDF). Relevant portions of this EA would be incorporated by reference into the CERCLA documentation to address NEPA values.

2.0 PROPOSED ACTION AND ALTERNATIVES

This EA evaluates the technologies to react and remove radioactively contaminated sodium residuals associated with the FFTF Project, as well as removal of associated equipment/components to allow removal of the sodium, and removal/disposal/stabilization of miscellaneous hazards and waste streams left over from the residual removal activities. Alternatives to the proposed action are also addressed.

2.1 Proposed Action

This EA focuses on removal and reaction of FFTF radioactively contaminated sodium residuals and other associated deactivation activities. DOE proposes to improve safety and reduce surveillance and maintenance costs by removing sodium residuals and other hazardous materials as a continuation of Phase I deactivation activities. Originally, in the 1995 EA, the proposed action and alternatives for sodium residuals were addressed as follows:

> "Following the drainage of the sodium and NaK systems, approximately 15,000 liters (4,000 gallons) of residual sodium would remain in the main portions of the FFTF's piping and equipment. Additional indeterminate quantities would remain in other portions of the plant systems, especially in complex, small-diameter piping systems. Included in the proposed action would be accommodation of these residuals to a stabilized condition such that long-term monitoring and surveillance of the FFTF could be conducted in a safe and environmentally sound manner. The current concept for accommodating residuals would be to maintain an inert gas atmosphere to prevent any chemical reactions during long-term surveillance and maintenance."

> "Alternative methods for accommodation of the sodium residuals will continue to be evaluated, including alternative cover gases and chemical reactants. These methods would not be expected to provide any additional environmental impacts, nor any new initiators or risks for accidents, and would be subject to appropriate safety and NEPA reviews."

In this EA, a different approach is evaluated whereby reaction of sodium residuals associated with the FFTF Project systems and equipment could be conducted in-place or at designated cleaning locations. These proposed sodium residual reaction activities (refer to Subsections 2.1.2 – 2.1.5) are based on use of the superheated steam process (SSP, refer to Subsection 2.1.1). It is recognized that for select situations that may be encountered, an alternative technology (refer to Subsection 2.2.2) could be implemented on a small scale for sodium residuals reaction.

Liquid wastes generated from removal and reaction of sodium residuals would be required to meet the waste acceptance criteria (including pH, sodium, and total dissolved solids) of existing liquid waste management facilities. These facilities are the existing Liquid Effluent Retention Facility (LERF) and the Effluent Treatment Facility (ETF) in the 200 East Area of the Hanford Site. Solid wastes would be disposed of in existing 200 Areas waste management facilities.

The following discussion presents details associated with activities considered under the proposed action.

2.1.1 Apply Process Technology for Removal and Reaction of Sodium Residuals and Associated Equipment

Removal of sodium residuals from systems/components has always been a part of the operation of LMRs. Removal of sodium residuals has been necessary during the operating period of LMRs to perform maintenance and to remove and repair various LMR components. Sodium residuals removal has also

been a part of the disposition of LMR spent nuclear fuel. As part of the development and operation of LMRs, a variety of processes were developed for removing sodium residuals to support reactor operation and maintenance. Further development of these processes has been conducted as LMRs around the world have been shut down and deactivation activities have been initiated.

In 2005, the technical feasibility of various methods to react the sodium residuals was evaluated [*Fast Flux Test Facility Sodium Residual Cleaning Process Selection* (HNF-26715)]. The methods evaluated were: water vapor; SSP; moist carbon dioxide; evaporation; and dissolution of sodium in ammonia. These processes were evaluated against four criteria (past performance, complexity, process hazards, and flexibility). Although each of the technologies evaluated in HNF-26715 had positive attribute(s), overall SSP appeared to have the greatest utility for reacting residual sodium in FFTF. It is recognized that in select instances, one of the other alternative technologies (refer to Subsection 2.2.2) could be implemented on a small scale.

The primary advantages of the SSP are that it does not allow condensation to occur and component cleaning can be performed in a shorter time period. Prior to steam injection into the system to be cleaned the steam is heated to ~ 400^{0}F. The equipment to be cleaned is heated to a minimum of 212^{0}F and higher if possible. Most systems will require multiple injection points. As the superheated steam reacts with the metallic sodium, the temperature increases to ~600-800^{0}F.

Because of the high initial temperature and the increase of the temperature caused by the reaction, no condensation occurs. Since no condensation can occur, no uncontrolled chemical reaction will occur as would be possible in the water vapor process (refer to Subsection 2.2.2.1) The caustic formed is a liquid at the processing temperatures and because it is denser than the liquid sodium, it settles to the bottom of any pools leaving the sodium on top where it is always exposed to the superheated steam. Due to the continued exposure of the molten sodium to the superheated steam, the reaction continues at a constant rate.

Superheated steam injection is continued until hydrogen is no longer being generated. The system is then cooled, the sodium hydroxide solution is diluted, the pH is adjusted to <13, and the fluid is removed from the system. The liquid waste would be transported to LERF and subsequent treatment at ETF in the 200 East Area of the Hanford Site.

The benefits of SSP are:

- Condensation of water vapor does not occur due to the initial high temperature of the steam and the components and the continued high temperature due to the heat generation by the reaction process.
- Since there is no water accumulation in the system, the reaction process can immediately be terminated by stopping the injection of steam.
- Since the surface of the molten sodium is always exposed to the steam, the reaction occurs at a high rate and components can be cleaned more quickly.

2.1.2 Perform In-place Cleaning of Vessels, Components, and Large-Bore Pipe

A portable reaction unit would be used to clean, in-place, large-bore sodium pipe (greater than or equal to 8-inch diameter), components and vessels in the primary and secondary sodium cooling systems (Figures 3 and 4). The portable reaction unit also would be used to clean the IDS and FSF vessels (Note: select components in the primary sodium system, and large diameter piping and components in the secondary sodium system may be removed and cleaned in FSF or MASF, as described in Subsections 2.1.3 or 2.1.4).

Typically, penetrations into the piping/vessels would be made at appropriate locations using a low-speed drill. Existing sodium heating systems would be energized, and piping/vessels heated to liquefy the existing sodium residuals. A portable reaction unit would be connected to the penetration points, and used at various locations to inject the superheated steam into plant systems.

The superheated steam would be injected as described in Subsection 2.1.1. Hydrogen generation would be monitored to follow the reaction. Liquid waste (i.e., sodium hydroxide solution) would be collected in a catch vessel. The pH of the resultant solution would be reduced to <13 (refer to Subsection 2.1.1) and transferred to interim staging vessel, before offloading the solution to tanker transport for overland transfer to LERF and subsequent treatment at ETF.

2.1.3 Remove Small Bore Pipe and Components for Reaction in a Cleaning Station

Small bore piping (<8" diameter), valves and other components [e.g., core component pots from IDS, fuel storage tubes from FSF, and Dump Heat Exchangers (DHX) tube bundles (Figures 3 and 4) may be removed and processed in a proposed stationary cleaning station that would be located in FSF. Mechanical means (e.g., portable saws, pipe cutters) would be used to cut the pipe, valves, and components into manageable size. All heat exchanger tube bundles, which contain multiple parallel flow paths, would be dismantled to assure effective cleaning.

The proposed FSF stationary cleaning station would consist of a chamber with removable rack for loading piping and components. The piping would be loaded at an angle, allowing the residual sodium to drain to a catch basin when heated before the injection of inert gas and/or reaction medium. The process in the cleaning station would be consistent with the in-place process (refer to Subsection 2.1.2) where the resultant waste sodium hydroxide solution is collected, the pH reduced to <13, and transported to the 200 Areas. The FSF is considered an appropriate location due to availability of sufficient floor space, existing overhead crane, available utilities, and proximity to proposed operations.

Cleaned piping and components would be stored at FFTF (e.g., existing lay down area) pending packaging and disposal in a Hanford Site solid waste management facility.

2.1.4 Remove Large Components for Cleaning

The Large Diameter Cleaning Vessel (LDCV) located in the existing MASF could be used for cleaning large components following removal (e.g., primary sodium pumps, intermediate heat exchanger (IHX) tube bundles, and instrument trees). The LDCV would be retrofitted with a new super-heated steam supply and associated control system for use in cleaning the aforementioned components. The IHX tube bundles, which contain multiple parallel flow paths, may be dismantled to assure effective cleaning. Small bore pipe and components (refer to Subsection 2.1.3) also could be cleaned in MASF, if necessary.

Cleaning and disposition of liquid/solid wastes would be as described in Subsection 2.1.2.

2.1.5 Remove Sodium Residuals from Bulk Storage Facilities

For a bounding analysis in this EA, it is assumed that less than 1,135 liters (300 gallons) of sodium residuals would remain after draining the storage containers (i.e., SSF tanks, Hallam tanks, and SRE drums). Drained SSF and Hallam tanks would be cleaned in the 400 Area using the process described in Subsection 2.1.2. The drained SRE drums could be cleaned in the sodium cleaning station located in FSF (refer to Subsection 2.1.3). The SSF tanks would be left in a safe configuration for disposition under FFTF decommissioning, and the Hallam tanks and the SRE drums would be disposed of as solid waste.

2.1.6 Remove Special Components (cesium trap, primary cold trap, two vapor traps)

There are four components that would require special disposition due to high levels of radiological contamination (primarily due to cesium-134 and -137) and/or the inability to drain the component effectively. The "Special Components" (primary cold trap, cesium trap, and two vapor traps[1]) would be removed from their installed position during sodium residual removal and packaged. The packages would be stored in the 400 Area pending final disposition.

