

S.4 DESCRIPTION OF ALTERNATIVES

S.4.1 LONG-TERM STORAGE ALTERNATIVES AND RELATED ACTIVITIES

No Action

[Text deleted.]

Under the No Action Alternative, all weapons-usable fissile materials would remain at existing storage sites. Maintenance at existing storage facilities would be done as required to ensure safe operation for the balance of the facility's useful life. Sites covered under the No Action Alternative include Hanford, INEL, Pantex, ORR, SRS, RFETS, and LANL. Although there are no weapons-usable fissile materials within the scope of the PEIS stored currently at NTS, it is also analyzed under No Action to provide an environmental basis against which impacts of the storage and disposition alternatives are analyzed. The Preferred Alternative for storage calls for No Action at Hanford, INEL, and LANL pending disposition.

Preferred Alternative

The Preferred Alternative for storage is described in Section S.2.

Upgrade at Multiple Sites

Under this alternative for storage, DOE would either modify certain existing facilities or build new facilities, depending on the site's requirements to meet standards for nuclear material storage facilities, and would utilize existing site infrastructure to the extent possible. These modified or new facilities would be designed to operate for up to 50 years. Pu materials currently stored at Hanford, INEL, Pantex, and SRS would remain at those four sites, and HEU would remain at ORR. This alternative does not apply to NTS because NTS does not currently store weapons-usable fissile materials that are within the scope of the PEIS.

A subalternative of relocating portions of the Pu inventory from RFETS and LANL (for a total of 14.4 t [15.9 tons] according to DOE's Openness Initiatives of December 7, 1993, and February 6, 1996, respectively) to one or more of the four existing Pu storage sites is analyzed. Storage without strategic reserve and weapons R&D materials is also included as a subalternative.

Within some of the five candidate storage sites under this alternative, there are one or more storage options. A summary of these options is presented in Table S.4.1-1.

Table S.4.1-1. Long-Term Storage Options for the Upgrade at Multiple Sites Alternative^a

| Candidate Site | Storage Option |
|--------------------------------|---|
| Hanford | Modify Existing Fuels and Materials Examination Facility for Pu Storage, or Construct New 200 West Area Facility for Pu Storage |
| INEL | Modify Existing and Construct New Argonne National Laboratory-West Facilities for Continued Pu Storage |
| Pantex (Preferred Alternative) | Modify Existing Zone 12 South Facilities for Continued Pu Storage |
| ORR (Preferred Alternative) | Modify Existing Y-12 Plant Facilities for Continued HEU Storage |
| SRS (Preferred Alternative) | Modify New Actinide Packaging and Storage Facility for Continued Pu Storage |

^a Proposed storage facility locations were primarily based on optimal use of existing facilities, and are in accordance with current site development and utilization plans and proposals.

Consolidation of Plutonium

Under this alternative, Pu materials at existing sites would be removed, and the entire DOE inventory of Pu would be consolidated at one site, while the HEU inventory would remain at ORR. Again, the four sites with existing Pu storage are candidate sites for Pu consolidation. In addition, NTS and ORR are candidate sites for this alternative. Consolidation of Pu at ORR would result in a situation in which inventories of Pu and HEU are collocated at one site; this alternative is therefore analyzed as the Collocation Alternative at ORR.

A subalternative to account for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–2.

Table S.4.1–2. Long-Term Storage Options for the Consolidation of Plutonium Alternative

| Candidate Site ^a | Storage Option |
|-----------------------------|---|
| Hanford | Construct New Pu Storage Facility Adjacent to 200 East Area |
| NTS | Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu Storage Facility in Area 6 |
| INEL | Construct New Pu Storage Facility Adjacent to the Idaho Chemical Processing Plant |
| Pantex | Construct New and Modify Existing Zone 12 South Facilities, or Construct New Pu Storage Facility in Zone 12 South |
| SRS | Construct New Pu Storage Facility Adjacent to Z Area |

^a Consolidation of Pu at ORR results in a collocation condition with HEU. See ORR Collocation Alternative in Table S.4.1–3.

Collocation of Plutonium and Highly Enriched Uranium

Under the Collocation Alternative, the entire DOE inventory of Pu would be consolidated and collocated at the same site as the HEU inventory. The six candidate sites are Hanford, NTS, INEL, Pantex, ORR, and SRS.

A subalternative for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–3.

