1 PURPOSE OF AND NEED FOR ACTION

1.1 Introduction

In 1992, at the end of the Cold War, the President commissioned the National Academy of Sciences to study management and disposition options for surplus weapons-usable plutonium. Several agreements were subsequently reached with Russia on the mutual reduction of plutonium stockpiles. The U.S. Department of Energy (DOE) is responsible for the surplus plutonium disposition program for the United States. Within this program, the U.S. Nuclear Regulatory Commission (NRC) has the independent responsibility of reviewing a proposal to design, construct, and operate a facility in the United States that would convert depleted uranium dioxide and weapons-grade plutonium dioxide into mixed oxide (MOX) fuel. A 1998 amendment to the Energy Reorganization Act of 1974 gave the NRC licensing and related regulatory authority over the proposed facility. In accordance with the National Environmental Policy Act (NEPA), 42 *United States Code* (U.S.C.) 4321 *et seq.*, the proposal to build and operate such a facility is being reviewed by the NRC in this final environmental impact statement (FEIS), to evaluate the potential environmental impacts that would result if the proposed action is taken.

The surplus plutonium disposition program is discussed in Section 1.1.1. The proposed action is described in Section 1.2, and the purpose and need for the proposed action are discussed in Section 1.3. Section 1.4 describes the process used by the NRC to determine the scope of this environmental impact statement (EIS), which identified the issues to be studied in detail and the issues that do not require detailed study.

1.1.1 Surplus Plutonium Disposition Program

Following the end of the Cold War, the United States and Russia took steps to mutually reduce their respective stockpiles of weapons-grade plutonium by declaring some of this plutonium excess to national security needs. The surplus plutonium disposition program involves making sure that this surplus plutonium cannot be used again to make nuclear weapons. The DOE evaluated a number of strategies to disposition the U.S. stockpile of surplus plutonium and has published two related EISs, a record of decision (ROD), and an amended ROD (DOE 1996, 1999, 2000, 2002). As part of this program, in 1999, the DOE selected a contractor, Duke Cogema Stone & Webster (DCS), to design, construct, and operate a facility that would convert uranium and weapons-grade plutonium into MOX fuel, as discussed further in Section 1.1.2.

To implement DOE's surplus plutonium disposition program, the DOE ROD in January 2000 set forth a "hybrid" approach, which involved immobilizing a portion of the surplus plutonium and converting the remaining portion into nuclear reactor fuel. Three new facilities were proposed for the DOE's Savannah River Site (SRS) in South Carolina to implement the hybrid approach. A Pit Disassembly and Conversion Facility (PDCF) would convert metallic weapons material, called pits, to plutonium dioxide powder. The proposed PDCF would be built and operated

under the DOE's jurisdiction and authority. A plutonium immobilization plant was proposed to convert some of the plutonium dioxide powder from the PDCF and plutonium from other sources into ceramic cylinders to be encapsulated in vitrified high-level waste. The Mixed Oxide Fuel Fabrication Facility (hereafter referred to as "the proposed MOX facility") would convert the balance of the plutonium dioxide powder from the PDCF into MOX fuel for subsequent irradiation in U.S. commercial reactors authorized by the NRC to use such fuel.

Under its January 2000 ROD, the DOE planned to convert 33 metric tons (MT)[1] (36.4 tons) of surplus plutonium into MOX fuel and to immobilize 17 MT (19 tons) in the plutonium immobilization plant. Among the plutonium disposition program's purposes is to reduce over time the number of locations in the United States where the various forms of plutonium are stored, to better ensure that weapons-usable material does not fall into the hands of rogue states or terrorist groups. Irradiated MOX fuel would be highly radioactive, making it inaccessible for reuse as nuclear weapons material. In September 2000, Russia and the United States agreed to disposition 34 MT (37.5 tons) of surplus weapons-grade plutonium from their respective stockpiles (White House 2000). Under this agreement, disposition may be accomplished either by immobilization or by MOX fuel fabrication and subsequent irradiation.

However in April 2002, the DOE issued an amended ROD (DOE 2002), in which it decided not to pursue its hybrid approach due to budgetary constraints. The DOE determined that in order to make progress with available funds, only one approach could be supported. Russia does not consider immobilization alone to be an acceptable approach because immobilization, unlike the irradiation of MOX fuel, fails to degrade the isotopic composition of the plutonium. Russia further contends that the United States could easily retrieve plutonium from the immobilized waste at a later date and reuse that plutonium in nuclear weapons (DOE 2002). Because an immobilization-only approach would jeopardize Russia's continued involvement in the joint effort to reduce supplies of weapons-grade plutonium, the DOE decided that if only one disposition approach is to be pursued, the MOX fuel approach is the preferred one. The DOE concluded that implementation of the MOX-only approach is the key to successfully completing the September 2000 agreement between Russia and the United States (DOE 2002). Accordingly, the DOE decided to pursue a MOX-only approach, under which all 34 MT (37.5 tons) of surplus weapons-grade plutonium would be converted into MOX fuel, and the DOE canceled the plutonium immobilization plant. The DOE had earlier identified Duke Power Company's four reactors at the Catawba and McGuire stations (two at each station) as potential candidates to irradiate MOX fuel. The potential candidate reactors can accommodate up to 25.5 MT (28.2 tons) of surplus plutonium in MOX fuel. The DOE has not yet identified the additional candidate reactors necessary to accommodate the additional MOX fuel (8.5 MT [9.4 tons]) to be irradiated under the amended ROD.

The DOE also issued a supplemental NEPA analysis on April 24, 2003 (DOE 2003). The Supplement Analysis (SA) addressed the above-referenced changes in DOE's surplus plutonium disposition program, to determine whether the Surplus Plutonium Disposition Final Environmental Impact Statement (SPD EIS) (DOE 1999) should be supplemented. The SA

[1] A metric ton (MT) equals 1,000 kilograms (kg) and is equivalent to 1.1 tons, or approximately 2,200 pounds (lb).

discussed how adoption of the MOX-only approach required additional aqueous processing steps at the proposed MOX facility to remove impurities — mainly chlorides — from the alternate feedstock material. Additional equipment at the proposed MOX facility to remove the chlorides includes two dissolution lines, an enlarged annular tank, and a chlorine gas wash column. The SA noted that the transuranic (TRU) waste generated by operation of the proposed MOX facility would, after processing at the Waste Solidification Building (WSB), be shipped from the SRS to the DOE's Waste Isolation Pilot Plant (WIPP). The DOE stated in its SA that prior to obtaining the necessary clearances for shipping TRU waste to WIPP, the amounts of such waste would be well within existing SRS storage capacity. The DOE further found that TRU waste generated by operation of the proposed MOX facility would meet the WIPP waste acceptance criteria, and that the impacts of packaging, transporting, and disposing of such waste would be bounded by prior DOE environmental analyses. The SA concluded that "the activities and potential environmental impacts associated with the proposed processing of 6.5 MT of surplus plutonium originally intended for immobilization and the increase in the total amount of surplus plutonium to be fabricated into MOX fuel from 33 MT to 34 MT are not different in kind, and only slightly in degree, from those described in the SPD EIS." Accordingly, the DOE found no requirements for supplementing the SPD EIS.

1.1.2 MOX Fuel Fabrication Facility

As referenced above, the DOE selected DCS to design, construct, and operate the proposed MOX facility. Because Congress gave the NRC licensing and related regulatory authority over the proposed MOX facility, its construction and operation will require NRC approvals, issued pursuant to the *Code of Federal Regulations*, Title 10, Part 70 (10 CFR Part 70), "Domestic Licensing of Special Nuclear Material." As part of its licensing review, the NRC has prepared this FEIS in accordance with the NRC's 10 CFR Part 51 regulations implementing NEPA and the generally applicable Council on Environmental Quality (CEQ) regulations in 40 CFR Part 1500. This FEIS addresses the direct, indirect, and cumulative impacts related to building, operating, and decommissioning the proposed MOX facility. Although the DOE has prepared previous EISs that cover impacts of the proposed MOX facility on a programmatic level, the NRC has prepared this EIS to incorporate additional site-specific information and design details in order to meet its NEPA requirements as stated in 10 CFR Part 51.

To obtain approval to construct the facility, DCS submitted a MOX Project Quality Assurance Plan (MPQAP) on June 22, 2000, an Environmental Report (ER) on December 19, 2000 (DCS 2000), a revised MPQAP on January 29, 2001, and a Construction Authorization Request (CAR) on February 28, 2001 (DCS 2001). The NRC then published its Notice of Intent to prepare an EIS for the proposed MOX

Categories of Impacts

Impacts of the proposed and connected actions include:

- Direct effects — caused by the proposed action and occur at the same time and place,
- Indirect effects — occur later in time or are farther removed in distance but are reasonably foreseeable, and
- Cumulative impacts — potential impacts when the proposed action is added to other past, present, and reasonably foreseeable future actions.

facility (NRC 2001a). Because of design changes in the proposed MOX facility resulting from DOE's amended ROD, DCS submitted Revision 2 of the ER on July 12, 2002 (DCS 2002a), and an amended CAR on October 31, 2002 (DCS 2002b). DCS submitted Revision 3 of the ER on June 20, 2003 (DCS 2003a), which updated Revision 2 to incorporate responses to requests by the NRC for additional information and revised impacts from the WSB to include preliminary design details provided by the DOE. DCS submitted Revision 4 of the ER on August 14, 2003 (DCS 2003b), which updated impacts from the WSB based on recent revisions by the DOE. On June 10, 2004, DCS submitted Revision 5 to the ER (DCS 2004a). This revision incorporated changes in the facility design affecting waste volumes. In particular, the silver recovery process was removed from the design. Other changes included movement of the controlled area boundary to be colocated with the SRS site boundary, design refinements to the WSB, and the decision to route the liquid low-level waste (LLW) streams from the proposed MOX facility and the PDCF to the WSB rather than the Effluent Treatment Facility at the SRS. On the same date, DCS also submitted revisions to its CAR (DCS 2004b). If the amended CAR is approved, DCS plans to submit its application for a 10 CFR Part 70 operating license. The date for DCS filing such an application is not known at this time.

The NRC's decision-making process for the proposed MOX facility includes an environmental review and a safety review (see text box on the MOX licensing process). In addition to this EIS, which documents NRC's environmental review, the NRC will prepare two final safety evaluation reports (FSERs). The first FSER will evaluate the CAR and will address whether construction of the proposed MOX facility may be authorized pursuant to 10 CFR Part 70 and the Atomic Energy Act. In this regard, 10 CFR 70.23(b) states that the NRC will approve construction of a plutonium processing and fuel fabrication facility if it finds that the design bases of the principal structures, systems, and components (PSSCs) and the quality assurance (QA) program provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The 10 CFR 70.23(b) safety findings on the CAR will be documented in the first FSER, now scheduled to be issued in February 2005. The NRC will use the safety findings in the first FSER and the environmental review in this EIS to decide whether or not to authorize construction of the proposed MOX facility.

If construction is authorized, a second FSER would address whether the proposed MOX facility, as built, may be authorized to operate under a 10 CFR Part 70 license. The second FSER would evaluate a DCS application for a license to possess and use special nuclear material (SNM) at the proposed MOX facility. DCS plans to submit such an application if the amended CAR is approved. The safety findings in the second FSER and the environmental review in this EIS would be used by the NRC to decide whether or not to issue an SNM possession and use license to DCS, which would authorize operation of the proposed MOX facility.

Under NEPA, the scope of this EIS is broader than that of the FSERs. This EIS addresses the environmental impacts of constructing, operating, and decommissioning the proposed MOX facility and the environmental impacts of the alternatives considered. This EIS does not address safety issues that are not considered to have potential environmental impacts. For example, the effects of a postulated criticality accident are presented here because such an accident could produce environmental impacts. However, the question of whether the criticality

MOX Licensing Process

DCS has chosen to request authorization to build and operate a mixed oxide (MOX) fuel fabrication facility in two steps. Step 1 was the Construction Authorization Request (CAR) initially filed by DCS in February 2001. The NRC staff is performing a safety review of the CAR and plans to issue a final safety evaluation report (FSER) on the CAR in February 2005. As reflected in this environmental impact statement (EIS), the NRC staff has also performed an environmental review evaluating the impacts of both the construction and operation of the proposed MOX fuel fabrication facility.

If the NRC staff grants the CAR, DCS plans as Step 2 of the process to apply for a license to possess and use special nuclear material (SNM) at the MOX fuel fabrication facility. If such an application is filed and accepted for docketing, the NRC staff would publish a notice of opportunity for hearing in the *Federal Register*. This notice would give individuals and organizations the opportunity to request the NRC to conduct an adjudicatory hearing regarding any DCS request for an SNM license. NRC hearings are governed by the requirements in 10 CFR Part 2. Regardless of whether or not an adjudicatory hearing is held, the NRC staff would perform a safety review of any DCS request for an SNM license, prepare a second FSER, and either issue DCS an operating license or deny the application. The MOX licensing process is further summarized in the chart below.

SAFETY REVIEWS

Construction Authorization

- In a CAR, the applicant must identify principal structures, systems, and components (PSSCs) that reduce the risk of accidents and natural phenomena hazards.
- The applicant must also address baseline design criteria and quality assurance (QA) requirements. These include issues such as fire protection, criticality control, and quality standards and records.
- The NRC staff issues a construction-related FSER that documents its findings on the CAR and QA program description.

License to Possess and Use SNM

- DCS must also submit a license application for authorization to possess and use SNM.
- The NRC staff would issue a second FSER that documents its findings relative to the license application.

ENVIRONMENTAL REVIEW

Environmental Impact Statement

- Pursuant to the *Code of Federal Regulations*, Title 10, Part 51 (10 CFR Part 51) implementing regulations for the National Environmental Policy Act (NEPA), the NRC staff prepares a single EIS.
- The NRC EIS includes impacts from both construction and operation of the proposed action and alternatives.

ADJUDICATION

Adjudication Hearing

- An adjudicatory hearing regarding the CAR is now being held.

safety controls proposed by DCS would adequately prevent such an accident is part of the NRC's safety review and is not discussed in this EIS.

1.2 Description of the Proposed Action and Connected Actions

As described further in Section 1.2.1, the proposed action involves a decision by NRC whether or not to authorize DCS to construct and later operate the proposed MOX facility at the SRS to convert 34 MT (37.5 tons) of surplus weapons-grade plutonium to MOX fuel. Section 1.2.2 describes actions that are connected to the proposed action. Connected actions fall within the scope of the actions evaluated in an EIS (40 CFR 1508.25). More detailed technical information about the proposed action and connected actions is presented in Section 2.2.

1.2.1 Proposed Action

Proposed Action

- The proposed federal action is for the U.S. Nuclear Regulatory Commission to authorize Duke Cogema Stone & Webster (DCS) to build and operate a facility to fabricate mixed oxide (MOX) fuel.
- NEPA requires preparation of an EIS for major federal actions that could significantly affect the human environment.
- To operate the MOX facility, DCS would need an NRC license to possess and use special nuclear material (surplus plutonium from the U.S. nuclear weapons program).
- Under contract with the DOE, DCS would build and operate a facility to manufacture nuclear fuel using surplus plutonium.
- The NRC-licensed facility for fabricating nuclear fuel would be located on the DOE's Savannah River Site.

The proposed MOX facility would be built on 16.6 ha (41 acres) of land in the F-Area of the SRS (see Figures 1.1 and 1.2). DCS is expected to request a license for 20 years. The facility would be designed for maximum annual throughput of 3.5 MT (3.9 tons) of plutonium. Impacts in the ER are based on the maximum annual design capacity. This FEIS is based on a total of 34 MT (37.5 tons) of surplus plutonium. The rate at which DCS actually processes the plutonium would likely be less than the facility's design capacity. Therefore, actual annual impacts should be less than those presented in the ER. The period of operation would likely be less than the 20-year license period. The actual period of operation would vary depending on the annual throughput over time. The 20-year licensing period would allow deactivation and decommissioning to occur prior to license termination. For purposes of this FEIS, a period of operation of 10 years is assumed to bound impacts. If the actual period of operation is longer than 10 years as a result of an actual throughput less than the maximum design capacity, the annual impacts would be less, even though they would occur over a longer period of time.