Table 1. FFTF Special Components.

Component	Description of Component	Volume of Residual Na (liters/gallons)	Radiation Consideration (maximum anticipated dose rate)	Disposition
Primary Cold Trap	Same	2,680/710	10 Rem/hour at contact	Cut/Cap remotely; Store
Cesium Trap	Same	300/80	60 Rem/hour at contact	Cut/Cap remotely; Store
Vapor Trap A* (5 SCFM)	Condenser vapor trap and two filter vapor traps	Residual only <4/<1	5 Rem/hour at contact	Cut/Cap remotely; Store
Vapor Trap B* (1 SCFM)	Condenser vapor trap and two filter vapor traps	Residual only <4/<1	0.6 Rem/hour at contact	Cut/Cap remotely; Store

*The 'A' and 'B' designation refers to flow capacity through the vapor trap; 'A' is 5 standard cubic feet per minute (SCFM) and 'B' is 1 standard cubic feet per minute.

[1] A trap basically is a piece of equipment or component used to filter out contaminants.

2.1.7 Other Deactivation Activities

Other related deactivation activities that would occur as part of the proposed action are described as follows.

- Remove/Dispose of asbestos

The original design specifications for FFTF included asbestos-free insulation around sodium piping and components. However, asbestos-containing materials were used in several locations. The majority of the asbestos-containing materials are in the form of cable tray fireproofing and asbestos-coated trace heat wiring for the sodium system piping and components. Approximately 100 cubic yards of asbestos-containing materials would be appropriately packaged and disposed.

- Remove/stabilize existing hazards in conjunction with systems and equipment deactivation associated with sodium residuals.

As systems become no longer necessary to support plant deactivation activities, the need for general maintenance and plant support would be reduced. Some of these systems and utilities contain hazardous materials, such as glycol, oils, and polychlorinated biphenyl (PCB) [e.g., approximately 360,000 liters (94,000 gallons) of ethylene glycol and 32,000 liters (8,500 gallons) of PCB transformer oil]. These materials would be recycled or disposed of. Excess chemicals (e.g., maintenance solvents) also would continue to be recycled or disposed of, as appropriate.

Essentially all of the plant systems would be deactivated at final shutdown, placing the FFTF into a long-term surveillance and maintenance phase. Actual facility support would be limited to minimal maintenance and facility walkdowns. Monitoring in the near-term would continue to be required for the SSF.

- Remove/recycle/dispose excess deactivated equipment and components.

Miscellaneous unnecessary/inactive equipment and components are present in FFTF. For example, ventilation ducts and cover gas systems are in locations in FFTF that are a hindrance to access of piping and components associated with sodium residuals. These equipment and components would be extracted by mechanical means to ease removal of sodium piping and components.

For conservatism, it is assumed that these materials would represent an additional approximately 30 percent (by weight) of the total piping [approximately 1,500,000 kilograms (1,600 tons)] directly involved with sodium residuals, or ~440,000 kilograms (~480 tons) [rounded to 450,000 kilograms (500 tons)]. These materials could be managed in a similar fashion as the piping; i.e., clean and dispose of as solid waste at the Hanford Site.

- Remove depleted uranium and/or lead shielding.

The FFTF reactor contains depleted uranium shielding (including head compartment shielding, center island shielding, branch arm piping shielding, and shielding for the fuel transfer ports), and lead shielding. The inventory of depleted uranium is approximately 37,800 kilograms (83,100 pounds). The inventory of lead shielding is approximately 48,000 kilograms (105,600 pounds). These materials would be removed to the extent practicable, and recycled, reused, or stored in the 400 Area.

2.1.8 Management of Waste Streams

As discussed in Subsection 1.3, CERCLA documentation is being prepared in parallel with this EA to obtain a CERCLA decision document that would allow disposal of waste at ERDF. The following is a list of waste streams and the potential applicable or relevant and appropriate requirements (ARARs) that could be applied under CERCLA.

2.1.8.1 Waste Handling

Continued deactivation (including residual sodium removal/reaction) of the FFTF would result in wastes and surplus materials which would be managed in a manner consistent with waste minimization requirements, including the *Pollution Prevention Act of 1990*, State of Washington requirements [i.e., Washington Administrative Code (WAC) 173-303, *Dangerous Waste Regulations*], and DOE Orders and policies (e.g., DOE Order 450.1, Change 1, *Environmental Protection Program*; and DOE Order 435.1, Change 1, *Radioactive Waste Management*). Compliance with the aforementioned laws, regulations, and orders requires, as appropriate, permits and approvals, waste minimization programs and practices, a pollution prevention awareness program, and annual waste reduction reports and goals. All wastes would meet the waste acceptance criteria of the existing waste management units.

2.1.8.2 Liquid Wastes

As discussed previously (refer to Subsection 2.1.1), sodium residual reaction would result in an estimated 3,780,000 liters (1,000,000 gallons) of radioactive sodium hydroxide solution. This liquid waste would be transported, via tanker truck, to the existing Hanford Site 200 Area LERF for subsequent treatment at ETF. The LERF/ETF provides integrated liquid effluent management to support cleanup of the Hanford Site. The LERF/ETF is used to remove hazardous chemicals and low-level radioactive contamination from wastewater effluent streams. The treated wastewater is disposed at a State-Approved Land Disposal Site (SALDS, refer to Figure 1) that discharges treated effluent under a WAC 173-216 Discharge Permit.

2.1.8.3 Solid Wastes

Cleaned piping and components could result in approximately 2,700,000 kilograms (3,000 tons) of low-level solid radioactive waste. At a nominal density of approximately 600 kilograms/cubic meter (37 pounds/cubic foot), this equates to approximately 4,500 cubic meters (162,000 cubic feet). This is comprised of approximately 1,500,000 kilograms (1,700 tons) of piping (large- and small-bore), approximately 670,000 kilograms (740 tons) of components [vessels, valves, pumps, heat exchangers, including 12,700 kilograms (14 tons) of IDS/FSF traps], approximately 450,000 kilograms (500 tons) of miscellaneous components (removed to facilitate access to sodium residuals), non-asbestos insulation [~1,400 cubic meters (~1,800 cubic yards)], and approximately 76 cubic meters (100 cubic yards) of asbestos-containing materials. These wastes would be transported to existing waste management facilities in the 200 Areas of the Hanford Site, or staged in the vicinity of FFTF for eventual transport to and disposal of at the Environmental Restoration Disposal Facility (ERDF, refer to Figure 1).

2.1.8.4 Air Emissions

Conversion of the sodium to a stabilized form would result in some airborne emissions. Radioactive airborne emissions from the cleaning stations are expected to be limited to tritium when cleaning piping and components from the secondary cooling system. Some fission products could be present when cleaning piping and components from the primary and fuel storage sodium systems.

2.1.8.5 Pollution Prevention/Recycling

Hazardous materials associated with the auxiliary systems may represent a quantity of materials that would be reused, recycled, or appropriately packaged and managed as regulated wastes. Such materials include approximately 360,000 liters (94,000 gallons) of ethylene glycol and 32,000 liters (8,500 gallons) of PCB transformer oil.

2.1.8.6 Waste Transportation

The solid and liquid effluents from the deactivation activities that contain radioactive and/or hazardous materials would be appropriately packaged. Primary consideration would be given to transportation of the wastes to (and use of) existing Hanford Site waste management facilities. All activities would be conducted in full compliance with applicable regulations, including the *Clean Air Act of 1977* and U.S. Department of Transportation (DOT) requirements, which would be in force at the time of the action.

2.2 Alternatives to the Proposed Action

Alternatives to the proposed action include the No-Action alternative, alternative process technologies for removal and reaction of sodium residuals, and alternative locations of the sodium residual reaction station(s).

2.2.1 No-Action Alternative

Under the No-Action Alternative, the FFTF would continue to be deactivated as described under the 1995 EA. This alternative would leave the sodium residuals in place.

2.2.2 Alternative Process Technologies for Removal and Reaction of Sodium Residuals and Associated Equipment Including the Proposed Action

Alternative process technologies for removal/reaction of FFTF sodium residuals have been considered. As addressed in HNF-26715, each process was qualitatively evaluated against four criteria of past performance, complexity, process hazards, and flexibility.

2.2.2.1 Water Vapor

This process has been used at Hanford since the 1970's. It was used extensively in the DOE Nuclear Energy Legacy Program to clean residual sodium and sodium/potassium (NaK) from a variety of test loops and components and is currently used at FFTF to clean sodium from fuel elements as part of the Fuel Offload Program.

Two methods are used to inject the water into nitrogen (or some other inert gas):

- A water column; or
- A steam generator.

The inert gas carries the water vapor into the equipment to the sodium where the water reacts with the sodium. The process is controlled by limiting the water content of the inert gas. However, water can build up in the equipment being cleaned and it can take several hours to consume the available water after water addition is terminated. This makes it difficult to quickly shut down the process.

