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Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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OVERVIEW OF THE SPENT NUCLEAR FUEL PROJECT AT HANFORD

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ABSTRACT

The Spent Nuclear Fuel Project's mission at Hanford is to "Provide safe, economic and environmentally sound management of Hanford spent nuclear fuel in a manner which stages it to final disposition." The inventory of spent nuclear fuel (SNF) at the Hanford Site covers a wide variety of fuel types (production reactor to space reactor) in many facilities (reactor fuel basins to hot cells) at locations all over the Site. The 2,129 metric tons of Hanford SNF represents about 80% of the total U.S. Department of Energy (DOE) inventory. About 98.5% of the Hanford SNF is 2,100 metric tons of metallic uranium production reactor fuel currently stored in the 1950s vintage K Basins in the 100 Area. This fuel has been slowly corroding, generating sludge and contaminating the basin water. This condition, coupled with aging facilities with seismic vulnerabilities, has been identified by several groups, including stakeholders, as being one of the most urgent safety and environmental concerns at the Hanford Site.

As a direct result of these concerns, the Spent Nuclear Fuel Project was recently formed to address spent fuel issues at Hanford. The Project has developed the K Basins Path Forward to remove fuel from the basins and place it in dry interim storage. A systems engineering approach of identifying requirements and the functions necessary to address those requirements was utilized. Alternatives that addressed the requirements were developed and analyzed. The result is a two-phased approach allowing the early removal of fuel from the K Basins followed by its stabilization and interim storage consistent with the national program. The DOE approved the Westinghouse Hanford Company (WHC) Recommended Path Forward for K Basins fuel on November 9, 1994. The WHC Recommended Path Forward starts fuel removal from K Basins by December 1998 and completes it two years later in December 2000 or earlier. The fuel is taken to a new Staging and Storage Facility located in the 200 Area at the Hanford Site. The fuel is staged or held in temporary storage while the stabilization process is finalized and design and construction of the facility is completed. Following stabilization, the fuel is returned to the Staging and Storage Facility for dry, interim storage (up to 40 years) until its ultimate disposition is determined at the national level. The path forward would have the K Basins fuel placed in interim dry storage by the year 2006.

In parallel with developing the path forward for the K Basins SNF, the Spent Nuclear Fuel Project also identified a path forward for management of the other Hanford SNF inventories. This planning is being integrated with the deactivation or utilization planning for each of the facilities containing SNF, as well as the national plan for placing DOE's SNF into interim storage.

HANFORD SPENT NUCLEAR FUEL PROJECT BACKGROUND

Nuclear production reactors were operated at the DOE's Hanford Site from 1944 until 1988 to produce plutonium by irradiating uranium. The fuel from these reactors was then processed at the Hanford chemical processing facilities to separate and recover the plutonium for its intended uses. Additional fuel was irradiated at the Hanford Site for research purposes or was shipped from off-site reactor facilities for study, storage, or recovery of nuclear materials at Hanford facilities.

The July 1990 Nuclear Weapons Stockpile Memorandum signed by the President of the United States stated that recovery of nuclear materials from Hanford SNF inventories was no longer required for national defense purposes or for future breeder reactor fuel. As a result, processing operations were phased out and legacy SNF inventories were left in a variety of facilities across the Hanford Site. Fuel irradiated at the Hanford N Reactor and single-pass production reactors, the Fast Flux Test Facility, and from the second core of the Shippingport Pressurized Water Reactor currently remain in storage on the Hanford Site, in addition to miscellaneous research and development program irradiated fuel materials.

In general, current SNF storage facilities at the Hanford Site were not intended for SNF storage for an extended period of time and are not adequate for continued storage until the means for final disposition is available (i.e., 40 years). In most cases, these facilities either have other missions or are being deactivated. The inadequacy of these existing facilities for continued SNF storage necessitates that plans to improve storage conditions at the Hanford Site, and ultimately implement interim storage, be identified and implemented in an expeditious manner.