Table S.4.1–3. Long-Term Storage Options for the Collocation of Plutonium and Highly Enriched Uranium Alternative

| Candidate Site | Storage Option |
|----------------|--|
| Hanford | Construct New Pu and HEU Storage Facilities Adjacent to 200 East Area |
| NTS | Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu and HEU Storage Facilities in Area 6 |
| INEL | Construct New Pu and HEU Storage Facilities Adjacent to the Idaho Chemical Processing Plant |
| Pantex | Construct New Pu and HEU Storage Facilities in Zone 12 South |
| ORR | Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Maintain Existing (No Action) HEU Storage Facilities at Y-12 Plant, or Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Modify Existing HEU Storage Facilities at Y-12 Plant, or Construct New Pu and HEU Storage Facilities Northwest of Oak Ridge National Laboratory |
| SRS | Construct New Pu and HEU Storage Facilities Adjacent to Z Area |

S.4.2 PLUTONIUM DISPOSITION ALTERNATIVES AND RELATED ACTIVITIES

[Text deleted.] The disposition technologies analyzed in the PEIS are those that would convert surplus Pu into a form that meets the Spent Fuel Standard. For the purpose of environmental impact analyses for the various disposition alternatives, both generic and specific sites are used to provide perspective on these alternatives. Under each alternative, there are various ways to implement the alternative. These “variants” (such as the can-in-canister¹³) are shown in Table S.4.2–1 to provide a range of available options for consideration.

The first step in Pu disposition is to remove the surplus Pu from storage, then process this material in a pit disassembly/conversion facility (for pits, a component of nuclear weapons) or in a Pu conversion facility (for non-pit materials). The processing would convert the Pu material into a form suitable for each of the disposition alternatives described in the following sections. The pit disassembly/conversion facility and the Pu conversion facility are assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the potential environmental impacts of constructing and operating these facilities.

No Disposition Action

A “No Pu Disposition” action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in storage in accordance with decisions on the long-term storage of weapons-usable fissile materials.

Preferred Alternative

The Preferred Alternative for disposition is described in Section S.2.

Deep Borehole Category

Under this category, surplus weapons-usable Pu would be disposed of in deep boreholes that are drilled at least 4 kilometers (km) (2.5 miles [mi]) into ancient, geologically stable rock formations beneath the water table. The deep borehole provides a geologic barrier against potential proliferation. A generic site is used for the construction and operation of a borehole complex where the surplus Pu would be prepared for emplacement in the borehole. This complex would consist of five major facilities: processing; drilling; emplacing/sealing; waste management; and support (security, maintenance, and utilities).

Direct Disposition

Under the Direct Disposition Alternative, surplus Pu would be removed from storage, processed as necessary, converted to a form suitable for emplacement, packaged, and placed in a deep borehole. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system. A generic site is used for the borehole complex to analyze the environmental impact of this alternative.

Immobilized Disposition

Under the Immobilized Disposition Alternative, the surplus Pu would be removed from storage, processed, and converted to a suitable form for shipment to a ceramic immobilization facility. The output of this facility would be spherical ceramic pellets containing Pu, facilitating handling during transportation and emplacement. The ceramic pellets (about 2.54 centimeters [cm] [1 inch {in}] in diameter and containing 1 percent Pu by weight) would then be placed in drums and shipped to the borehole complex. At the deep borehole site, the ceramic

¹³ In the can-in-canister variant, cans of Pu glass or Pu ceramic would be placed in a DWPF canister or a DWPF type canister. This canister would then be filled with borosilicate glass containing HLW. This variant is described in Appendix O of the Final PEIS.

Table S.4.2-1. Description of Variants Under Plutonium Disposition Alternatives

| Alternatives Analyzed | Possible Variants |
|--|--|
| • Deep Borehole Direct Disposition | • Arrangement of Pu in different types of emplacement canisters. |
| • Deep Borehole Immobilized Disposition | • Emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets. |
| • New Vitrification Facilities | • Collocated pit disassembly/conversion, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS. |
| • New Ceramic Immobilization Facilities | • Collocated pit disassembly/Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS. |
| • Electrometallurgical Treatment (glass-bonded zeolite form) | • Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL. |
| • Existing LWR With New MOX Facilities | • Pressurized or Boiling Water Reactors. • Different numbers of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals). |
| • Partially Completed LWR With New MOX Facilities | • Same as for existing LWR (except that MOX fuel would not be fabricated in Europe). |
| • New Evolutionary LWR With New MOX Facilities | • Same as for partially completed LWR. |
| • Existing CANDU Reactor With New MOX Facilities | • Different numbers of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals). |

pellets would be mixed with ceramic pellets containing no Pu and fixed with grout during emplacement. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system.

Although a generic site is used for the borehole complex in this alternative, the ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of the facility.

Immobilization Category

Under this category of alternatives, surplus Pu would be immobilized to create a chemically stable form for disposal in a geologic repository pursuant to the *Nuclear Waste Policy Act (NWPA)*.¹⁴ The Pu material may be mixed with HLW or other radioactive isotopes and immobilized to create a radiation field that could serve as a proliferation deterrent, along with safeguards and security comparable to those of commercial spent nuclear fuel, thereby achieving the Spent Fuel Standard. All immobilized Pu would be encased in stainless steel canisters and would remain in onsite vault-type storage until a separate geologic repository pursuant to the NWPA is operational.