Water vapor is injected into the vessel or piping (multiple injection points are usually required) where the frozen sodium strips the water vapor from the carrier gas, releasing hydrogen and producing sodium hydroxide (NaOH) (Equation 1).

$$2Na + 2H_2O \rightarrow 2NaOH + H_2 \quad (1)$$

As the process continues in vessels with puddles of frozen sodium[2], the sodium hydroxide is normally siphoned off on a regular basis to prevent a rapid reaction and uncontrolled pressurization event. As the water reacts with the sodium on the surface of a sodium puddle, a sodium hydroxide layer is formed. As the thickness of this layer increases, the rate of reaction slows down since the water must diffuse through the hydroxide layer. A substantial gradient of water content can develop, with a high concentration at the "top" of the layer. If the layer is disturbed and the water contacts the sodium, a very rapid reaction will result releasing hydrogen gas and a large amount of heat. This will cause a temperature and pressure surge in the system being cleaned and if sufficient free volume is not available can result in damage to the equipment being cleaned or to the cleaning equipment. One method to mitigate this problem is to expend additional effort to remove additional sodium from the equipment to reduce the size of the sodium puddles.

The progress of the cleaning process is normally monitored by measuring the hydrogen concentration in the effluent gas stream. The oxygen concentration is also measured to assure that flammable conditions cannot exist in the equipment being cleaned. As the hydrogen concentration subsides, the water content of the inert gas is increased. The process eventually switches over to water injection while continuing to monitor oxygen and hydrogen. Local temperature (near the reaction zone) may also be monitored.

The equipment is rinsed, as necessary, to assure the sodium has been reacted and to remove any remaining caustic. The amount of water required varies with the complexity of the item being washed, it could require full submersion. After final rinsing, the equipment is purged with inert gas (e.g., nitrogen) to dry the system.

2.2.2.2 Moist Carbon Dioxide

Sodium metal reacts with carbon dioxide and water to form sodium bicarbonate and/or sodium carbonate, depending upon the temperature and availability of water and carbon dioxide. Under some conditions, both reaction products can be formed. These chemical reactions are generally stated by Equations 2 and 3.

$$2Na + 2CO_2 + 2H_2O \rightarrow 2NaHCO_3 + H_2 \quad (2)$$

$$2Na + CO_2 + H_2O \rightarrow Na_2CO_3 + H_2 \quad (3)$$

In reaction 2, sodium metal reacts with gaseous carbon dioxide and water to form solid sodium bicarbonate and hydrogen gas. In reaction 3, sodium metal reacts with gaseous carbon dioxide and water to form solid sodium carbonate and hydrogen gas. These reactions are called passivation since once these products are formed the sodium will no longer react with air.

The rate of sodium bicarbonate formation depends partly on the concentration of carbon dioxide and partly on the concentration of the water vapor. In the open air where the concentration of carbon dioxide

[2] After draining molten sodium, some of the residual sodium may form a 'puddle' at low points in the piping or components. As the sodium cools, it solidifies; thus the surface of the 'frozen' puddle of sodium is what is available for reaction.

is less that 0.04 volume percent, the conversion to sodium bicarbonate can occur quite slowly (i.e., hours to days). The layer of sodium bicarbonate that forms is porous and allows for the penetration of water and carbon dioxide to the sodium metal underneath; however, the rate of reaction slows as the bicarbonate layer thickens. The volume of the porous layer is approximately five times that of the solid metal. Therefore, the process works well in places where there is space available for the expansion but plugging occurs if sufficient space is not available.

When humidified carbon dioxide reacts with residual sodium at ambient temperature, the product is greater than 90 percent sodium bicarbonate. The rate of reaction is proportional to the moisture concentration and is inversely proportional to the thickness of the sodium bicarbonate layer on top of the residual sodium assuming a constant layer chemical composition and no changes in layer density as the layer thickness increases. The rate of reaction is slower than can be achieved using superheated steam or water vapor.

The carbon dioxide process has been used in two variations: dry carbon dioxide; and moist carbon dioxide. The dry process results in a sodium carbonate layer and the moist process a sodium bicarbonate layer. The dry carbon dioxide process produces a hard carbonate layer on the surface of the sodium. This rather impervious layer effectively limits the reaction to only the first few millimeters of the sodium layer. Moist carbon dioxide reacts faster than the dry carbon dioxide and more of the sodium is reacted.

Passivation allows the sodium or at least the surface sodium to be reacted and left in the piping, tanks, and other equipment in a state with a reduced hazard. Complete reaction of all residual sodium has not been shown to be possible with this process and water vapor, superheated steam or some other processing may still be required to complete reaction of the sodium prior to flushing or dismantling of the equipment/components.

2.2.2.3 Evaporation

The removal of sodium from components using heat and vacuum has been studied and used by most operators of sodium systems (HNF-26715). Tests have shown that successful sodium removal could be accomplished at temperatures as low as 260°C (500°F) using a diffusion-pumped system capable of attaining very low pressures [i.e., 0.013 to 0.0013 pascals (10^{-5} to 10^{-6} torr]. Evaporation of sodium from a component also has been demonstrated successfully by heating the component in a flowing stream of inert gas, such as argon, although the time to remove sodium by evaporation in an inert gas may be several orders of magnitude longer than vacuum evaporation at the same temperature.

In the evaporation process, the component or system to be cleaned would be isolated and heated to the desired temperature. The system would then either be evacuated or purged with an inert gas. The sodium would be removed from the system as a vapor and condensed where it would be disposed of by converting it to sodium hydroxide or some other compound. It could also be added to any bulk sodium disposition process.

One of the potential advantages of evaporation is that it may be able to clean large components in-place. Evaporation appears to be capable of more effectively cleaning some items, particularly those having inverted long tube configurations or long narrow crevices. However, although evaporation of sodium has been investigated and used to clean some components by almost all countries developing LMFBR technology, it has not been applied in the deactivation or decommissioning of LMFBR facilities. Therefore, evaporation, while potentially useful in selected instances, is not considered as adaptive as SSP for reacting FFTF sodium residuals.

2.2.2.4 Dissolution of Sodium in Ammonia

Sodium dissolves in liquid anhydrous ammonia, producing a free electron (Equation 4):

$$NH_3 + Na \rightarrow NH_3 + Na^+ + e^- \quad (4)$$

This is called a solvated electron solution. At atmospheric pressure, anhydrous ammonia boils at -33°C (-28°F). Thus, when 0.03 cubic meters (1 cubic foot) of liquid anhydrous ammonia at 16°C (60°F) expands, the result is approximately 24 cubic meters (850 cubic feet) of gas.

The ammonia process is a two-phase process since both liquid and gaseous ammonia would be present in the equipment while it is being cleaned. Headspace (minimum of 20 percent) is required to accommodate evaporation (or boiling) of the anhydrous ammonia to provide for appropriate liquid expansion. Headspace would be accommodated in any circulating system simply by providing suitable vessels. In the case of FFTF, these vessels would be external to the sodium systems and the interconnecting piping (and selected vessels themselves) would have safety relief valves installed to prevent excessive pressure buildup. Pressure relief valves would be necessary to discharge ammonia at whatever levels are necessary to protect FFTF systems in case of failure of ammonia vapor recovery (refrigeration) systems. The backup would be to manually discharge the ammonia vapor directly into the scrubber system, where it would be removed by reaction with sulfuric acid. The relief valves would be piped to a header, which is subsequently piped to the scrubber. It is expected that the entire system would be monitored 24 hours per day during ammonia recovery operations.

Advantage is taken of the thermodynamics of the ammonia refrigeration cycle wherever possible, and the refrigeration system takes care of vapor pressures and heat loads. The FFTF trace heaters and circulation pumps would be off, with the systems allowed to reach ambient temperature before ammonia introduction. Ammonia would be forced through the equipment being cleaned using the pressure generated when the ammonia vaporizes in a closed system. While the systems being cleaned would never be completely filled with ammonia it is hoped that all system surfaces would be washed by the flushing action of the liquid ammonia as it is forced through the system.

Once sodium has dissolved in anhydrous ammonia, it cannot revert to its metallic form. If an absolutely "pure" solvated solution is evaporated, as the sodium concentration reaches a high level the sodium will finally react with ammonia to form solid sodium amide ($NaNH_2$) and hydrogen gas. Sodium amide will react with water (or water vapor) to produce ammonia and sodium hydroxide, which is corrosive, and would be regulated for disposal as such. No ammonia solution (sodium dissolved in ammonia) would be left in the FFTF systems, recirculation of the solution through a reaction vessel to remove the sodium would be continued until its conductivity reaches zero. At this point there are essentially no remaining reactive sodium molecules in the system.

A primary concern with this process is the release of ammonia vapor. Actions would be taken to alleviate these concerns. For example, during processing, scavenger nozzles could be used to sweep tramp (i.e., residual) ammonia into flex hoses, using cage blowers to evacuate leak areas. The ammonia would be routed to a scrubber for absorption and acid neutralization. Work areas would need to be continuously monitored for ammonia leaks using gas detectors, both permanently mounted and carried by operating technicians. These controls are necessary to comply with DOE's occupational safety and health requirements for permissible exposure to the vapors.

The anhydrous ammonia process was not developed and tested as part of the LMR program and it has not been used to remove sodium from equipment as part of operations or maintenance of a LMR and has not been used for the deactivation of an LMR. The main application of the anhydrous ammonia process has

been in the treatment of hazardous (organic) wastes. However, sodium is known to dissolve readily in liquid anhydrous ammonia and since the use of this process has been proposed for the FFTF, it is included in this evaluation. However, as with the evaporation technology addressed in Subsection 2.2.2.3, while potentially useful in selected instances, is not considered as adaptive as SSP for reacting FFTF sodium residuals.