The deficient conditions at the existing Hanford Site SNF storage facilities were identified in a number of internal and external reviews, including the DOE findings documented in the November 1993 report, "DOE Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and other Reactor Irradiated Nuclear Materials and the Environmental, Safety and Health Vulnerabilities," (Reference 1). These reviews identified degraded fuel being stored in two deteriorating basins located near the Columbia River as requiring urgent action. In 1993 and 1994, Hanford Site stakeholders, regulators, and tribal governments also emphasized their desire for the DOE to relocate the fuel from the K Basins to an alternate location as safely and quickly as possible. These actions ultimately resulted in commitments for the expedited removal of fuel and sludge from the basins.

The Hanford Site's Spent Nuclear Fuel Project was formed in early 1994 to manage Hanford's SNF and to meet those commitments. The mission of the Spent Nuclear Fuel Project is to provide safe, economic, and environmentally sound management of Hanford spent nuclear fuel in a manner which stages it to final disposition. In completing this mission, all of the Site's spent nuclear fuel will be safely stored on site or transferred to appropriate off-site storage, consistent with national plans for all DOE-owned spent nuclear fuel, and the Project facilities prepared for deactivation or alternate use. When these conditions are met, the Project will be completed and the responsibility for

management of the Hanford spent nuclear fuel will be turned over to an operating program.

HANFORD SPENT NUCLEAR FUEL STORAGE LOCATIONS AND INVENTORIES

DOE-owned spent nuclear fuel is currently located at several facilities on the Hanford Site as shown in Figure 1. The facilities, their current primary missions, their fuel storage functions and quantities of spent nuclear fuel are as follows:

K East and K West Basins The K East and K West Basins store irradiated defense production reactor fuel, primarily N Reactor irradiated fuel. These basins contain about 3,800 cubic meters (1 million gallons) of water each and were part of the K East and K West production reactor complex constructed in the 1950s. They were used to cool discharged fuel prior to chemical processing. After the K Reactors production mission ended, the basins were used as temporary storage capacity for N Reactor fuel while the PUREX processing facility was being refurbished and restarted. When the defense production mission ended in 1990 and PUREX operations were terminated in December 1992, part of the N Reactor fuel inventory remained in the K Basins with no means for near-term removal and processing. The K East Basin contains 1,145.8 metric tons of N Reactor fuel and 0.4 metric tons of single pass reactor fuel. The K West Basin holds 953.8 metric tons of N Reactor fuel and 0.1 metric tons of single pass reactor fuel.

The fuel at the K West Basin has been stored in lidded canisters and the basin environment is relatively clean and free of corrosion products. The fuel at the K East Basin is currently stored in open canisters and some have corroded extensively, releasing fission products to the basin water and producing a substantial quantity of sludge. The basins also have a history of leaking. In the late 1970s, K East leaked about 57,000 cubic meters (15 million gallons) of basin water and again in 1993, another 340 cubic meters (90,000 gallons) escaped. The suspected location of the leak is an unreinforced construction joint between the basin and reactor structures. These conditions lead to an extreme sense of urgency for removal of the fuel, sludge, and contaminated water as quickly as possible.

PUREX Plant The PUREX Plant was operated to recover uranium, plutonium, and other nuclear materials from irradiated fuel for defense and research purposes. It too contained a small quantity of irradiated production reactor fuel when its operation was terminated. Some single pass reactor fuel is stored in the receiving basin at the facility and a small amount of N Reactor fuel resides on the dissolver cell floor. The total amount of spent nuclear fuel at PUREX is 2.9 metric tons. The PUREX Plant is currently in a program to place the facility in a safe, environmentally sound condition prior to decontamination and decommissioning. These plans include the transfer of the spent nuclear fuel to the K Basins to be managed along with the rest of the production reactor fuel.