Direct effects of the proposed action include effects resulting from construction, operation, and decommissioning of the proposed MOX facility to convert 34 MT (37.5 tons) of surplus plutonium into MOX fuel. Plutonium dioxide powder would be processed at the proposed MOX

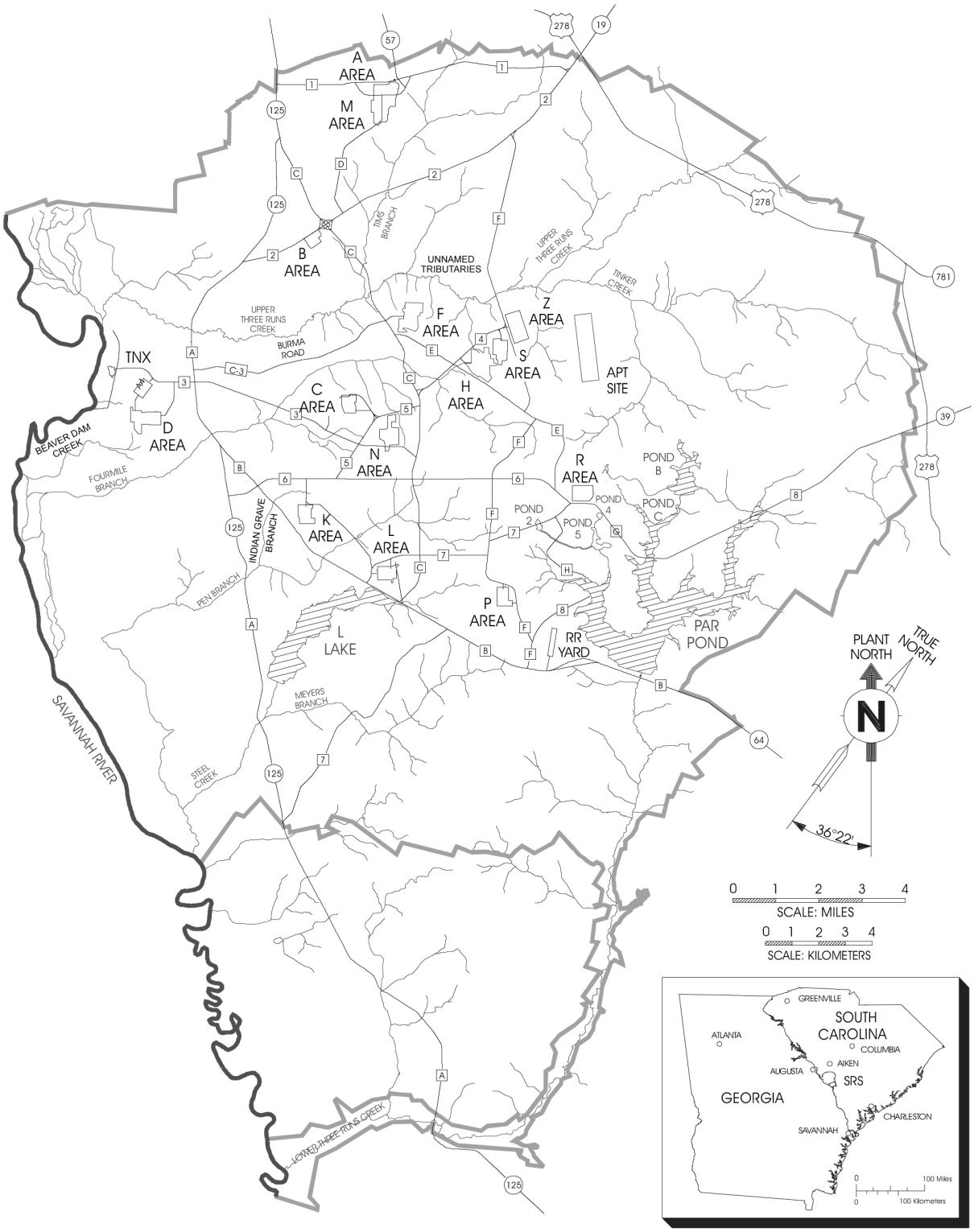

Figure 1.1. Location of the Savannah River Site and the F-Area (*Source*: DCS 2001).

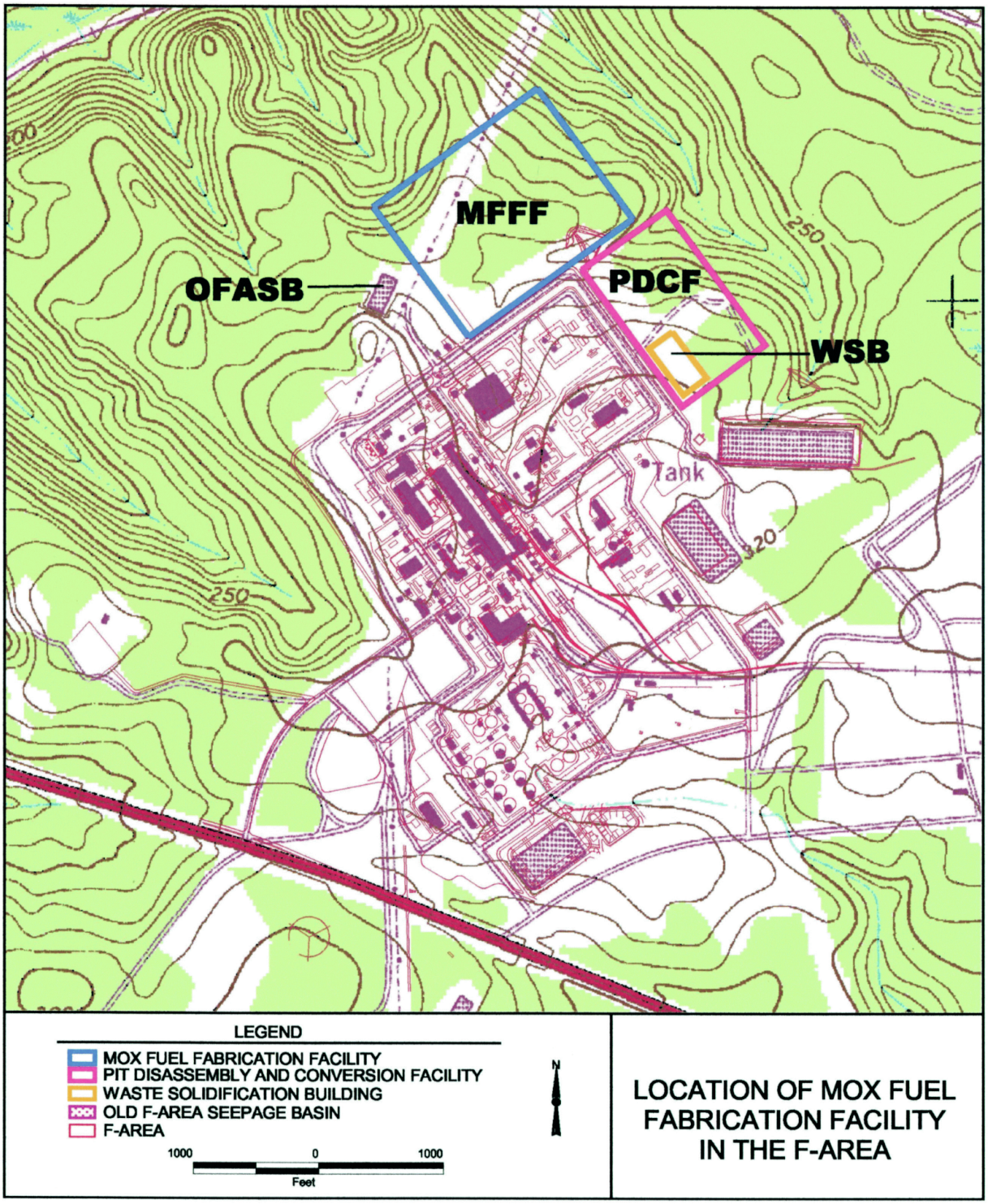

Figure 1.2. Locations of the proposed MOX facility, the PDCF, and the WSB in the F-Area on the SRS complex (*Source*: DCS 2002a).

facility to remove impurities, such as americium and gallium, and would be mixed with the depleted uranium dioxide to form the MOX fuel. The final blend for MOX fuel would have a required plutonium content of 2.3% to 4.8% (percent by weight). The facility would be capable of producing MOX fuel with a plutonium content of up to 6% (DCS 2001).

1.2.2 Connected Actions

In order for the proposed MOX facility to fulfill its function, other "connected actions" would also occur. For example, the PDCF would be the source of some of the plutonium dioxide needed to make MOX fuel. Therefore, the PDCF must be constructed and authorized by the DOE to operate so that the proposed MOX facility would have the required material with which to make MOX fuel.

Connected Actions

Actions closely related to the proposed action that:

- Automatically trigger other actions which may require environmental impact statements,
- Cannot or will not proceed unless other actions are taken previously or simultaneously, or
- Are interdependent parts of a larger action and depend on the larger action for their justification.

Feedstock (surplus plutonium dioxide and depleted uranium dioxide) would be required to be transported to the SRS to make the MOX fuel. Because the surplus plutonium is currently stored at seven DOE facilities (see Figure 1.3 and Table 1.1), it would need to be transported to the SRS (DOE 2000). The depleted uranium hexafluoride would first be transported from a DOE site (assumed to be the gaseous diffusion uranium enrichment facility in Portsmouth, Ohio) to an existing commercial fuel fabrication facility (assumed to be the Global Nuclear Fuel-Americas, LLC, facility in Wilmington, North Carolina), where it would be converted to depleted uranium dioxide, which would then be transported to the SRS.

Two new DOE facilities (the PDCF and the WSB) are needed to support the proposed MOX facility. The PDCF would be required to convert approximately 25.6 MT (28.2 tons) of surplus plutonium metal to plutonium dioxide. The remaining quantity of surplus plutonium, called "alternate feedstock," would be in a form that would be suitable to go directly to the proposed MOX facility. The WSB would process liquid waste streams from the PDCF and the proposed MOX facility. Since the PDCF and WSB would not be under NRC's Atomic Energy Act jurisdiction, the safety issues pertaining to the PDCF and WSB will not be addressed by the NRC in the FSERs.

As discussed in Section 4.3.4, the wastes generated at the proposed MOX facility and the PDCF would be managed at the WSB, sent to the SRS waste management system, or sent to approved facilities off the SRS property for disposition. In addition, infrastructure upgrades would be needed to support the proposed MOX facility. These upgrades include waste transfer pipelines, electric utility line realignment, and addition of access roads.

The FEIS also evaluates transporting the fresh (unirradiated) MOX fuel made by the proposed MOX facility (assuming it is built and is authorized to operate) to mission reactors for irradiation.

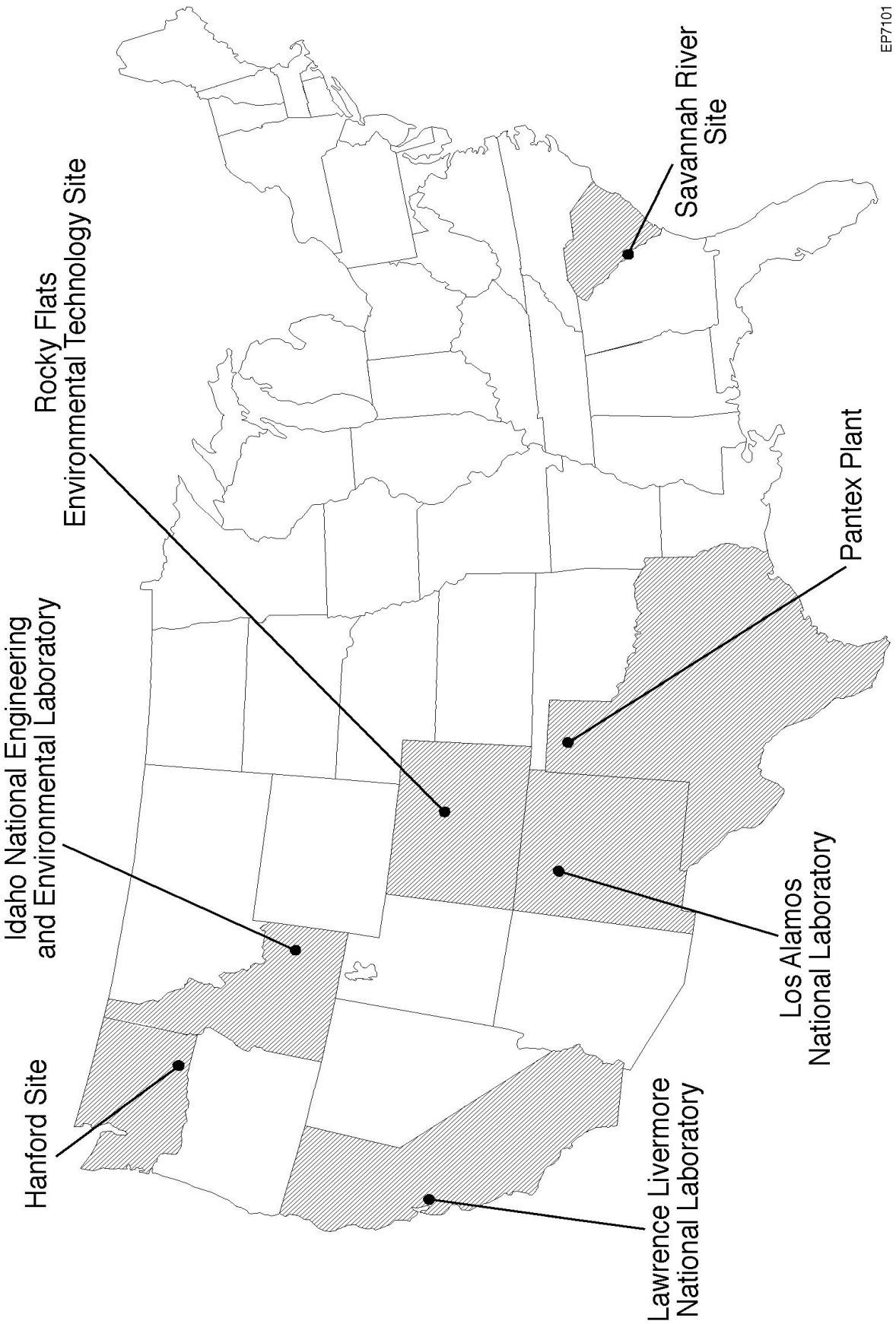

Figure 1.3. Locations of DOE facilities containing surplus plutonium (*Source*: Adapted from DOE 1999).

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to proliferation-resistant forms (DOE 1999). The purpose and need discussion establishes a range of reasonable alternatives to the proposed action that can satisfy this underlying purpose and need.

Following the subsequent September 2000 surplus plutonium disposition agreement between Russia and the United States (White House 2000), the DOE determined that a MOX-only approach best ensures the joint reduction of existing plutonium stockpiles held by the two nations, and concluded in its amended ROD that reliance on this approach is the key to successfully completing the agreement (DOE 2002). The result of this action would be to reduce over time the number of locations where the various forms of plutonium are stored and to ensure that this weapons-usable material does not fall into the hands of rogue states or terrorist groups.

1.4 Scope of the EIS

1.4.1 Scoping Process

On March 7, 2001, the NRC issued a Notice of Intent (NOI) in the *Federal Register* (66 FR 13794) to prepare an EIS for construction and operation of the proposed MOX facility at the SRS near Aiken, South Carolina. In the NOI, NRC announced plans for two scoping meetings: one in North Augusta, South Carolina, on April 17, 2001, and another in Savannah, Georgia, on April 18, 2001. In a second *Federal Register* notice on April 11, 2001 (66 FR 18223), the NRC announced that a third scoping meeting would be held in Charlotte, North Carolina, on May 8, 2001.

Proposed Action Elements

- Construction, operation, and decommissioning of proposed MOX facility, PDCF, and the WSB;
- Infrastructure upgrades;
- Shipment of surplus plutonium from the DOE sites to the SRS;
- Transport of depleted uranium hexafluoride from the DOE facility at Portsmouth, Ohio, to the commercial fuel fabrication facility in Wilmington, North Carolina;
- Transport of depleted uranium oxide from the Wilmington facility to the SRS;
- Transport of MOX fuel and fuel irradiation in surrogate reactors; and
- Spent MOX fuel transport to a geologic repository.

The three scoping meetings were held as planned. At each meeting, the NRC staff distributed background materials on the MOX fuel program and NRC's plans for conducting licensing and environmental reviews for the facility. An open house held before each meeting provided attendees an opportunity to view informational materials and talk informally with NRC staff. During the meeting, the NRC staff presented an overview of the NRC's role in the facility licensing process and described the NRC's approach to meeting its obligations under NEPA. The presentations were followed by a question and answer period in which the NRC staff responded to questions from attendees. The majority of time at the meetings was devoted to allowing individuals to express their views on the scope of the EIS.

A total of about 300 individuals attended the three scoping meetings, and about 80 of them asked questions or provided oral comments at the meetings. In addition, approximately 60 individuals or organizations submitted written comments to the NRC by regular mail, fax transmittal, e-mail, or in person at the meetings. Some of the individuals who provided written comments also spoke at the meetings. Some individuals attended and offered comments at more than one meeting. Although issues raised during the scoping period were considered in the preparation of the draft environmental impact statement (DEIS), some of those issues were either analyzed in less detail or were not analyzed at all, depending on their relevance to the proposed action and the anticipated impacts. The full scoping summary report (NRC 2001b) is included as Appendix I.

The scoping process helped to determine the scope of the EIS and identify significant issues to be analyzed in depth. For instance, two technology options for the proposed action were identified during the scoping process. The first option is to substitute sand filters for the proposed high-efficiency particulate air (HEPA) filters to control air emissions from the facility. The second option is to substitute a dry process for the proposed wet process to remove impurities from plutonium dioxide powder. Cumulative impacts of the proposed action, in addition to other contaminant sources, were also identified as a relevant issue.

