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" Final F-Canyon Plutonium Solutions EIS "

FINAL F-CANYON PLUTONIUM SOLUTIONS ENVIRONMENT IMPACT STATEMENT AND RECORD OF DECISION -EIS-

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FINAL
F-CANYON PLUTONIUM SOLUTIONS
ENVIRONMENTAL IMPACT STATEMENT

Department of Energy - Savannah River Site - Aiken, South Carolina

DECEMBER 1994

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE)

TITLE: Final Environmental Impact Statement, F-Canyon Plutonium Solutions, Savannah River Site, Aiken, South Carolina (DOE/eis-0219)

CONTACT: For additional information on this statement, write or call:

A. B. Gould, Jr., Director
Environmental Compliance Division
NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
P. O. Box 5031
Aiken, South Carolina 29804-5031
Attention: F-Canyon Plutonium Solutions eis
Telephone: (800) 242-8269

For general information on the DOE NEPA process, write or call:

Ms. Carol M. Borgstrom, Director
U.S. Department of Energy
Office of NEPA Oversight (EH-25)
1000 Independence Avenue, S.W.
Washington, D.C. 20585
Telephone: (202) 586-4600, or leave a message at
(800) 472-2756

ABSTRACT: This document evaluates the potential environmental impacts over the next 10 years of alternatives for stabilization of plutonium solutions currently stored in the F-Canyon at the Savannah River Site (SRS). The plutonium solutions remain from chemical separation operations that DOE suspended in 1992. Because of safety concerns associated with the solutions, DOE proposes to take expedited action to stabilize them. Alternatives analyzed are the preferred alternative of processing the plutonium solutions to a plutonium metal; processing to a plutonium oxide; transferring the plutonium solutions to the SRS waste management system for proposed vitrification in the Defense Waste Processing Facility; vitrification in the F-Canyon; and no action. Other potential activities for the reduction of risk are also described.

PUBLIC COMMENTS: In its preparation of this Final Environmental

Impact Statement, DOE considered both written comments sent to DOE and comments received at public meetings held in Columbia, South Carolina (October 4, 1994); North Augusta, South Carolina (October 6, 1994); and Savannah, Georgia (October 11, 1994).

FOREWARD

The Savannah River Site (SRS) is a major U.S. Department of Energy installation. Th mission of the SRS was to produce nuclear materials that supported the defense, res medical programs of the United States. In 1922 the Secretary of Energy directed the phase out defense-related chemical separations activities. As a result, SRS present large inventory of nuclear materials such as in-process solutions, fuel assemblies, targets.

On March 17, 1994, DOE published a Notice of Intent (NOI) (59 FR 12588) to prepare enviromental impact statement (eis) on the Interim Management of Nuclear Materials the SRS. The proposed DOE interim management actions are to stabilize those nuclear at the SRS that represent a health or safety concern for the public, workers, and t environment and to convert certain materials to a usable form to support DOE progra such as research and development and other programs. These interim actions are nece while DOE makes and implements long term decisions on the disposition of nuclear ma DOE is addressing its long-term decisions in a Programmatic Environmental Impact St for Storage and Disposition of Weapons-Usable Fissile Materials, for which it issue NOI on June 21, 1994 (59 FR 311985). DOE expects that it could require 10 years or make and implement these long-term decisions.

After identifying the need for the Interim Management of Nuclear Materials eis, DOE determined the there are safety concerns associated with plutonium solutions stored the F-Canyon that warrant consideration of actions prior to the issuance of a Recor Decision for the Interim Management of Nuclear Materials eis. Therefore, DOE decide prepare a separate eis on an expedited basis. On August 23, 1994, DOE published in Register a notice of an amendment to the NOI for the Interim Management of Nuclear eis at the SRS. The notice explained DOE's decision to prepare this eis on F-Canyon Plutonium Solutions.

The NOI for the Interim Management of Nuclear Materials eis requested public commen suggestions for DOE to consider in its determination of the scope of that eis, and a public scoping period that ended on May 31, 1994. DOE held scoping meetings in Sa Georgia, North Augusta, South Carolina, and Columbia, South Carolina, on May 12, 17 1994, respectively. As a result of this public scoping process, DOE recieved commen applicable to the stabilization of F-Canyon plutonium solutions from the individual organizations, and government agencies, and has considered these comments in the pr of this eis.

On September 9, 1994, the U.S. Environmental Protection Agency published a Notice o Availability (NOA) in the Federal Register (59 FR 174, pages 46643-46644), which of started the public comment period on the Draft F-Canyon Plutonium Solutions eis; DO a corresponding NOA for the Draft F-Canyon Plutonium Solutions eis; DOE published a corresponding NOA for the Draft eis on September 9, 1994 (59 FR 174, pages 46627-46 The public comment period ended on October 24, 1994.

DOE has revised the Draft eis, as approapriate, in response to the comments recieve and during public hearings in Columbia, South Carolina, North Augusta, South Caroli Savannah, Georgia (October 4, 6, and 11, 1994, respectively) from individuals, orga and Federal and state agencies. These revisions are indicated in the Final eis by v change bars in the margin. Most of these change bars are marked either TC (technica or TE (editorial change). The remaining change bars are cross-referenced to specifi comments, which are presented in Appendix C, along with the DOE responses to the co and cross-references to appropriate sections of the eis.

Transcripts of public testimony, copies of scoping letters, scoping comments and DO and reference materials cited in this eis are available for review in the DOE Publi Room at the University of South Carolina-Aiken Campus, Gregg-Graniteville Library, 171 University Parkway, Aiken, South Carolina, (803) 648-6851, and at the Freedom o

Reading Room, Room 1E-190, Forrestal Building, 1000 Independence Avenue, S.W., Wash D.C., (202) 586-6020.

DOE has prepared this eis in accordance with the NEPA regulations of the Council on Environmental Quality (40 CFR Parts 1500-1508) and DOE NEPA Implementing Procedures (10 CFR Part 1021). This eis identifies the methods used and the scientific and oth information consulted. In addition, it incorporates, physically or by reference, av results of ongoing studies.

Th eis uses a variety of technical terms (e.g., vintrification) to describe activit and events. Technical terms not explained in the text are defined in the Glossary.

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SUMMARY

On March 17, 1994, the U.S. Department of Energy (DOE) announced in the Federal Register its intent to prepare an Environmental Impact Statement (eis) to assess the Interim Management of Nuclear Materials currently stored at the Savannah River Site (SRS). On June 21, 1994, DOE announced in the Federal Register its intent to prepare a Programmatic eis for Storage and Disposition of Weapons-Usable Fissile Materials, which will evaluate the long-term storage and disposition of such materials nationwide at DOE sites. Proposed interim management activities at the SRS would not affect long-term disposition decisions. The purpose of these interim actions would be to stabilize materials at the SRS that could pose environmental, health, and safety risks to the public, workers, and the environment. The nuclear materials inventory at the SRS includes weapons-usable fissile materials. DOE has committed to prohibit the use of plutonium-239 and weapons-usable highly enriched uranium separated or stabilized during the phaseout, shutdown, and cleanout of weapons complex facilities for nuclear explosive purposes (Reis and Grumbly 1994).

Since the publication of the Notice of Intent for the eis on Interim Management of Nuclear Materials, DOE has determined that a potentially significant safety concern exists with the continued storage of plutonium solutions in the F-Canyon chemical separations facility. The condition of these plutonium solutions warrants consideration of their stabilization before DOE plans to make any decisions in relation to the Interim Management of Nuclear Materials eis. On August 23, 1994, DOE published a notice of an amendment to the Notice of Intent for the eis for the Interim Management of Nuclear Materials at the SRS. The notice explained the DOE decision to prepare this eis on F-Canyon Plutonium Solutions to consider alternative ways to stabilize such solutions. DOE has prepared this eis in accordance with the regulations of the Council on Environmental Quality (40 CFR Parts 1500-1508) and DOE NEPA Implementing Procedures (10 CFR Part 1021).

Purpose and Need

During the time the SRS was actively involved in nuclear material production, DOE transferred irradiated fuels and targets from SRS reactors to disassembly basins, which are water-filled pools, to allow short-lived radioactive isotopes to decay. From the pools, DOE transferred the fuel and targets to canyon facilities in F- and H-Areas, which chemically dissolved them into liquid solutions. The useful isotopes were recovered, converted to a solid form, and either shipped to other DOE facilities or stored on the Site.

In March 1992, DOE suspended chemical processing operations in the F-Canyon to address a potential safety concern. That concern was addressed; however, prior to the resumption of processing, the Secretary of Energy directed that SRS phase out defense-related chemical separations activities (i.e., reprocessing). Non-safety-related facility operations have remained shut down since that time (March 1992). Approximately 303,000 liters (80,000 gallons) of solutions containing plutonium have remained in tanks in F-Canyon since the suspension of

operations.

The plutonium solutions currently in storage in F-Canyon have been held much longer than called for in the original design and routine operation of the canyon. As a result, the solutions are now in a condition not previously envisioned. DOE has taken mitigating actions, such as the addition of boron, to prevent an imminent hazard from occurring. Continued deterioration in solution chemistry requires increasing vigilance to ensure safe storage. However, this does not reduce the inherent risk of storing plutonium in a liquid form.

The vulnerabilities associated with the continued storage of the plutonium in solutions have been documented in environmental, safety, and health studies conducted by DOE review teams and outside experts (see DNFSB 1994 and DOE 1994a). The Defense Nuclear Facilities Safety Board "concluded from observations and discussions with others that imminent hazards could arise within 2 to 3 years unless certain problems are corrected....The Board is especially concerned about... (s)everal large tanks in the F-Canyon at the Savannah River Site (that) contain tens of thousands of gallons of solutions of plutonium and trans-plutonium isotopes. The trans-plutonium solutions remain from californium-252 production; they include highly radioactive isotopes of americium and curium. These tanks, their appendages, and vital support systems are old, subject to deterioration, prone to leakage, and are not seismically qualified. If an earthquake or other accident were to breach the tanks, F-Canyon would become so contaminated that cleanup would be practically impossible. Containment of the radioactive material under such circumstances would be highly uncertain.... Therefore, the Board recommends...(t)hat preparations be expedited to process the dissolved plutonium and trans-plutonium isotopes in tanks in the F-Canyon at the Savannah River Site into forms safer for interim storage. The Board considers this problem to be especially urgent" (DNFSB 1994). The DOE study concluded that there is an increasing risk of criticality and abnormal transients due to the uncertainty of solution chemistry.

Proposed Action and Alternatives

DOE is proposing to process F-Canyon plutonium solutions into forms that it can store with less risk to the public, worker health and safety, and the environment. This eis considers the following alternatives for the stabilization of these solutions:

- No Action: DOE would continue to manage the existing 303,000-liter (80,000-gallon) inventory of solutions in stainless-steel tanks in the F-Canyon. The solutions would be monitored to minimize the potential for precipitation of the plutonium and the possibility of an inadvertent criticality. This action would continue for the 10-year time period evaluated in this eis.

- Processing to Plutonium Metal (the preferred alternative): DOE would process the plutonium solutions, using proven chemical separations and conversion techniques, into plutonium metal that could be stored with less risk to the public, worker health and safety, and the environment in comparison to the No-Action Alternative. DOE expects this stabilization alternative could be accomplished in 20 months from the date of the Record of Decision of this eis, which would be significantly faster than stabilization could be

accomplished under the other alternatives (described below).

The FB-Line is not currently configured to package plutonium in accordance with the new DOE standard for long-term storage of plutonium (DOE 1994b). After converting the plutonium solutions to a metal and packaging and storing the resulting metal discs, DOE would modify part of the FB-Line facility. New equipment would provide the capability to repackage the plutonium metal into a configuration that meets the new DOE standard. DOE estimates that it could modify FB-Line and repackage the material by late 1997 at a cost of approximately $3 million.

Rather than modifying FB-Line, DOE could modify another vault facility (Building 235-F) or construct a new repackaging and vault facility in the F-Area. DOE estimates this could cost between $70-150 million and that it could complete this work by 2001.

Although repackaging of plutonium metal could occur in the FB-Line at the completion of stabilization actions, the environmental impacts are based on the assumption that the repackaging would take place in a new vault facility.

- Processing to Plutonium Oxide: DOE would modify the FB-Line to support conversion of the plutonium solutions to a plutonium oxide and to package the material for storage. The objective would be to produce a material form and packaging configuration that met the new DOE standard for long-term storage of plutonium. If the extent of the FB-Line modifications necessary to meet this standard were economically or physically impractical, DOE would perform the stabilization in two phases. DOE would modify FB-Line to be able to convert the material initially to an oxide form and package it in FB-Line. At the same time, DOE would design and construct a new facility (the Repackaging and Vault Facility; see Appendix A) to process, package, and store the oxide in accordance with the new standard. DOE estimates that the minimum required modifications to FB-Line would cost $7 million and take 3 years to complete. Following completion and modification, DOE would operate the FB-Line for approximately 7 months to convert and package the oxide for storage.

- Vitrification (Defense Waste Processing Facility): DOE would transfer the plutonium solutions to the SRS waste tank farm. Before transfer, the solutions would be adjusted to ensure the safety of the material in the tanks. DOE has identified several concepts for adjusting the solutions: diluting the solutions with water and chemicals to achieve very low plutonium concentrations, diluting the solutions with depleted uranium, or adding iron and manganese or other neutron poisons such as gadolinium (DOE 1994a). In the waste tanks, high-activity waste would settle to the bottom of the tank in the form of sludge. DOE would transfer highly radioactive sludge to the Defense Waste Processing Facility, where it would be vitrified (converted to a glass-like substance) and stored on the Site until DOE made final disposition decisions.