T Plant The T Plant was the first fuel reprocessing facility at Hanford. The processing equipment had been removed and the plant decontaminated. It now serves as a beta-gamma decontamination facility and provides solid waste

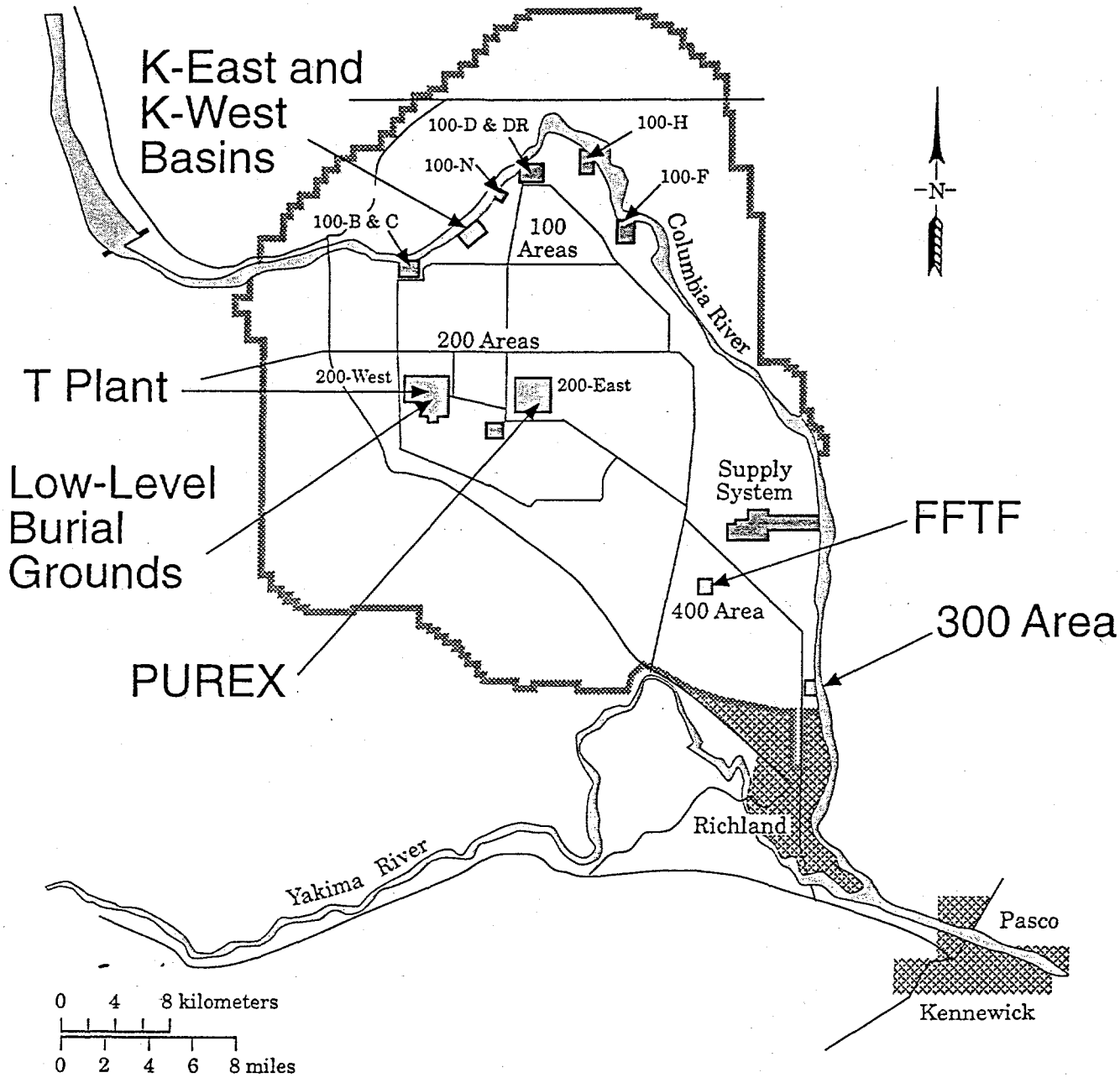

Figure 1. Location of Hanford Spent Nuclear Fuels

management services. The Shippingport Pressurized Water Reactor Core II is stored in the receiving basin at T Plant and contains 15.8 metric tons of fuel.