The no-action alternative, if NRC does not authorize construction or operation of the proposed MOX facility, was also refined through the scoping process. In addition to the no-action alternative of continued storage of all of the surplus weapons-grade plutonium at the present DOE sites in an unaltered form, the public suggested considering immobilizing all of the surplus weapons-grade plutonium at the SRS as a no-action alternative.

The scoping process identified several relevant areas of concern to the public.[2] Concerns were expressed about the existing groundwater contamination at the SRS and the potential for the proposed facility and waste disposal to further deteriorate groundwater quality. Existing deep boreholes at the SRS were identified as a possible conduit for contaminant migration. Concerns were also expressed about the existing contamination of the Savannah River and the potential for the proposed facility to affect surface water quality. The impacts of facility-induced surface water quality changes on the downstream fishing and marine economy and on the downstream tidal wetlands were also concerns raised at the scoping meetings. Similarly, concerns were expressed regarding air quality impacts from both chemical and radiological materials.

The potential for human health impacts to the public and workers was also a concern. This included workers at the proposed facility, at the SRS, at the proposed reactors, and at disposal facilities. It was also suggested that the impacts to groups other than the “Standard Man” be assessed, such as unborn fetuses, children, and elderly populations. Impacts from possible accidents at the proposed facility during transport of radioactive materials and at the proposed reactors also were a significant concern. It was suggested that the worst-case accidents should be evaluated, including natural disasters and terrorist acts.

[2] The Scoping Summary Report (Appendix I) contains a complete summary of all comments received.

Some issues identified during the scoping process were considered to be beyond the scope of the EIS. In general, these issues are not directly related to the assessment of potential impacts from the proposed action now under consideration. The lack of in-depth discussion in the EIS, however, does not imply that an issue or concern lacks value.

A number of commenters requested that the SPD EIS prepared by the DOE be supplemented and many of the decisions already made by the DOE be revisited. Because the scope of the EIS was limited to the action now under review by the NRC, issues pertaining to decisions already made by the DOE and not affected by new information were addressed by referencing the appropriate DOE analysis.

Comments that seek to alter international treaties or affect national, state, or local laws, statutes, or regulations (e.g., comments that asked to alter Price-Anderson Act[3] limits) were not addressed because they do not pertain to reasonably foreseeable impacts arising from the construction and operation of the proposed MOX facility.

Comments on the scope of assessing reactor use impacts in the EIS for the proposed MOX facility were varied. Considering that the environmental impact of reactor use of MOX fuel was a significant issue with many commenters, it is appropriate to consider those impacts in the EIS. However, the currently available information does not lend itself to performing new analyses. The DOE's SPD EIS (DOE 1999) analyzed impacts of MOX fuel use at the McGuire, Catawba, and North Anna reactors. Therefore, the FEIS refers to the SPD EIS, but does not reanalyze generic reactor use impacts of MOX fuel. The specific environmental impacts resulting from the use of 40% MOX fuel cores in any particular reactor would be addressed by the NRC in reviewing the requisite 10 CFR Part 50 license amendment application. Duke Energy has submitted a license amendment request to the NRC to place lead test assemblies in its reactors. As discussed in Section 4.4.3, impacts associated with the lead test assemblies are considered to be outside the scope of this EIS because these activities would occur regardless of any decision by the NRC on the proposed MOX facility.

A number of commenters requested that the EIS analyze the impacts of having to upgrade the emergency response equipment and retrain emergency responders in the communities around the SRS, at the reactors, and along transportation routes. Other commenters requested that the EIS identify capabilities of local, regional, and national medical facilities to manage the casualties resulting from potential accidental releases and assess the readiness of communities to evacuate certain areas along the transportation routes in case of an accident. These issues are discussed in the EIS to the extent that they are required as mitigation measures presented in Chapter 5.

Many commenters raised a number of different issues concerning terrorism. The Scoping Summary Report stated that the EIS would not address the impacts of terrorism because these impacts are not considered to be reasonably foreseeable as a result of the proposed action. However, following the events of September 11, 2001, the Commission decided to consider the

[3] The Price-Anderson Act limits the liability of the nuclear industry in the event of a nuclear accident in the United States.

question of whether NEPA requires the evaluation of such impacts. By order dated December 18, 2002 (CLI-02-24), the Commission ruled that NRC has no obligation under NEPA to consider intentional malevolent acts in conjunction with the licensing of the proposed MOX facility.

In response to the cancellation of the plutonium immobilization facility (DOE 2002), the NRC delayed the issuance of the DEIS. The NRC held three public meetings in North Augusta, South Carolina; Savannah, Georgia; and Charlotte, North Carolina, and solicited additional written comments on how the immobilization of surplus plutonium as a no-action alternative should be discussed (NRC 2002). The NRC also solicited views on other alternatives that should be considered in the DEIS. In response, most commenters said they still wanted immobilization considered as an alternative in the DEIS, while some urged the NRC to instead focus on the proposed action. As discussed further in Section 2.3, the NRC has determined that immobilization of plutonium did not require an in-depth evaluation in the DEIS, because it was not a reasonable alternative to the proposed action. In response to the NRC's solicitation on other alternatives that should be considered, the alternative of deliberately producing off-specification MOX fuel was identified. This alternative is discussed in Section 2.3.

With respect to the proposed PDCF, the DOE's change from a "hybrid" to a MOX-only approach resulted in a change in the scope of the DEIS from that described in the NRC's March 7, 2001, NOI. The NRC stated there that the PDCF would not be part of the NRC's NEPA review of the proposed MOX facility (NRC 2001a). Initially, the PDCF had independent utility apart from the MOX facility, since the DOE planned to build and operate the PDCF along with the plutonium immobilization plant regardless of whether MOX fuel was also produced (DOE 2000). Now, because of the DOE's subsequent decision in its amended ROD to cancel the plutonium immobilization plant and implement a MOX-only approach (DOE 2002), the PDCF no longer has independent utility apart from the proposed MOX facility. Thus, for NEPA purposes, the PDCF must be evaluated in the EIS to avoid an improper segmentation of the potential impacts discussion.

1.4.2 Issues Studied in Detail

As discussed in the Scoping Summary Report (Appendix I), the goal of this EIS is to set forth the impact analyses in a manner that is readily understandable by the public. Significant or more important impacts are discussed in Chapter 4 of this FEIS. On the basis of the NRC's analyses and consideration of comments received during the scoping process, the following topics are discussed in detail in Sections 4.2 and 4.3 for the no-action alternative and the proposed action, respectively: (1) human health, (2) air quality, (3) hydrology, (4) waste management, (5) accident impacts, (6) decommissioning, and (7) environmental justice. Transportation of radioactive materials, conversion of depleted uranium, and use of MOX fuel in reactors are discussed in Section 4.4. Cumulative impacts are discussed in Section 4.5. The cost-benefit analysis for the no-action and proposed action alternatives, which builds on the comparison of alternatives in Section 2.4, is provided in Section 4.6. Mitigation actions to address the potential impacts are discussed in Chapter 5.

1.4.3 Issues Eliminated from Detailed Study

Impacts found to be less significant are discussed in FEIS Appendixes G and H. These impacts include those pertaining to geology, seismology, soils, noise, ecology, land use, cultural and paleontological resources, infrastructure, socioeconomics, and aesthetics.

1.4.4 Preparation of the Final Environmental Impact Statement

The NRC made the DEIS available for public review and comment in February 2003 in accordance with 10 CFR 51.73, 10 CFR 51.74, and 40 CFR 1503.1. The NRC provided a 75-day public comment period (which ended May 14, 2003) on the DEIS. The length of the comment period exceeded the minimum of 45 days specified in 10 CFR 51.73.

During that period, the NRC held three public meetings to receive oral comments regarding the contents of the DEIS. These public meetings were held on March 25, 2003, in Savannah, Georgia; March 26, 2003, in North Augusta, South Carolina; and March 27, 2003, in Charlotte, North Carolina. The NRC published notice of these meetings in the *Federal Register* (68 FR 97208, February 28, 2003), on its Web site, and in local newspapers.

Approximately 45 people provided oral comments at the public meetings. A certified court reporter recorded the oral comments and prepared written transcripts. The transcripts of the public meetings are part of the public record for the proposed project and were used in developing the comment summaries contained in Appendix J. In addition to oral comments received at the public meetings, the NRC received written comments, letters, facsimile transmittals, and e-mails regarding the DEIS and associated issues. A summary of the comments and responses are included in Appendix J. The written comments and transcripts are reproduced in Appendix L.

The NRC has reviewed each comment letter and all transcripts of the public meetings and has grouped comments relating to similar issues and topics, as permitted by the Council on Environmental Quality's NEPA regulations and the NRC regulations at 10 CFR 51.91 and 40 CFR 1503.4(b). Because the comments were voluminous, Appendix J provides summaries of all substantive comments received on the DEIS. The NRC then prepared responses to each of the comments or summaries of comments. Commenters are identified in each summary with a commenter number. Appendix K contains an index of commenter names and commenter numbers.

1.4.5 Other National Environmental Policy Act Documents Related to This Action

In preparing the EIS, the following other NEPA documents were considered:

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement, DOE/EIS-0229, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, D.C., December 1996.

Surplus Plutonium Disposition Final Environmental Impact Statement, DOE/EIS-0283, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, D.C., November 1999.

Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement, U.S. Department of Energy, Washington, D.C., January 11, 2000 (*65 Federal Register* [FR] 1608).

Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, DOE/EIS-0250, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Feb. 2002.

1.5 Cooperating Agencies

No cooperating agencies have been involved in preparation of the EIS.

1.6 Other State and Federal Agencies

Several federal, Native American, state, and local agencies and organizations were contacted to gather relevant information for this EIS. The scope of the analysis necessitated obtaining information from state agencies in both South Carolina and Georgia. The following is a list of all agencies contacted during early stages of the DEIS preparation:

Federal Agencies

U.S. Department of Energy, Savannah River Operations Office
U.S. Department of Energy, Office of Fissile Material Disposition
U.S. Fish and Wildlife Service

Native American Organizations

Catawba Indian Nation
Pee Dee Indian Association
Ma Chis Lower Alabama Creek Indian Tribe
Muscogee (Creek) Nation
Indian People's Muskogee Tribal Town Confederacy
Yuchi Tribal Organization, Inc.
United Keetowah Band of Cherokee Indians

State Agencies

South Carolina State Historic Preservation Office, Department of Archives and History
South Carolina Department of Natural Resources, Wildlife and Freshwater Fisheries Division

South Carolina Department of Health and Environmental Control, Bureau of Air Quality
South Carolina Department of Transportation
Georgia Department of Natural Resources, Wildlife Resources Division
Georgia Department of Natural Resources, Environmental Protection Division, Air Protection Branch

Towns, Cities, and Counties

Columbia County, Georgia
Town of Grovetown, Georgia
Town of Harlem, Georgia
City of Augusta/Richmond County, Georgia
City of Blythe, Georgia
City of Hephzibah, Georgia
Aiken County, South Carolina
City of Aiken, South Carolina
Town of Jackson, South Carolina
Town of New Ellenton, South Carolina
City of North Augusta, South Carolina
Town of Wagener, South Carolina
Barnwell County, South Carolina
City of Barnwell, South Carolina
Town of Blackville, South Carolina
Town of Williston, South Carolina

School Districts

Columbia County Board of Education, Georgia
Richmond County Board of Education, Georgia
Aiken County Board of Education, South Carolina
Williston School District #19, South Carolina
Williston School District #29, South Carolina
Williston School District #45, South Carolina

1.7 References for Chapter 1

DCS (Duke Cogema Stone & Webster) 2000. *Mixed Oxide Fuel Fabrication Facility Environmental Report.* Docket Number 070-03098. Charlotte, NC. Dec.

DCS 2001. *Mixed Oxide Fuel Fabrication Facility Construction Authorization Request*. Docket Number 070-03098. Charlotte, NC. Feb.

DCS 2002a. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 1 & 2*. Docket Number 070-03098. Charlotte, NC.

DCS 2002b. *Amended Mixed Oxide Fuel Fabrication Facility Construction Authorization Request*. Docket Number 070-03098. Charlotte, NC.

DCS 2003a. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 3*. Docket Number 070-03098. Charlotte, NC. June.

DCS 2003b. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 4*. Docket Number 070-03098. Charlotte, NC.

DCS 2004a. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 5*. Docket Number 070-03098. Charlotte, NC. June 10.

DCS 2004b. *Mixed Oxide Fuel Fabrication Facility Construction Authorization Request, Revision 6/10/04.* Docket Number 070-03098. Charlotte, NC.

DOE (U.S. Department of Energy) 1996. *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*. DOE/EIS-0229. Office of Fissile Materials Disposition, Washington, DC. Dec.

DOE 1999. *Surplus Plutonium Disposition Final Environmental Impact Statement*. DOE/EIS-0283. Office of Fissile Materials Disposition, Washington, DC. Nov.

DOE 2000. "Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement." *Federal Register* 65:1608, Jan. 11.

DOE 2002. "Surplus Plutonium Disposition Program." Amended Record of Decision. *Federal Register* 67(76):19432-19435, April 19.

DOE 2003. *Changes Needed to the Surplus Plutonium Disposition Program, Supplement Analysis and Amended Record of Decision*. DOE/EIS-0283-SA1. Office of Fissile Materials Disposition, Washington, DC, April.

NRC (U.S. Nuclear Regulatory Commission) 2001a. "Notice of Intent to Prepare an Environmental Impact Statement for the Mixed Oxide Fuel Fabrication Facility." *Federal Register* 66:13794, March 7.

NRC 2001b. *Environmental Impact Statement Scoping Process Scoping Summary Report*, *Mixed Oxide Fuel Fabrication Facility Savannah River Site*. U.S. Nuclear Regulatory Commission, Aug. [Reproduced in Appendix I of this EIS.]

NRC 2002. "Notice of Delay in Issuance of the Draft and Final Environmental Impact Statements for the Mixed Oxide Fuel Fabrication Facility." *Federal Register* 67: 20183-20185, April 24.

Tuckinan, M.S., 2003. "Proposed Amendments to the Facility Operating License and Technical Specifications to Allow Insertion of Mixed Oxide (MOX) Fuel Lead Assemblies and Request for Exemption from Certain Regulations in 10 CFR Part 50," personal communication from Tuckinan (Duke Power, Charlotte, NC), to U.S. Nuclear Regulatory Agency (Washington, DC). February 27.

White House 2000. *Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation.* White House, Washington, DC. Sept.

2 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

This chapter presents details of the alternatives considered in this environmental impact statement (EIS). The no-action alternative, which is discussed in Section 2.1, considers the continued storage of surplus plutonium in various locations throughout the U.S. Department of Energy (DOE) complex in the event the U.S. Nuclear Regulatory Commission (NRC) either denies Duke Cogema Stone & Webster's (DCS's) construction authorization request for the Mixed Oxide Fuel Fabrication Facility (the proposed MOX facility) or, later, denies DCS's subsequent request for a Title 10, Part 70 of the *Code of Federal Regulations* (10 CFR Part 70) license to possess and use special nuclear material. Section 2.2 presents the technical details of the proposed action and the connected actions.

Section 2.3 considers several alternatives to the proposed action and explains why they are not analyzed further in Chapter 4. These alternatives include alternate locations for the proposed MOX facility in the F-Area, alternative technology and design options, immobilization of surplus plutonium, deliberately making off-specification MOX fuel, the MIX MOX alternative, and the Parallex Project.

The NRC recognizes that under the provisions of 10 CFR 70, the Commission may approve construction of the proposed MOX facility and subsequently deny the DCS application for a 10 CFR Part 70 license to possess and use special nuclear material. Although this is a possible outcome relative to the proposed action, the NRC is not considering construction alone as a separate alternative because the NRC would not knowingly select an alternative involving construction of a facility that cannot be used for its intended purpose.

Section 2.4 compares the potential impacts related to the proposed action with those of the no-action alternative. Section 2.5 presents the NRC staff's final environmental recommendation on the action to be taken.

2.1 No-Action Alternative — Continued Storage of Surplus Plutonium

The no-action alternative would be a decision by the NRC not to approve the proposed MOX facility. It is reasonable to assume that if the NRC does not approve the proposed MOX facility, the DOE's surplus plutonium would remain in storage at DOE facilities. The surplus plutonium inventory is now stored at seven DOE sites. If this storage were to continue, it is possible that limited new construction would be required at one or more of these sites to upgrade storage conditions. However, the impacts of such construction, if required, would be addressed under a separate site-specific environmental review by DOE. For purposes of this EIS, the impacts of continued storage of surplus plutonium are assumed to be essentially the same as those analyzed by DOE in the Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS) (DOE 1999a). However, the analysis in this EIS also considers the DOE's action to consolidate the storage of 6 MT (6.6 tons) of non-pit surplus plutonium from the Rocky Flats Environmental Technology Site to the Savannah River Site's K-Area Material Storage (KAMS)

facility (DOE 2002b). The impacts of the no-action alternative are presented in Section 4.2 and Appendix G.