DOE estimates it would take approximately 6 years to perform the technical studies, training, and qualification efforts necessary to ensure safe operation for transferring the solutions and subsequent vitrification using this stabilization alternative. DOE has estimated that

evaluations for transferring the solutions to the high-level waste tanks could be completed in approximately 3 years (WSRC 1994a). However, the solutions would not be transferred to these tanks until all studies for vitrification were final. After these studies are complete, DOE estimates that it would take an additional 3 years to complete the process of transferring all the plutonium solutions to the high-level waste tanks because of the availability of tank space and criticality concerns. The plutonium solutions would remain in the high-level waste tanks until DOE transferred the contents to the Defense Waste Processing Facility for vitrification.

- Vitrification (F-Canyon): Under this alternative, DOE would vitrify the plutonium into a borosilicate glass matrix using the F-Canyon Vitrification Facility. The modifications to the F-Canyon would include the installation of a geometrically favorable evaporator to concentrate plutonium solution and equipment to convert the concentrated plutonium solution to a glass matrix using technology similar to that to be used on a larger scale in the Defense Waste Processing Facility. The capital costs of these modifications would be about $27 million; the facility could be available by January 1999.

When the modifications to the F-Canyon Vitrification Facility were complete, the plutonium solutions would be transferred to the facility and evaporated. This concentrated plutonium solution would be fed, along with finely ground glass (frit), to a melter to produce a borosilicate glass containing the plutonium. The molten glass would be poured into a stainless-steel package and stored in an existing vault at the F-Canyon.

Although the vitrification of this plutonium could begin as early as January 1999, DOE analyzed the Vitrification in F-Canyon Alternative as though it began during the first 6 months of 2000. Although DOE has not established the final schedule for this alternative, this eis describes its environmental consequences. Further changes to the schedule would not cause changes to the environmental impacts.

Affected Environment

The SRS occupies an area of approximately 800 square kilometers (300 square miles) adjacent to the Savannah River, primarily in Aiken and Barnwell Counties in South Carolina. The Site is approximately 40 kilometers (25 miles) southeast of Augusta, Georgia, and 32 kilometers (20 miles) south of Aiken, South Carolina. The alternatives (including no action) would all occur within an existing industrial area (i.e., F-Area) at SRS.

Environmental Impacts

Table S-1 compares the environmental consequences for the five alternatives based on the assessments contained in Chapter 4. The table summarizes how each alternative compares to the others.

Table S-1. Comparison of the potential environmental impacts of the alternatives

In addition to comparing alternatives against the environmental criteria listed in Table S-1, DOE considered the following

factors related to the stabilization of nuclear materials:

- New facilities required
- Security and nonproliferation
- Implementation schedule
- Technology availability and technical feasibility
- Labor availability and core competency
- Aging facilities
- Minimum custodial care

These factors are representative of issues addressed by the National Academy of Science in its study of the management and disposition of plutonium (NAS 1994), the Office of Technology Assessment plutonium study (OTA 1993), and comments received during the eis scoping period. The Processing to Plutonium Metal Alternative would be the most advantageous for all factors except two:

- Security and nuclear nonproliferation concerns, because it would result in a form that closely resembles materials used in weapons production

- Aging facilities, because it would involve continued storage of the metal in the FB-Line vault

In relation to security and nonproliferation concerns, the Vitrification Alternative would be preferable because it would produce a form of material least likely to be used in manufacturing or producing a nuclear weapon. However, the technology to accomplish the vitrification of plutonium (in other than trace quantities) does not currently exist; DOE estimates it would take 6 years to develop the capability.

The Processing to Oxide and the Vitrification Alternatives could involve minimal reliance on aging facilities. These alternatives eventually could result in the use of new facilities for the final step involved in stabilizing the plutonium and for storing the plutonium after the completion of stabilization.

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CHAPTER 1. PURPOSE AND NEED FOR ACTION

1.1 Background

The Savannah River Site (SRS) occupies an area of approximately 800 square kilometers (300 square miles) adjacent to the Savannah River, primarily in Aiken and Barnwell Counties in South Carolina. The Site is approximately 40 kilometers (25 miles) southeast of Augusta, Georgia, and 32 kilometers (20 miles) south of Aiken, South Carolina (Figure 1-1). Figure 1-2 shows the locations of the principal SRS facilities.

The past mission of the Savannah River Site included the production of plutonium-239 for national defense. Figure 1-3 shows the historic nuclear material production cycle for plutonium-239. During the Cold War, SRS produced, processed, and recovered special radioactive isotopes for use in nuclear weapons. First, material was fabricated in the Materials Area (M-Area) for use in the SRS reactors. Uranium-235 was fashioned into long thin cylinders and clad with aluminum to form reactor fuel assemblies. Uranium-238 was clad with aluminum to form reactor targets for the production of plutonium-239. The fuel and targets were loaded into one of the reactors (e.g., K-Reactor). The fuel assemblies provided the source of the neutrons that sustained the nuclear reaction in the reactors and produced the desired product, plutonium-239.

After irradiation, the targets were transferred to water-filled basins to allow short-lived radioactive isotopes to decay. The uranium-238 targets were transferred to the F-Canyon for plutonium-239 recovery. The targets were chemically dissolved into liquid solutions, and the plutonium-239 was recovered, converted to a metal form in the FB-Line facility, and either shipped to other U.S. Department of Energy (DOE) facilities or stored at the SRS. Typically, plutonium solutions were in storage no longer than 6 months. The separated fission products were transferred as waste to the F-Area high-level waste tanks. Other processing activities resulted in the generation of transuranic, low-level, hazardous, and mixed waste.

On March 13, 1992, DOE suspended F-Canyon chemical separations activities to address a potential safety concern regarding the survival of the canyon ventilation system should an earthquake occur. That concern was addressed; however, on April 28, 1992, prior to the resumption of separations operations, the Secretary of Energy directed the phaseout of reprocessing operations at the Savannah River Site, which included operations in F- and H-Canyons. The Secretary directed that the phaseout plan consider efforts that would accelerate transition of the F-Area facilities to a standby condition. The Secretary also stated: "It should be recognized that any phaseout activities that are not typical of

ongoing or previous facility operations are subject to appropriate National Environmental Policy Act review" (Claytor 1992).

In September 1992 the Savannah River Site prepared a plan that detailed the actions that DOE would have to take to phase out reprocessing. The plan included contemplated actions for removing the material that remained in the canyons as a result of the suspension of chemical separation activity in March 1992. In February 1993 the Site requested approval from DOE to restart F-Canyon after the completion of operational readiness reviews conducted as part of the response to the March 1992 safety concern. The SRS made this startup request in light of the Secretary's direction to accelerate the transition of F-Area reprocessing facilities to a standby condition and because all contemplated actions were typical of ongoing or previous facility operations.

During this same period, DOE was drafting new requirements for the operational readiness review necessary for the startup or restart of nuclear facilities. Under these requirements, facilities had to be able to demonstrate the capability to perform satisfactorily in relation to a broad range of topics associated with the safe operation of a nuclear facility. DOE promulgated these requirements in DOE Order 5480.31, "Startup and Restart of Nuclear Facilities," which it issued in September 1993. DOE decided that the SRS should apply these requirements to the F- and H-Canyons and, in November 1993, determined that the Site should hold the proposed F-Canyon (and FB-Line) restart in abeyance until it had completed a restart review in accordance with the new Order. In January 1994 DOE determined that unless there was an emergency condition, there should be no processing in F-Canyon before the completion of an environmental impact statement. In March 1994 DOE issued a Notice of Intent to prepare an environmental impact statement on the interim management of nuclear materials at the Savannah River Site to determine what actions, if any, would be required to ensure safe management of the nuclear material at the Savannah River Site until the Department could make disposition decisions.

In May 1994 the Manager of the Savannah River Operations Office recommended that the DOE Assistant Secretary for Defense Programs seek alternative arrangements for compliance with the National Environmental Policy Act (NEPA) to allow stabilization of the plutonium solutions in F-Canyon and the Mark-31 targets stored in the L-Reactor Disassembly Basin. This recommendation was based on the determination that the material presents risks to workers, the public, and the environment in the form of radiation exposure from normal operations and potential accidents, which DOE could reduce by converting the material to a solid stable form.

In June 1994 the DOE Office of Environment, Safety and Health performed an independent evaluation of the SRS request for alternative arrangements for compliance with NEPA (DOE 1994a). The report from this evaluation characterized the following

potential facility accidents to be of serious concern: (1) the potential for inadvertent criticality due to precipitation of plutonium from the F-Canyon plutonium solutions, and (2) potential radiological releases to the environment due to leakage of plutonium solutions through vessel cooling coils. The loss of facility personnel was an issue of "marginal" concern, with the note that this could become a serious concern if the current trend continued. The report did not include the Mark-31 targets in the material of serious concern. DOE evaluated the SRS request for alternative arrangements for compliance with NEPA in light of the Office of Environment, Safety and Health's evaluation and determined that the appropriate action would be to accelerate the evaluation of stabilization alternatives for the F-Canyon plutonium solutions by preparing a separate expedited environmental impact statement on this subject.

In an earlier assessment, the Defense Nuclear Facilities Safety Board "concluded from observations and discussions with others that imminent hazards could arise within two to three years unless certain problems are corrected....The Board is especially concerned about....(s)everal large tanks in the F-Canyon at the Savannah River Site (that) contain tens of thousands of gallons of solutions of plutonium and trans-plutonium isotopes....The trans-plutonium solutions remain from californium-252 production; they include highly radioactive isotopes of americium and curium. These tanks, their appendages, and vital support systems are old, subject to deterioration, prone to leakage, and are not seismically qualified. If an earthquake or other accident were to breach the tanks, F-Canyon would become so contaminated that cleanup would be practically impossible. Containment of the radioactive material under such circumstances would be highly uncertain.... Therefore, the Board recommends...(t)hat preparations be expedited to process the dissolved plutonium and trans-plutonium isotopes in tanks in the F-Canyon at the Savannah River Site into forms safer for interim storage. The Board considers this problem to be especially urgent" (DNFSB 1994).

Plutonium is a radioactive and highly toxic material. Plutonium is also fissile, which means that if enough plutonium is arranged in a particular geometric configuration, it can sustain a nuclear chain reaction (i.e., achieve a critical mass). The solutions stored in the F-Canyon contain enough plutonium to pose a criticality concern. The chemistry and concentration of these solutions must be maintained within specified limits to ensure that the plutonium remains in solution and does not precipitate as a solid to the bottom of the tanks. Such precipitation could result in an inadvertent criticality and potential exposure of workers and the public. Maintaining the safety of the solutions in storage requires frequent sampling, analyses, and chemical additions (e.g., nitric acid to account for evaporation). This becomes increasingly difficult over time because the chemistry of the solutions changes due to radiation effects and degradation of the solvent. There is limited historic experience and analytical data on extended storage of large quantities of plutonium in solution. For example, unexpected precipitation of plutonium solids was found in two of the F-Canyon storage tanks in 1993 at chemistry and concentration levels where precipitation had never been observed. In response, DOE took immediate measures to add chemicals (e.g., boron to reduce criticality concerns) to the tanks and return the precipitated plutonium to solution. However, unexpected chemical changes and the associated potential for an inadvertent criticality continue to be of concern.

An inadvertent criticality is only one of the potential accidents that could result from maintaining the plutonium solutions. Others include transfer errors, fires, vessel cooling coil failures, earthquake, uncontrolled reaction (i.e., violent chemical reaction), tank overflows, and tank leaks. The risk associated with each of these accidents is the possible exposure of workers and the public to radioactive material released as a result of an accident. For example, a tank leak or overflow accident could release a large amount of radioactive material into the canyon structure. The material would become airborne and be carried out of the canyon by the facility ventilation system. This airborne material would be removed by the special filters associated with the ventilation system. However, if a sufficient amount of such material was released in the canyon, a significant quantity could get past the filters and into the atmosphere. The wind could carry the airborne radioactive material off the Site where the public could receive a radiation dose as a result of exposure to the material.

The reduction of risk would come from the fact that many of the accidents associated with the plutonium solutions would be eliminated by converting this plutonium to a solid (such as metal). For example, the leak and overflow accident mentioned above would be eliminated because the solid form of the material would not be likely to leak or overflow from its container. In fact, of the major credible accidents for the plutonium solutions in F-Canyon, the only accidents still applicable after conversion to a solid would be earthquake, fire, and inadvertent criticality. The transfer error, tank leak, vessel cooling coil failure, tank overflow, and uncontrolled reaction accidents would not be applicable because they involve an initial release of plutonium in a liquid form and a subsequent transport of the material to workers or the public via the air or, in some cases, water. If the material is not a liquid, these accidents cannot release it.

In the eis on the Interim Management of Nuclear Materials, DOE is evaluating the risks associated with the continued storage of all nuclear materials at the SRS. DOE anticipates that it will issue the Draft Interim Management of Nuclear Materials eis for public comment in February 1995. That eis will identify any materials that would pose safety concerns within approximately 10 years and will evaluate alternatives for stabilization. Although the process of identifying materials of concern is still under way as part of the evaluation DOE is performing for the Interim Management of Nuclear Materials eis, the materials currently identified as posing potential concerns represent less than 1 percent of all the nuclear materials stored at the SRS. These materials contain a variety of radionuclides (e.g., plutonium, highly enriched uranium, americium), vary in physical form (powders, metals, liquids), and are in a wide range of storage containers (cans, drums, tanks, etc.) and facilities (chemical separations facilities, vaults, spent fuel pools, etc.). As a result, the range of reasonable alternatives for each material (or material type) can vary greatly.