2.2.3 Alternative Locations of Sodium Residual Reaction Station(s)

Alternatives to the proposed locations of the sodium residual reaction stations (i.e., mobile unit, FSF stationary unit, and LDCV in MASF) were considered. For example, additional modifications to MASF would be required to accommodate the small bore piping. The Small Diameter Cleaning Vessel has utility for cleaning external surfaces of equipment, but would have to be modified to accommodate reacting residual sodium on the internals of piping. Additional handling would be required to re-locate the materials to be reacted to MASF, rather than to the adjacent location (FSF).

Offsite treatment/disposal also was considered. Hanford Site alkali metal test loops have been dispositioned using privately operated, *Resource Conservation and Recovery Act* (RCRA) *of 1976* treatment, storage, and/or disposal (TSD) facilities for treatment and/or disposal (*Environmental Assessment: Disposition of Alkali Metal Test Loops, Hanford Site, Richland, Washington,* DOE/EA-0987). However, those activities involved reacting relatively small quantities of nonradioactive materials at available facilities. If a facility were available for offsite treatment of radioactively contaminated sodium residuals, there would be additional expense and potential transportation impacts incurred.

3.0 AFFECTED ENVIRONMENT

Details regarding the Hanford Site can be found in the *Hanford Site Environmental Report for Calendar Year 2004* [Pacific Northwest National Laboratory (PNNL)-15222] and *Hanford Site National Environmental Policy Act (NEPA) Characterization* (PNNL-6415), and *Hanford Site Groundwater Monitoring for Fiscal Year 2004* (PNNL-15070). These documents (all 2005 revisions) are updated annually for the Hanford Site, and are based on current site inventories, modeling data, and related information.

3.1 Land Use

The FFTF, located in the 400 Area of the Hanford Site, is not located within a wetland or a floodplain. The final decommissioning end state of the FFTF (which will be addressed in the TC&WM EIS) would determine ultimate land use. Presently, the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS) Record of Decision* (ROD, 64 FR 61615, November 12, 1999), issued after the 1995 EA updated land used considerations and analyses for the FFTF, states that the 400 Area is designated Industrial.

3.2 Meteorology and Climatology

The Hanford Site has a semiarid climate with 15 to 18 centimeters (6 to 7 inches) of annual precipitation, and infrequent periods of high winds of up to 128-kilometers (80-miles) per hour. Tornadoes are extremely rare; no destructive tornadoes have occurred in the region surrounding the Hanford Site. The probability of a tornado hitting any given location on the Hanford Site is estimated at 1 chance in 100,000 during any given year. No notable changes in meteorology and climatology at the Hanford Site have occurred since the 1995 EA was published. Additional details on Hanford Site meteorology and climatology may be found in PNNL-6415.

3.3 Geology and Seismology

The Hanford Site contains all the main geologic characteristics of the Columbia Basin. The Columbia Basin is the area bounded by the Cascade Range to the west, the Rocky Mountains to the northeast, and the Blue Mountains to the southeast. Four major geologic processes occurring over millions of years formed the soil, rocks, and geologic features (ridges and valleys) in the Columbia Basin and therefore the Hanford Site. The region is categorized as one of low to moderate seismicity. Additional details on Hanford Site geology and seismology may be found in PNNL-6415.

3.4 Ecological and Cultural Resources

Ecological and cultural resources are routinely evaluated (and updated annually) for the Hanford Site in general. The latest status and discussion of changes can be found in PNNL-15222 and PNNL-6415. The following Subsections briefly summarize these resource areas as they pertain to the FFTF.

3.4.1 Ecological Resources

General information pertaining to ecological resources on the Hanford Site may be found in PNNL-6415.

The cities of Richland, Pasco, and Kennewick constitute the nearest population centers and are located southeast of the Hanford Site. The 2003 census figures indicate the distribution of the Tri-Cities population by city as follows: Richland 41,650; Pasco 37,580; and Kennewick 57,900.

Threatened and endangered plants and animals identified on the Hanford Site, as listed by the federal government [50 Code of Federal Regulations (CFR) 17] and Washington State (Washington Natural Heritage Program 1997), typically are not found in the vicinity of the FFTF. However, migratory birds (including the house finch, Say's phoebe, barn swallow, violet-green swallow, American robin, and western kingbird) and/or their nests have been observed in the 400 Area. Two species of birds (Aleutian Canada goose and bald eagle) on the federal list of threatened and endangered species have been observed on the Hanford Site but are not present at the FFTF.

The Columbia River and other water bodies on the Hanford Site provide valuable habitat for aquatic organisms. The Hanford Reach represents the only remaining significant mainstream Columbia River spawning habitat for stocks of upriver bright fall chinook salmon and white sturgeon. The Upper Columbia River spring run chinook salmon, Middle Columbia River steelhead, and Upper Columbia River steelhead have been placed under the protection of the *Endangered Species Act of 1973*. These fish spawn in or migrate through the Hanford Reach. No species of aquatic organisms are present at FFTF.

As discussed in PNNL-6415, natural plant communities have been altered by Euro-American activities that have resulted in the proliferation of nonnative species. Of the 590 species of vascular plants recorded for the Hanford Site, approximately 20% of all species are considered nonnative. The biodiversity inventories conducted by The Nature Conservancy of Washington have identified 85 additional taxa[3], establishing the actual number of plant taxa on the Hanford Site at 675. Cheatgrass is the dominant nonnative species at FFTF. No species of the natural plant communities are found at FFTF.

3.4.2 Archeological Resources

General information regarding the cultural resources on the Hanford Site can be found in PNNL-6415. A number of site-specific biological and cultural resource reviews for FFTF have been conducted. Most of the buildings and structures in the 400 Area were constructed during the Cold War era. Six buildings/structures were determined eligible for the National Register of Historic Places as contributing properties within the Historic District recommended for mitigation. These include the 405 Reactor Containment Building, 436 Training Facility, 4621-W Auxiliary Equipment Facility, 4703 FFTF Control Building, 4710 Operations Support Building, and the 4790 Patrol Headquarters.

3.4.3 Hydrology/Water Quality

A discussion of the Hanford Site hydrology and water quality may be found in PNNL-6415. Surface water at Hanford includes the Columbia River, springs, and ponds. Intermittent surface streams, such as Cold Creek, may also contain water after large precipitation or snowmelt events. In addition, the Yakima River flows along a short section of the southern boundary of the Hanford Site, and there is surface water associated with irrigation east and north of the Site. The water quality of the Columbia River from Grand Coulee Dam to the Washington-Oregon border, which includes the Hanford Reach, has been designated as Class A, Excellent, by Washington State.

Groundwater originates as surface water, either from natural recharge, such as rain, streams, and lakes, or from artificial recharge, such as reservoirs, excess irrigation, canal seepage, deliberate augmentation,

[3] Orderly classifications of plants and animals according to their presumed natural relationships.

industrial processing and wastewater disposal. Groundwater beneath the Hanford Site is found in an upper unconfined aquifer system and deeper basalt-confined aquifers. Groundwater in the unconfined aquifer at Hanford generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site, and toward the Columbia River on the eastern and northern boundaries. Natural area recharge from precipitation across the entire Hanford Site ranges from about 0 to 10 centimeters (0 to 4 inches) per year. Groundwater beneath large areas of the Hanford Site has been impacted by radiological and chemical contaminants resulting from past Hanford Site operations. Groundwater contamination is monitored. At the Hanford Site, radiological constituents, including carbon-14, cesium-137, iodine-129, strontium-90, technetium-99, total alpha, total beta, tritium, uranium, and plutonium-239/240 have been detected at concentrations greater than the maximum contaminant level in one or more onsite wells within the unconfined aquifer. Certain non-radioactive chemicals have been detected as well: carbon tetrachloride, chloroform, chromium, cyanide, cis-1,1 dichloroethene, fluoride, nitrate, sulfate, and trichloroethene.

The groundwater in the 400 Area is influenced by artificial recharge associated with the North Richland recharge basins and nearby irrigated farming. The southern portion of the tritium plume from the 200 East Area extends under the 400 Area. Nitrate contamination is also found; this is the result of industrial and agricultural sources off the Hanford Site. The nitrate plume is migrating eastward and entering the Columbia River.

3.4.4 Noise/Aesthetics

A discussion of Hanford Site noise levels and aesthetics may be found in PNNL-6415. Noise is technically defined as sound waves that are unwanted and perceived as a nuisance by humans. Sound waves are characterized by frequency, measured in Hertz, and sound pressure expressed as decibels. Most humans have a perceptible hearing range of 31 to 20,000 Hertz. A decibel is a standard unit of sound pressure. The threshold of audibility for most humans ranges from about 60 decibels at a frequency of 31 Hertz to less than about 1 decibel between 900 and 8,000 Hertz. For regulatory purposes, noise levels for perceptible frequencies are weighted to provide a weighted sound level (dBA) that correlates highly with individual community response to noise. Environmental noise measurements were made on the Hanford Site in 1981 and in 1987. Site characterization activities ranged from about 30 dBA to 60 dBA. Wind was identified as the primary contributor to background noise levels. Noise levels as a result of field activities, such as well drilling and sampling were measured. Baseline offsite noise measurements attributable to automobile traffic also were determined; baseline noise levels for operational and construction workforces were around 70 dBA.