2.2 Proposed Action — Description of Mixed Oxide Fuel Fabrication Facilities and Connected Actions[1]

2.2.1 Introduction

The proposed MOX facility is designed to convert surplus weapons-grade plutonium and depleted uranium dioxide (UO_2) into MOX fuel that could be used at commercial nuclear power plants authorized to use such fuel. If the construction authorization for the proposed MOX facility is granted, the facility would be built on the north-northwest side of the F-Area at the SRS (see Figure 1.2 in Section 1.2). The Pit Disassembly and Conversion Facility (PDCF) would be built by DOE on the north-northeast side of the F-Area. The PDCF would be used to recover the plutonium metal from the pits[2] of disassembled weapons and would convert the weapons-grade plutonium to plutonium dioxide powder, which would subsequently be transferred to the proposed MOX facility as feedstock.

Within the boundaries of the PDCF, the DOE would also construct the Waste Solidification Building (WSB) (see Figure 1.2). The WSB would be used to process several liquid waste streams from the proposed MOX facility and the PDCF and convert them to solid transuranic (TRU) waste or low-level waste (LLW). This section describes the general layout of the proposed MOX facility, the processes to be used to manufacture MOX fuel, and the systems that would be used to handle the waste streams from the facility. As discussed in Section 1.2.2, since the PDCF and WSB are connected actions, these proposed DOE facilities are also discussed in Sections 2.2.2 and 2.2.4, respectively. Other elements of the proposed action as described in Section 1.2 that are not discussed in Chapter 2 are discussed in Chapter 4. Direct and indirect impacts of the proposed action and connected actions are presented in Sections 4.3 and 4.4, and Appendix H.

As discussed in Section 1.4.1, the technology option of substituting a sand filter for the proposed high-efficiency particulate air (HEPA) filters to control air emissions from the proposed MOX facility was identified during the scoping process. This technology option is described in Section 2.2.5 and is analyzed in Section 4.3.8.

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[1] Except as noted, the descriptions provided in this section are based on information from DCS (2000, 2001, 2002, and 2004) and DOE (1999a).

[2] Pits are weapon components with a spherical metal core made of plutonium metal and several outer layers.

2.2.2 Pit Disassembly and Conversion Facility

2.2.2.1 Description of the Pit Disassembly and Conversion Facility

The PDCF would be built by the DOE and would not be subject to NRC licensing. The facility would be used to recover plutonium metal from weapon components, and convert it to an unclassified (i.e., no longer exhibiting any characteristics that are protected for reasons of national security) plutonium dioxide. The plutonium dioxide would be transferred to the proposed MOX facility. In addition to excess weapon components, the PDCF would be able to receive excess plutonium metal in other forms and be capable of converting it to plutonium dioxide.

The PDCF would be designed to process up to 3.5 MT (3.9 tons) of plutonium metal into plutonium dioxide annually. Facility operations would require a staff of about 400 personnel. The facility would be built in a hardened space of thick-walled concrete that meets all applicable standards for processing special nuclear material. One or possibly both levels of the two-story building would be below grade. Areas of the facility in which plutonium would be processed or stored would be designed to survive natural phenomena such as earthquakes, floods, and tornadoes, as well as potential accidents associated with fissile and radioactive materials. Ancillary buildings would be required for support activities.

Activities involving radioactive materials or externally contaminated containers of radioactive materials would be conducted in gloveboxes. The gloveboxes would be interconnected by a contained conveyor system to move materials from one process step to the next. Gloveboxes would remain completely sealed and operate independently, except during material transfer operations. Built-in safety features would limit the temperature and pressure inside the gloveboxes and ensure that operations remain within criticality safety limits. When dictated by process needs or safety concerns, an inert atmosphere would be maintained in gloveboxes. The exhaust from the gloveboxes would be continuously monitored for radioactive contamination. The atmosphere in the gloveboxes would be kept at a lower pressure than that of the surrounding areas so that any leaks of gaseous or suspended particulate matter would be contained and filtered appropriately. The building ventilation system would include HEPA filters and would be designed to maintain confinement, thus precluding the spread of airborne radioactive particulates or hazardous chemicals within the facility or to the outside environment. Both intake and exhaust air would be filtered, and exhaust gases would be monitored for radioactivity.

Beryllium may be a constituent of some of the pits that would be disassembled in the PDCF. Because inhalation of beryllium dust and particles has been proven to cause a chronic and sometimes fatal lung disease, beryllium is of special interest from a health effects perspective. However, the process operations in the PDCF are expected to generate only larger, nonrespirable turnings and pieces of the metal, and all work would be performed in gloveboxes. No grinding would be done that could cause small pieces of beryllium to become airborne.

The PDCF would accommodate the following surplus plutonium-processing activities: pit receipt, storage, and preparation; pit disassembly; plutonium conversion; oxide blending and sampling; nondestructive assay; product canning; product storage; product inspection and sampling for international inspection; product shipping; declassification of parts not made from special nuclear materials; highly enriched uranium (HEU) decontamination, packaging, storage, and shipping; tritium capture, packaging, and storage; and waste packaging, sampling, and certification. Additional areas for support activities would be needed, including office space, change rooms, a central control room, a laboratory, mechanical equipment rooms, mechanical shops, an emergency generator to supply power to critical safety systems in the event of a power outage, a warehouse, shipping and receiving areas, waste storage, guard stations, entry portals, and parking.

2.2.2.2 Processes Occurring in the PDCF

At the PDCF, the storage containers in which the plutonium is received would be removed from their overpacks (outer shipping containers), the contents verified, and the information regarding the material entered into the PDCF's material accountability system. Pits and plutonium metal would be placed in a short-term receiving vault, checked for radiological contamination, and transferred to the pit storage vault until processing. Before being processed in the pit disassembly line, the pits would be segregated on the basis of the potential presence of tritium.[3] Pits without tritium would go into the pit bisector glovebox, and those containing tritium would start in the Special Recovery Line glovebox.

In the pit bisector glovebox, external structures would be cut away from the pit, and the pit would be cut in half. Nonbonded pits (pits whose components separate easily) would be separated into plutonium metal, HEU, classified metal shapes, and classified nuclear material parts. The plutonium parts would be assayed as part of the material accountability program. HEU would be sent to the HEU-processing station for material accountability, electrolytic decontamination, and packaging; the classified metal shapes and metal shavings would go to the declassification furnaces; the nuclear material parts to the storage at the pit conversion facility; and the plutonium to the hydride-oxidation (HYDOX) station for the next step of the process. Bonded pits, which cannot be separated prior to processing, would be sent to the HYDOX station intact. For these pits, HEU, classified metal shapes, and classified nuclear material parts would be separated from the plutonium metal during the HYDOX process, then sent to the HEU-processing station, declassification furnaces, and storage at the pit conversion facility, respectively. Recovered HEU would be stored in a vault at the pit conversion facility until shipped to the Y-12 Facility at the Oak Ridge Reservation (ORR) for declassification, storage, and eventual disposition. The HEU would meet Y-12 acceptance criteria prior to shipment to the ORR.

[3] Tritium can be used as a boosting fuel in high-energy atomic weapons. Although the operators of the pit conversion facility would know which pits contain tritium, the pit types and the number of surplus pits that contain tritium are classified.

Pits with tritium would also be bisected, and the HEU, classified metal shapes, and classified nuclear material parts would be separated from the plutonium; this would occur in the Special Recovery Line glovebox. Under normal circumstances, all of the tritium associated with a given pit would be captured and recovered during the tritium removal process in the Special Recovery Line. It is expected that the tritium in a small number of pits will have absorbed into the plutonium. For these pits, an additional step would occur in the Special Recovery Line glovebox: the plutonium would be heated in a vacuum furnace to drive off the tritium as a gas. The tritium would then be captured on a catalyst bed and packaged as LLW for treatment and disposal. HEU and classified metal shapes would be decontaminated and sent to the HEU-processing station and declassification furnaces, respectively; classified nuclear material parts would be placed in storage at the pit conversion facility. After confirmation that the plutonium metal was free of tritium, the plutonium would be assayed as part of the special nuclear material accountability program and transferred to the HYDOX station. Recovered HEU would be stored in a vault at the pit conversion facility until shipped to the ORR for declassification, storage, and eventual disposition. The HEU would meet Y-12 acceptance criteria prior to shipment to the ORR.

In the HYDOX module, plutonium metal would react with hydrogen, nitrogen, and oxygen at controlled temperatures and pressures in a pressure vessel to produce plutonium dioxide. The plutonium metal would first be reacted with hydrogen gas to form a hydride. Then the vessel would be purged of the hydrogen and the hydride reacted with nitrogen gas to form a nitride. The nitrogen would then be purged and replaced with oxygen for the final reaction forming plutonium dioxide. The plutonium dioxide product would be collected and assayed for the material accountability program to confirm that all of the plutonium metal entering the HYDOX process left as an oxide.

In the primary canning module, the cans of plutonium dioxide would be placed into a primary storage can made of stainless steel. This can would then be welded shut and leak tested to ensure that the weld was sound. If the can were to fail the leak test, it would be reopened and rewelded. After passing the leak test, the primary can would be sent to the electrolytic decontamination module. After decontamination, each can would be rinsed, dried, and surveyed to verify decontamination, then sent to the secondary canning module.

In the secondary canning module, primary cans would be placed into secondary stainless steel storage cans meeting the DOE's long-term storage requirements. Also in this module, secondary storage cans would be welded shut and leak tested. After leak testing, each can would be marked with a laser to identify the can and its contents, and passed to the nondestructive assay module.

In the nondestructive assay module, each can would be assayed to confirm its contents. Following assay, the cans would be moved into the main storage vault and would be available for international inspection. After inspection, the cans would be transferred to another vault that would also be subject to international inspection. The cans would subsequently be transferred to the proposed MOX facility.

2.2.2.3 Radioactive Effluents and Wastes at the PDCF

Potential effluents and wastes from the PDCF are described in a Los Alamos National Laboratory report (LANL 1998) and the SPD EIS (DOE 1999a). The facility would be designed to minimize the quantities of both the effluents and wastes. Preliminary estimates indicate that small quantities of various plutonium isotopes and americium-241 and tritium gas would be emitted to the air from the facility. No releases to surface water would be expected directly from the PDCF. The facility would be expected to generate small quantities of TRU waste, LLW, mixed waste, and nonradioactive hazardous waste. All liquid radioactive wastes generated in the PDCF would be sent to the WSB for treatment. The treated waste would either be sent to an approved disposal facility or discharged to a permitted outfall on the SRS. Radioactive solid wastes generated at the facility would be packaged in accordance with the acceptance criteria of the receiving disposal site and sent to the WSB for temporary storage and final processing before being shipped to an approved disposal facility. Mixed waste and hazardous waste generated at the facility would be sent to the SRS waste management system or to an off-site permitted facility for disposition. Nonradioactive/nonhazardous solid waste would be sent to an approved landfill. An evaluation of waste management impacts for this EIS is presented in Section 4.3.4.

2.2.3 MOX Fuel Fabrication Facility

2.2.3.1 Description of the MOX Fuel Fabrication Facility

As designed, the project site would occupy an area of about 16.6 ha (41 acres). Approximately 6.9 ha (17 acres) of the site would be developed with buildings, other facilities, and paving. The remaining 9.7 ha (24 acres) would be landscaped with either grass or gravel.

No highways, railroads, or waterways traverse the proposed MOX facility site, and material and personnel would be moved to and from the site on existing SRS roads. The proposed MOX facility would consist of the following buildings:

- MOX Fuel Fabrication Building
- Emergency Diesel Generator Building
- Standby Diesel Generator Building
- Secured Warehouse Building
- Administration Building
- Technical Support Building
- Reagents Processing Building
- Receiving Warehouse Building

All of these buildings except the Administration Building and the Receiving Warehouse Building would be enclosed within a double fence perimeter intrusion detection and assessment system. The area within this system would total about 5.7 ha (14 acres) and would be designated as the “Protected Area” (10 CFR Part 73).

The Technical Support Building, located between the Administration Building and the MOX Fuel Fabrication Building, would house the main support facilities for MOX Fuel Fabrication Building personnel and would contain the access facilities for the Protected Area and the MOX Fuel Fabrication Building. The building would not be directly involved in the principal processing functions of the facility. Supporting activities and facilities located in this building would include health physics, an electronics maintenance laboratory, a mechanical maintenance shop, personnel locker rooms, and a first aid station.

The MOX Fuel Fabrication Building would have three major functional areas: the MOX Processing Area, the Aqueous Polishing Area, and the Shipping and Receiving Area. The MOX Processing Area would include the blending and milling area, pelletizing area, sintering area, grinding area, fuel rod fabrication area, fuel bundle assembly area, a laboratory area, and storage areas for feed material, pellets, and fuel assemblies. Space would also be provided in the MOX Fuel Fabrication Building for support equipment, such as temporary waste storage; heating, ventilation, and air conditioning (HVAC) equipment; HEPA filter plenums; inverters; switchgear; and pumps. The Aqueous Polishing Area would be used to remove impurities from the feed plutonium coming from the PDCF as well as from the plutonium in the alternate feedstock for use in the MOX Processing Area. The aqueous polishing process would extract impurities from the weapons-grade plutonium dioxide. The Shipping and Receiving Area would contain the equipment and facilities used to handle incoming and outgoing materials to and from the MOX Processing Area and Aqueous Polishing Area.

The Emergency Diesel Generator Building would contain the emergency diesel generator to provide the emergency on-site electrical power supply for safety related structures, systems, or components. The Standby Diesel Generator Building would contain the diesel generators that would provide the on-site electrical power source in the event of loss of off-site power. The Secured Warehouse Building would include the Material Receipt Area, the Storage Area, the MOX Fresh Fuel Package Storage Area, the Parts Washing Facility, the Vehicle Access Portal, and the Vehicle Gatehouse. The Material Receipt Area would serve as the receiving facility for most of the materials (including depleted uranium dioxide), supplies, and equipment necessary for facility operations. The Administration Building, located outside of the Protected Area of the complex, would provide administrative support to the facility and its operations. Space would be provided in the building for facility management, facility operations, finance and administration, health and safety, quality assurance, and management personnel.

The Reagents Processing Building, located adjacent to the Aqueous Polishing Area of the MOX Fuel Fabrication Building, would provide storage for pure reagent-grade chemicals and facilities for preparation of chemical solutions used in the Aqueous Polishing Area. The Reagents Processing Building would consist of several separate rooms or areas for the various chemicals. Concrete curbs around the chemical storage areas would provide for spill containment. Chemicals would be transferred to the Aqueous Polishing Area from the Reagents Processing Building via piping located in a below-grade concrete trench between the two buildings.

The Receiving Warehouse Building would be a single-story, pre-engineered metal building located outside of the perimeter intrusion detection and assessment system. The building

would consist of the Unloading Dock, the Materials Receiving Area, the Inspected Warehouse Holding Area, the Material Transfer Dock, offices, vestibule, and the Inspection Guard Station.

2.2.3.2 Processes Occurring in the Proposed MOX Facility

The proposed MOX facility is being designed to convert plutonium dioxide and depleted uranium dioxide to MOX fuel. Operations at the facility would begin with the receipt of the plutonium dioxide and depleted uranium dioxide feed materials. The plutonium dioxide would then be purified in the aqueous polishing process before being blended with the depleted uranium dioxide. The blended material would then be formed into pellets, the pellets incorporated into fuel rods, the fuel rods placed in fuel assemblies, and the assemblies loaded into transport casks for shipment to the nuclear power plants authorized to use MOX fuel. The technology used in the fuel fabrication process includes recycling of waste and scrap streams. The major steps in the aqueous polishing and fuel fabrication processes are shown in Figures 2.1 and 2.2, respectively.

2.2.3.2.1 Feed Materials

The plutonium dioxide feed material from the PDCF, transported in approved shipping containers, would be received in the shipping and receiving area of the MOX Fuel Fabrication Building. The feed material would be offloaded, the packaging would then be removed, and control would be transferred to the responsible facility manager. Material control and accounting (MC&A) and radiation protection functions would then be performed, and the feed material would be moved to the MOX Processing Area.

Alternate feedstock (feed material not coming from the PDCF) would be received as plutonium dioxide. Some of this material might contain higher than normal salt contaminants, some would contain chloride contaminants, and some would contain trace amounts of enriched uranium. All alternate feedstock would be milled to a uniform particle size to facilitate dissolution. The alternative feedstock would be analyzed for contaminants.

If chloride contaminant concentrations were found to be above feedstock specifications, they would be removed by conversion to chlorine gas. The chlorine gas would be passed through a scrubber to convert the chlorine to a sodium chloride solution. If the chloride contaminants were within feedstock specifications, the feedstock would be processed as described in Section 2.2.3.2.2.

For uranium-rich alternate feedstock, an additional scrubbing column would be used to remove uranium to levels that meet the specification for purified plutonium.