For many of the materials, the range of alternatives does not involve either F-Canyon or FB-Line because neither facility has the capability to process or handle such materials. In fact, of all the nuclear materials of concern identified to date, only irradiated fuels and targets stored in reactor basins and various scrap forms of plutonium-bearing materials stored in vaults involve the potential use of F-Canyon or FB-Line for stabilization.

However, alternatives for these materials could involve portions of the F-Canyon and FB-Line processes (specifically, the dissolution unit operation or the capability for dissolution) that are not operational and that DOE would not declare operable as a result of any alternative evaluated under this eis.

DOE anticipates that alternatives for the materials evaluated in the Interim Management of Nuclear Materials eis will be based on several factors, including but not limited to:

1. The degree to which the alternative alleviates the safety concerns identified;

2. The determination of how quickly the alternative could be implemented to alleviate safety concerns associated with the material;

3. The degree to which the alternative relies on proven technology;

4. The use of existing capabilities where feasible to minimize taxpayer costs; and

5. The consistency of the alternative with national or DOE objectives.

DOE acknowledges that the existing capabilities at the F-Canyon, FB-Line, and other facilities will be a factor in selecting an alternative for analysis. Similarly, DOE acknowledges that the operational status of such facilities can affect how quickly the Department could implement certain alternatives.

However, as discussed above, DOE will consider other factors. For this reason, the alternatives evaluated in this eis would not tend to determine the subsequent development or limit the alternatives evaluated in the Interim Management of Nuclear Materials eis.

1.2 Purpose and Need for Action

The purpose of DOE's action is to eliminate the risk to its workers, the public, and the environment from continued storage of the plutonium in a liquid form. In the current liquid form, a number of accidents could result in a release of the plutonium to the environment and potential exposure of workers or the public. These accidents could be the result of personnel errors, equipment failures, or natural phenomena (e.g., earthquake). By converting the plutonium to a solid stable form, DOE can eliminate the potential for plutonium releases from such accidents. While DOE expects some reductions in environmental impacts from normal operations on conversion of the solutions to a solid form, DOE's primary objective is to eliminate risks from accidents that could occur.

1.3 Related National Environmental Policy Act Documents

On March 17, 1994, DOE announced in the Federal Register its intention to prepare an eis to assess the interim management of all nuclear materials currently stored at the SRS. The original scope of that Interim Management of Nuclear Materials eis included the F-Canyon plutonium solutions. However, because of the need to address the inherent risk of storing plutonium in a

liquid form, DOE decided to prepare this separate eis. On August 23, 1994, DOE published an amendment to the Notice of Intent for the eis for the Interim Management of Nuclear Materials at the SRS.

In addition, DOE is preparing a Programmatic eis for Disposition of Weapons-Usable Fissile Materials, as announced in the Federal Register on June 21, 1994. This programmatic eis will evaluate the long-term storage of weapons-usable fissile materials, primarily plutonium-239 and highly enriched uranium, and the disposition of such materials that the President has declared surplus to national defense needs. The decisions on weapons-usable fissile material long-term storage and disposition and their implementation could require 10 years or more. This F-Canyon Plutonium Solutions eis describes proposed interim actions that DOE could accomplish before making decisions related to the disposition of surplus weapons-usable fissile material.

On April 6, 1994, DOE issued a Notice of Intent to prepare a Savannah River Site Waste Management eis, which will provide a basis for selecting a sitewide strategic approach to managing present and future waste generated at SRS. These waste streams would be generated by several activities including ongoing operations and potential actions, new missions, environmental restoration, and decontamination and decommissioning programs. The SRS Waste Management eis will include the treatment of wastewater discharges in the F- and H-Effluent Treatment Facility, F- and H-Area tank operations and waste removal, and the construction and operation of a replacement high-level waste evaporator in the H-Area Tank Farm. The SRS Waste Management eis will also evaluate the Consolidated Incineration Facility technology for mixed waste. The Record of Decision is scheduled for July 1995.

Also on April 6, 1994, DOE issued a Notice of Intent to prepare the Defense Waste Processing Facility (DWPF) Supplemental eis to examine the environmental impacts of completing construction and operating the DWPF at SRS. This document supplements an eis that DOE issued in 1982, and will assist DOE in deciding whether and how to proceed with the DWPF in light of changes to processes and facilities that have occurred since the issuance of the 1982 eis. The Final Supplemental eis was made available in November 1994. The Record of Decision is scheduled for December 1994 . One of the alternatives considered in this eis, Vitrification (Defense Waste Processing Facility), would depend on a DOE decision under the DWPF Supplemental eis, to complete construction and to operate the DWPF.

In January 1991 the then Secretary of Energy announced that the Department would prepare a programmatic environmental impact statement examining alternatives for the reconfiguration of the nuclear weapons complex. On October 28, 1994, the Department issued a notice it would separate the current Reconfiguration Programmatic eis into separate analyses: a Tritium Supply and Recycling eis and a Stockpile Stewardship and Management eis. The latter eis includes activities required to maintain a high level of confidence in the safety, reliability, and performance of nuclear weapons, as well as maintenance, evaluation, and repair of replacement activities.

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CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES

This chapter describes alternatives for the stabilization of plutonium solutions currently stored in the F-Canyon (Figure 2-1). Sections 2.1 through 2.5 describe the following alternatives, which Chapter 4 evaluates in detail:

- No Action
- Processing to Plutonium Metal (preferred alternative)
- Processing to Plutonium Oxide
- Vitrification (Defense Waste Processing Facility)
- Vitrification (F-Canyon)

Figure 2-2 shows the schedules for these alternatives.

Section 2.6 discusses other actions that would have the potential to reduce the risk associated with the plutonium solutions but that, standing alone, do not fulfill the identified purpose and need for agency action.

Section 2.7 compares the environmental impacts associated with each alternative, including the storage of plutonium in vaults or tanks, as analyzed in Chapter 4. Section 2.8 discusses other factors which DOE considers relevant and compares these factors to the alternatives.

Appendix A describes the facilities involved in the alternatives (i.e., F-Canyon, FB-Line, and associated support facilities). The appendix also describes the historic processing methods used in these facilities (including F-Canyon, FB-Line, and the PUREX process). These descriptions might be helpful in understanding the alternatives discussed below. Figure 2-3 shows the PUREX process in F-Canyon and indicates where DOE has stored plutonium solutions in various stages.

Appendix B describes the potential accidents related to the continued storage of plutonium solutions and to facility operations that would be necessary to implement the alternatives.

In relation to the stabilization alternatives described in this chapter, and in support of United States nonproliferation policy, DOE is exploring the possibility of making plutonium that is surplus to the Nation's defense requirements available for verification and inspection by the International Atomic Energy Agency (IAea).

Figure 2-1. F-Canyon and surrounding area.

Figure 2-2. Schedules for storage and stabilization alternatives.

Figure 2-3. PUREX process in F-Canyon and location of plutonium solutions.

With the shutdown of the Rocky Flats Plant near Denver, Colorado, DOE no longer has the capability to manufacture plutonium weapon components for the U.S. stockpile. DOE will address the plutonium manufacturing capability in the

Programmatic eis on Stockpile Stewardship and Management, and will address plutonium disposition in the Programmatic eis for Disposition of Weapons-Usable Fissile Materials (see Section 1.3).

2.1 No Action

Under the No-Action Alternative, DOE would continue to manage the approximately 303,000 liters (80,000 gallons) of plutonium solutions stored in stainless-steel tanks in the F-Canyon as it has for approximately the past 2-1/2 years. DOE would continue to maintain the canyon facility in essentially a "warm standby" mode of operation in which no additional nuclear materials would be introduced into the canyons for chemical dissolution and subsequent processing. Existing plutonium solutions would not be processed to produce another form of nuclear material. DOE would continue to monitor the storage tanks and would sample plutonium solutions periodically to evaluate chemistry. As evaporation of a solution occurred or as chemical changes warranted, nitric acid or other chemicals would be added to minimize the potential for the precipitation of plutonium and the possibility of an inadvertent criticality. Solutions would be transferred within F-Canyon only as required for sampling or to alleviate problems with equipment (e.g., storage tanks).

The implementation of the No-Action Alternative would neither reduce the risks associated with storage of the plutonium as a liquid nor stabilize the solutions. Further, the implementation of the No-Action Alternative would not fulfill the need for agency action.

2.2 Processing to Plutonium Metal

Under this alternative, DOE would use the existing PUREX process in F-Canyon (see Appendix A) and equipment in FB-Line to convert the plutonium solutions to metal (see Figure 2-4). The FB-Line would convert the solutions to a metal form, similar to that the facility produced historically. The metal would be a chemically stable form of plutonium that DOE could produce without modifying the existing equipment. Because there is no need for additional plutonium for weapons, DOE would not attempt to meet previous specifications or chemical purities that were applicable for weapons production (Reis 1994). The plutonium metal would be packaged and stored, similar to other plutonium metal already in the FB-Line vault.

Figure 2-4. Plutonium to Metal Alternative

After converting the plutonium solutions to a metal, and packaging and storing, DOE would modify part of the FB-Line facility. New equipment would provide the capability to repackage the plutonium metal into a configuration that meets the DOE standard for long-term storage of plutonium (DOE 1994b). DOE estimates that it could accomplish this activity by late 1997 at a cost of approximately $3 million. The DOE standard establishes criteria to ensure the safe storage of plutonium metal and oxide. The criteria are intended to reduce the generation of gas inside the storage containers. The generation of gas has the potential to pressurize and subsequently damage containers.

Rather than modifying FB-Line, DOE could modify another vault facility (Building 235-F) or construct a new repackaging and vault

facility in the F-Area. DOE estimates this could cost between $70 and 150 million and that it could complete this work by 2001. Although repackaging of plutonium metal could occur in the FB-Line at the completion of stabilization actions, the environmental impacts are based on the assumption that the repackaging would take place in a new vault facility.

The alternative of Processing to Metal would produce a solid form of plutonium that would be safer and easier to store in the shortest amount of time. As a result, this is DOE's preferred alternative.

2.3 Processing to Plutonium Oxide

DOE would use the existing PUREX process, including the second plutonium cycle, in F-Canyon to prepare the solutions for introduction into FB-Line. Under this alternative, DOE would modify the FB-Line to support conversion of the plutonium solutions to a plutonium oxide and to package the material for storage (see Figure 2-5). DOE would produce a material form and packaging configuration that meets the new DOE standard for long-term storage of plutonium (DOE 1994b).

If the extent of the FB-Line modifications necessary to meet this standard were economically or physically impractical (i.e., too expensive or not enough space for the equipment required), DOE would perform the stabilization in two phases. DOE would provide the capability to convert the material initially to an oxide form and package it in FB-Line. At the same time, DOE would either modify an existing vault facility (e.g., 235-F) or construct a new facility (the Repackaging and Vault Facility; see Appendix A) to process, package, and store the oxide in accordance with the new standard. The oxide initially produced in FB-Line would be stored in the existing FB-Line vault until the new or modified facility could be completed. The new facility would be in the existing F-Area industrial complex.

Figure 2-5. Plutonium to Oxide Alternative

DOE estimates that the minimum required modifications to FB-Line would cost $7 million and take 3 years to complete. DOE would operate the FB-Line for approximately 7 months to convert and package the oxide for storage.

DOE estimates that modifications to an existing facility or a new facility would cost between $70 and $150 million and could be completed by 2001. Heating and repackaging the oxide would take approximately 3 months.

2.4 Vitrification (Defense Waste Processing Facility)

Under this alternative, DOE would transfer the plutonium solutions to the SRS waste tank farm (see Figure 2-6). Before transfer, the solutions would be adjusted to ensure the safety of the material in the high-level waste tanks. DOE has identified several concepts for adjusting the solutions: diluting the solutions with water and chemicals to achieve very low plutonium concentrations, diluting the solutions with depleted uranium, or adding iron and manganese or other neutron poisons such as gadolinium (DOE 1994a).
DOE would operate portions of the PUREX process, as required, to make the necessary chemical adjustments. The addition of

poisons or the dilution with depleted uranium would minimize the potential for inadvertent nuclear criticality in the waste tanks. This material would eventually be transferred to the Defense Waste Processing Facility for proposed vitrification.

To demonstrate the feasibility of this alternative, DOE would have to address a number of issues:

- The potential for criticality if plutonium precipitated during and following transfer to the high-level waste tanks. Detailed safety analysis would be required to address this concern and determine methods to reduce the potential for criticality.

- The capability of the Defense Waste Processing Facility to process plutonium-bearing high-level waste (in other than trace quantities) has not been fully evaluated with respect to the effect that this material would have on the vitrification process.

- Transfer of plutonium solutions to the high-level waste tanks has not been included in the High-Level Waste System Plan (WSRC 1994b). The availability of sufficient tank space, given plans to remove waste from and retire old waste tanks, must be addressed.