Fast Flux Test Facility The Fast Flux Test Facility (FFTF) is a 400 megawatt sodium-cooled fast reactor that provided materials, fuel, and component testing capability for the U.S. breeder reactor program during the 1980s. The FFTF is located in the 400 Area at the Hanford Site. When its mission ended in 1993, 11.0 metric tons of reactor fuel cores and numerous fueled experiments remained in the reactor and in storage at the facility. The reactor has been shutdown and the facility is currently being deactivated.

308 Building The 308 Building in the 300 Area of the Hanford Site was used for the manufacture and assembly of FFTF fuel and test assemblies. The building contains a small Training Reactor, Isotopics, General Atomic (TRIGA) reactor that was used as a neutron radiography facility to inspect fueled components. The 308 Building is being deactivated and the TRIGA reactor has been shutdown. Its core contains 0.02 metric tons of fuel which is currently stored in the reactor vessel.

325 Building The 325 Building Shielded Analytical Laboratory in the 300 Area supports process demonstration and analytical chemistry requirements for a variety of DOE programs. Over the years, a variety of small spent nuclear fuel samples were stored initially as archive material and then accumulated while awaiting processing or disposal.

324 Building The 324 Building, located in the 300 Area, is a shielded chemical processing laboratory used for the development of chemical processes from laboratory to pilot scale and for the examination and mechanical testing of irradiated specimens. Seven light water reactor fuel assemblies are stored in the facility. These assemblies were intended for test purposes but remain in the 324 Building only because there is no other storage location.

327 Building The 327 Building is also located in the 300 Area. It provides shielded, ventilated, and specially equipped laboratories for physical and metallurgical examination and testing of irradiated fuels and structural materials. While the facility is central to the characterization of the fuel stored in the K Basins, its long-term future is uncertain. The spent nuclear fuel stored in this facility comes from a variety of DOE fuel testing programs that used the facility for destructive testing and metallurgical examination.

The combined spent nuclear fuel inventories at the 324, 325 and 327 Buildings total 2.3 metric tons. The total spent nuclear fuel at Hanford is 2,132 metric tons and represents about 80% of the total inventory at all DOE sites. The 2,100 metric tons of metallic uranium production reactor fuel currently stored in the K Basins is about 98% of the total spent nuclear fuel at the Hanford Site.

K BASINS PATH FORWARD

The Spent Nuclear Fuel Project has focused on resolution of the K Basins issues. A recommended path for resolving the safety and environmental

concerns and providing for the safe interim storage of this material was developed. The recommendation culminates five months of engineering studies and evaluations focused on accelerated removal of fuel and sludge from the K Basins and its placement in a stable, dry storage configuration until final disposition is achieved in the future.

To arrive at the recommendation, systems engineering and risk-based decision techniques were utilized, in conjunction with a variety of technical and programmatic reviews that included independent assessments by senior experts from outside Hanford. The evaluation process included analysis of cost, schedule, regulatory and stakeholder drivers, and affected tribal values to assure a comprehensive, balanced treatment of the various alternatives. Results from these reviews and analyses were used to formulate a technical and regulatory strategy which optimizes within the alternatives studied. In developing the recommended path, a broad range of alternatives were considered including:

1. Containerization of the fuel and sludge in K East Basin and storage of these materials in the K Basins until facilities are available for the transition to dry interim storage.

2. Removal of the fuel and sludge from both basins at the earliest possible date to a newly constructed temporary wet storage basin that meets modern safety and environmental requirements until facilities are available for the transition to dry interim storage.