Depleted uranium dioxide feed material, packaged in drums and shipped by truck, would be received at the Material Receipt Area of the Secured Warehouse Building. Conventional materials and supplies would be received at the Secured Warehouse Building. The materials

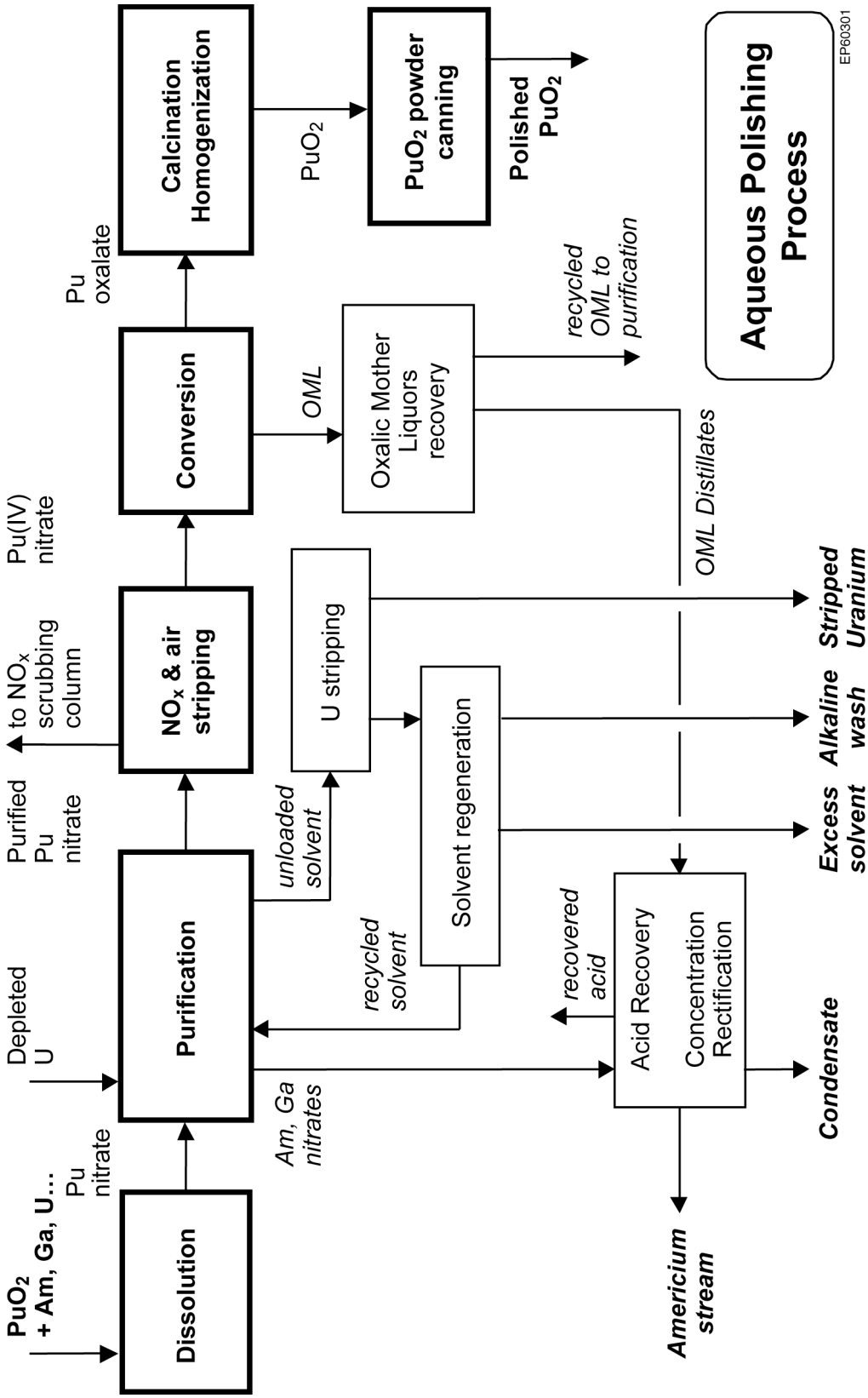

Figure 2.1. Principal steps in the aqueous polishing process (*Source*: DCS 2004).

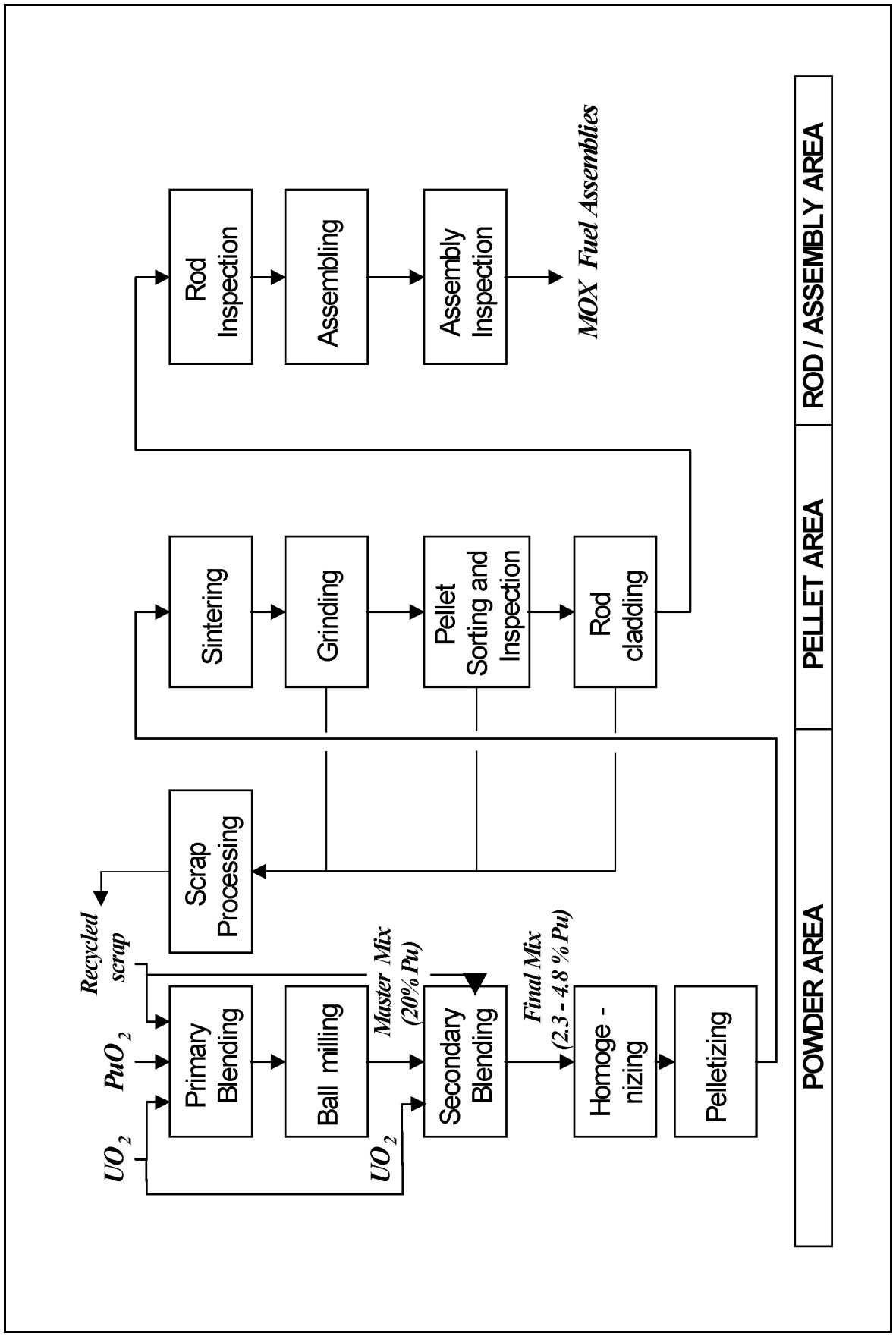

Figure 2.2. Principal steps in the fuel fabrication process (*Source*: DCS 2002).

would be inventoried, sorted, and removed to storage in the Secured Warehouse Building or delivered via on-site vehicles to the proper processing area.

2.2.3.2.2 Aqueous Polishing Process

The plutonium dioxide received at the facility would contain small amounts of impurities, mainly gallium, americium, highly enriched uranium, and, in the case of alternate feedstock, additional impurities. These impurities would have to be removed before the plutonium could be used in reactor fuel. The chloride contaminants would be removed from alternate feedstock before further aqueous polishing (see Section 2.2.3.2.1). The aqueous polishing process would remove remaining impurities in three major steps: dissolution, purification, and conversion.

The *dissolution step* would involve dissolving the plutonium dioxide powder in a water-based (aqueous) solution of silver (Ag^{2+}) and nitric acid at nearly room temperature. An electrical current would be passed through the solution to help dissolve the powder.

In the *purification step*, the plutonium in the aqueous solution would be separated from uranium, americium, gallium, and other impurities by solvent extraction. In this process, the aqueous solution and an organic solvent solution are mixed. The organic solvent does not readily mix with or dissolve in water, and the two solutions will separate if they are allowed to settle. However, by forcibly mixing the two solutions and adjusting chemical parameters in the aqueous solution, individual metals like plutonium can be selectively extracted from the aqueous solution into the organic solvent. In the process proposed by DCS, the solvent extraction process would involve mixing the aqueous solution with an organic solvent composed of 30% tri-butyl phosphate in dodecane. The mixing would occur in the middle of tall and narrow process vessels called columns. During mixing, the solvent would selectively extract the plutonium and uranium from the aqueous solution. The less dense solvent containing uranium and plutonium would then separate from the aqueous solution at the top of the columns. The impurities would remain in the denser aqueous solution and would be removed at the bottom of the column.

The solvent solution containing the uranium and plutonium would be washed with a nitric acid solution. This wash solution would be returned to the acid recovery unit for recycling of the acid. The plutonium and uranium in the organic solvent would then be mixed with an aqueous solution containing hydroxylamine nitrate. This process would reduce the tetravalent plutonium [Pu(IV)] to trivalent plutonium [Pu(III)], which would allow the plutonium to be removed from the organic solvent in an aqueous solution of nitric acid, hydrazine nitrate, and hydroxylamine nitrate. The organic solvent, which would then contain only high-enriched uranium and residual amounts of plutonium, would be mixed with another aqueous “wash” solution to remove the residual plutonium. The washed solvent would be routed to the uranium stripping process. High-enriched uranium would be stripped from the solvent by mixing the solvent with dilute nitric acid in another separation column. The stripped uranium solution would be diluted with depleted uranium before being transferred to the WSB for further treatment. The solvent, which would no longer contain significant amounts of uranium, plutonium, or impurities, would be routed to the solvent recovery mixer-settlers to be recycled.

The Pu(III) solution would be converted back to a solution of Pu(IV) by driving nitrous fumes (dinitrogen tetroxide [N_2O_4] and nitrogen dioxide [NO_2]) through the plutonium solution in a packed column. The offgas would be routed through an offgas treatment system before being discharged to the atmosphere.

The conversion step would be a continuous oxalate conversion process. The oxidized Pu (IV) would be reacted with excess oxalic acid ($H_2C_2O_4$) to precipitate plutonium oxalate. Plutonium oxalate would be collected on a filter, then dried in a screw calciner to produce purified plutonium dioxide powder. The purified plutonium dioxide powder would be blended and stored in cans.

Offgas from the screw calciner would be routed through the process offgas treatment unit and HEPA filters prior to discharge to the atmosphere through the exhaust stack. The filtered oxalic mother liquors would be concentrated, reacted with manganese to destroy the oxalic acid, and recycled to the beginning of the extraction cycle, to minimize losses of plutonium to waste.

A liquid americium waste stream would be generated by the aqueous polishing process described above. DCS estimates that approximately 24.5 kg (54.0 lb) of americium-241 would annually become part of this waste stream, an amount that would contain 84,000 Ci of radioactivity (DCS 2002). This liquid waste stream — together with an excess acid stream and an alkaline wash stream — would be combined into the high-alpha activity waste to be piped from the proposed MOX facility to the WSB, where it would be solidified through the use of the WSB's planned evaporation, neutralization, and cementation methods. (The WSB is discussed further in EIS Section 2.2.4). The maximum annual volume of these streams from the proposed MOX facility is estimated to be 44,200 L (11,700 gal) (DCS 2004).

2.2.3.2.3 MOX Fuel Fabrication Process

The MOX fuel fabrication process would consist of four major steps: (1) powder master blend and final blend production, (2) pellet production, (3) rod production, and (4) fuel rod assembly.

The first operation would be the production of the powder master blend. The purified plutonium dioxide from the aqueous polishing process would be mixed with depleted uranium dioxide and recycled scraps to produce an initial mixture that would be approximately 20% plutonium. This mixture would be ground in a ball mill and mixed with additional depleted uranium dioxide and recycled scraps to produce a final blend with the required plutonium content (typically from 2.3 to 4.8%). This final blend would be further homogenized to meet stringent plutonium distribution requirements. During the final homogenizing, lubricants and pore-formers would be added to control the density of the final mixture.

The final homogenized powder blend would be pressed to form green pellets. The green fuel pellets would be sintered to obtain the required ceramic qualities. Sintering is the process of heating the green pellets in a furnace at temperatures of up to 1,700°C (3,100°F). The sintering step would remove organic products dispersed in the pellets and remove the

pore-formers that were added during powder homogenization. The sintered pellets would be ground to a specified diameter and sorted. Recovered powder from grinding and discarded pellets would be recycled through a ball mill and reused in the powder processing.

Fuel rods would be loaded to an adjusted pellet length column, welded, pressurized with helium, and then decontaminated in gloveboxes. The decontaminated rods would be removed from the gloveboxes and placed on racks for inspection and assembly. Fuel rods would be inserted into the fuel assembly frame, and the fuel assembly construction would be completed. The fuel assembly would be subjected to a final inspection before shipment to reactors.

2.2.3.3 Radioactive Effluents and Wastes at the Proposed MOX Facility

2.2.3.3.1 Airborne

DCS has proposed to treat exhausts from the Fuel Fabrication Building and remove airborne radioactive materials with (at a minimum) a two-stage HEPA filter system before exhaust air is discharged to the environment. The exhaust streams would include those from building ventilation; gloveboxes; the process vents of tanks, vessels, and other equipment in the Aqueous Polishing Area; and the sintering furnaces in the Processing Area.

The filtered exhausts would be discharged through a common stack (MOX vent stack) on the roof of the Fuel Fabrication Building. Stack effluents would be continuously monitored. The stack would be 37 m (120 ft) above grade.

2.2.3.3.2 Liquids

After sampling and characterization, liquid waste streams containing radioactive materials would be transferred to the WSB for processing and treatment. Thus, no radioactive liquids would be released directly from the facility to the environment. Within the Aqueous Polishing Area, recycling would be used extensively to reduce liquid waste volumes and impurities before transfer to the WSB.

The liquid waste streams from the Aqueous Polishing Area would include the following:

- Chloride removal waste
- Liquid americium stream
- Excess acid stream
- Excess low-level radioactive solvent waste
- Stripped uranium stream
- Rinsing water
- Contaminated drains

2.2.3.3.3 Solids

Solid radioactive wastes would be placed in appropriate containers (typically 55-gal drums), assayed, and transferred to the WSB for processing and disposal. Whenever practical, the solid wastes would be compacted to reduce volume and disposal costs.

The solid radioactive wastes generated in the Fuel Fabrication Building would include TRU solid wastes and LLW (which would include uranium and/or plutonium contamination). Other potentially radioactive, mixed, or nonradioactive hazardous wastes that might be generated by the facility would be transferred to the WSB, SRS waste management system, or an off-site permitted facility for disposition. Impacts associated with management of wastes from the proposed MOX facility are presented in Section 4.3.4.

2.2.4 Waste Solidification Building

2.2.4.1 Description of the Waste Solidification Building

The WSB, which is not subject to NRC licensing, would be constructed by the DOE on the PDCF site south of the PDCF to process the following liquid waste streams from the PDCF and the proposed MOX facility:

- MOX facility high-alpha-activity waste stream
- MOX facility stripped uranium stream
- PDCF laboratory liquid stream
- PDCF low-level liquid waste streams
- MOX facility low-level liquid waste streams

In addition, space would be provided in the WSB for temporary storage and minimal processing (e.g., sorting, packaging) of other waste streams, including solid LLW and TRU waste.

The WSB would occupy approximately 6,970 m^2 (75,000 ft^2) of land and would be a combination concrete and steel-frame structure (DCS 2003a,b, 2004). Concrete would be utilized as necessary to protect against the potential impacts of natural phenomena hazards events. In addition, a concrete-cell configuration would be used in areas where the proposed MOX facility high-alpha stream is processed. Process enclosures adjacent to the cells would provide worker protection to accommodate operations and maintenance activities. The shielding and confinement would also serve as fire isolation barriers. Secondary confinement features, such as dikes, sumps, and leak detection, would be provided for those areas with liquid spill potential. The major pieces of process equipment would be tanks, evaporators, and cementation equipment. Other equipment may include reverse osmosis, filtration, and activated carbon and ion exchange columns.

The processed liquid would be mixed in the WSB with concrete and poured into containers to produce solid waste. Cold chemical processing rooms, waste container storage, and truck

loading/unloading areas may also be contained in hardened structures. The waste container storage area would be at grade. The waste receipt area would have tanks to separately receive high-alpha waste, stripped uranium waste, and the PDCF laboratory liquid stream waste. The tank volumes would be sufficient to receive and store waste from six weeks of processing the high-alpha-activity and stripped uranium waste streams by the proposed MOX facility and eight weeks of processing the laboratory liquid stream by the PDCF. Additional receipt storage would be available for low-level liquid waste streams from the proposed MOX facility, PDCF, and WSB internal sources.