Figure 2-6. Vitrification (Defense Waste Processing Facility) Alternative

DOE estimates it would take approximately 6 years to perform the technical studies, training, and qualification efforts necessary to ensure safe operation for transferring the solutions and subsequent vitrification using this stabilization alternative. DOE has estimated that evaluations for transferring the solutions to the high-level waste tanks could be completed in approximately 3 years (WSRC 1994a). However, the solutions would not be transferred to these tanks until all studies for vitrification were final. After these studies were complete, DOE estimates that it would take an additional 3 years to complete the process of transferring all the plutonium solutions to the high-level waste tanks because of the availability of tank space and criticality concerns. Under this alternative, DOE would continue to store plutonium solutions in the F-Canyon, similar to the No-Action Alternative, during the 6 years required to complete the technical evaluations. As a precursor to stabilization, DOE would operate the second plutonium cycle. The vitrification of plutonium solutions would not begin within the 10-year period evaluated in this eis. As a result, this analysis does not inclu de the impacts of vitrification. However, if this alternative were implemented, solutions would eventually be vitrified and the environmental impacts associated with proposed Defense Waste Processing Facility operation would occur.

2.5 Vitrification (F-Canyon)

Under this alternative, DOE would modify an existing portion of F-Canyon, previously called the Multi-Purpose Processing Facility and now called the F-Canyon Vitrification Facility. The modifications would include removal of equipment no longer required and the installation of any new equipment required for the vitrification process. Appendix A contains a brief description of the F-Canyon Vitrification Facility and a summary of the modifications required. DOE would operate portions of the

PUREX process in F-Canyon, as required, to prepare the solutions for vitrification. The vitrification process would involve concentrating the plutonium solution in a small geometrically favorable tank (i.e., the physical dimensions of the tank are such that a nuclear criticality could not occur). The solution would be mixed with finely ground glass (frit) and fed to a small melter. Molten borosilicate glass would be produced and poured into stainless-steel canisters. The canisters would be stored in existing vaults at the F-Canyon facility. Figure 2-7 shows this process.

The process relies on similar, large-scale technology developed for proposed use in the Defense Waste Processing Facility. However, some process development work would be required due to the amount of fissile material that would be vitrified. DOE estimates that approximately $27 million in capital costs would be required to modify the F-Canyon to provide vitrification capability. In addition, DOE estimates that it could complete the necessary process development work and physical

Figure 2-7. Vitrification (F-Canyon) Alternative

modifications by early 1999 and that it would take approximately 6 months to vitrify the plutonium solutions.

2.6 Other Activities for Reduction of Risk

DOE identified the following activities that would have the potential to reduce the risks associated with the plutonium solutions in F-Canyon: the transportation of the solutions to H-Canyon for stabilization, purification of the solutions by processing those that had the greatest criticality risk through the second plutonium cycle in F-Canyon, those risk reduction activities identified in the DOE Assessment of Interim Storage of Plutonium Solutions in F-Canyon and Mark-31 Targets in L-Basin at the Savannah River Site (DOE 1994a), and shipment of the solutions off the Site for stabilization. These risk reduction activities would be in addition to those encompassed by the No-Action Alternative and already taken to reduce the risk, such as the addition of boron to selected tanks and the periodic adjustments of tank chemistry and concentrations to minimize the potential for precipitation of plutonium.

DOE evaluated the potential alternative of operating portions of the PUREX process (e.g., the second plutonium cycle) in F-Canyon. Figure 2-3 shows the current storage locations of the solutions in the various portions of the PUREX process. As Figure 2-3 demonstrates, only a small amount of the solutions [approximately 15,100 liters (4,000 gallons)] have been through all the PUREX stages.

The initial stages of the PUREX process, head-end and first cycle, remove fission products and some impurities. In addition, first cycle separates uranium and plutonium solutions from each other. The second cycle concentrates plutonium for introduction to the FB-Line for conversion into a metal.

Before the preparation of this eis, DOE discussed the possibility of operating only second cycle to process all the plutonium solutions currently in F-Canyon to reduce the risk of continued storage of plutonium (Fiori 1994). Operational upgrades for that portion of the F-Canyon were nearing completion, and the performance operational readiness review was under way. DOE believed that the operation of second cycle as a purification

activity would reduce the risk of inadvertent criticality, which could occur as a result of the current abnormal solution chemistry. Operation of the second cycle could also reduce the chance of leakage by consolidating the solutions in fewer tanks. However, releases could still occur from accidents due to leaks, spills, transfer errors, and other accidents associated with storing plutonium in a liquid form. These accident risks could be eliminated only by converting the liquid form to a solid form.

The use of the second cycle only would require changes to the process historically used to process plutonium solutions. Rather than moving the solutions sequentially through each stage of the PUREX process, the revised process would transfer the solutions directly to the second cycle for the removal of fission products and the separation and concentration of plutonium and uranium. The PUREX process has never been operated in this manner. To do so would require process development work and establishment of operating parameters, which would take several months. Nevertheless, even if DOE could resolve the technical issues, there would be several important issues associated with implementation of this potential alternative. For example, the operation of the second plutonium cycle would result in unprecedented high levels of radiation in the second cycle portion of the facility due to the presence of fission products. These fission products normally would have been removed in the head end and first cycle portion of the facility, which has shielding to reduce potential radiation exposure to workers. The portion of the facility housing the second plutonium cycle is not as heavily shielded. The chemistry of the solutions produced would be within known technical experience. The risk associated with plutonium in solution (e.g., inadvertent criticality) would remain until the plutonium solutions were converted to a stabilized form. Further, because the second plutonium cycle functions to increase the concentration of the plutonium, an inadvertent criticality would result in a greater release of radioactivity. Purification, like the other risk reduction activities described in DOE (1994a), would not fully mitigate the inherent risks of plutonium being stored in liquid form. As evaluated in this eis, however, purification of the solutions utilizing the second plutonium cycle would be part of the alternatives that would stabilize to a metal or an oxide.

DOE estimates that the impacts for normal operations and accidents associated with PUREX-related operations are within the impacts discussed in Chapters 4 and 5 of this eis. PUREX operations would be likely to generate slightly greater impacts than the No-Action Alternative because operating the process would involve transferring the material through equipment not used for No Action. However, the impacts would be well below those estimated for the Processing to Metal or Processing to Oxide Alternative because the operation of the PUREX process would be part of the activities necessary to complete those stabilization alternatives. The increase in impacts above No Action would be likely to occur primarily in the generation of high-level waste and F-Canyon worker radiation exposure.

Finally, regarding the transportation of the plutonium solutions in F-Canyon to H-Canyon for stabilization, the shipment, while theoretically feasible, would involve all the risks associated with the alternatives for stabilization plus the risks that would be associated with the transport of radioactive liquids between two facilities. Further, the time required to accomplish this alternative would be longer than that for any other alternative.

The shipment of the plutonium solutions to another site for stabilization would involve the additional risk and questionable feasibility of shipping plutonium solutions over public thoroughfares.

2.7 Comparison of Alternatives

Table 2-1 compares the environmental consequences for the five alternatives based on the assessments contained in Chapter 4. The table summarizes how each alternative compares to the others.

2.8 Other Factors

The selection of an alternative for stabilizing the F-Canyon plutonium solutions depends in part on existing technology (or on technology that DOE could develop quickly), the capabilities of existing SRS facilities, and the extent to which the actions would support long-term storage objectives. Consistent with a comprehensive review of long-term options for plutonium disposition, DOE will consider the technical, nonproliferation, environmental, budgetary, and economic aspects of each alternative before it selects one alternative for implementation. In addition to comparing alternatives against the environmental criteria listed in Table 2-1, DOE considered other factors related to the

Table 2-1. Comparison of the potential environmental impacts of the alternatives.

stabilization of nuclear materials. These factors are representative of issues addressed by the National Academy of Science in its study of the management and disposition of plutonium (NAS 1994), the Office of Technology Assessment plutonium study (OTA 1993), and comments received during the eis scoping period. The following sections describe these factors.

2.8.1 NEW FACILITIES REQUIRED

This factor considers qualitative impacts on the number and size of new facilities required, and the probable long-term restoration requirements after their use. The No-Action and Vitrification Alternative using the Defense Waste Processing Facility would rely totally on existing facilities and, therefore, would be the most advantageous because they could be implemented immediately with no additional capital or environmental impact due to construction. The Processing to Metal Alternative would require minor modifications to FB-Line to provide new repackaging capabilities for the metal produced. The Processing to Oxide Alternative would involve more extensive modifications to FB-Line and potentially a new facility. Similarly, the Vitrification Alternative using F-Canyon would require extensive modifications to the facility.

2.8.2 SECURITY AND NONPROLIFERATION

This factor relates to how well each alternative supports national security objectives and nonproliferation. This issue is being debated on the national and international level, and consensus has yet to be reached. However, DOE has qualitatively evaluated the alternatives and rated them in comparison to one another.

All the alternatives involve the use of facilities within controlled industrial areas of the SRS, which are supported and protected by an armed guard force. However, the solutions or stabilized forms of plutonium would have varying degrees of use in potentially supporting or leading to the manufacture of a nuclear weapon. Methods could be used to further reduce this potential. For example, DOE considered the addition of fission products to increase the radioactivity of the stabilized form of material (e.g., metal). The addition of fission products would make the material essentially "self-protecting" from theft or potential use in weapons because of high radiation levels. However, this method would result in increased exposures to personnel performing processing and handling operations (e.g., at FB-Line). DOE does not consider such increased exposures to personnel to be warranted based on the relatively small amount of plutonium that these solutions represent in comparison to the U.S. stockpile. DOE has committed to prohibit the use of plutonium-239 and weapons-usable highly enriched uranium separated or stabilized during the phaseout, shutdown, and cleanout of weapons complex facilities for nuclear explosive purposes (Reis and Grumbly 1994). Further, in support of United States nonproliferation policy, DOE is exploring the possibility of making plutonium that is surplus to the Nation's defense requirements available for verification and inspection by the International Atomic Energy Agency (IAea).

The Vitrification Alternatives would produce a material form that would be least attractive for use in manufacturing or producing a nuclear weapon. Therefore, they represent the most advantageous alternatives in this regard. The Processing to Plutonium Metal Alternative would result in a form that closely resembled that used in weapons production. The No-Action and Processing to Plutonium Oxide Alternatives would maintain or convert plutonium to forms that would require increasing degrees of processing to produce a form suitable for weapons use. In either the Metal or Oxide alternative, large quantities of plutonium already exist in these forms; therefore, processing this small increment of plutonium to either of these forms would not impact decisions and alternatives for ultimate disposition.

2.8.3 IMPLEMENTATION SCHEDULE

Of the stabilization alternatives, the Processing to Metal Alternative could be implemented in the shortest period of time. The Processing to Oxide Alternative could begin within approximately 3 years. The Vitrification Alternative using F-Canyon could begin within approximately 5 years. Vitrification in the Defense Waste Processing Facility could not be completed within 10 years, but initial actions to implement that alternative could begin in approximately 6 years. The No-Action Alternative could be implemented immediately, but would not satisfy the DOE purpose and need.

2.8.4 TECHNOLOGY AVAILABILITY AND TECHNICAL FEASIBILITY

This factor relates to the extent that technology development is required and the likelihood of success. Of the stabilization alternatives, Processing to Plutonium Metal represents the most technically proven; it would use existing technology and equipment. The Processing to Plutonium Oxide Alternative is also technically feasible, but would require technology development and new equipment to accomplish stabilization. Similarly, the Vitrification Alternatives appear to be technically feasible, but would require

the most technology development. The technical uncertainty would increase as the stabilized form differed from that historically produced. There would also be technical uncertainty associated with the continued storage of the plutonium solutions under the No-Action Alternative as a result of radiation and chemically induced changes in the solution chemistry and form.

2.8.5 LABOR AVAILABILITY AND CORE COMPETENCY

There are differences between the level of personnel knowledge and training required for each alternative. In addition, there would be impacts from providing the needed level of training. All the alternatives would require approximately the same amount of labor to implement. The No-Action and Processing to Plutonium Metal Alternatives would involve activities similar to those performed in the past; as a result, facility personnel would have existing training and qualification programs to maintain core competency. The Processing to Plutonium Oxide and Vitrification Alternatives would require additional levels of training; the only impact anticipated from such additional training would be the incremental funding required.

2.8.6 AGING FACILITIES

All the alternatives involve the use of existing facilities, some of which have been in operation for more than 40 years (e.g., F-Canyon). The No-Action Alternative would require continued storage of the material in the F-Canyon and is, therefore, the least desirable or advantageous in this regard.

The Vitrification (Defense Waste Processing Facility) Alternative would require maintenance of the solutions in F-Canyon for approximately 6 to 9 years. In addition, it would involve the transfer of the plutonium solutions to the high-level waste tanks, some of which have been in use since the 1950s. Therefore, this alternative has only a slight advantage over the No-Action Alternative.

The Vitrification (F-Canyon) Alternative would require maintenance of the solutions in the canyon for approximately 5 years. Even though this alternative would use a substantial amount of new equipment, the area that would be modified is in the F-Canyon, which is more than 40 years old. The vitrified material would be stored in an existing vault or the F-Canyon. As with the Vitrification (DWPF) Alternative, this alternative has only a slight advantage over the No-Action Alternative.

The Processing to Plutonium Oxide Alternative could involve limited use of the F-Canyon and FB-Line facilities. It could use a new or modified facility for conversion or repackaging of the oxide and eventual storage. If a new facility were required, it would represent the minimum reliance on existing facilities.