Aesthetics pertaining to the Hanford Site also are discussed in PNNL-6415. With the exception of Rattlesnake Mountain, the land near the Hanford Site is generally flat with little relief. Rattlesnake Mountain, rising to 1060 m (3477 ft) above mean sea level forms the western boundary of the Hanford Site, and Gable Mountain and Gable Butte are the highest landforms within the Site. The White Bluffs, steep whitish-brown bluffs adjacent to the Columbia River and above the northern boundary of the river in this region, are a major feature of the landscape.

A main feature of the 400 Area is the FFTF. The central structure of FFTF is the reactor containment building, an all-welded cylindrical steel structure 41 meters (135 feet) in diameter and 57 meters (187 feet) high. There is an array of buildings and equipment that surround the containment building and comprise the FFTF complex. Within the FFTF fenced area there are 44 structures or buildings. Specific details of the FFTF Complex are discussed in HNF-18346.

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4.0 ENVIRONMENTAL IMPACTS

The following presents information on those potential environmental impacts that may result from the proposed action and alternatives for the changed approach to the continued deactivation of FFTF. There are uncertainties and risks associated with even the most routine operations.

4.1 Impacts from Siting and Construction

The potential impacts from siting and construction activities would be similar to those associated with routine industrial activities. The areas associated with sodium residual cleaning stations are within the FFTF property protected area (PPA), which is a highly disturbed area. It would be expected that siting activities would be consistent with appropriate land use designations from the ROD for the HCP EIS (64 FR 61615).

Specific ecological resource review(s) would be conducted, as appropriate, before any construction activities. Certain restrictions may be applied as a result of these surveys; e.g., limitations of construction activities during migratory bird nesting seasons and bald eagle winter roosting seasons. If cultural or paleontologic (i.e., fossils) resources were to be encountered during construction, all work would stop immediately and the Hanford Cultural Resource Center would be notified. Construction and operational activities would be consistent with the *Hanford Site Biological Resources Management Plan* (DOE/RL-96-32) and the *Hanford Site Biological Resources Mitigation Strategy* (DOE/RL-98-10).

No harmful radiological or toxicological exposure to personnel or the general public is expected to occur as a result of routine construction operations. The materials would be handled in a manner consistent with commercial industrial construction activities. Hanford Site personnel handle these types of materials daily. Routine methods (e.g., use of appropriate personnel protective clothing), specific training, and equipment safeguards are in place, and are adequate to ensure the safe recovery and handling of this material.

Temporary particulate emissions likely would result from using heavy equipment for excavation or materials transport. Specific emissions estimates and modeling were not performed because particulate matter emissions would be controlled by using appropriate wetting procedures and surfactants, resulting in compliance with federal and state air quality standards.

4.2 Impacts from Routine Operations

Environmental consequences from routine operations have been considered and are discussed in the following Subsections.

4.2.1 Radiological Exposure

The potential for release of radioactive emissions during routine activities exists. Additional radioactive airborne emissions from the cleaning stations are expected to be limited to tritium when cleaning piping and components from the secondary cooling system (some fission products could be available when cleaning piping and components from the primary sodium cooling system). The emissions would be in compliance with applicable DOE and other Federal and State guidelines and regulations.

The cleaning stations would be used to convert metallic sodium to aqueous sodium hydroxide. A facility could be designed to process about 100 kilograms (220 pounds) of sodium per batch. The hydrogen produced by the process would be swept out of the reaction vessel using approximately 730 kilograms

(1,600 pounds) of nitrogen per hour. At this processing rate, theoretically, the maximum tritium concentration in the effluent would be about 2.1 E-05 microcuries per milliliter. At the point of public access, the DOE guideline for public exposure to tritium would not be exceeded. This maximum discharge value would result in an onsite dose rate (i.e., non-involved worker at approximately 100 meters or 300 yards) of approximately 0.16 millirem (1.6 microSv) per year, substantially less than the DOE onsite limit of 5 rem (0.05Sv) per year. The calculated dose rate at the site boundary to the maximally exposed individual (MEI) from airborne emissions, 2.6 E-04 millirem (2.6 E-03 microSv) per year, would be less than the DOE limit of 10 millirem (0.1 milliSv) per year for members of the public due to airborne emissions. These calculated release values are considered conservative because the calculations assume all the tritium would be released to the atmosphere. In reality, the radiological inventory in the airborne discharge concentration would be less since much of the tritium would remain in the sodium hydroxide solution as tritiated water.

There would be some radiological exposure for the workers involved in the proposed activities. Personnel exposure to radiation from removal of sodium piping and components was considered. It is estimated that a total of approximately 288 person-rem exposure to radiation workers could be expected from the removal of small-diameter piping (FFTF-18346). This value is conservatively doubled to account for exposure during removal of large components and 'special components' ('special components' were discussed in Subsection 2.1.6). Thus, a total worker dose of 576 person-rem (5.8 person-Sv) is assumed from the proposed activity. Based on the current dose-to-risk conversion factor of 6 E-04 latent cancer fatalities (LCF) per person-rem (DOE 2002), 0.35 LCFs would be expected for the involved worker population.

Essentially no public exposure above that currently experienced from Hanford Site operations is anticipated as a result of these actions. That is, the potential dose to the hypothetical offsite MEI during Calendar Year (CY) 2004 from Hanford Site operations was 0.014 millirem (0.14 microSv) (PNNL-15222). The potential dose to the local population of 486,000 persons from 2004 operations was 0.32 person-rem (0.0032 person-Sv). The 2004 average dose to the population was 0.0007 millirem (0.007 microSv) per person. The current DOE radiation limit for an individual member of the public is 100 millirem (1 milliSv) per year, and the national average dose from natural sources is 300 millirem (3 milliSv) per year. No adverse health effects from routine operations would be expected to result from these low doses. Further, it is anticipated that routine operations would not provide additional exposure of toxic or noxious vapors to workers or members of the general public.

4.2.2 Waste Management

Essentially no environmental impacts from the transportation of liquid wastes would be anticipated as a result of the proposed action. The routine transport of low-level liquid wastes from the 400 Area to the 200 Areas would be similar to waste water transports that occur throughout the Hanford Site. From January 2000 to August 2005, approximately 470 shipments of liquid waste from various locations on the Hanford Site to the 200 Area liquid effluents waste management facility were conducted, transporting approximately 8,800,000 liters (2,300,000 gallons).

Environmental impacts from the treatment/disposal of the estimated 3,780,000 liters (1,000,000 gallons) of waste water (refer to Subsection 2.1.8.2) would be expected. The waste water would be disposed of at LERF/ETF in the 200 Areas (there would be no waste water discharged to the environment in the 400 Area). The waste stream meeting LERF/ETF waste acceptance criteria would be a sodium hydroxide solution with small amounts of tritium. This waste stream would be treated and disposed of in a similar fashion as typical day-to-day operations at the existing LERF/ETF. The ETF routinely is used to remove toxic metals, radionuclides, and ammonia, and destroy organic compounds. The treated effluent is stored in tanks, sampled and analyzed, and discharged to the SALDS (refer to Figure 1). Treatment capacity of

the facility is a maximum of approximately 570 liters (150 gallons) per minute. Approximately 107,000,000 liters (28,250,000 gallons) of liquid waste were treated in Calendar Year 2004 (PNNL-15222). For perspective, as discussed in Subsection 2.1.8, the maximum estimated volume of aqueous liquid waste to be transported from FFTF to ETF for the proposed action would be less than 473,000 liters (125,000 gallons) per year. No modifications to the existing LERF/ETF would be required to support the proposed action.

Radioactive material, radioactively contaminated equipment, and radioactive mixed wastes would be appropriately packaged, stored, and disposed of at existing facilities on the Hanford Site. None of the materials would be anticipated to be generated in substantial quantities when compared to the annual amount routinely generated throughout the Hanford Site. For example, as reported in DOE/EIS-0286F, the Hanford Site low-level waste forecast for onsite life-cycle waste for the years 2002 through 2046 was 106,681 cubic meters (3,800,000 cubic feet). This is compared with the projection (refer to Subsection 2.1.8) of approximately 4,500 cubic meters (157,000 cubic feet) of cleaned piping and components associated with the proposed action. For perspective, the existing capacity for disposal of solid wastes at the Hanford Site in lined trenches is approximately 22,330 cubic meters (788,000 cubic feet); approximately 5,000 cubic meters (177,000 cubic feet) of this existing capacity have been used through September 2005. Current available disposal capacity at ERDF is much greater than the lined trenches; approximately 993,000 cubic meters (1,300,000 cubic feet).

Hazardous materials (e.g., asbestos) which may be removed or stabilized would be managed and reused, recycled, stored, or disposed of in accordance with applicable federal and state regulations. Confirmatory analyses, as appropriate, on insulation would verify the relatively small amount [76 cubic meters (100 cubic yards)] of asbestos (refer to Subsection 2.1.8).

4.2.3 Other Impacts

Noise levels would be comparable to existing conditions in the 400 Area (refer to Subsection 3.4.4). The amount of equipment and materials to be used, such as materials (e.g., steel, plastic) for sodium washing stations and fossil fuels for vehicles, represent a minor long-term commitment of nonrenewable resources. It would be expected that annual electrical usage requirements would be less than 110,000 megawatts [Note: during historical FFTF operations the average annual electrical usage was approximately 110,000 megawatts; during FFTF standby the annual average electrical usage was about 55,000 megawatts.] The estimated nitrogen volume for sodium residuals reaction is approximately 8,000,000 cubic meters (300,000,000 cubic feet).

The proposed action is not expected to impact the flora and fauna, air quality, geology, hydrology and/or water quality, land use, or the population. Minor modifications to the existing 400 Area for access and lay down areas would be conducted in previously disturbed areas.