Vitrification

Under the Vitrification Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to the vitrification facility. In this facility, the Pu would be mixed with glass frit and the highly radioactive isotope cesium-137 (Cs-137) or HLW to produce borosilicate glass logs (a slightly different process, using HLW, would be used for the can-in-canister variant discussed in Appendix O of the Final PEIS). The Cs-137 isotope could come from the cesium chloride (CsCl) capsules currently stored at Hanford or from existing HLW if the site selected for vitrification already manages HLW. Each glass log produced from the vitrification facility would contain about 84 kilograms (kg) (185 pounds [lb]) of Pu.

The vitrification facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Ceramic Immobilization

Under the Ceramic Immobilization Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to a ceramic immobilization facility. In this facility, the Pu would be mixed with nonradioactive ceramic materials and Cs-137 or HLW to produce ceramic disks (a slightly different process, using HLW, would be used for the can-in-canister variant). Each disk would be approximately 30 cm (12 in) in diameter and 10 cm (4 in) thick, and would contain approximately 4 kg (9 lb) of Pu. The Cs-137 or HLW would be provided as previously described.

The ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Electrometallurgical Treatment

Under the Electrometallurgical Treatment Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to new or modified facilities for electrometallurgical treatment. This process could immobilize surplus fissile materials into a glass-bonded zeolite (GBZ) form. With the GBZ material, the Pu is in the form of a stable, leach-resistant mineral that is incorporated in durable glass materials.¹⁵

¹⁴ Also referred in the PEIS as a geologic, permanent, or HLW repository.

[Text deleted.]

Reactor Category

The reactor alternatives considered in the Storage and Disposition PEIS would utilize surplus Pu in MOX fuel for use in non-defense reactors. The irradiated MOX fuel would meet the Spent Fuel Standard to reduce the proliferation risks of the Pu material, and the reactors would also generate revenues through the sale of electricity. MOX fuel would be used in a once-through fuel cycle, with no reprocessing or subsequent reuse of spent fuel. The spent nuclear fuel generated by the reactors would then be sent to a geologic repository pursuant to the NWPA.

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or modified at a U.S. Government or existing commercial fuel fabricator's site. The surplus Pu from storage would be processed, converted to PuO₂, and transferred to the MOX fuel fabrication facility. In this facility, PuO₂ and UO₂ (from existing domestic sources) would be blended and fabricated into MOX pellets, loaded into fuel rods, and assembled into fuel bundles suitable for use in the reactor alternatives under consideration. The PEIS evaluates the potential environmental impacts of the MOX fuel fabrication facility at the six DOE sites and at a generic commercial site. MOX fuel fabrication at existing European facilities would be a viable option in the near-term to meet the initial fuel needs of the Existing LWR Alternative, pending availability of a domestic MOX fuel fabrication facility.¹⁶

Existing Light Water Reactor

Under the Existing LWR Alternative, the MOX fuel containing surplus Pu would be fabricated and transported to existing commercial LWRs in the United States, where the MOX fuel would be used instead of conventional UO₂ fuel. The LWRs employed for domestic electric power generation are pressurized water reactors (PWRs) and boiling water reactors (BWRs). Both types of reactors use the heat produced from nuclear fission reactions to generate steam that drives the turbines and generates electricity. The Storage and Disposition PEIS assumes a throughput of 3 to 5 t/year (yr) (3.3 to 5.5 tons/yr) for disposition of surplus Pu; three to five LWRs would be used. A sample of operating reactors (eight PWRs and four BWRs built after 1975) was compiled to obtain generic operating characteristics for environmental analysis of this alternative.

It is possible that an existing LWR can be configured to produce tritium, consume Pu as fuel, and generate revenue through the production of electricity. This configuration is called a multipurpose reactor. Environmental analysis of the multipurpose reactor is included in Chapter 4 of the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (TSR PEIS) (DOE/EIS-0161, October 1995). In the TSR PEIS ROD (December 1995), the multipurpose reactor was preserved as an option for future consideration. Information on the Fast Flux Test Facility (FFTF) at Hanford and the costs and benefits of the multipurpose reactor is presented in Appendix N of the Final PEIS.

Partially Completed Light Water Reactor

Under the Partially Completed LWR Alternative, commercial LWRs on which construction has been halted would be completed. The completed reactors would use MOX fuel containing surplus Pu. The characteristics of

¹⁵ The Department has recently issued a FONSI (61 FR 25647) and decision to proceed with the limited demonstration of the electrometallurgical treatment process at Argonne National Laboratory-West (ANL-W) at INEL for processing up to 125 spent fuel assemblies from the Experimental Breeder Reactor II (100 driver and 25 blanket assemblies). Although this alternative could be conducted at other DOE sites, ANL-W is described in the PEIS as the representative site for analysis. The National Research Council prepared a report called *An Evaluation of the Electrometallurgical Approach for Treatment of Excess Weapons Plutonium* (National Academy Press, Washington, DC, 1996). The results of this evaluation will be considered in DOE's decision-making process for Pu disposition.

¹⁶ European MOX fuel fabrication would only be available in the near-term, and is not a part of the Preferred Alternative.