While the Processing to Plutonium Metal Alternative would involve limited use of the F-Canyon and FB-Line for stabilization, it would involve continued storage of the metal in the FB-Line vault. Therefore, it represents some reliance on aging facilities, but also represents an advantage over the No-Action and Vitrification Alternatives.

2.8.7 MINIMUM CUSTODIAL CARE

The Vitrification Alternative would eventually result in a stabilized form of material that would require a minimum of custodial care. However, continued custodial care of the solutions would be required in F-Canyon or the high-level waste tanks until vitrification was accomplished. Continued storage would involve maintaining a dispersible form of material for at least 5 years in facilities with limited passive safety features, such as tanks that do not have a physical geometry that prevents the possibility of a criticality. Therefore, this alternative is undesirable. The No-Action Alternative would involve a similar level of custodial care and, therefore, is also undesirable.

The Processing to Plutonium Oxide Alternative would require continued storage of the solutions for approximately 3 years. This material form would require continued surveillance on a frequent basis. The alternative could use existing facilities that have limited passive safety features. The new or modified facility and eventual storage configuration could incorporate the increased use of passive safety systems such as specially designed and built racks that would prevent movement of material during earthquakes. (A passive safety system is one that requires no action to function, such as a reinforced door panel for a vehicle. An active safety system is one that requires an action, such as buckling a vehicle seatbelt.)

The Processing to Plutonium Metal Alternative would result in a reduced level of custodial care after stabilization of the solutions. Although the passive safety systems of the storage facility (FB-Line vault) are limited, plutonium metal is a significantly less dispersible form than solutions or oxide. As a result, this alternative is the most advantageous in minimizing custodial care.

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CHAPTER 3. AFFECTED ENVIRONMENT

The F-Area is an industrial area with buildings, paved parking lots, and graveled areas. While some grassed areas occur around the administration buildings and vegetation is present along the ditches that drain these areas, most of the area has little or no vegetation. Consequently, F-Area has little value as wildlife habitat. No aquatic habitat or wetlands occur in the F-Area. Actions in this area would not affect threatened and endangered species and their habitat. The nearest red-cockaded woodpecker (Picoides borealis) recruitment stand is more than 3.2 kilometers (2 miles) to the north. No SRS facilities have been nominated for inclusion in the National Register of Historic Places, and there are no plans for such nomination. Because the F-Area is an industrial site constructed during the 1950s, the presence of any important cultural resources remaining is unlikely.

The Final Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina (DOE 1990) presents a comprehensive discussion of the Savannah River Site and its environs; that document provides a supplement to the information in this chapter.

3.1 Geologic Setting and Seismicity

The Savannah River Site is on the Aiken Plateau of the Upper Atlantic Coastal Plain about 40 kilometers (25 miles) southeast of the Fall Line that separates the Atlantic Coastal Plain from the Piedmont (Figure 3-1). The F-Area is generally flat and featureless with local relief as high as about 60 meters (190 feet) and with slopes of 0 to 10 percent. The Final Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina (DOE 1990) contains a complete description of the geologic setting and the stratigraphic sequences of the SRS. The Soil Survey of Savannah River Plant Area, Parts of Aiken, Barnwell, and Allendale Counties, South Carolina (USDA 1990) describes soil characteristics and erosion potential for the area.

3.1.1 SUBSURFACE FEATURES

Several fault systems occur off the Site northwest of the Fall Line (DOE 1990). A recent study of available geophysical evidence (Stephenson and Stieve 1992) identified six faults under the SRS: the Pen Branch, Steel Creek, Advanced Tactical Training Area (ATTA), Crackerneck, Ellenton, and

Figure 3-1. General location of the Savannah River Site and relationship to physiographic provinces of the eastern United States.

Upper Three Runs Faults. Figure 3-2 shows the locations of these faults. The Upper Three Runs Fault passes closest to F-Area. The fault lines on Figure 3-2 represent the projection of the faults to the ground surface; the actual faults do not reach the surface of the ground but stop several hundred feet below the surface.

Based on information developed to date, none of the faults discussed in this section is "capable." A fault is capable if it has moved at or near the ground surface within the past 35,000 years or is associated with another fault that has moved in the past 35,000 years. For a more detailed definition of a capable fault, see 10 CFR Part 100.

3.1.2 SEISMICITY

Two major earthquakes have occurred within 300 kilometers (186 miles) of the SRS. The first was the Charleston, South Carolina, earthquake of 1886, which had an estimated Richter scale magnitude of 6.8 and occurred approximately 145 kilometers (90 miles) from the Site. The SRS area experienced an estimated peak horizontal acceleration of 10 percent of gravity (0.10g) during this earthquake (URS/Blume 1982). The second major earthquake was the Union County, South Carolina, earthquake of 1913, which had an estimated Richter scale magnitude of 6.0 and occurred about 160 kilometers (99 miles) from the Site (Bollinger 1973). Because these earthquakes are not associated conclusively with a specific fault, researchers cannot determine the amount of displacement resulting from them.

In recent years, two earthquakes occurred inside the SRS boundary. On June 8, 1985, an earthquake with a local Richter scale magnitude of 2.6 and a focal depth of 0.96 kilometer (0.59 mile) occurred on the Site; its epicenter was west of C- and K-Areas. The acceleration (measured in terms of a percentage of the acceleration due to gravity) produced by the earthquake did not activate instruments in the reactor areas, which were set to detect an acceleration of about 0.015g or 1.5 percent of gravity. On August 5, 1988, an earthquake with a local Richter scale magnitude of 2.0 and a focal depth of 2.68 kilometers (1.66 miles) occurred on the Site; its epicenter was northeast of K-Area. Existing information does not correlate the two earthquakes conclusively with the known faults on the Site.

Figure 3-2 shows the locations of the epicenters of these two earthquakes. A report on the August 1988 earthquake (Stephenson 1988) reviewed the latest earthquake history. This report predicts recurrence rates of one per year at a Richter scale magnitude of 2.0 in the southeast coastal plain. The report also notes that historic data that could be used to calculate recurrence rates accurately are sparse.

Figure 3-2. Savannah River Site, showing seismic fault lines and locations of onsite earthquakes.

Most recently, a Richter scale magnitude 3.2 earthquake occurred on August 8, 1993, approximately 16 kilometers (10 miles) east of the City of Aiken near Couchton, South Carolina. Residents reported feeling this earthquake in Aiken, New Ellenton (immediately north of the SRS), North Augusta (approximately 40 kilometers [25 miles] northwest of the SRS), and on the Site.

The accident analyses for this eis evaluated an earthquake of a magnitude that would produce a peak ground acceleration of 0.2g, which is estimated to recur at an interval of about once every 5,000 years. The F-Canyon structure was designed to resist a bomb blast impact against the exterior walls. The acceleration of the blast "front" from a nearby detonation would be many times the acceleration due to gravity (32 feet per second squared).

For this reason, the structure would be highly damage-resistant to an earthquake with a horizontal ground acceleration of 0.20g or 20 percent of gravity at the structure base, although some materials probably would be released. A precise translation of this acceleration to a Richter scale reading is not possible because the impact at the F-Area would be greatly affected by the type of soil in the area of the earthquake epicenter, the nearness of a shallow fault line, and attenuation of the shock wave in rock or other formations.

3.2 Water Resources

3.2.1 SURFACE-WATER AND GROUNDWATER FEATURES

Six tributaries of the Savannah River - Upper Three Runs Creek, Fourmile Branch, Beaver Dam Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek - drain almost all of the SRS (Figure 3-3). Surface waters in the vicinity of the F-Area flow into Upper Three Runs Creek and Fourmile Branch. The F-Area is on a surface and groundwater divide. Shallow groundwater in the vicinity of the area recharges both Upper Three Runs Creek and Fourmile Branch.

The Savannah River, which forms the boundary between the States of Georgia and South Carolina, supplies potable water to several municipalities. Upstream from the SRS, the river supplies domestic and industrial water needs for Augusta, Georgia, and North Augusta, South Carolina. Approximately 203 river kilometers (126 river miles) downstream of the SRS, the river supplies domestic and industrial water needs for the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia, through intakes at river kilometer 47 (river mile 29) and for Beaufort and Jasper Counties in South Carolina through intakes at about river kilometer 63 (river mile 39.2).

Figure 3-3. Savannah River Site, showing 100-year floodplain and major stream systems.

Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County are from the deep aquifers. Domestic water supplies are primarily from the intermediate and shallow zone. In Barnwell and Allendale Counties, the intermediate zone and overlying units that thicken to the southeast supply some municipal users. At SRS most groundwater production is from the deep zone, with a few lower-capacity wells pumping from the intermediate zone. Every major operating area at SRS has groundwater wells. Total groundwater production at SRS is from 34,000 to 45,000 cubic meters (9 to 12 million gallons) per day, similar to the volume pumped for industrial and municipal production within 16 kilometers (10 miles) of the Site (Arnett, Karapatakis, and Mamatey 1993).

Groundwater beneath the Site flows slowly toward SRS streams and swamps and into the Savannah River at rates ranging from inches per year to several hundred feet per year. The depth to which the onsite streams cut into the soils controls the horizontal movement of groundwater. The valleys of the smaller perennial streams allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (e.g., Upper Three Runs Creek) drain formations of intermediate depth, and the valley of the Savannah River drains deep formations.

Groundwater flow in F-Area is upward, from the lower to the upper sediments. The horizontal flow direction from the F-Canyon building is toward Upper Three Runs Creek and Fourmile Branch.

3.2.2 SURFACE-WATER AND GROUNDWATER QUALITY

In 1993, the major releases of radionuclides from the SRS to surface waters were 12,700 curies of tritium, 0.477 curie of strontium-89 and -90, and 0.246 curie of cesium-137. The resulting doses from all radionuclides released from the Site were less than 2 percent of applicable dose standards. From a nonradiological perspective, there was no significant difference between upriver and downriver water quality parameters. Other than 72 instances of exceeding fecal coliform standards, river and stream analyses met the more stringent 1992 updated river classification of Freshwaters; that is, 99.9 percent of the analyses were in compliance with the SRS National Pollutant Discharge Elimination System permit. Table 3-1 lists radioactive liquid releases by source for 1993.

Table 3-1. 1993 liquid releases by source (include direct and

seepage basin migration releases).a

Industrial solvents, metals, tritium, and other constituents used or generated on the Site have contaminated the shallow aquifers beneath 5 to 10 percent of the SRS. Figure 3-4 shows groundwater contamination on the Site (Arnett, Karapatakis, and Mamatey 1993). Most contaminated groundwater at the SRS flows beneath a few facilities; contaminants reflect the operations and chemical processes performed at those facilities. At F- and H-Areas, contaminants in the groundwater include tritium and other radionuclides, metals, nitrates, chlorinated and volatile organics.

Radioactive constituents (tritium, cesium-137, iodine-131, ruthenium-106, and strontium-89 and -90) above drinking water standards have occurred in F-Area monitoring wells. One well (FCA-9DR) showed activities considerably higher than others; strontium activities were especially notable, as much as 1,000 more than 500 times over drinking water standards (Arnett, Karapatakis, and Mamatey 1994). Studies of flow directions, infiltration rates, and operating history indicate that this contamination is from an isolated incident that occurred more than 35 years ago (Reed 1993).

Figure 3-4. Groundwater contamination at the Savannah River Site.

3.3 Air Resources

Based on SRS data collected from onsite meteorological towers for the 5-year period from 1987 to 1991, maximum wind direction frequencies are from the northeast and west-southwest and the average wind speed is 3.8 meters per second (8.5 miles per hour) (Shedrow 1993). The average annual temperature at the SRS is 17.8-C (64-F). The atmosphere in the SRS region is unstable approximately 56 percent of the time, neutral 23 percent of the time, and stable about 21 percent of the time (Shedrow 1993). In general, as the atmosphere becomes more unstable, atmospheric dispersion of airborne pollutants increases and ground-level pollutant concentrations decrease.

3.3.1 SEVERE WEATHER CONDITIONS

The SRS area experiences an average of 55 thunderstorm days per year with 50 percent of these occurring in June, July, and August (Shedrow 1993). On an annual average, lightning flashes will strike six times per year on a square-kilometer area (Hunter 1990). The highest windspeed recorded at Bush Field (Augusta, Georgia) between 1950 and 1990 was 100 kilometers (62 miles) per hour (NOAA 1990).

From 1954 to 1983, 37 reported tornadoes occurred in a 1-degree square of latitude and longitude that includes the SRS (WSRC 1993a). This frequency of occurrence is equivalent to an average of about one tornado per year. The estimated probability of a tornado striking a point on the SRS is 0.0000711 per year. This results in a point-strike recurrence interval of about once every 14,000 years (Bauer et al. 1989). Since operations began at the SRS in 1953, nine tornadoes have been confirmed on or near the Site. Nothing more than light damage was reported, with the exception of a tornado in October 1989 that caused considerable damage to forest resources in an undeveloped southeastern sector of the SRS (Shedrow 1993).

From 1700 to 1992, 36 hurricanes occurred in South Carolina, resulting in an average frequency of about one hurricane every 8 years (WSRC 1993a). Because SRS is about 160 kilometers (100 miles) inland, the winds associated with hurricanes have usually diminished below hurricane force [i.e., equal to or greater than a sustained wind speed of 33.5 meters per second (75 miles per hour)] before reaching the SRS. Winds exceeding hurricane force have been observed only once at SRS (Hurricane Gracie in 1959) (Shedrow 1993).