No impacts to archeological properties are expected occur as a result of the proposed action. A cultural resource review was completed for the FFTF Complex (FFTF-18346, Attachment 7). The State Historic Preservation Officer (SHPO) has concurred with the finding that this project would have an adverse effect to five historic buildings identified for individual documentation and mitigation (Griffith 2003), but these affects have been mitigated by the completion of walkthroughs and assessments of these buildings. Artifacts were identified that may have interpretive or educational value and these items have been tagged. SHPO also concurred that this project will have no effect to archaeological properties (Griffith 2003).

Present staff at FFTF would be used to the extent practicable for the continued deactivation activities, including the disposition of the sodium residuals. Current skills mix would be evaluated, and personnel

changes may be required to support some specific activities associated with the sodium residuals removal due to the hazards involved and the special expertise required. Personnel changes required to complete sodium residual work would be expected to be small (plus or minus 20 people). Regardless, the FFTF staffing would remain less than one percent of the current workforce at Hanford (approximately 11,000 Hanford Site workers, including DOE and contractor staff). This small incremental manpower change would not be expected to result in noticeable social or economic impacts to the local community.

4.3 Impacts from Accidents

The specific accident scenarios discussed below are drawn from in the 1995 EA because DOE believes they continue to provide the bounding consequences for the proposed deactivation activities. That is, the 1995 EA analyzed the consequences of events involving 984,000 liters (260,000 gallons) of bulk, molten sodium (as well as reactor fuel). This EA addresses the residual volume of sodium remaining after the bulk sodium was drained and transferred to the SSF. The sodium residuals [approximately 15,000 liters (4,000 gallons) remaining in the main portions of FFTF's piping and equipment plus indeterminate quantities remaining in other portions of the plant systems, especially in complex, small-diameter piping systems] represent a small fraction (less than 2 volume percent) of the bulk sodium inventory evaluated in the 1995 EA.

Environmental impacts associated with sodium residuals on the Hanford Site also were addressed in the aforementioned DOE/EA-0987 (*Environmental Assessment: Disposition of Alkali Metal Test Loops, Hanford Site, Richland, Washington*, refer to Section 2.9.3) Therein, postulated accidents during disposition of alkali metal test loops were evaluated. Since the test loops contained relatively (to FFTF) small quantities of nonradiological material only, the environmental effects of accidents related to disposition of the test loops were limited to those associated with routine industrial activity and accidents associated with sodium metal (e.g., sodium spills, fire). All accident scenarios in DOE/EA-0987 are bounded by those presented in the 1995 EA; specific events addressed in DOE/EA-0987 are not addressed further.

Scenarios related to sodium drain/reaction were presented in the 1995 EA. These events, involving large quantities of sodium and some radiation, included both high consequence/low probability, and low consequence/high probability scenarios for the onsite (100 meters, 0.062 miles) worker and the MEI offsite (i.e., approximately 7 kilometers or 4.3 miles). For the following accident scenarios, the daytime population of the 400 Area was estimated to be no greater than 1,000 people, including visitors[4]. The maximum offsite population sector for analysis is assumed to be toward the south-southeast (population approximately 80,000).

The risk to the directly involved worker (i.e., an individual in the immediate vicinity of an event) is highly dependent upon the worker's specific location, meteorological conditions, and nature of the accident. All of the aforementioned circumstances could either increase or minimize the severity of the consequences. Further, although the consequences of the most serious postulated event (a sodium fire as discussed in Subsection 4.3.5) could be severe, the probability of such an occurrence is extremely low, and therefore the risk is considered to be small.

Also, the handling of materials such as alkali metals is similar to routine activities that have been conducted at FFTF, and the current workforce is experienced with handling the hazards and initiators that would be associated with potential events for the proposed actions. Workers wear required protective clothing and follow administrative controls in accordance with a radiation work permit and hazardous

[4] This estimate of 1,000 persons is drawn from the 1995 EA; current (2006) 400 Area population is less than 400 persons. Therefore, this scenario is considered bounding.

materials permit. The DOE's reviews of appropriate procedures, work plans, and related information, would help reduce the potential for future unanticipated events and minimize the potential impacts.

4.3.1 Reasonably Foreseeable Accident Scenarios During Residual Sodium Removal/Reaction

Reasonably foreseeable accident scenarios, associated with residual sodium removal and/or reaction, are identified in the 1995 EA, and are discussed in the following subsections.

4.3.1.1 FFTF Sodium Drain and Storage Supporting Shutdown

In a reasonably foreseeable accident scenario (probability greater than 1 E-02), approximately 9 kilograms (20 pounds) of radioactive sodium leaks from a mechanical joint during a transfer from the primary heat transport system to the sodium storage facility located adjacent to FFTF. The sodium is at low temperature (300 to 400°F) and at low pressure (25 pounds per square inch). Under these conditions, the sodium is assumed to burn. However, if a small fire were to occur, trained onsite personnel and emergency response equipment are available for immediate intervention to minimize potential environmental consequences both onsite and to the general public.

Conservatively, assuming the release fraction for a fire to be bounding in this case, the estimated onsite and offsite dose consequences were 5.3 E-02 rem (5.3 E-04 Sv) and 8.8 E-03 rem (8.8 E-05 Sv), respectively. These equate to calculated onsite (assuming 200 affected personnel) and offsite (assuming 80,000 persons) population LCFs of approximately 6.4 E-03 and 0.42, respectively (using 6 E-04 LCF per person-rem conversion factor). The corresponding toxicological releases would be small.

This accident is considered to be bounding because of the relatively small volume of residual sodium that would be available for a leak. Re-energizing heat trace systems to melt residual sodium would result in isolated, smaller volumes of molten sodium. Additionally, there would be no pressure transfer of molten sodium, thus minimizing releases.

4.3.1.2 Postulated Accidents During Sodium Reaction

The release of sodium hydroxide solution, hydrogen fire, and a tritium release are all possible accident scenarios applicable to the reaction of sodium residuals, and the consequences of these scenarios presented in the 1995 EA are still considered to be bounding for the activities proposed in this EA. Two reasonably foreseeable accidents in the Sodium Reaction Facility (SRF) were identified. These events could occur, on a smaller scale, during proposed in-place cleaning or during operations at a cleaning station.

One postulated accident is a potential sodium hydroxide spill. A maximum discharge of radioactively contaminated, 50-percent aqueous sodium hydroxide would be approximately 3,780 liters (1,000 gallons) from a storage tank. This material would not burn and would be contained in catch pans within the facility. All radionuclides except tritium would be retained in the sodium hydroxide solution and would not be discharged to the environment. Any small amount of tritium that would be released would be much less than that discharged during plant operation.

A second postulated accident is accumulation of hydrogen in the process equipment during reaction activities, such that flammable concentrations resulted in a brief hydrogen fire. Hydrogen gas is released during the reaction of sodium metal and water. The hydrogen typically would be vented from the process along with the nitrogen purge used to maintain mixing in the reaction vessel. For safety, the percentage of hydrogen is maintained below that which can burn in air (i.e., 4 percent by volume). Should the nitrogen gas supply fail, the reaction process would be automatically stopped. The fire itself is not

expected to result in any environmental impacts; the loss of nitrogen flow might allow the measured concentration of tritium being exhausted to temporarily increase (i.e., amount of tritium per unit volume of sample). The annual average allowable limit for release of tritium (1.0 E-07 microcuries per milliliter per year) would not be exceeded.

It was conservatively assumed that all the tritium (1.2 E-02 curies) contained in 105 kilograms (230 pounds) of sodium (that amount of sodium processed in an hour) is released as a result of the postulated hydrogen fire. If the 1.2 E-02 curies of tritium were released into, and mixed with, the air in the building (2.1 E+09 milliliters or 74,000 cubic feet), the tritium concentration would be 5.7 E-06 microcuries per milliliter. This was compared with the allowable worker limits (derived air concentrations) for tritium of 2 E-05 microcuries per milliliter. A facility worker would receive a dose of 0.7 millirem from a 1-hour exposure. If the entire 1.2 E-02 curies were released from the facility, the maximum dose to an onsite worker (assumed to be located 100 meters [300 feet] from the facility) would be less than 1.1 E-05 rem (1.1 E -07 Sv). Assuming an onsite population of 1,000 people, and that each received the maximum dose, the collective onsite population dose would be 1.1 E-02 person-rem (1.1 E-04 person-Sv). This equates to 4.4 E-06 LCFs for the onsite worker population. Release of the 1.2 E-02 curies would result in a dose of 1.2 E-08 rem (1.2 E-10 Sv) to the maximum offsite individual. Assuming a maximum offsite population of 80,000 people, the collective dose to the offsite population would be 9.6 E-04 person-rem (9.6 E-06 person-Sv). This equates to 4.8 E-07 LCFs. Such a brief release would provide minimal risk to workers and the general public.

It is recognized that approximately one-half of the tritium has decayed away (tritium half-life is 12.3 years), the work force at FFTF is approximately one-half of that identified in the 1995 EA, and realignment of public access structures at FFTF has reduced the probability of a general daytime population of 1,000 persons. Therefore, in both scenarios, the low probability and minimal effects associated with the postulated events remain bounding, and make the risks small.