3. Expedited transition directly to dry interim storage based on a drying and passivation process.

4. Processing the fuel at a foreign reprocessing plant and providing retrieval and disposition of the sludge at Hanford.

5. Variations within and among the above alternatives.

The Recommended Path Forward utilizes fuel containerization, drying, passivation, and vault dry storage to achieve interim storage. Construction of the proposed vault storage facility is accelerated to allow early removal from the K Basins by staging of wet packed fuel and sludge while the more complex Stabilization Facility is constructed and brought to a fully operable state. The vault storage facility also serves the 40-year dry interim storage function as fuel and sludge are processed at the Stabilization Facility by drying and passivating and returned to the storage vault. The resulting strategy removes fuel and sludge from the K Basins by the year 2000 at a cost (through the year 2012) of approximately $1,150 million (unescalated) including operation and deactivation of Project facilities (including the K Basins).

The framework for the recommendation is a workable National Environmental Policy Act (NEPA) overlay which requires division of the Recommended Path Forward into two phases: the expedited response phase and the interim storage phase. The goal of the expedited response phase is to move the fuel and sludge into a new facility for temporary storage away from the Columbia River

as soon as possible. The interim storage phase is structured to implement the Record of Decision (ROD) for a Hanford Site Spent Nuclear Fuel Management Environmental Impact Statement (EIS) which is compatible with the ROD for the DOE Programmatic EIS (Reference 2). The Recommended Path Forward is described in Reference 3. The key elements of the Recommended Path Forward are shown in Figure 2 and described below.

Expedited Response Phase This phase, which would be evaluated as the preferred alternative in an interim action EIS, rapidly improves protection of the public, the environment, and Hanford workers. Fuel and sludge would be transferred from the K Basins to a newly constructed Staging and Storage Facility away from the Columbia River. The interim action EIS is justified by the urgent need to remove fuel and sludge from the K Basins. The preferred alternative is compatible with the DOE Programmatic EIS in that all options being evaluated in the DOE Programmatic EIS for management of spent nuclear fuel remain viable. Existing and modified facilities would be managed in accordance with DOE Orders. The new Staging and Storage Facility would be constructed and operated consistent with Nuclear Regulatory Commission (NRC) technical requirements.

In the expedited response phase, fuel and sludge in K-East and K-West basins would be packaged in large multi-canister overpacks (MCO). Modifications would be constructed at the K Basins to enable minimum fuel and sludge handling to load the MCO. The MCOs would be designed to store fuel and sludge in a wet or dry condition and would enable direct monitoring of fuel, sludge, and surrounding liquid and gas spaces during the temporary wet storage stage. A line item project would be proposed to construct a shielded vault Staging and Storage Facility to receive, store, and monitor the MCOs. Upon receipt from K Basins, the MCOs would contain wet-packed fuel and sludge and would be stored until staged into the Stabilization Facility. Design criteria for the Staging and Storage Facility would consider other Hanford spent nuclear fuel in development of functions and requirements. The wet packed MCOs would be held in the Staging and Storage Facility only until the fuel stabilization process is available.

Interim Storage Phase The second phase develops and constructs a fuel Stabilization Facility, based on a drying and passivation process. The fuel and sludge are dried and passivated in the MCO and recycled to the vault storage facility to be stored dry for up to 40 years. This phase is dependent on a completed ROD for the DOE Programmatic EIS and would be evaluated as the reference alternative in a Hanford Spent Nuclear Fuel Management EIS. New facilities constructed during the second phase would be designed to the intent of NRC technical requirements.