3.3.2 RADIOLOGICAL AIR QUALITY

DOE provides detailed summaries of radiological releases to the atmosphere from SRS operations along with the resulting concentrations and doses in a series of annual environmental data reports. This section references several of these documents, which contain information additional to that presented in the following paragraphs. The information enables comparisons of current data with releases, concentrations, and doses associated with each alternative.

In the SRS region, airborne radionuclides originate from natural sources (i.e., terrestrial and cosmic), worldwide fallout, and Site operations. The SRS maintains a network of air monitoring stations on and around the Site to determine concentrations of radioactive particulates and aerosols in the air (Arnett, Karapatakis, and Mamatey 1994).

Table 3-2 lists average and maximum nontritium atmospheric radionuclide concentrations at the SRS boundary and at background monitoring locations [160-kilometer (100-mile) radius] during 1993. Tritium is the only radionuclide of SRS origin detected routinely in offsite air samples above background (control) concentrations (Cummins, Martin, and Todd 1990, 1991; Arnett et al. 1992; Arnett, Karapatakis, and Mamatey 1993). Table 3-3 lists average concentrations of tritium in the atmosphere, as measured at the boundary and offsite monitoring locations.

Table 3-2. Radioactivity in air at the SRS perimeter and at the 160-kilometer (100-mile) radius during 1993 (pCi/m3).a

Table 3-3. Average atmospheric tritium concentrations around the Savannah River Site (pCi/m3).a

Table 3-4 lists 1993 radionuclide releases from each major operational group of SRS facilities. All radiological impacts are within regulatory requirements.

3.3.3 NONRADIOLOGICAL AIR QUALITY

The SRS is in the Augusta (Georgia) - Aiken (South Carolina) Interstate Air Quality Control Region (AQCR). This region, which is designated as a Class II area, is in compliance with National Ambient Air Quality Standards (NAAQS) for criteria pollutants. (Class II is the initial designation of any area that is not considered a pristine area; pristine areas include international parks or National wilderness areas). The criteria pollutants include sulfur dioxide, nitrogen oxides (reported as nitrogen dioxide), particulate matter (less than or equal to 10 microns), carbon monoxide, ozone, and lead (40 CFR Part 50).

DOE utilized the comprehensive emissions inventory data for 1990 to establish the baseline year for showing compliance with national and state air quality standards by calculating actual emission rates for existing sources. DOE based its calculated emission rates for the sources on process knowledge, source testing, material balance, and U.S. Environmental Protection Agency (EPA) Air Pollution Emission Factors (AP-42; EPA 1985). The inventory also included maximum potential emissions for sources permitted for construction through 1992.

DOE performs no onsite ambient air quality monitoring. State agencies operate ambient air quality monitoring sites in Barnwell and Aiken Counties in South Carolina and Richmond County in Georgia.

DOE has performed atmospheric dispersion modeling for criteria and toxic air pollutants for actual emissions for the base year 1990 (plus potential emissions for sources permitted for construction), using the EPA Industrial Source Complex Short Term No. 2 Model. This model used data from the SRS meteorological tower for 1991 along with the 1990 emissions data to estimate maximum

Table 3-4. 1993 atmospheric release by operational group.a

ground-level air pollutant concentrations at the SRS perimeter. DOE added the incremental impacts associated with the alternatives evaluated in this eis to the baseline concentrations to estimate total air quality impacts.

The South Carolina Department of Health and Environmental Control (SCDHEC) has air quality regulatory authority over the SRS and determines ambient air quality compliance based on SRS air pollutant emissions and estimates of concentrations at the Site perimeter based on atmospheric dispersion modeling. The SRS is in compliance with National Ambient Air Quality Standards for criteria pollutants and gaseous fluoride and total suspended particulate standards, as required by SCDHEC Regulation

R.61-62.5, Standard 2, "Ambient Air Quality Standards" (AAQS). Table 3-5 lists these standards and the results of the atmospheric dispersion modeling for base year 1990.

The SRS is in compliance with SCDHEC Regulation R.61-62.5, Standard 8, "Toxic Air Pollutants," which regulates the emission of 257 toxic air pollutants (WSRC 1994c). DOE has identified emission sources for 139 of the 257 regulated air toxics; the modeled results indicate that the Site is in compliance with SCDHEC air quality standards. Table 3-6 lists toxic air pollutants that are the same as those that the alternative actions described in this eis will emit. Table 3-6 also compares maximum downwind concentrations at the Site boundary for base year 1990 to SCDHEC standards for toxic air pollutants.

3.4 Socioeconomics

This section discusses baseline socioeconomic conditions in a region of influence where approximately 90 percent of the SRS workforce lived in 1992. The SRS region of economic influence includes Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. Socioeconomic Characteristics of Selected Counties and Communities Adjacent to the Savannah River Site (HNUS 1992) contains additional information on the economic and demographic characteristics of the six-county region.

3.4.1 EMPLOYMENT

Between 1980 and 1990, total employment in the six-county region increased from 139,504 to 199,161, an average annual growth rate of approximately 5 percent. The unemployment rates for 1980 and 1990 were 7.3 percent and 4.7 percent, respectively (HNUS 1992). Table 3-7 lists projected employment data for the region, which indicate that regional employment should increase to approximately 264,000 by 2004 (HNUS 1994).

Table 3-5. Estimated ambient concentrations of criteria air

pollutants from SRS sources.a,b

In Fiscal Year 1992, employment at the SRS was 23,351, approximately 10 percent of regional employment, with an associated payroll of more than $1.1 billion. Site employment in 2000 is likely to decrease to approximately 18,700 (Turner 1994), which would represent 7 percent of regional employment. Employment is likely to continue to decrease in subsequent years.

3.4.2 POPULATION

Between 1980 and 1990, population in the region of influence increased 13 percent, from 376,058 to 425,607. More than 88 percent of the 1990 population lived in Aiken County (28.4 percent),

Table 3-6. Estimated 24-hour average ambient concentrations at

the SRS perimeter - toxic air pollutants regulated by South Carolina from SRS sources.a

Table 3-7. Forecast employment and population data for the SRS region of influence.a

Columbia County (15.5 percent), or Richmond County (44.6 percent). Table 3-7 lists population data for the region of influence forecast to 2004. According to census data, in 1990 the estimated average number of persons per household in the six-county region was 2.72, and the median age of the population was 31.2 years (HNUS 1992).

3.4.3 COMMUNITY CHARACTERISTICS

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs and activities on minority and low-income populations; minority populations are hereafter referred to as people of color. DOE is in the process of developing official guidance on the implementation of the Executive Order; in addition, the Department is a participating member of the Interagency Working Group on Environmental Justice, which is developing definitions for environmental justice analyses. The guidance that the Working Group and DOE eventually develops might depart somewhat from the approach taken in this eis for analysis of environmental justice issues. This approach is intended to identify the potential effects from onsite activities on individuals in the identified communities of people of color or low income. The following discussion describes the framework for analysis of environmental justice issues for the alternatives considered in this eis.

The potential offsite health impacts would result from releases to the air and to Savannah River water downstream of the SRS. For air releases, standard population dose analyses are based on an 80-kilometer (50-mile) radius because expected dose levels beyond that distance are negligible. For liquid releases, the region of interest includes areas along the river that draw on the river for drinking water (Beaufort and Jasper Counties in South Carolina and Port Wentworth in Georgia). Combining these two areas, the analysis included U.S. Bureau of the Census data for populations in all census tracts that have at least 20 percent of their area in the 80-kilometer (50-mile) radius and all tracts from Beaufort and Jasper Counties in South Carolina and Effingham and Chatham Counties in Georgia, which are downstream of the Site. DOE used data from each census tract in this combined region to identify the racial composition of communities and the number of persons characterized by the U.S. Bureau of the Census as living in poverty. The combined region contains 245 census tracts, 98 in South Carolina and 147 in Georgia.

Tables 3-8 and 3-9 list racial and economic characteristics, respectively, of the population within the combined region. Table 3-8 indicates a total population of more than 1 million in the combined area. Of that total population, approximately 652,000 (63.6 percent) are white. Within the population of people of color, approximately 95 percent are African American. The remainder of the population of people of color is made up of small percentages of Asian, Hispanic, and Native American persons. Figure 3-5 shows racial distribution of people of color by census tract areas within the SRS region.

Table 3-8. General racial characteristics of population in the SRS region of analysis.a

Table 3-9. General poverty characteristics of population in the SRS region of analysis.a

Executive Order 12898 does not define minority populations. One approach to identifying minority communities would be to identify those communities that contain a simple majority of people of color (greater than or equal to 50 percent of the total community population). A second approach, identified by EPA, is that for environmental justice purposes, communities of people of color are defined as those that have higher-than-average (over the region of interest) percentages of minority persons (EPA 1994). In Figure 3-5 shaded areas show census tracts where (Approach 1) people of color comprise 50 percent or more (simple majority) of the total population in the census tract, or (Approach 2) people of color comprise less than 50 percent but more than 36 percent of the total population in the census tract. For purposes of analysis, DOE has adopted Approach 2, which is more expansive in this eis.

In the combined region, 84 tracts (34.3 percent) contain concentrations of people of color that are equal to or greater than 50 percent of the total population of the tract. In an additional 33 tracts (13.5 percent), people of color comprise between 36 and 50 percent of the population. These tracts are well distributed throughout the region, although weighted toward the south and with higher concentrations in the immediate vicinities of Augusta and Savannah, Georgia.

Figure 3-5. Racial distribution of census tracts in SRS region.

Low-income communities generally are defined as those in which 25 percent or more of the population is characterized as living in poverty (EPA 1993). The U.S. Bureau of the Census characterizes persons in poverty as those whose income is less than a "statistical poverty threshold." This threshold is a weighted average based on family size and the age of the persons in the family. The baseline threshold for the 1990 census was a 1989 income of $8,076 for a family of two.

Table 3-9 indicates that in the SRS region, more than 197,000 persons (19.3 percent of the total population) are characterized as living in poverty. In Figure 3-6, shaded census tracts in the region identify low-income communities. In the region, 77 tracts (31.4 percent) are identified as low-income communities. These tracts are distributed throughout the region, although more exist to the south of the SRS. As discussed in Chapter 4, no adverse health effects are expected to occur in any offsite community, including minority and low-income communities.

3.5 Occupational and Public Health

3.5.1 PUBLIC RADIOLOGICAL HEALTH

The release of radioactivity to the environment from any nuclear facility is a sensitive issue for onsite workers and the public. Because there are many other sources of radiation in the human environment, evaluations of radioactive releases from nuclear facilities must consider all the ionizing radiation to which

people are routinely exposed.

Public radiation exposure in the vicinity of the Site amounts to approximately 357 millirem per year, consisting of natural background radiation from cosmic, terrestrial, and internal body sources; radiation from medical diagnostic and therapeutic practices; radiation from weapons test fallout; radiation from consumer and industrial products; and radiation from nuclear facilities. Figure 3-7 shows the relative contributions of each source to people living in the vicinity of the Site. All radiation doses mentioned in this eis are "effective dose equivalents"; internal exposures are reported as "committed effective dose equivalents."

Releases of radioactivity to the environment from the Site account for less than 0.1 percent of the total annual average environmental radiation dose to individuals within 80 kilometers (50 miles) of the Site. Natural background radiation contributes about 293 millirem per year or 82 percent of the annual dose of 357 millirem received by an average member of the population within 80 kilometers (50 miles) of the Site. Based on national averages, medical exposure accounts for an additional

Figure 3-6. Low-income distribution of census tracts in SRS region

Figure 3-7. Major sources of radiation exposure in the vicinity of Savannah River Site.

14.8 percent of the annual dose, and the combined doses from weapons test fallout, consumer and industrial products, and air travel account for about 3 percent of the total dose (NCRP 1987a).

Other nuclear facilities within 80 kilometers (50 miles) of the Site include a low-level waste burial site operated by Chem-Nuclear Systems, Inc., near the eastern SRS boundary, and the Georgia Power Company's Vogtle Electric Generating Plant, directly across the Savannah River from the Site. In addition, Carolina Metals, Inc., which is northwest of Boiling Springs in Barnwell County, processes depleted uranium. The South Carolina Department of Health and Environmental Control annual report for 1992 on nuclear facility monitoring (SCDHEC 1992) documents that the Chem-Nuclear and Carolina Metals Facilities do not appear to influence radioactivity levels in the air, precipitation, groundwater, soil, vegetation, or external radiation, based on State measurements. Plant Vogtle began commercial operation in 1987; in 1991, releases from the plant produced a maximally exposed individual dose of 0.00017 rem at the plant boundary and a total population dose within an 80-kilometer (50-mile) radius of 0.057 person-rem (NRC 1994).

In 1993, releases of radioactive material to the environment from SRS operations resulted in a maximum Site perimeter individual dose from atmospheric releases of 0.11 millirem per year in the north-northwest sector around the Site, and a maximum dose from liquid releases of 0.14 millirem per year, for a maximum total annual dose at the Site perimeter of 0.25 millirem. The maximum dose to downstream consumers of Savannah River water - 0.05 millirem per year - occurred to Port Wentworth public water supply users (Arnett 1994).

In 1990 the population within 80 kilometers (50 miles) of the Site was approximately 620,100. The collective effective dose

equivalent to that population in 1993 was 7.6 person-rem from atmospheric releases. The 1990 population of 65,000 people using water from the Cherokee Hill Water Treatment Plant near Port Wentworth, Georgia, and the Beaufort-Jasper Water Treatment Plant near Beaufort, South Carolina, received a collective dose equivalent of 1.5 person-rem (Arnett 1994). Population statistics indicate that cancer caused 23.5 percent of the deaths in the United States in 1990 (CDC 1993). If this percentage of deaths from cancer continues, 23.5 percent of the U.S. population will contract a fatal cancer from all causes. Thus, in the population of 620,100 within 80 kilometers (50 miles) of the Site, 145,700 persons will be likely to contract fatal cancers
from all causes.