4.3.1.3 Reasonably Foreseeable Nonradiological Accident Scenario(s)

The environmental effects of accidents related to nonradiological materials are represented by those associated with most routine industrial activity. Personnel injuries, such as back strains or minor abrasions, would receive appropriate medical treatment. Implementation of the DOE Integrated Safety Management System, including work planning, administrative controls, proper training and specification of detailed procedures used in handling the materials would be in place, all of which would minimize the potential of effects from such accidents.

An example of the environmental effects of accidents related to nonradiological materials would be a postulated spill of ethylene glycol (i.e., antifreeze) in the FFTF itself. As with typical industrial activities, ethylene glycol is used routinely in chilled water systems. The existing FFTF chilled water system was designed to preclude such a spill. Impervious sumps or alternative control measures are used to ensure containment of the ethylene glycol should a pump seal fail or a pipe leak occur. Any spill would be isolated, and trained personnel would take the necessary steps to contain the spill and effect cleanup. Proper training and specification of detailed procedures used in handling the materials are in place, which also would minimize any effects of such an accident.

Additionally, many isolated areas of oxygen-deficient atmospheres not only routinely exist, but could appear with leakage of cover gas into confined areas. The potential for accidents associated with such an environment are minimized by proper monitoring equipment and alarms. Also, personnel training and appropriate administrative controls (e.g., placards, barricades) further enhance personnel safety.

4.3.2 Maximum Reasonably Foreseeable Accident

The Maximum Reasonably Foreseeable Accident is postulated to be a large leak (due to growth of a metal defect in a storage tank) in the sodium storage facility. The tank is initially filled with approximately 265,000 liters (70,000 gallons) of molten sodium at about 177°C (350°F) with a static head of approximately 6 meters (20 feet). The entire inventory of the tank is assumed to discharge onto the steel floor of the secondary containment (an area of approximately 770 square meters (8,200 square feet) and to burn, releasing a sodium hydroxide aerosol plume. Although hydrogen generation would occur in the scenario, the environmental impacts of an ignition or explosion would be expected to be bounded by a continuous burn of the sodium. Finally, even though the facility structure is assumed to remain intact, the sodium hydroxide aerosol release fraction is assumed to be 35 percent.

This scenario is extremely conservative. The calculated frequency of tank leaks is approximately 1 E-05 per year, based primarily on commercial light water reactor data. However, this is for small leaks initiated by growth of manufacturing defects; the frequency of large leaks would be much lower. Furthermore, this leakage frequency is conservatively based on applications which typically experience much more severe duty (i.e., higher pressures and temperatures, and substantial thermal transient usage). In a more realistic accident scenario, the sodium would leak from a small crack at a relatively slow rate, and the covered sump system would self-extinguish the burning sodium. No credit was taken in the analysis for this safety feature. The scenario described was selected to bound the consequences of a sodium spill and fire, even though the scenario is considered to be extremely low probability of occurrence (less than 1 E-06). Simultaneous failure of more than one tank was considered too remote and not within the range of credible accidents, and was not analyzed.

For this scenario, it is assumed that the onsite receptor is exposed to only the first 10 minutes of the plume. This is based on the obvious nature of the plume, which is a visible, very irritating, white cloud. The calculated onsite dose consequence is 2.5 E-04 rem (2.5 E-06 Sv). The offsite receptor is assumed to be exposed for the duration of the fire. The additional exposure time results in a calculated offsite dose consequence of 3.9 E-04 rem (3.9 E-06 Sv).

The daytime population of the 400 Area was estimated to be no greater than 1,000 people, including visitors. Only a fraction of the population would be exposed as a result of this postulated event. Even so, using 1,000 people as the exposed onsite population, no more than approximately 1 E-04 LCFs (i.e., essentially zero) would occur. However, the daytime population of the 400 Area is substantially less today than in 1995 (e.g., a visitor's center has been removed, and the estimate of 1,000 persons in 1995 is less than 400 in 2006). The maximum offsite population dose would be approximately 31 person-rem, equating to 1.6 x E-02 LCFs. Therefore, no latent fatalities due to radiation from this accident would be expected.

Of greater potential impact are the toxicological consequences of the sodium hydroxide plume from the postulated fire associated with the maximum reasonably foreseeable accident. The calculated onsite [100 meters (330 feet)] sodium hydroxide concentration is approximately 166 milligrams per cubic meter. The sodium hydroxide concentration at the site boundary [approximately 7 kilometers (5 miles)] was calculated to be approximately 0.05 milligrams per cubic meter.

The resultant calculated toxicological consequences are identified as Hanford-specific Emergency Response Planning Guidelines (ERPG, refer to the 1995 EA) for sodium hydroxide. These guidelines, which are based on lesser consequences being acceptable for higher frequency events, provide the basis for evaluating potential risk to onsite workers and the offsite population.

Emergency Response Planning Guidelines 1 (ERPG-1) is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects (e.g., headaches, dizziness, nausea) or perceiving a clearly defined objectionable odor. Similarly, ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. Finally, ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Typically, calculated onsite consequences are limited to a range from ERPG-2 to ERPG-3, dependent upon event frequency (1 per year and 1 E-06 per year, respectively). The criteria for sodium hydroxide are 40 milligrams per cubic meter (ERPG-2), and 100 milligrams per cubic meter (ERPG-3). The calculated onsite consequences of 166 milligrams per cubic meter would fall above the ERPG-2 to ERPG-3 range. However, experienced personnel working near sodium facilities would be well aware of the potential hazards and response procedures, and would evacuate and remain clear of any white plume of smoke coming from a sodium facility. Based on the extremely low probability of occurrence, even if the consequences of such an event are as severe as calculated for the onsite worker, the extremely low probability of occurrence and administrative training and controls make the risks of a sodium fire from the proposed action small.

Similarly, the offsite consequences are limited from ERPG-1 (corresponding to an event frequency of 1 per year) to ERPG-2 (corresponding to an event frequency of 1 E-06 per year). These guidelines correspond to 2 milligrams of sodium hydroxide per cubic meter and 40 milligrams of sodium hydroxide per cubic meter, respectively. The calculated offsite toxicological consequences of approximately 0.05 milligrams sodium hydroxide per cubic meter fall well below the applicable guidelines. The aforementioned training, procedures, and controls, coupled with local municipal emergency preparedness (e.g., telecommunications, law enforcement response) would minimize risks to the public.

The projected effects from the maximum reasonably foreseeable accident are considered bounding for the proposed sodium residuals removal activities evaluated in this EA. While large quantities of sodium currently are being stored in the sodium storage facility, the sodium is not in molten form, thereby minimizing the probability of release. Heating pockets of residual sodium for removal and reaction, with subsequent failure of containment, could result in a release of no more than approximately 3,780 liters (1,000 gallons). This is substantially less than the 265,000 liters (70,000 gallons) of molten sodium analyzed in the 1995 EA.

4.3.3 Transportation

Transportation accidents during transport of liquid and solid wastes associated with disposition of sodium residuals have been considered.

4.3.3.1 Liquid Wastes

Transport of liquid waste from FFTF [the estimated 3,789,000 liters (1,000,000 gallons) of sodium hydroxide solution] to LERF would involve an estimated approximately 48 kilometers (30 miles) round-trip. As noted in Subsection 4.2.2, it is expected that there would be less than 473,000 liters (125,000 gallons) transported to LERF per year (2 shipments per month). For perspective, from January 2000 to August 2005, approximately 470 shipments of liquid waste from various locations on the Hanford Site to the 200 Area liquid effluents waste management facility were conducted, transporting approximately 8,800,000 liters (2,300,000 gallons). During that time, no vehicular accidents were

reported. Three small spills occurred, resulting in less than approximately 200 liters (50 gallons) of slightly-contaminated liquid waste to be discharged to the environment. No measurable exposure to workers or the public resulted from these spills. No unique circumstances associated with the proposed transfer of waste water from FFTF to the 200 Areas have been identified.

4.3.3.2 Solid Wastes

The potential consequences of transport of solid wastes (predominantly low-level waste piping and components) to the 200 Areas would be expected to be bounded by those associated with liquid wastes. The residual contamination associated with the rinsed piping and components is in a less dispersible form than the liquid sodium hydroxide solution, and therefore would be less likely to present an adverse impact to workers or the public. Further, transportation of Hanford Site solid wastes has a proven safety record. Overall, ERDF transportation has driven over 8.9 million kilometers (5.5 million miles) without an at fault accident, while transporting over 3 million tons of waste since inception.

4.4 Potential Impacts of Alternatives to the Proposed Action

Potential environmental impacts from the No-Action Alternative and other alternatives identified in Section 2.2 are addressed as follows.

4.4.1 No-Action Alternative

As stated earlier, the potential impacts associated with deactivation of the FFTF were addressed in the 1995 EA. It is anticipated that the No-Action Alternative for this EA would present no greater environmental impacts than those evaluated as the proposed action alternative in the 1995 EA. In fact, the potential impacts presented in the 1995 EA would be reduced; fuel has been removed from the 400 Area, the bulk of the sodium has been transferred to storage in a solid form, there has been a 10-year decay in the radioisotope inventory, and the population in and outside of the FFTF PPA has been reduced (as discussed in Subsection 4.3.5, a daytime population in 1995 was assumed to be 1,000 persons; today that population is less than 400).