The proposed MOX facility would transfer a liquid high-alpha-activity waste and liquid LLW streams to the WSB. The PDCF would transfer LLW streams. Within the WSB, these waste streams would be treated separately. The WSB would process the liquid wastes into TRU waste and LLW solid waste forms acceptable for shipment and disposal at their respective disposal locations. Treated effluents from liquid LLW streams would be discharged to a permitted outfall. The TRU waste form would be stored until cleared for shipment to the Waste Isolation Pilot Plant (WIPP) (DOE 2003). The LLW form would be sent to a suitable disposal site.

Within the WSB, the waste streams would be collected into receipt tanks, chemically adjusted, evaporated, neutralized, solidified in containers, stored, and shipped. These processes would be located inside a hardened (reinforced concrete) structure. Emissions from the process areas would pass through a HEPA filtration confinement system before release through an exhaust stack.

2.2.4.2 Processes Occurring in the WSB

The WSB would be designed to process and solidify three waste streams from the proposed MOX facility and two waste streams from the PDCF. The processes that would be conducted for each waste stream are described below.

2.2.4.2.1 Proposed MOX Facility High-Alpha-Activity Waste Stream

The proposed MOX facility high-alpha-activity waste stream, consisting of the liquid americium waste stream and two other liquid waste streams from the proposed MOX facility, namely the excess acid stream and the alkaline waste stream, would be pumped approximately 610 m (2,000 ft) from the proposed MOX facility to the WSB in a double-walled stainless steel pipe. The maximum volume received would be anticipated to be approximately 33,300 L (8,800 gal) per year, which would be received in approximately 25 transfers, at a frequency of about once every two weeks.

The WSB receipt tanks would be sized to hold three transfers (six weeks capacity in two 9,500-L [2,500-gal] tanks). The MOX facility high-alpha-activity stream collection tanks are sized for three months capacity. This arrangement would provide continued MOX facility

processing capacity in the event of a shutdown of WSB operations because of maintenance or other disruptions. The tanks would be agitated or recirculated to mix the contents.

In the WSB, the proposed MOX facility high-alpha-activity waste stream would be sent to an evaporator to reduce its water content. The acidic bottoms collected in the evaporator would be neutralized with sodium hydroxide, mixed with cement, and poured into approved containers. The TRU waste collected in the containers would meet the WIPP waste acceptance criteria and would eventually be shipped to the WIPP for disposal (DOE 2003). The overheads from the evaporation step would be condensed, collected, sampled, and subjected to further evaporation or chemical treatment as necessary and finally would be sent to the Clean Water Treatment System for final treatment and discharge to a permitted outfall (see Section 2.2.4.2.4).

2.2.4.2.2 MOX Facility Stripped Uranium Stream

The proposed MOX facility stripped uranium stream would be pumped approximately 610 m (2,000 ft) from the proposed MOX facility to the WSB in a double-walled stainless steel pipe. The nominal waste volume of this stream would be 174,000 L (46,000 gal) per year, received in approximately 42 transfers at a frequency of about one every week.

The WSB receipt tanks would be sized to hold six transfers (six weeks of MOX facility capacity). The proposed MOX facility tanks would be sized to hold three months of MOX facility waste. The tanks would be agitated or recirculated to mix the waste.

In the WSB, the proposed MOX facility stripped uranium stream would be evaporated, the bottoms neutralized with sodium hydroxide, and the resulting waste mixed with cement and deposited into approved containers. The waste in the containers would be classified as LLW and would be shipped to a LLW disposal facility. The overheads from the evaporation step would be condensed, collected, sampled, and subjected to further evaporation or chemical treatment as necessary and finally would be sent to the Clean Water Treatment System for final treatment and discharge to a permitted outfall (see Section 2.2.4.2.4).

2.2.4.2.3 PDCF Laboratory Liquid Stream

The PDCF laboratory liquid stream would be pumped approximately 240 m (800 ft) to the WSB from the PDCF in a welded-jacketed stainless steel pipe, which would be direct buried. The volume of this waste stream is anticipated to be a nominal 41,600 L (11,000 gal) per year (DCS 2004), and would be received in approximately 12 transfers (3,400 L [900 gal] each) at a frequency of about one transfer every month.

The WSB receipt tank would be sized to hold two transfers (eight weeks of PDCF laboratory liquid stream capacity) in one 11,400-L (3,000-gal) tank. The PDCF tank is sized to provide up to 8 weeks of PDCF processing capacity in the event of a shutdown of WSB operations for maintenance or processing anomalies. The tank would be agitated or recirculated to mix the waste.

In the WSB, the PDCF laboratory liquid stream would be evaporated, the bottoms neutralized with sodium hydroxide, and the resulting waste would be mixed with cement and deposited into approved containers. The waste in the containers would be classified as LLW and would be shipped to a LLW disposal facility. The overheads from the evaporation step would be condensed, collected, sampled, and subjected to further evaporation or chemical treatment as necessary and finally would be sent to the Clean Water Treatment System for final treatment and discharge to a permitted outfall (see Section 2.2.4.2.4).

2.2.4.2.4 MOX Facility and PDCF Low-Level Liquid Streams

The proposed MOX facility and the PDCF would generate various aqueous liquid streams with either very low radioactive contamination or the potential for radioactive contamination due to their origin. These streams would be transferred, through double-walled transfer lines, to a receipt tank or tanks at the WSB. In addition, low-level liquid waste streams would be generated in the WSB from the evaporator overhead associated with the treatment of other liquid waste streams sent to the WSB from the proposed MOX facility and the PDCF (see Sections 2.2.4.2.1, 2.2.4.2.2, and 2.2.4.2.3). All of these waste streams would be transferred to the Clean Water Treatment System in the WSB. The Clean Water Treatment System would be designed using standard wastewater treatment technologies to meet U.S. Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and DOE discharge limits for the SRS. The discharges would be to a permitted outfall.

2.2.4.3 Radioactive Effluents and Wastes at the WSB

The WSB would be designed to minimize effluents to the air. The facility would also be designed to minimize effluents to surface water, as discussed in Section 2.2.4.2.4.

As discussed in Section 2.2.4.2, the WSB would receive five liquid waste streams, three from the proposed MOX facility and two from the PDCF, and convert those waste streams to solid TRU waste or solid LLW. An evaluation of waste management impacts for this EIS is presented in Section 4.3.4. The solidified TRU waste would eventually be shipped to WIPP for disposal (DOE 2003). LLW would be disposed of at a suitable disposal site.

2.2.5 Sand Filter Technology Option

This section describes the technology option of using a sand filter for air filtration instead of high-efficiency particulate air (HEPA) filters. Although DCS has selected the use of HEPA filters as its preferred option for removal of particulate contaminants before exhaust air is released to the atmosphere, this EIS also evaluates the use of a sand filter (Orr 2001). The differences in impacts are discussed in Section 4.3.8.

It is useful to understand the physical differences in the two types of filters. HEPA filters are designed to remove extremely fine particles suspended in the air. HEPA filters are enclosed in rigid casing with full-depth pleated filter medium. The filter medium is normally fibrous borosilicate glass, which is formed into a sheet folded into a series of accordion pleats. The standard HEPA filter measures 61 cm × 61 cm × 29.2 cm deep (24 in. × 24 in. × 11.5 in. deep). The filter edge will be a high-temperature silicon gasket to prevent bypass leakage, and improper installation or damage to the sealing surface can dramatically reduce the filter's efficiency and performance. HEPA filters function and are used in the HVAC system similarly to standard home air filters. DCS proposes to use HEPA filters in multiple stages. The proposed MOX facility would have many HEPA filters (Orr 2001).

Sand filters have a long history of use in DOE facilities at the SRS and at the Hanford Site near Richland, Washington. At the SRS, DOE currently uses sand filters in the F-Area, H-Area, and the Savannah River Laboratory. Unlike the case for HEPA filters, a facility would typically use only a single sand filter. A sand filter designed for the proposed MOX facility would be rectangular and would require a surface area of about 313 m^2 (33,650 ft^2). The filter would be about 3 m (10 ft) deep and would consist of gravel layers overlaid with sand layers arranged in order of decreasing particle size (Orr 2001). A coarse sand layer would be placed at the top of the filter to maintain integrity of the lower sand layers during filter operations. Air enters through a supply tunnel at the bottom of the structure and is collected at the top of the sand filter. Large fans or blowers are used to draw the air through the sand filter media. Suspended particles in the air are trapped by the sand filter. No routine maintenance is required during operation of sand filters (Orr 2001).

It is also useful to understand the performance differences in the two types of filters. Both filter types have approximately the same efficiencies for collection of particulates. Neither filter type is designed to trap gases. The filters would perform differently during some accidents. As discussed below, the selection of filter type can affect the facility design.

Several commenters during the public scoping meetings urged the NRC to evaluate the use of sand filters instead of HEPA filters, claiming sand filters would be better from a safety standpoint, particularly in case of a fire at the facility. Fires often generate large volumes of smoke that threaten the effective functioning of the filtration system by rapidly loading the filters with smoke particles. The resulting pressure drop across the filter could cause a break in the filter, followed by the release of contamination to the environment. This situation would not occur with sand filters in case of a fire because they have a much larger surface area that could trap smoke particles (Orr 2001). The integrity of HEPA filters could also be compromised during explosion accidents.

Given the potential vulnerability of HEPA filters during fire accidents, the proposed MOX facility is designed to mitigate the effects of an internal fire. The facility is designed into numerous fire areas to limit the amount of combustibles involved in a single fire; this reduces the amount of soot reaching individual banks of HEPA filters and ensures that the HEPA filters will not fail because of excessive plugging. If a sand filter was used, fewer fire areas could be used because sand filters are more resistant to smoke and sudden pressure changes. However, in

the evaluation of the impacts of using sand filters instead of HEPA filters, changes in facility design are not considered.

2.3 Alternatives Considered But Not Analyzed in Detail

This section discusses some of the more significant alternatives identified during the scoping process and alternatives identified by DCS, but that are not subjected to in-depth evaluations in Chapter 4. Such alternatives include alternate locations for the proposed MOX facility in the F-Area, technology and design options, immobilization of surplus plutonium, off-specification MOX fuel, and the Parallex Project.

2.3.1 MOX Facility Location in F-Area

The DOE previously selected the SRS as the location of the proposed MOX facility, after evaluating several alternative sites across the country (DOE 2000). In its subsequent Environmental Report, DCS described the process the DOE used in choosing the specific site for the proposed MOX facility within the SRS F-Area (DCS 2000). The currently proposed location of the MOX facility was selected from five proposed sites within the F-Area. Final site selection was based on three siting qualification criteria that the site must meet and nine siting evaluation criteria that were more qualitative in nature (DCS 2002). The currently proposed location of the facility, as identified in Figure 1.2, was the only location that met all of the qualification criteria and scored the highest when all of evaluation criteria were considered. The criteria used by DCS in the selection process were as follows (DCS 2002):

Siting Qualification Criteria

1. Free from subsurface contamination,
2. Adequate terrain and area, and
3. Free from Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) features.

Siting Evaluation Criteria

1. No known or protected plant or animal species,
2. Water table significantly below the facility substructure,
3. Relatively level area in a higher location for increased security and so as not to block drainage,
4. Proximity to existing roads and the PDCF site,
5. Location with respect to subsurface soft zones,
6. Availability of utilities,
7. Location with respect to wetland areas,
8. Proximity to archaeological features, and
9. Interference with existing site operations.

Based on the above, this EIS does not consider alternatives to the SRS in which to locate the proposed MOX facility, nor does it further consider alternative locations within SRS F-Area.

2.3.2 Technology and Design Options

The general design of the proposed MOX facility was provided in DOE's SPD EIS (DOE 1999a). In developing the detailed proposed MOX facility design, DCS used the technology at Cogema's MELOX and La Hague facilities, with modifications to meet U.S. regulations, codes, and standards. A general description of the proposed MOX facility design is provided in Section 2.2.3. In its Environmental Report, DCS (2002) considered a number of technology and design alternatives. The technology and design alternatives considered by DCS were discussed if they had a possibility of having some potential impact or significance from an environmental perspective. These technology and design alternatives are summarized below. In evaluating these technology and design alternatives, NRC concluded that, with the exception of sand filters compared to HEPA filters, further detailed analysis was not warranted in Chapter 4. This technology option is also summarized in Section 2.2.5.

2.3.2.1 Dry Compared to Wet Impurity Removal

A polishing process is used to remove gallium and other impurities from the plutonium dioxide feedstock before pellet production. These impurities affect the performance of the MOX fuel in a reactor. Although the proposed aqueous (wet) polishing process meets the criteria for controlling the gallium content to less than 120 parts per billion (ppb) (Framatome ANP 2001), it also generates liquid radioactive and mixed wastes. An alternate technology for purifying the plutonium dioxide is the dry process. The dry process generates significantly less liquid waste and involves thermally induced gallium removal (TIGR). However, in an experimental setting, the TIGR process only reduced the gallium content to 25,000 ppb. The DOE considered the dry process in the SPD EIS (DOE 1999a) and concluded that the dry process would not meet the technical requirements for MOX fuel. The best reported gallium removal (Kolman et al. 2000) results in impurity contents are over 100 times the required criteria. Thus, the dry process was not further evaluated because it could not meet the technical specifications set for MOX fuel. In addition, TIGR remains an experimental process requiring further testing to scale the process to production while ensuring uniform pellet feedstock (DCS 2002; Kolman et al. 2000).

2.3.2.2 Reagent Storage

DCS considered two options for locating reagent storage and solution preparation for the aqueous polishing process. The options were to locate the storage and solution preparation process in the same area as the Aqueous Polishing Area or to locate them in a separate building and to pump reagents to the aqueous polishing process. Because of the potential explosion hazards of the chemical reagents, DCS decided to use a separate building to reduce this hazard. Because the design alternative to this approach involves potentially larger

environmental impacts, namely, an increase in the explosion accident consequences, consideration of colocating the aqueous polishing and reagent storage is not evaluated in Chapter 4.

DCS also considered whether to store the chemical reagents in aboveground or belowground tanks. Belowground tanks have the advantage of limiting immediate human exposure to spills. However, there is increased environmental risk associated with leaking belowground tanks. DCS decided to use aboveground tanks with concrete curbs to contain potential spills and overflows. The NRC considered the design alternative of belowground storage tanks. However, this alternative would likely pose a greater risk of groundwater contamination. For this reason, consideration of belowground tanks is not evaluated in Chapter 4.

2.3.2.3 Acid Recovery Process

DCS added an evaporator to the acid recovery process. This evaporator reduces the activity of the distillates and recycles approximately half of the volume of distillates in lieu of using fresh demineralized water. This also results in a volume reduction of liquid wastes that would be processed and treated by the WSB. Because the design alternative to this approach involves larger environmental impacts, namely, a demand for more process chemical shipments and handling and larger waste volumes, further consideration of the aqueous polishing process without the acid recovery process as an alternative is not evaluated in Chapter 4.

2.3.2.4 Glovebox Cooling

In the MELOX design, gloveboxes are cooled at a higher air flow rate to remove heat generated from the reactor-grade plutonium. Because weapons-grade plutonium has a lower heat release, gloveboxes at the proposed MOX facility can be cooled using natural convective cooling. This results in a reduced airflow and permits a smaller HEPA filter size. The smaller filter size reduces the volume of solid TRU waste generated by filter replacement. Because the alternative to this design consideration (i.e., higher glovebox air flow) is unnecessary to meet any conceivable alternative relative to the proposed MOX facility's purpose and need to disposition weapons-grade plutonium, use of higher glovebox flows and larger HEPA filter banks is not evaluated as an alternative in Chapter 4.

2.3.2.5 Treatment of Aqueous Laboratory Waste

Aqueous laboratory wastes at the MELOX facility are precipitated and solidified, resulting in TRU wastes. DCS decided to remove the plutonium from the laboratory waste and recycle this plutonium into the aqueous polishing process. This step reduces the classification of the laboratory waste from TRU waste to LLW. Because the alternative laboratory waste management design would involve generation of more TRU waste and, therefore, have larger environmental impacts, inclusion of plutonium in laboratory waste streams is not further evaluated as an alternative in Chapter 4.

2.3.2.6 Pellet Grinding Process

In the facility design, DCS replaced the two-stage cyclone separator in the MOX powder processing operation with a decloggable metallic filter. This filter would reduce the TRU waste volume that would result from the periodic replacement of other filters downstream of the pellet grinding process. Therefore, the use of a two-stage cyclone separator instead of a decloggable filter would result in the generation of additional TRU wastes. Since additional TRU waste poses a larger environmental impact, use of a two-stage cyclone separator is not evaluated further as an alternative in Chapter 4.