The total population dose from the SRS of 9.1 person-rem (i.e., 7.6 person-rem from atmospheric pathways plus 1.5 person-rem from water pathways) could result in 0.0046 additional latent cancer death expected in the same population (based on 0.0005 cancer death per person-rem).

3.5.2 PUBLIC NONRADIOLOGICAL HEALTH

The hazards associated with the alternatives described in this eis include nonradiological chemicals. Exposure to nonradiological chemicals occurs in the form of air and water pollution. Table 3-5 lists ambient air quality standards and concentrations for selected pollutants. Section 3.2.2 discusses water
quality in the vicinity of the SRS.

3.5.3 WORKER RADIOLOGICAL HEALTH

One of the major goals of the SRS Health Protection Program is to keep worker exposures to radiation and radioactive material as low as reasonably achievable (ALARA). An effective ALARA program must balance minimizing individual worker doses with minimizing the collective dose of all workers in a given group.

The purpose of an as-low-as-reasonably-achievable program is to minimize doses from both external and internal exposure. Such a program must evaluate both doses with the goal to minimize the total effective dose equivalent. ALARA evaluations must consider individual and group collective doses to ensure the minimization of both. (Using many workers to perform extremely small portions of a task would reduce the individual worker doses to very low levels. However, the frequent worker changes would make the work inefficient, with the result that the total dose received by all the workers would be significantly higher than if fewer workers received slightly higher individual doses.)

SRS worker doses have typically been well below DOE worker exposure limits. DOE has set administrative exposure guidelines at a fraction of the exposure limits to help enforce doses that are as low as reasonably achievable. For example, the current DOE worker exposure limit is 5 rem per year, and the 1993 SRS administrative exposure guideline was 1.5 rem per year.

Table 3-10 lists the maximum and average individual doses and the SRS collective doses from 1988 to 1993.

Workers exposed to radiation have an additional risk of contracting a fatal cancer of 0.04 percent per person-rem (NCRP 1993). In 1993, 5,157 SRS workers received a measurable dose of

radiation. Statistically, these workers should contract approximately 1,200 fatal cancers from all causes during their lifetimes; however, this cancer incidence rate depends on the age and sex distribution of the population. In 1993 this group received 263 person-rem and could experience as many as 0.1 additional cancer death due to their 1993 occupational radiation exposure. Continuing operation

Table 3-10. SRS annual individual and collective radiation doses.a

of SRS could result in as many as 0.1 additional cancer death for each year of operation, assuming future annual worker exposures continue at the 1993 level.

3.5.4 WORKER NONRADIOLOGICAL HEALTH AND SAFETY

Industrial hygiene and occupational health programs deal with all aspects of a worker's health and relationship with the work environment. The basic objective of an effective occupational health program is to protect employees against health hazards in their work environment. To evaluate these hazards, routine monitoring determines employee exposure levels to hazardous chemicals. Exposure limit values are the basis of most occupational health codes and standards. If an overexposure to a harmful agent does not exist, that agent generally does not create a health problem.

The Occupational Safety and Health Administration (OSHA) has established Permissible Exposure Limits (PELs) to regulate worker exposure to hazardous chemicals. These exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could receive repeated exposures day after day without adverse health effects.

Table 3-11 lists the estimated maximum annual concentrations of existing OSHA-regulated workplace pollutants modeled in and around the F- and H-Canyons. These nonradiological concentrations are associated with the continued maintenance and storage of plutonium solutions as well as other nuclear materials and, with the exception of nitric acid and nitrogen dioxide (as NOx), should not change from current levels. Section 4.1.2 describes the incremental impacts for nitric acid and NOx. Estimated concentration levels for existing OSHA-regulated workplace pollutants are

Table 3-11. Estimated maximum concentrations (milligrams per cubic meter) of OSHA-regulated workplace pollutants.a

less than 1 percent of the OSHA Permissible Exposure Limits, with the exception of benzene, which is 2 percent of the OSHA limit averaged over 8 hours.

DOE has established industrial hygiene and occupational health programs for the processes covered by this eis and across the SRS to protect the health of workers from nonradiological hazards.

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CHAPTER 4. ENVIRONMENTAL IMPACTS

This analysis covers the 10-year period from 1995 to 2004. DOE chose this period because it represents the period of time that DOE might require to make and implement decisions on the ultimate disposition of nuclear materials.

The environmental impact analyses in this chapter are based on conservative assumptions. The small calculated consequences indicate that DOE estimates small impacts. However, such estimates should not imply that the environmental consequences that could result from the alternatives are known to a precise degree of accuracy. Regardless of the size or degree of impact, this chapter presents the calculated consequences to enable relative comparisons of the alternatives.

The results of the analyses indicate that there would be little or no impact on the affected environment discussed in Chapter 3. DOE believes that, in light of planned SRS workforce reductions, it could fill the jobs associated with the implementation of any of the alternatives through the reassignment of current workers (e.g., transition of personnel from the FB-Line to a new oxide processing facility). Thus DOE anticipates no measurable impacts to socioeconomic resources from increases in operations employment. Similarly, DOE believes that current SRS workers could fill any construction jobs associated with the alternatives, thereby having no discernible impact on regional socioeconomic resources.

DOE analyzed the potential impacts of the alternatives evaluated in this environmental impact statement in relation to a number of subject areas (e.g., ecological systems) normally examined in such documents. However, because the F-Area is an industrial area with buildings, paved parking lots, and graveled areas with most natural vegetation removed, its value as habitat for wildlife is marginal. No aquatic habitat or wetlands occur in the area. The alternatives described in this eis would not affect threatened and endangered species and their habitat. No SRS facilities have been nominated for inclusion in the National Register of Historic Places, and there are no plans for such nomination. In this regard, these facilities meet one of the criteria for listing on the National Register of Historic Places; however, they do not meet other National Register criteria, such as being more than 50 years old. DOE will continue the process of evaluating SRS facilities to determine their eligibility for nomination to the National Register. Because the F-Area is an industrial site constructed during the 1950s, the presence of any important cultural resources remaining is unlikely. For these reasons and because minimal environmental impacts would occur, DOE believes that discussions of the following subjects are unnecessary in this chapter:

- Geologic Resources
- Ecological Systems
- Socioeconomics
- Cultural Resources
- Aesthetics and Scenic Resources
- Noise

This chapter describes the impacts of the alternatives related to:

- Health Effects of Normal Operations (Section 4.1)
- Health Effects from Accidents (Section 4.2)
- Air Resources (Section 4.3)
- Water Resources (Section 4.4)
- Utilities (Section 4.5)
- Waste Management (Section 4.6)
- Land Use and Transportation (Section 4.7)

4.1 Health Effects of Normal Operations

This section discusses the radiological and nonradiological health effects on the public and workers from all of the alternatives for the stabilization of the F-Canyon plutonium solutions during normal operations, which are planned activities associated with the alternative (e.g., sampling, maintenance). Health effects are represented as additional latent cancer fatalities likely to occur in the general population around the SRS and in the population of workers that would be associated with the alternatives.

4.1.1. RADIOLOGICAL HEALTH EFFECTS

Table 4-1 summarizes the radiological health effects from the combination of airborne and liquid releases (see Section 4.3.1 and 4.4, respectively) for each alternative to enable a comparison of the 10-year health effects; the table represents health effects as latent cancer fatalities. The increase

Table 4-1. Estimated radiological health effects from normal operations.a

would be small for any alternative (i.e., much less than one additional latent fatal cancer in the population during the lifetimes of the affected individuals). Impacts from alternatives other than No Action include impacts from operation of facilities and storage of materials.

The calculated health effects are based on (1) the collective dose to the population around the Site (approximately 620,000 people); (2) the collective dose to all workers in the affected group; and (3) the doses to the hypothetical maximally exposed individual in the public and the maximally exposed worker. The collective population doses include the dose from airborne releases and the dose resulting from the use of the Savannah River for drinking water, recreation, and as a source of food. The estimated worker doses are based on past operating experience and the projected activity maintenance and facility modification schedule for implementing the alternative actions (WSRC 1994a), as shown in Figure 2-2. From these radiological doses, estimates of latent cancer fatalities were calculated using the conversion factor of 0.0004 latent cancer fatality per rem for workers and 0.0005 latent cancer fatality per rem for the public (10 CFR Part 20). The value for the public is greater than that for workers because the public consists of all age groups (including children), while the worker population consists of adults.

Under the No-Action Alternative, the effect on the public could be 0.00055 additional cancer death in the population within 80 kilometers (50 miles) of the Site sometime over their lifetimes.

For comparison, 145,700 deaths from cancer due to all causes (see Section 3.6.1) would be likely in the same population over their lifetimes. The effect to SRS workers involved with the No-Action Alternative could be 0.24 cancer death over their lifetimes resulting from exposure to radiation over the 10-year period. In comparison, 136 cancer deaths would be likely from all causes in the same worker population over their lifetimes. The effects on the maximally exposed individual and the maximally exposed worker are not expressed as a latent cancer fatality but as the probability of contracting a fatal cancer from the doses listed in Table 4-1. For the maximally exposed member of the public, the probability of contracting a cancer associated with the 10-year dose would be 1 in 100 million. For the radiation worker, the probability would be 3 in 1,000.

These latent cancer probability values would be the same for the Processing to Metal, Processing to Oxide, Vitrification (Defense Waste Processing Facility), and Vitrification (F-Canyon) alternatives for both the maximally exposed individual and the maximally exposed worker. Under these alternatives, the health effects to the public would be 0.00049, 0.0006, 0.00046, and 0.00055 additional cancer deaths, respectively, over the lifetimes of the affected individuals. For the SRS worker population, the effect would be 0.13, 0.19, 0.11, and 0.19 additional cancer deaths, respectively. Tables 4-2 through 4-6 list the radiation dose information that was the basis for the composite radiological health effects. The magnitude of the errors associated with the projected radiation doses for all the alternatives would result in health effects that would be essentially the same for all alternatives.

4.1.2 NONRADIOLOGICAL HEALTH EFFECTS

This section discusses worker nonradiological health impacts from toxic pollutants that could be associated with the F-Canyon plutonium solution stabilization alternatives during normal operations and storage of materials. These releases would be small and, for each expected pollutant, would be only a small percentage of the discharges allowed by Federal and state regulations. Table 4-7 summarizes these impacts. Of these pollutants, benzene is the only carcinogen. The F-Canyon benzene emissions would result in a maximum annual average concentration of 0.001 milligram per cubic meter at the SRS boundary, and DOE modeling indicates that no offsite concentration would exceed this value. DOE calculates that F-Canyon benzene emissions would result in a lifetime probability of a latent cancer of 3 in 1 billion.

DOE estimated the worker impacts using a mathematical model to calculate concentrations in and around F-Area (WSRC 1994a) and compared them to the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) or ceiling limits. The OSHA limits (29 CFR Part 1910.1000) are time-weighted average concentrations that a facility cannot exceed during any 8-hour work shift of a 40-hour week. The facility cannot exceed OSHA ceiling concentrations during any part of the workday. These exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could be exposed day after day without adverse health effects. However, because of the wide variation in

Table 4-2. Estimated doses from the No-Action Alternative for normal operations.

Table 4-3. Estimated doses from the Processing to Plutonium Metal Alternative for normal operation.

Table 4-4. Estimated doses from the Processing to Plutonium Oxide Alternative for normal operations.

Table 4-5. Estimated doses from teh Vitrification (Defense Waste Processing Facility) Alternative for normal operations.

Table 4-6. Estimated doses from the Vitrification (F-Canyon) Alternative for normal operations.

Table 4-7. Estimated worker nonradiological health summary impacts (milligrams per cubic meter).a

individual susceptibility, a small percentage of workers could experience discomfort from some substances at concentrations at or below the permissible limit.

DOE expects minimal public health impacts from nonradiological effects. Further, because discharges and emissions would vary little among the alternatives, public health effects would vary little among the alternatives.

4.1.3 ENVIRONMENTAL JUSTICE ASSESSMENT

This eis examines whether communities of people of color or low income could be subject to disproportionately high and adverse impacts of emissions. Even though, as noted above, adverse radiological health impacts are not likely, this assessment presents an analysis to determine if any such impacts could have disproportionate distribution in the spirit of Executive Order 12898. Figures 3-5 and 3-6 identify communities of people of color or low income by census tract. This section presents the predicted average radiation doses received by individuals in the identified communities and compares them to the predicted per capita doses received in the other communities within the 80-kilometer (50-mile) region.

Figure 4-1 shows a wheel with 22.5-degree sectors and concentric rings from 16 to 80 kilometers (10 to 50 miles) at 16-kilometer (10-mile) intervals. The fraction of the total population dose was calculated for each sector (Simpkins 1994), the sector wheel was laid over the census tract map, and each tract was assigned to a sector. For this analysis, if a tract fell in more than one sector, it was assigned to the sector with the largest value.

To determine the per capita radiation dose received in each type of community, the number of people in each tract was multiplied by that tract's dose value to obtain a total population dose for each tract. These population doses were summed over all sectors of the region for each type of community and divided by the total community population to obtain a community per capita dose.
Table 4-8 lists these results.