4.4.2 Alternative Process Technologies

The potential environmental impacts from the alternative process technologies (refer to SubSection 2.2.2) for removal/reaction of FFTF sodium residuals have been considered. In general, it would be expected that overall, impacts would be very similar for each technology (i.e., similar energy requirements, same radiological dose consequences, same volume of solid waste generated) as with SSP. There would be some difference in liquid waste generated, depending on the technology (refer to Table 2). Specific technologies could require materials not used in other technologies [e.g., an estimated 980 cubic meters (35,000 cubic feet) of carbon dioxide gas would be required for the moist carbon dioxide process].

Table 2. Summary of Liquid/Solid Wastes for Reaction Technologies.

Technology	Total Liquid Waste (liters/gallons)	Total Solid Waste (cubic meters/cubic feet)
Superheated Steam	3,780,000/1,000,000 sodium hydroxide	4,500/162,000
Water Vapor	3,780,000/1,000,000 sodium hydroxide	4,500/162,000
Moist Carbon Dioxide	3,780,000/1,000,000 sodium hydroxide, carbonate/bicarbonate	4,500/162,000
Evaporation	1,134,000/300,000 sodium hydroxide	4,500/162,000
Ammonia*	<3,780,000/1,000,000 sodium hydroxide	4,500/162,000

*Insufficient information for production scale operation. Assume process could be applied on individual pieces of equipment with limited volume mixed and included with the aqueous sodium hydroxide waste stream.

4.4.3 Alternative Locations

The potential environmental impacts from alternative locations for residual sodium reaction stations briefly were addressed in Subsection 2.2.3. As noted, alternative onsite locations would require additional handling of radiologically- and sodium-contaminated piping and components. Offsite treatment could result in increased handling (for packaging) and transportation impacts, as well as additional expense.

4.5 Socioeconomic Impacts and Environmental Justice

The proposed action would not result in substantial socioeconomic impacts. It would be expected that the existing FFTF workforce of approximately 200 people would provide the bulk of necessary personnel to support the proposed activities. There would be no discernible impact to employment levels within Benton and Franklin counties.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs and activities on minority and low-income populations. Based on the analyses in this EA, it is not expected that there would be any disproportionately high and adverse impacts to any minority or low-income populations.

4.6 Cumulative Impacts

The proposed actions would contribute minimal risks in addition to those associated with routine Hanford Site operations. The proposed actions also would reduce the potential for, and consequences of, inadvertent releases of radioactive and hazardous materials from FFTF. The proposed actions would result in a long-term decrease in radiation exposure, due to removal of residual sodium and the attendant radioactivity.

The proposed action would involve existing operations personnel to the extent practicable; therefore, no substantial change in the Hanford Site workforce would be expected. There would be no adverse socioeconomic impacts or any disproportionately high and adverse impacts to any minority or low-income population of the community.

The proposed action would result in radioactive air emissions consisting predominantly of tritium. As discussed in Subsection 4.2.1, minimal public exposure to radiation above that currently experienced from routine Hanford Site operations would be anticipated as a result of these proposed actions. Specifically,

as discussed in Subsection 4.2.1of this EA, the calculated exposure to the maximally exposed member of the public due to the proposed action is approximately 2.6 E-04 millirem (2.6 E-03 microSv) per year. As reported in PNNL-15222, the potential dose to the maximally exposed individual during calendar year 2004 from Hanford Site operations was 0.014 millirem (0.14 microSv). Collectively, the potential dose to the local population of 486,000 persons [within 80-kilometer (50-mile) radius of center of Hanford Site] from 2004 operations was 0.32 person-rem (0.0032 person-Sv). These doses are well below the current DOE radiation limit for an individual member of the public of 100 millirem (1 milliSv) per year, and the national average dose from natural sources of 300 millirem (3 milliSv) per year (PNNL-15222). The low doses associated with the radioactive inventory within the scope of this EA would not result in substantial offsite public exposure. No adverse health effects to the public would be expected.

The proposed action would result in minimal nonradioactive air emissions. The Hanford Site and surrounding areas are in attainment with ambient air quality standards. Particulate concentrations can reach relatively high levels in eastern Washington State because of exceptional natural events (i.e., dust storms, volcanic eruptions, and large brushfires) that occur in the region. Washington State ambient air quality standards have not considered 'rural fugitive dust' from exceptional natural events when estimating the maximum background concentrations of particulates in the area east of the Cascade Mountain crest. The potential low concentrations of particulate emissions from FFTF activities would not be expected to contribute substantially to recent releases. The Washington State Department of Ecology in 1998 conducted offsite monitoring near the Hanford Site for particulate matter. Particulate matter was monitored at one location in Benton County, at the Tri-Tech Vocational Center, near the Hanford Site network's Vista Field meteorological monitoring site in Kennewick. During 1998, the 24-hour and annual particulate matter standards established by Washington State were not exceeded. The highest and second highest 24-hour particulate matter concentrations recorded in 1998 were 123 micrograms per cubic meter and 90 micrograms per cubic meter respectively. The arithmetic mean for 1998 was 18 micrograms per cubic meter (most recent data as provided in PNNL-6415).

No long-term groundwater impacts are anticipated. No long-term radionuclides would be present in waste waters generated from FFTF deactivation activities. The proposed action would result in liquid wastes that would be treated and disposed of in the SALDS under a WAC 173-216 Discharge Permit. Releases would be in accord with limits addressed in 40 CFR 191, *Environmental Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Radioactive Wastes* (Subpart C, "Environmental Standards for Groundwater Protection").

Minimal impacts are anticipated from disposition of solid wastes. Existing Hanford Site disposal facilities have the capacities to receive the estimated 4,500 cubic meters (157,000 cubic feet) of cleaned piping and components associated with the proposed action.

As stated in Subsection 4.2.2, hazardous materials (e.g., solvents, glycols, PCBs, asbestos) which may be removed or stabilized would be managed and reused, recycled, or disposed of in accordance with applicable federal and state regulations. Such materials include approximately 360,000 liters (94,000 gallons) of ethylene glycol and 32,000 liters (8,500 gallons) of PCB transformer oil. None of the materials would be anticipated to be generated in substantial quantities when compared to the annual amount routinely generated throughout the Hanford Site.

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5.0 PERMITS AND REGULATORY REQUIREMENTS

The activities described in this EA are planned to be implemented pursuant to CERCLA and current TPA requirements. Appropriate CERCLA decision documents would be prepared and issued. Determinations of applicable or relevant and appropriate requirements would be made in those documents.

Any generated radioactive solid waste would be subject to the requirements of DOE Order 435.1, Change 1. Disposal of solid, low-level mixed waste would be subject to DOE Order 435.1 and the applicable requirements of RCRA, and WAC 173-303. No specific permits under RCRA are anticipated for the proposed action.

All activities would be conducted in accordance with applicable Federal Clean Air Act requirements (e.g., *Clean Air Act of 1977*, as amended), and State requirements [e.g., *Washington Clean Air Act* (Chapter 70.94, Revised Code of Washington)]. No substantial additive radioactive airborne emissions are anticipated from FFTF as a result of the proposed action. The FFTF is registered with the State of Washington Department of Health, pursuant to WAC 246-247, "Radiation Protection - Air Emissions." This regulation establishes the same standards as the "National Emission Standards for Hazardous Air Pollutants" (40 CFR 61) (0.01 rem, maximum individual effective dose equivalent), and additional requirements such as source registration. Best Available Radionuclide Control Technology is required for new or modified sources by WAC 402-80, "Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides," and WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides." Appropriate notifications would be provided. Fugitive emissions (especially dust) from any activities would be controlled in accordance with normal practices, as per Benton County Clean Air Authority, Regulation 1, and in accordance with the requirements in WAC 173-400, "General Regulations for Air Pollution Sources."

A small quantity of waste solvents may be handled as a liquid hazardous waste. Present plans do not involve storing this waste onsite for more than 90 days. All applicable requirements pertaining to generators of hazardous waste (i.e., RCRA, WAC 173-303) would be met. Liquid waste would be appropriately stored and disposed of in the existing 200 Area liquid effluents waste management facility.

Waste transportation would be in accordance with applicable regulations and orders, including DOE Order 460.1B, *Packaging and Transportation Safety* and DOE Order 5480.4, Change 4, *Environmental Protection, Health, and Safety Protection Standards*. In addition, applicable requirements promulgated by DOT and U.S. Nuclear Regulatory Commission (NRC) would be followed, including 10 CFR 71 and 49 CFR 171 through 178 (as applicable).

In addition, under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 2003), the Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office (DOE-RL) negotiated a series of milestones (M-81) associated with deactivation of FFTF.

6.0 AGENCIES CONSULTED

The States of Washington and Oregon, the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, the Colville, the Wanapum, the Nez Perce Tribe, and associated stakeholders have been notified regarding the proposed action. The States of Washington and Oregon, the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, the Colville, the Wanapum, the Nez Perce Tribe, Benton and Franklin counties, and interest groups were provided copies of the draft EA for pre-approval review.

Copies were made available in the Tri-Party Agreement repositories including the DOE Hanford public reading room. Notice was made in the Tri-City Herald of the availability of the EA.

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7.0 REFERENCES

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40 CFR 61, 1993, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

40 CFR 191, 1985, "Environmental Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Radioactive Wastes," *Code of Federal Regulations*, as amended.

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49 CFR 171, 1993, "General Information, Regulations, and Definitions," *Code of Federal Regulations*, as amended.

49 CFR 172, 1993, "Hazardous Materials Tables and Hazardous Materials Communications Regulations," *Code of Federal Regulations*, as amended.

49 CFR 173, 1993, "Shippers - General Requirements for Shipments and Packagings," *Code of Federal Regulations*, as amended.

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