2.3.2.7 Facility Heat Exchangers

DCS considered two options to remove heat from the facility. The options were to use water-cooled or air-cooled heat exchangers. Water-cooled exchangers can have impacts associated with cooling tower drift or blowdown. To reduce these potential impacts, DCS decided to use air-cooled heat exchangers. Because the water-cooled exchangers would involve generation of cooling tower drift or blowdown and, therefore, larger environmental impacts, using this type of exchanger is not further evaluated as an alternative in Chapter 4.

2.3.2.8 Physical Security Barriers

DCS considered several options to provide a physical security barrier around the proposed MOX facility. One of these was the construction of an earthen berm. Because this method would have resulted in a larger disturbed area for the site, DCS decided to use physical security barriers that resulted in less land disturbance. Because the earthen berms would involve a larger disturbed area and, therefore, larger environmental impacts, use of berms is not further evaluated as an alternative in Chapter 4.

2.3.2.9 Material Transfer from the PDCF to the Proposed MOX Facility

As discussed in Section 1.2.1, the PDCF would produce plutonium dioxide feedstock for the proposed MOX facility. The material would need to be transferred to the proposed MOX facility. DCS considered three transfer options: (1) tunnel, (2) closed transfer trench, and (3) vehicle transfer. Because the first two options would result in greater land disturbance, DCS decided to use vehicles to transfer the plutonium dioxide feedstock. Because the tunnel or closed transfer trenches would involve a larger disturbed area and, therefore, larger environmental impacts and because vehicle-related impacts would be small for the short distance between the facilities, use of tunnels or trenches is not further evaluated as an alternative in Chapter 4.

2.3.3 Immobilization of Surplus Plutonium

As discussed below, the NRC has concluded that immobilizing surplus plutonium is not a reasonable alternative to the proposed action, and, therefore, this alternative does not require detailed analysis in Chapter 4.

Before the DOE's January 2002 decision to cancel the plutonium immobilization plant, plutonium immobilization was available as a no-action disposition alternative to the proposed action. The DOE had already evaluated the environmental impacts of this alternative as alternative 12a in the SPD EIS (DOE 1999a), so that a new NRC analysis of this alternative was not required. However, as discussed in Section 1.4.1, following the DOE's January 2002 decision, the NRC solicited views on whether the immobilization alternative should still be evaluated in this EIS. The comments solicited did not identify any persuasive reasons to further consider the immobilization alternative.

The NRC has now determined for two reasons that immobilization is no longer a reasonable alternative to the proposed action. First, immobilization of the 34 MT (37.5 tons) of surplus plutonium would not meet a key element of the purpose and need for the proposed action, as described in Section 1.3. Due to budgetary constraints, the DOE decided to cancel the immobilization portion of the surplus plutonium disposition program and adopt a MOX-only approach. The DOE determined that in order to make progress with available funds, only one approach could be supported. The DOE stated that after evaluating the feasibility of implementing two disposition approaches, it believed that the best way to make the most progress with available funds while maintaining Russian interest in and commitment to surplus plutonium disposition was to pursue a MOX-only disposition strategy (DOE 2002a). The DOE further stated that Russia does not consider immobilization alone to be an acceptable approach. In the DOE's judgment, reliance by the United States on immobilization would therefore cause Russia to abandon its plutonium disposition efforts. Because immobilization fails to degrade the isotopic composition of the plutonium, Russia distrusts the immobilization alternative, as it would leave open the possibility of future retrieval and reuse of the plutonium in nuclear weapons (DOE 2002a). As discussed further in Section 1.1.1, the DOE therefore concluded that reliance on a MOX-only approach is the key to successfully completing the September 2000 agreement between Russia and the United States.

The second reason that immobilization is no longer a reasonable alternative to the proposed action is its connection with the conduct of United States foreign policy. Evaluating the immobilization alternative now would involve the NRC in foreign policy matters that the DOE has been conducting on behalf of the United States. In the NRC's view, an alternative that would block the implementation of an agreement with another country involves foreign policy matters that are outside NEPA's scope. Therefore, the NRC concludes that immobilization is not a reasonable alternative requiring detailed analysis in this FEIS.

2.3.4 Off-Specification MOX Fuel

During public information meetings in September 2002, NRC was asked to consider an alternative in which MOX fuel would be manufactured but not irradiated in commercial nuclear power plants. Under this alternative, as understood by the NRC, off-specification fuel rods would be manufactured in the proposed MOX facility and transported to spent fuel pools. These spent fuel pools could be located at either commercial nuclear power plants or interim spent fuel storage installations (ISFSIs). Once at the pool, the rods would be commingled with spent fuel rods, and possibly even incorporated into vacant positions in existing spent fuel assemblies. The final configuration would be a proliferation-resistant form that would be a candidate for the National Academy of Sciences' (NAS') spent fuel standard for surplus plutonium disposition (NAS 2000).

Since the demands for fuel quality and specifications would be lower, the fuel rods could be manufactured "off-specification." The so-called "off-specification" fuel rods would offer both environmental costs and benefits, as described below. Therefore, the NRC gave some consideration to this alternative based on the information provided by principal proponents of this approach (Macfarlane et al. 2001).

The alternative would involve a modified approach to manufacturing MOX fuel. The final powder blend would still have to be homogenized, pressed into pellets, and the pellets sintered in order to manufacture off-specification fuel rods. However, most impurities, including gallium and americium, could remain in the finished rods. This could significantly reduce liquid radioactive waste volumes associated with polishing the feedstock plutonium. As a result, the demand on the WIPP to accommodate solidified high-alpha-activity waste derived from the aqueous polishing process would be reduced.

Since the off-specification rods would not be used in a reactor, any risks of reactor accidents involving MOX fuel would not occur. In addition, the cause of some accidents in the proposed MOX facility would be prevented. For example, if aqueous polishing could be eliminated, then the risks of inadvertent nuclear criticality, solution spills, electrolyzer fires, and explosions would be considerably lower.

Since the concentration of plutonium dioxide in each off-specification rod would not be constrained by reactor fuel specifications, the mass of plutonium dioxide in each rod could be higher. This would result in lower numbers of manufactured rods and correspondingly lower vehicle-related transportation risks associated with transporting rods to any reactor sites. Fewer rods would also reduce the time required to operate the proposed MOX facility, which could result in lower operational costs. Criticality issues arising from the higher concentration of plutonium could be avoided by mixing neutron-absorbing gadolinium and hafnium with the plutonium.

However, there would be environmental costs associated with this alternative. Americium-241 would not be removed by the aqueous polishing process. Since americium-241 is a high-specific-activity alpha-emitter and poses a direct radiation hazard, radiation exposures to facility workers, site workers, and the public would be higher during MOX facility operations,

off-specification MOX rod transportation, and handling of the off-specification rods at the reactor site or ISFSI.

The costs of manufacturing off-specification MOX fuel rods would also be affected by the elimination of the "fuel credit." The fuel credit is a project cost offsetting factor that accounts for the price a reactor licensee would pay for completed MOX fuel that meets its specifications. The estimated additional project costs would be $1.0 billion, thereby raising the total project costs from $3.8 billion to $4.8 billion.

The benefit of producing electricity from the use of MOX fuel would also be eliminated by the manufacture of off-specification MOX fuel.

Having qualitatively weighed the costs and benefits of this alternative, the staff find that this alternative likely involves a net increase in environmental costs. Therefore, no compelling reason exists to pursue this alternative in further detail. In addition, it is uncertain that this proposal would meet the National Academy of Sciences' spent fuel standard for surplus plutonium disposition (NAS 2000). The off-specification rods would not be irretrievably configured in irradiated spent fuel, and the isotopic distribution of the plutonium in off-specification rods would not be altered. As a result, this form is unlikely to meet with approval from the Russian Federation, whose parallel progress on plutonium disposition under formal bilateral agreements is integral to the purpose of and need for the proposed action. As discussed above for the immobilization of plutonium alternative, because this alternative does not meet the purpose of and need for the proposed action, the off-specification alternative is not further analyzed in detail in the EIS.

2.3.5 Parallex Project Alternative

Another suggested alternative to the proposed action was to transfer the surplus plutonium to Canada under the Parallex Project. The Parallex Project was identified by DOE in its ROD for the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement (DOE 1997) as a possible option for dispositioning some of the surplus plutonium. The Parallex Project is a joint Canadian, Russian, and U.S. demonstration effort to evaluate the feasibility of burning MOX fuel in heavy-water-moderated reactors. The Parallex Project is still ongoing. It is a limited scale test of approximately 27 kg (59 lb) of MOX fuel that was manufactured at the DOE's Los Alamos National Laboratory (LANL) and at the Bochvar Institute in Moscow, Russia. This MOX fuel was shipped to Canada and is currently being tested in a Canadian Deuterium Uranium (CANDU) reactor. Following irradiation, additional analyses will be required to evaluate the usefulness of this approach. The DOE prepared an environmental assessment (EA) for this action and issued a Finding of No Significant Impact (FONSI) (DOE 1999b).

The suggested alternative of considering the Parallex Project would mean that the PDCF, the WSB, and the proposed MOX facility would be constructed and operated, but that the MOX fuel would be transferred to Canada for irradiation in heavy-water-moderated reactors there. This suggested alternative would be similar to the proposed action, except that the surplus plutonium

would be irradiated in Canada. Implementing this alternative would require a change in national policy regarding the disposition of surplus weapons plutonium that is the responsibility of the DOE. Therefore, this alternative is not considered further in this EIS.

2.3.6 MIX MOX Alternative

During the public comment meetings on the DEIS in March 2003, NRC was asked to consider an alternative in which surplus weapons-grade plutonium would be mixed with reactor-grade plutonium. This alternative was named "MIX MOX" by the proponent and is described further below.

Weapons-grade plutonium has a lower percentage of plutonium-240 than does reactor-grade plutonium. One concern with the immobilization alternative was that it would not isotopically degrade the plutonium. The MOX fuel alternative does isotopically degrade the plutonium. The depleted uranium (uranium-238) and plutonium-239 in MOX fuel would be converted to plutonium-240 when subjected to irradiation in a nuclear reactor. The MIX MOX alternative would change the overall percentage of plutonium-240 by adding/mixing surplus weapons-grade plutonium with reactor-grade plutonium. The source of reactor-grade plutonium would be European stockpiles. For example, Britain has approximately 60 MT of surplus reactor-grade plutonium that was generated from reprocessing spent nuclear fuel. The MIX MOX proponent stated that after the materials were mixed, they could be disposed of in a geologic repository.

Several details of the MIX MOX alternative have not been fully developed. For example, it is not clear if new facilities would be required to perform the mixing and whether any processing of portions of the surplus plutonium would be required prior to mixing. In addition, the percentages of the two plutonium materials required to achieve suitable isotopic degradation have not been determined. The legality, availability, and cost of purchasing the reactor-grade plutonium is uncertain. As such, the environmental impacts cannot be determined. Assuming that existing DOE facilities could be used, it is conceivable that the costs of the MIX MOX alternative could be slightly lower than the proposed action; however, the benefit of producing electricity from the use of MOX fuel would be eliminated by the MIX MOX alternative.

The MIX MOX alternative appears to satisfy one element of the purpose of and need for the proposed action. It appears to result in material that is proliferation resistant and would therefore reduce the threat of nuclear weapons proliferation. However, the MIX MOX alternative does not satisfy the second element of the purpose of and need for the proposed action. The current United States - Russia agreement does not allow for disposition of surplus plutonium using the MIX MOX alternative. Moreover, given that the environmental costs of the proposed action are considered to be small, the MIX MOX alternative is not a clearly superior alternative. Therefore, the NRC concludes that MIX MOX is not a reasonable alternative requiring detailed analysis in this EIS.

2.4 Comparison of Alternatives

In weighing the environmental, economic, and other benefits of the proposed action against its environmental, economic, and other costs, the NRC must also consider and compare reasonable alternatives to the proposed action. These evaluations will be factored into the ultimate decision of whether the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. The proposed action and the no-action (continued storage) alternative are compared in the text below and in Table 2.1. The terms used in impact categorization are defined in the text box to the right.

Determination of the Significance of Potential Environmental Impacts

For purposes of describing impacts in this EIS, each impact was assigned one of the following three significance levels:

- ***SmalI:*** The environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the environment.
- ***Moderate:*** The environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the environment.
- ***Large:*** The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the environment.

The impacts of the no-action alternative and the proposed action are compared for each technical area considered in this EIS. The level of impacts associated with the no-action alternative evaluated includes those impacts incurred by continued storage of surplus plutonium at DOE sites if the proposed MOX facility is not approved by the NRC. As stated previously, projected impacts for the no-action alternative were based on the analysis presented in the DOE SPD EIS (DOE 1999a) and were not reevaluated for this EIS.

The proposed action was evaluated for impacts from the following activities:

- Construction, operation, and deactivation and decommissioning of the proposed MOX facility, PDCF, and WSB at the SRS;
- Transport of depleted uranium hexafluoride from a DOE site at Portsmouth, Ohio, to a commercial fuel fabrication plant at Wilmington, North Carolina, to produce uranium dioxide needed as feedstock for the MOX fuel fabrication process;
- Conversion of depleted uranium hexafluoride to uranium dioxide;
- Transport of the uranium dioxide from Wilmington to the SRS;
- Transport of fresh MOX fuel from the SRS to a surrogate reactor site;
- Reactor use of MOX fuel; and
- Transport of spent MOX fuel to a geologic repository.

The continued storage (i.e., the no-action) alternative would result in no new construction at the DOE locations currently storing surplus plutonium, with the possible exception of minor

Table 2.1. Comparison of alternatives[a]

Impact area	Continued storage (no action)	Proposed action
Human Health Risk		
Construction	Not applicable	Human health impacts would be small.
Radiological		Same exposure as SRS employees from existing SRS operations.
Chemical		No adverse impacts from inhalation of construction-related emissions.
Physical hazards		<1 fatality, 122 injuries annually over 3 to 5 years.
Normal Operations	Under current operating conditions, human health impacts would be small.	Human health impacts would be small.
Radiological (annual impacts)		
Collective public dose (person-Sv/yr)	0.029	0.016
Annual LCFs	0.002	0.0009
Public MEI dose (mSv/yr)	0.065	6.1×10^{-5}
Risk of LCF	4×10^{-6}	4×10^{-9}
Facility workers collective dose (person-Sv/yr)	1.4	2.6
Annual LCFs	0.08	0.2
Average facility worker dose (mSv/yr)	$\leq$3.2	<5
Risk of LCF	$\leq$0.0002	<0.0003
Chemical	Insufficient data	No adverse impacts from chemical exposures.
Physical hazards	Insufficient data	<1 fatality, 41 injuries annually over 10 or more years.
Accidents	If an accident occurred, human health impacts would be small to moderate, depending on the type of the accident. Risks would be small.	If an accident occurred, human health impacts would be small, moderate, or large depending on the type of the accident. Risks would be small.
Radiological		
Event	Beyond design basis earthquake	PDCF tritium release (short-term exposure).
Dose to collective public (person-Sv)	6.6	42
LCFs	0.4	3

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Chemical	No data	Large accidental releases of chlorine or nitrogen tetroxide could have adverse impacts on SRS employees and would require rapid emergency response actions.
Air Quality		
Construction	Continued storage of surplus plutonium at the DOE sites would not require new construction, thus no impacts to air quality would occur.	Air emissions impacts would be small.
Annual standard level for $PM_{2.5}$		<0.1% of standard level.
24-h standard level for $PM_{2.5}$		4.3% of standard level.
CO, SO_2, NO_2 emissions from construction equipment		<0.29% of ambient standard level.
Operations	No violation of air quality standards at DOE sites from continued storage of surplus plutonium.	Air emission impacts would be small.
24-h standard level for $PM_{2.5}$		1.9% of standard level.
$PM_{2.5}$ annual standard level		0.01% of standard level.
Toxic air pollutants and PAHs		<0.04% of South Carolina standard levels.
Prevention of significant deterioration of air quality		<6.0% of PSD Class II Area increment for SO_2 emissions. <6.0% PM_{10} increments to Class II Areas. <1% of Class I increment of PM_{10} standard at Cape Romain National Wildlife Refuge 160 km (100 mi) from proposed facilities.
Hydrology		
Construction	Not applicable	Hydrological impacts would be small.
Surface water		No surface water use or discharges to surface waters during construction.
Groundwater		139 million L/yr (37 million gal/yr). Total use for construction would be 10% of A-Area loop water demand and 3% of excess capacity.

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Operations	No impacts on water use from continued surplus plutonium storage at DOE sites.	Hydrological impacts would be small.
Surface water		No significant impacts from discharges to an NPDES outfall and discharge of treated sanitary waste effluents.
Groundwater		76 million L/yr (20 million gal/yr). Total use by proposed facilities would be 5% of A-Area loop water demand in 2000 and 2% of excess capacity.
Waste Management		
Construction	No impacts to waste management systems from continued storage of surplus plutonium at DOE sites.	No TRU, LLW, or mixed LLW generation; small impacts to SRS treatment capacity for nonhazardous liquid waste.
Waste volumes generated during a 3-5-yr construction period:		
Hazardous [m^3 (yd^3)]		710 (929)
Nonhazardous liquid [m^3 (million gal)]		300,900 (79.5)
Nonhazardous solid [m^3 (yd^3)]		53,410 (69,858)
Operations	Small impacts on waste management systems from continued storage of surplus plutonium at DOE sites.	Small to moderate impacts on waste management systems at SRS and WIPP.
Waste volumes generated during 10-yr operation period:		
TRU [m^3 (yd^3)]		4,431 (5,796). TRU waste volume would be 13% of SRS storage capacity; 2.6% of WIPP disposal capacity.
Liquid LLW [m^3 (million gal)]		22,786 (6.0). The liquid LLW constitutes 4% of the discharge capacity of SRS.
Solid LLW [m^3 (yd^3)]		6,052 (7,916). Estimated volumes for solid LLW would represent about 21% of the SRS disposal capacity (if disposed of entirely at SRS).
Hazardous/mixed [m^3 (yd^3)]		120 (157). Estimated volume of hazardous waste would represent less than 2% of SRS storage capacity.