During the second phase, MCOs would be transferred from the Staging and Storage Facility to the newly constructed Fuel Stabilization Facility which would be co-located with the Staging and Storage Facility. Here, the fuel and unseparated sludge are dried and passivated to reduce the potential hazards associated with dry storage of the metal fuel. The size (annual throughput) of the Stabilization Facility would be balanced against operations costs to optimize plant size and processing duration since processing is not on the critical path to K Basins deactivation. Development of design criteria for

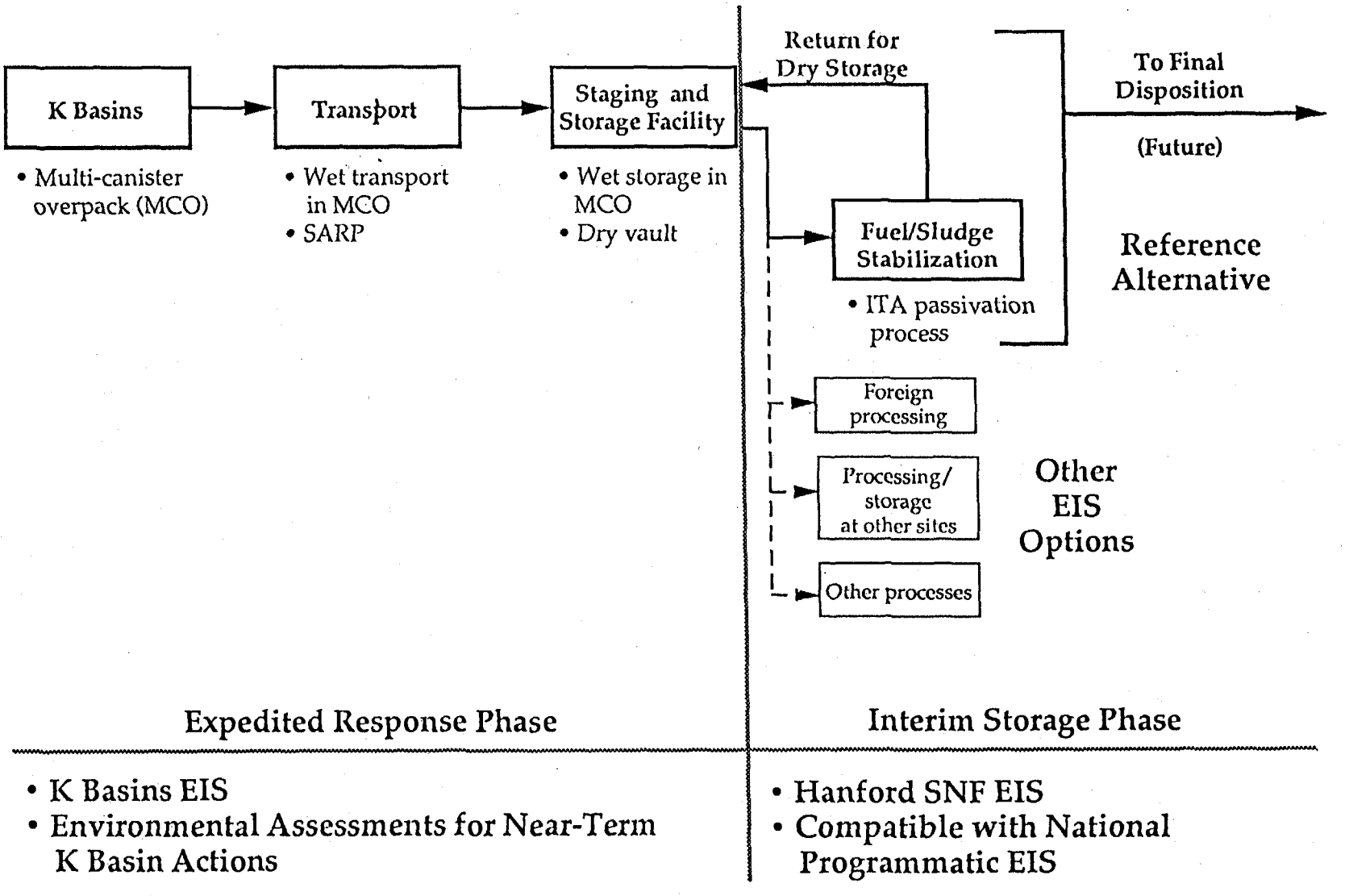

Figure 2. K Basins Recommended Path Forward

the Stabilization Facility will consider other Hanford spent nuclear fuel in development of functions and requirements. The Staging and Storage Facility would be redeployed for use as an interim storage facility until final disposition capability is available.