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Nonhazardous liquid [m^3 (million gal)]		602,000 (159). Nonhazardous liquid waste would be 6% of SRS treatment capacity.
Nonhazardous solid [m^3 (yd^3)]		41,400 (54,149). Nonhazardous solid waste would be disposed off-site.
Environmental Justice		
Construction	No impacts would occur since no new construction would be needed for continued storage of surplus plutonium at DOE sites.	No exposure to radiological emissions and no adverse impacts from inhalation of construction-related chemical emissions, regardless of population group or income status.
Normal Operations	Radiological and nonradiological risks from continued storage of surplus plutonium would be small. No disproportionately high and adverse effects would occur.	No disproportionately high and adverse effects would occur from routine operations.
Accidents		An environmental justice impact is possible from a severe accident.
Aesthetics		
Construction and Operation	No impacts would occur because no new construction is needed for continued storage of surplus plutonium at the DOE sites.	Small impacts on visual resources from construction and operation of the proposed facilities.
Cultural and Paleontological Resources		
Construction	No impacts would occur because no new construction is needed for continued storage of surplus plutonium at the DOE sites.	Two archaeological sites, 38 AK 546/547 and 38 AK 757, would be directly affected by construction of the proposed MOX facility. The South Carolina State Historic Preservation Office accepted a data recovery plan for the sites, and data recovery was completed for both sites in 2002. Five additional eligible sites could experience indirect impacts by the construction workforce unless proper mitigation is used.
Operations	No impacts on cultural or paleontological resources are expected from continued storage of surplus plutonium at the DOE sites.	Routine operations would not impact archaeological sites near the proposed facilities.

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Ecology		
Construction	No impacts would occur since no new construction is anticipated for continued storage of surplus plutonium at the DOE sites.	Impacts from habitat loss or noise generation during construction of the proposed facilities would be small.
Habitat loss		Impacts to wetlands and endangered/ threatened species would be small. Up to 14.7 ha (36.4 acres) of woodlands would be cleared for facilities, representing <1% of annual timber harvest at SRS, and trees would be small.
Noise impacts		Construction noise levels as high as 80 dBA could impact wildlife within 122 m (400 ft) of the project area.
Operations	Ecological impacts would be small.	Ecological impacts would be small.
Geology, Seismology, and Soils		
Construction	Continued storage of surplus plutonium at the DOE sites would not impact soils and geology since no new construction is expected.	Impacts to soils and geology would be small. Up to 50 ha (123 acres) would be disturbed in F-Area; some soil erosion and compaction.
Operations	Continued storage of surplus plutonium at the DOE sites would not impact soils and geology.	Impacts to soils and geology from routine operations would be small.
Infrastructure		
Construction	No new construction is expected, thus there would be no impacts to existing DOE infrastructure.	Impacts to existing infrastructure would be small.
Roads		An additional 4.8 to 6.4 km (3 to 4 mi) of roadways would be needed in the F-Area to support construction.
Electrical power		17,700 MWh/yr representing about 3.7% of SRS capacity would be needed during the 5-yr construction period.

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Water		139 million L/yr (37 million gal/yr) representing about 3.3% of A-Area loop groundwater capacity.
Operations	Impacts occurring at DOE facilities during continued storage of surplus plutonium would be small.	Impacts to existing infrastructure would be small.
Electrical power		Use of about 186,000 MWh/yr, representing 36.4% of F-Area capacity, would occur during normal operations.
Water		76 million L/yr (20.1 million gal/yr) or about 5% of A-Area loop water demand in 2000 and 2% of excess capacity would be used.
Land Use		
Construction	No impacts would occur since no new construction of storage facilities for surplus plutonium is needed at the DOE facilities.	Small impacts to designated land use at SRS would occur for construction of the proposed facilities.
Normal Operations	No impacts to land use would occur at DOE facilities during continued storage of surplus plutonium.	Small impacts to land use would occur from routine operations.
Accidents		Depending on the type and extent of an accident during operations, impacts could be small, moderate, or large. Portions of the F-Area could be precluded from employee use until corrective cleanup and appropriate monitoring measures were implemented. Small, moderate, or large impacts to land use in the immediate vicinity of SRS could occur in the event that a highly unlikely accident results in radioactive material migrating off site.
Noise		
Construction	Not applicable	Small impacts would occur from noise levels generated during construction.
Equipment noise levels		Equipment and vehicle noise would reach levels of 85–90 dBA at distances of 15 m (50 ft) from the source.

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
		Noise levels at the SRS boundary could reach 38 dBA, which is below EPA guidance of 55 dBA for protection of the public.
Operations	No significant impacts would occur at DOE plutonium storage facilities above noise levels currently generated by traffic and worker activities.	Small impacts would occur from noise levels generated during operation.
Process equipment, diesel generators, air-conditioning noise		Noise levels could be as high as <29 dBA at the SRS boundary, which is well below the 55-dBA EPA guidance level.
Socioeconomics		
Construction	Not applicable	Impacts on the REA and ROI would be small.
Employment		1,010 direct jobs, 810 indirect jobs for peak construction year.
Income		$91.9 million in peak construction year.
In-migrating population		350
Operations	No impacts would occur from continued storage of surplus plutonium at DOE facilities.	Small impacts on the REA and ROI would occur during operations.
Employment		490 direct jobs, 780 indirect jobs.
Income		$64 million per year
In-migrating population		180
Cost-Benefit Impacts		
Construction	Continued storage of surplus plutonium at DOE facilities would not result in additional impacts to the REA and ROI.	No significant adverse impacts related to costs would occur from construction of the proposed facilities. Some beneficial impacts would occur. In general, the impacts would be considered small.
REA & ROI impacts		
Employment		1,020 average annual employment
Total income		$370 million
Total regional product		$760 million

Table 2.1. Continued

Impact area	Continued storage (no action)	Proposed action
Operations	Impacts related to costs and benefits from continued storage would be small.	Impacts related to costs and benefits from operation of the proposed facilities would be small.
REA & ROI impacts		
Employment		1,270 jobs
Total income		$640 million
Total regional product		$1,180 million
Net benefit		$1,940 million
National Impacts		
Costs		$4,064 million
Benefits		Economic benefits for materials supplied, services, new scientific knowledge, safe use of plutonium stockpile, generation of electricity from MOX fuel.
Transportation		
Radiological	No intersite transportation expected.	Radiological impacts would be small.
Routine dose to the public (person-Sv)		3.1-5.6
LCFs		0.2-0.3
Dose to the transportation crew (person-Sv)		2.1-5.3
LCFs		0.1-0.3
Accident dose risk to the public (person-Sv)		0.23
LCFs		0.01
Nonradiological	No intersite transportation expected.	Nonradiological impacts would be small.
Vehicle emissions (latent fatalities)		1-2
Accidents (fatalities)		0.078-0.20

[a]Some of the impacts for the no-action alternative are from the entire DOE site, not just activities associated with continued storage. Therefore, the impacts of the no-action alternative are overestimated.

expansion of storage facilities at the Pantex site in Texas. Construction impacts would be small or negligible at Pantex if storage facility expansion was necessary and would occur on previously disturbed land adjacent to the existing storage facilities (DOE 1999a). For all present DOE storage sites, radiological and nonradiological risks would be small. Continued storage would be expected to have no impacts on air quality, water quality, waste management systems, cultural resources, or soils, and the economic cost would be lower than that for the proposed action. However, continued storage would meet none of the DOE's goals for the plutonium disposition program.

Construction of the proposed MOX facility, PDCF, and WSB (hereafter referred to as the proposed facilities) would disturb up to 50.0 ha (123.4 acres) of land. Impacts to endangered or threatened species, wetlands, or aquatic or terrestrial habitats (including woodlands) at the SRS and the F-Area vicinity would be small. Impacts to two prehistoric archaeological sites eligible for listing on the *National Register of Historic Places* (NRHP) have been mitigated through data recovery, and the removal of the fill during construction will be monitored (see Section 5.2.9).

The primary benefit of operation of the proposed MOX facility would be the resulting reduction in the supply of weapons-grade plutonium available for unauthorized use once the plutonium component of MOX fuel has been irradiated in commercial nuclear reactors. Converting surplus plutonium in this manner is viewed as being a safer use/disposition strategy than the continued storage of surplus plutonium at DOE sites, as would occur under the no-action alternative, since it would reduce the number of locations where the various forms of plutonium are stored (DOE 1997). Further, converting weapons-grade plutonium into MOX fuel in the United States — as opposed to immobilizing a portion of it as DOE had previously planned to do — lays the foundation for parallel disposition of weapons-grade plutonium in Russia, which distrusts immobilization for its failure to degrade the plutonium's isotopic composition (DOE 2002a). Converting surplus plutonium into MOX fuel is thus viewed as a better way of ensuring that weapons-usable material will not be obtained by rogue states and terrorist groups. Implementing the proposed action is expected to promote the above nonproliferation objectives. Additionally, building and operating the proposed MOX facility is expected to result in a gain of scientific knowledge relative to the conversion of weapons-grade plutonium into reactor fuel.

In addition to the above primary benefits, there are secondary economic benefits of the proposed action. Impacts of construction on the regional economic area (REA) and region of influence (ROI) would be beneficial with respect to jobs and income. Direct construction jobs for the proposed action would total about 1,010 in the peak construction year. Although in-migration of workers during construction would be greater for the proposed action, no adverse impacts are anticipated to public services, schools, housing availability, or the local transportation network. Construction of the proposed facilities would be expected to generate 91.9 million in total income within the REA during the peak construction year.

During operations, the MOX facility, PDCF, and WSB would be expected to generate 490 direct and 780 indirect jobs, producing a total annual income of $64 million in the REA. Approximately 180 people would be expected to relocate to the SRS area during operation of the proposed facilities. No adverse socioeconomic impacts are expected as the result of proposed facility

operations. Adequate public services, schools, and housing exist to satisfy needs of the in-migrating population.

The economic cost benefit analysis for the proposed action showed an overall net benefit to the ROI and REA of $1,940 million. National economic impacts (costs) for the proposed MOX facility, PDCF, and WSB are estimated to be $4,064 million. The economic benefits would include adding employment income in various national economic sectors and adding income to businesses from the purchase of related goods and services.

The following discussion compares the primary and secondary benefits set forth above to the environmental and economic costs of the proposed action.

Construction and routine operation of the proposed MOX facility would not be expected to cause any disproportionately high and adverse impacts to low-income or minority populations in the SRS vicinity. Of the accidents evaluated, a hypothetical tritium release accident at the proposed PDCF had the highest estimated short-term impacts, approximately 3 latent cancer fatalities (LCFs) among members of the off-site public. The same accident also had the highest 1-year exposure impact, up to 100 LCFs among members of the off-site public if ingestion of contaminated crops was considered. However, it is highly unlikely that such an accident would occur, and the risk to any population, including low-income and minority communities, is considered to be low. However, the communities most likely to be affected by a significant accident would be minority or low income, given the demographics and prevailing wind direction. The extent to which low-income or minority population groups would be affected would depend on the amount of material released and the direction and speed of the wind.

Continued storage of plutonium by the DOE at its present locations would not be expected to produce additional LCFs. (Annual LCFs of approximately 0.002 in the surrounding population of the storage sites [DOE 1999a] were estimated.) The annual collective dose to members of the public (i.e., those living and working within 80 km [50 mi] of the SRS) produced by routine operation of the proposed MOX facility, the PDCF, and the WSB would be expected to result in an LCF rate of approximately 0.0009/yr or less. Therefore, continued storage results in higher annual impacts.

No adverse impacts from chemical exposure of workers at the proposed MOX facility are anticipated. Less than one fatality, and approximately 120 worker injuries per year are anticipated during construction of the proposed facilities. Facility operations would result in about 40 injuries per year and less than one fatality per year.

Routine MOX facility operations are expected to produce small air quality impacts and would not result in concentrations above air quality standard levels for criteria pollutants at the SRS. Facility construction would contribute temporarily less than 0.1% of the $PM_{2.5}$ standard level, and facility operation would contribute about 0.01% or less of this level.

Water consumption during operation of the proposed facilities would be an increase of about 5% of the water demand for the A-Area loop in 2000 and about 2% of the excess A-Area loop capacity. Impacts to surface water are expected to be small during facility operations because

the concentrations of nonhazardous wastes in the discharge produced by the proposed facilities would be within the guidelines of the existing NPDES permit.

Waste management systems at the SRS would not be adversely affected by wastes generated by the proposed MOX facility, PDCF, and the WSB. Adequate storage capacity and handling procedures are in place at the SRS to process hazardous wastes generated during both construction and facility operations. Nonhazardous liquid and solid wastes would not adversely affect operation of the Central Sanitary Waste Treatment Facility at the SRS.

Transportation of uranium and plutonium feedstock materials, transuranic waste, and fresh MOX fuel would result in approximately 3,300,000 to 8,200,000 km (2,050,000 to 5,100,000 mi) traveled by 1,497 to 3,512 truck shipments over the operations period of the proposed MOX facility. Up to 1 latent cancer fatality (LCF) might be expected because of the radioactive nature of the cargo. (Estimated LCFs for members of the public and the transportation crews were 0.2 to 0.4 and 0.1 to 0.3, respectively.) One to two latent fatalities from vehicle emissions were estimated, and no fatalities (0.078 to 0.20 fatality) from the physical trauma of potential vehicle accidents were estimated.

The use of sand filters was identified during the EIS scoping process as a potential substitute for final HEPA filters. The sand filter technology is described in Section 2.2.5. A comparison between sand filter and HEPA filter impacts is presented in Section 4.3.8. The NRC concludes that the technology option to install a sand filter poses no clear reduction in overall environmental impacts over the installation and use of HEPA filters.

A sand filter typically is designed to use locally available sand and gravel. The outer wall of the sand filter consists of reinforced concrete placed below or partially below grade. It is designed to withstand a design-basis earthquake and/or flood without cracking or leaking. A sand filter designed for the proposed MOX facility would be rectangular and would require a surface area of about 313 m^2 (33,650 ft^2). The filter would be about 3 m (10 ft) deep and would consist of gravel layers overlaid with sand layers arranged in order of decreasing particle size (Orr 2001). A coarse sand layer would be placed at the top of the filter to maintain the integrity of the lower sand layers during filter operations. No routine maintenance is required during operation of sand filters.

Use of the HEPA filters would result in a slightly higher radiological dose to facility workers during the course of normal operations, as discussed in Section 4.3.1.1.2, and the use of a sand filter might result in some accident impacts lower than those estimated in Section 4.3.5.2. As discussed in Section 4.3.2.2, the air filtration method would not have an impact on air quality. Both filter types have approximately the same efficiencies for particulates, and neither filter type is designed to trap gases. In addition, the disposal costs were estimated to be similar for each filter type (Section 4.3.4).

2.5 Recommendation Regarding the Proposed Action

After weighing the costs and benefits of the proposed action and comparing alternatives (see FEIS Sections 2.4 and 4.6), and after considering the comments received on the DEIS (see FEIS Appendix J), the NRC staff, in accordance with 10 CFR 51.91(d), sets forth below its NEPA recommendation regarding the proposed action. The NRC staff recommends that, unless safety issues mandate otherwise, the action called for is the issuance of the proposed license to DCS, with conditions to protect environmental values. In this regard, the NRC staff concludes that (1) the applicable environmental requirements set forth in FEIS Chapter 6 and (2) the proposed mitigation measures discussed in FEIS Chapter 5 would eliminate or substantially lessen any potential adverse environmental impacts associated with the proposed action.

The NRC staff has concluded that the overall benefits of the proposed MOX facility outweigh its disadvantages and costs, based upon consideration of the following:

- The national policy decision to reduce supplies of surplus weapons-grade plutonium, as reflected in agreements between the United States and Russia;
- The small radiological impacts on, and risk to, human health, that would be caused by constructing, operating, and decommissioning the proposed MOX facility;
- The small environmental impact the proposed action would have; and
- The economic benefit to the local community.

As discussed in FEIS Chapter 4, postulated severe accidents evaluated in connection with the proposed action would be expected to produce moderate to large impacts. While the consequences of these bounding accidents would be expected to produce moderate to large impacts, the likelihood of such accidents occurring is expected to be very low (highly unlikely). Accordingly, the NRC concludes in its NEPA analysis that the benefits of the proposed action outweigh its connected risks and costs.

2.6 References for Chapter 2

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