K BASINS PATH FORWARD NEAR-TERM OBJECTIVES

Major acquisitions will be initiated to support the K Basins Path Forward. These include the Staging and Storage Facility, the Fuel Transportation System, the Multi-Canister Overpacks and the Stabilization Facility. These acquisitions, except for the Stabilization Facility, will be necessary for completion of the expedited response phase of the path forward. Other activities will also proceed in parallel with the major acquisitions to improve the near-term safety posture at the K Basins. These actions are:

- Installation of cofferdams to mitigate the consequences of a seismic event by isolating the basin from the anticipated leak site;
- Establishing and maintaining Formal Conduct of Operations at the K Basins;
- Completing essential systems recovery actions necessary for safe operations, such as electrical, water, fire protection, and maintenance systems improvements;
- Reducing personnel exposure through improved dose reduction measures, particularly through source term reductions from cesium contaminated concrete basin walls;
- Removing debris from the K East Basin such as unused canisters and discarded tools;
- Implementing sludge management activities consistent with the path forward for sludge;
- Treating and dispositioning K East Basin water;
- Providing basin modifications and readiness for fuel removal.

Fuel and sludge characterization is in progress and technology development activities will be performed as necessary to support implementation of the major acquisitions and the other identified activities.

OTHER HANFORD SPENT NUCLEAR FUELS

To resolve vulnerabilities at other Hanford SNF facilities, and to support facility deactivations, a two-step approach will be utilized to attain safe, interim storage for these fuels. The first step for each fuel involves near-term actions to attain safe, economic pre-interim storage. The second step will be to place each fuel into interim storage as defined in the DOE Programmatic EIS ROD when completed.

Near-term actions for these fuels are as follows:

- Most FFTF spent nuclear fuel will be transferred to dry storage casks at the 400 Area for pre-interim storage. The planning basis for pre-interim storage of non self-protecting (Class I by the year 2030) FFTF spent nuclear fuel is transfer to the Plutonium Finishing Plant at the 200 Area in dry storage casks.

- The 308 Building TRIGA reactor spent nuclear fuel will be transferred to the 400 Area storage pad for pre-interim storage in casks that can be qualified for off-site shipment.
- The 324/325/327 Building light water reactor fuel inventories will be relocated to the 400 Area storage pad in dry storage casks to correct vulnerabilities at those facilities.
- The PUREX Plant spent nuclear fuel will be transferred to the K Basins for consolidated management with the K Basins spent nuclear fuel.
- The Shippingport Core II will continue to be managed at T Plant until transfer to interim storage.
- The other miscellaneous spent nuclear fuels will remain where they are currently located until their disposition is defined by the DOE Programmatic EIS ROD.

CONCLUSION

In response to the identification of vulnerabilities associated with the storage of spent nuclear fuel at the Hanford Site, the Spent Nuclear Fuel Project was formed. The Project's mission is to provide safe, economic, and environmentally sound management of Hanford spent nuclear fuel in a manner which stages it to final disposition. In just a few months, the Project developed and recommended to the DOE, a path forward to place 2,100 metric tons of fuel currently stored in the K Basins (80% of the DOE's spent nuclear fuel) into dry interim storage. This plan will begin fuel removal from the basins in 1998 and complete that phase over the next two years. Planning for management of other spent nuclear fuel at the Hanford Site is also completed.

REFERENCES

1. "DOE Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and other Reactor Irradiated Nuclear Materials and the Environmental, Safety, and Health Vulnerabilities," U.S. Department of Energy (November 1993).

2. "Department of Energy Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Draft Environmental Impact Statement," DOE/EIS-0203-D (June 1994).

3. J. C. FULTON, "Hanford Spent Nuclear Fuel Project Recommended Path Forward," WHC-EP-0830 (October 1994).