Table 4-8. Estimated per capita 10-year dose by identified communities

in 80-kilometer (50-mile) region.a

Because these numbers are very small and differ very little, this analysis indicates that people of color or low income in the 80-kilometer (50-mile) region would not receive disproportionate impacts.

Table 4-13 (page 4-22) lists predicted doses to the maximally exposed individual and to the downstream population from exposure to water resources for each of the alternatives. The doses reflect people using the Savannah River for drinking water, recreation, and as a source of food. Because the identified communities in the areas downstream from the SRS are well-distributed, and because there would be no adverse impacts to any downstream region (the highest 10-year dose to the maximally exposed individual for any of the alternatives would be 0.0000029 rem for the Processing to Metal or Processing to Oxide Alternative), there would be no environmental justice concerns for any of the alternatives in the downstream areas.

Figure 4-1. Identification of annular sectors around the

Savannah River Site

4.2 Health Effects from Accidents

This section summarizes the risks to members of the public, workers, and the environment from potential facility accidents associated with the alternatives for stabilization of the plutonium solutions. This assessment does not include solutions other than those containing plutonium (e.g., americium/ curium solutions) because these materials provide no basis for discriminating among alternatives. An accident is an unplanned event leading to an undesirable release of radioactive or hazardous material within a facility or to the environment. A potential exists for facility accidents in all of the alternatives, including the No-Action Alternative. Appendix B provides further detail and discussion on the accident analyses.

This assessment is based on potential accidents identified and described in the safety analysis reports for the F-Area facilities and on the inventories of hazardous chemicals in the F-Area facilities that could be required to implement the alternatives. The assessment includes the F-Canyon, FB-Line, FB-Line vault, and F-Area Outside Facilities. The accidents considered include events resulting from external initiators (e.g., aircraft crashes, nearby explosions), internal initiators (e.g., equipment failures, human errors), and natural phenomena initiators (e.g., earthquakes, tornadoes).

DOE calculated a baseline set of doses using mathematical models that estimate these doses based on 1-curie releases to an uninvolved worker at 640 meters (2,100 feet), the maximally exposed offsite individual, and the collective offsite population within 80 kilometers (50 miles) of the Site (see Appendix B for more details). DOE adjusted these doses based on the number of curies estimated for release in each accident. These accident doses were multiplied by estimated accident frequencies to determine the accident risk. When available, the frequency of the projected release is provided in lieu of the frequency of the initiator. Estimates of latent fatal cancers are calculated from the accident doses using the conversion factors of 0.0004 latent

cancer fatality per rem for workers and 0.0005 latent cancer fatality per rem for the public (10 CFR Part 20).

Appendix B provides the projected latent fatal cancer risks for a spectrum of accidents for each facility that would be involved with the alternatives. To enable a relative comparison of impacts among the alternatives, the accident with the highest consequence was assumed to occur and the maximum latent cancer fatalities were calculated. For F-Canyon and the F-Canyon Vitrification Facility, the accident was a severe fire; for FB-Line, it was a severe earthquake; and for F-Area Outside Facilities, it was a chemical event leading to a ruthenium vapor release. Table 4-9 provides information on the number of latent cancer fatalities that would be likely in the population as a result

Table 4-9. Maximum potential impacts from accidents involving

plutonium solution alternatives.a,b

of the accidents. The information listed for the uninvolved workers and the maximally exposed individual would be the individual's probability of contracting a fatal cancer if the accident occurred. For all the alternatives, the increase would be a small fraction of an individual's chance of developing a fatal cancer from all other causes. The population data are somewhat more meaningful because the conversion factors used to estimate latent fatal cancers are statistically based.

Figure 2-2 shows the schedules for the use of facilities for each alternative. The data from Table 4-9 for the number of potential latent cancer fatalities in the population around SRS provide a perspective on risk over time. The frequency for the accidents with the highest consequence (i.e., how often they are likely to occur) is once in 5,000 years for a severe earthquake and once in 17,000 years for a plutonium solutions fire involving solvent. Section B.2.5 explains the method for projecting the frequency of a plutonium solutions fire, which is a "fault-tree" approach.

Changes and reductions in latent cancer fatalities are related to the activities associated with the alternatives and the form of the material. For example, in the Processing to Metal or Processing to Oxide Alternative the latent cancer fatalities would increase during processing operations This is because accidents that would not occur during storage, such as those associated with FB-Line, must be included. The possibility of latent cancer fatalities would decrease after processing because the set of accidents associated with storing solutions (transfer errors, leaks, etc.) could no longer occur.

For accidents involving the release of hazardous material, the EPICode- computer code (Homann 1988) analyzed the consequences of spills and gaseous releases of hazardous materials used in the F-Area that the U.S. Environmental Protection Agency (EPA) categorizes as "Extremely Hazardous Substances" (29 CFR Part 1910). The assessment calculated chemical concentrations to an uninvolved worker at 640 meters (2,100 feet) and the maximally exposed offsite individual at the nearest Site boundary. The calculated chemical concentrations were compared to Emergency Response Planning Guidelines (ERPG) values issued by the American Industrial Hygiene Association (AIHA 1991) or equivalent sanctioned limits if there were no guidelines for the hazardous material.

Table 4-10 lists the postulated impacts from maximum reasonably foreseeable accidents (e.g., severe earthquakes) involving hazardous materials in the F-Area. These impacts generally would be based on estimated releases from F-Area Outside Facilities or would

assume the release of the "maximum daily amount" in the entire area; they would not change from alternative to alternative. There is a potential for serious worker injury or fatality involving the accidental release of hydrogen fluoride. No other hazardous substance accidents are likely to result in long-term health impacts to workers, the public, or the environment.

Table 4-10. Estimated impacts from potential releases of Extremely Hazardous Substances in F-Area resulting from a severe earthquake.

4.3 Air Resources

This section discusses radiological (Section 4.3.1) and nonradiolo gical (Section 4.3.2) air quality impacts to the public from normal operations and storage of material for all of the alternatives. The information in this section was one of the bases for the health effects discussed in Section 4.1.

4.3.1 RADIOLOGICAL AIR QUALITY

This assessment of radiological air quality used the MAXIGASP and POPGASP computer programs (Simpkins 1994) to calculate radiological doses from estimated annual airborne releases of radionuclides. These programs calculate the dose to a hypothetical maximally exposed individual at the SRS boundary and the collective dose to the population within a 80-kilometer (50-mile) radius, respectively. For this assessment, DOE assumed that the population would remain constant over the 10-year period of interest; this assumption is justified because (1) current estimates indicate that the population will increase by less than 5 percent during this period, (2) there are uncertainties in the determination of year-to-year population distributions out to 80 kilometers (50 miles), and (3) the comparison between alternatives would not be affected. The assessment compared maximally exposed individual doses to the SRS airborne dose limit of 10 millirem (0.010 rem) per year (DOE 1993). It estimated annual airborne radionuclide releases for each alternative from emission or environmental monitoring data from F-Canyon operations and the projected schedules for the alternative actions (WSRC 1994a).

Table 4-11 summarizes the calculated doses from airborne radionuclide releases for each alternative. The maximum annual doses would be equal to or higher for each of the stabilization alternatives than for the No-Action Alternative; higher doses would be the result of additional releases that would occur due to processing activities in the F-Canyon.

Table 4-11. Estimated radiological doses from airborne releases during normal operation.

As Table 4-11 indicates, there would be little or no difference in the doses to either the offsite population or the maximally exposed individual from any of the alternatives. All doses would be less than those from the total SRS air emissions. In 1993 the total SRS air emissions resulted in a dose of 0.11 millirem (0.00011 rem) to the maximally exposed individual and 7.6 person-rem to the offsite population. The dose to the maximally exposed individual from the total SRS emissions (0.11 millirem) is approximately 1 percent

of the SRS airborne limit of 10 millirem.

4.3.2 NONRADIOLOGICAL AIR QUALITY

For the assessment of nonradiological air quality impacts, DOE used the Industrial Source Complex No. 2 (ISC2) model (EPA 1992) to calculate the SRS boundary concentrations for estimated normal releases of four criteria pollutants [carbon monoxide, nitrogen oxides, particulate matter less than or equal to 10 microns (PM10), and sulfur dioxide], total suspended particulates, gaseous fluorides, and the six major toxic air pollutants expected from F-Canyon processing (benzene, hexane, nitric acid, sodium hydroxide, toluene, and xylene). The assessment did not include two criteria pollutants: lead because there would be no lead emissions associated with the activities analyzed in this eis, and ozone because F-Canyon sources do not emit it directly. However, ozone can be formed by photochemical reactions of other pollutants including nitrogen oxides and volatile organic compounds. F-Canyon sources do result indirectly in the generation of ozone. Photochemical modeling would be required to assess ozone concentrations; at the present time, adequate input data for such modeling do not exist. Monitoring data, however, indicate that the area in the SRS vicinity is in compliance with the ozone air quality standard.

The assessment used the ISC2 short-term model for all calculations except the annual concentrations for the toxic air pollutants, for which it used the long-term model. Emissions data for the worst-case year (the year with the highest emissions) were entered in the model along with the meteorological data discussed in Section 3.3. The assessment estimated nonradiological airborne releases from the F-Canyon main stack for each alternative from emission or environmental monitoring data during past F-Canyon operations, engineering judgment, and the schedule for the alternative actions (WSRC 1994a). Emissions information was not available by alternative for the diesel generators that power the canyon exhaust fans and for the storage tanks that contain diesel fuel or feed chemicals for canyon processes. Therefore, emissions from diesel generators and storage tanks were determined from the SRS air emissions inventory and current operating permit data for F-Area (WSRC 1994e). These generator and storage tank emissions represent maximum usage and capacity; DOE assumes that they would not vary by alternative. The computed SRS boundary incremental concentrations were added to the baseline concentrations and compared to applicable air quality standards.

Table 4-12 lists the ISC2 modeling results for each alternative. The impacts associated with the stabilization alternatives except Vitrification through the Defense Waste Processing Facility would be higher for certain pollutants than those for the No-Action Alternative; this would be the result of processing activities in the F-Canyon to both prepare and stabilize the solutions. As Table 4-12 indicates, there would be little or no difference in the increase of pollutants from any of the alternatives. When added to the SRS baseline, all alternatives would result in levels below air quality standards.

4.4 Water Resources

This section describes the impacts on surface-water and groundwater quality during normal operations and storage of materials associated with the alternatives for F-Canyon plutonium solutions. The information in this section was one of the bases for the

health effects discussed in Section 4.1.

None of the alternatives would result in significant impacts to either surface water or groundwater. This section also presents the methods used for and the results of the assessment of the impacts of normal operational releases of radionuclides and chemicals to surface water for each alternative. The two major sources of liquid effluents would be process cooling water and steam condensate that could become slightly contaminated with small quantities of radionuclides and chemicals. Another source of liquid effluents would be the F-Area sewage treatment plant. Because none of the facilities that would be required for implementing alternatives is within the 100-year floodplain, DOE anticipates no surface-water impacts from floods.

This assessment calculated the health effects from radioactive releases to surface water and groundwater to a hypothetical maximally exposed individual living just downriver of SRS and to the collective population using the Savannah River downstream of SRS (including downstream municipal water users at

Beaufort-Jasper and Port Wentworth) (Simpkins 1994) using the LADTAP computer code (Hamby 1991). The assumed exposure pathways are drinking water, fish ingestion, shoreline exposure, swimming, and boating. The estimates of radionuclide releases are based on effluent and environmental monitoring data during past F-Canyon operations and the projected schedules for the alternative actions (WSRC 1994a). Plutonium and uranium isotopes would be the major contributors to the offsite population dose; cesium-137 in fish and strontium would be secondary contributors.

Table 4-13 summarizes the calculated annual doses to the public from liquid releases to surface waters. For each stabilization alternative, the total population dose from liquid releases would be somewhat lower than that from the No-Action Alternative. The lower total dose would result from the

Table 4-12. Estimated maximum incremental air pollutant impacts

at the SRS boundary.a(page 1)

Table 4-12. Estimated maximum incremental air pollutant impacts

at the SRS boundary.a(page 2)

Table 4-13. Estimated doses received by the public from liquid

pathways.a

decrease in releases after the processing of the solutions and their removal from the F- Canyon. The calculated dose to the maximally exposed individual would show the same trend as that for the offsite population dose for each alternative.

As Table 4-13 indicates, there would be little or no difference in the doses either to the offsite population or the maximally exposed individual from any of the alternatives. The doses from each alternative would be small compared to the drinking water standard of 4 millirem per year.

All alternatives would involve the release of chemicals to Fourmile Branch via process cooling water. Although the gross amount of material would not be constant, the concentration of these materials for all alternatives would not vary. The

estimated release concentrations are listed below (WSRC 1994a):

- Nitrate (40 micrograms per liter)
- Ammonia (30 micrograms per liter)
- Manganese (10 micrograms per liter)
- Uranium (20 micrograms per liter)
- Lead (6 micrograms per liter)
- Nickel (50 micrograms per liter)
- Chromium (20 micrograms per liter)
- Aluminum (200 micrograms per liter)
- Copper (10 micrograms per liter)
- Zinc (70 micrograms per liter)

Proposed or final Federal drinking water standards would apply at the nearest downstream drinking water supply in the Savannah River, after dilution of the release with river water. Although these would not apply to the release itself, the chemical concentrations listed above would not exceed such standards (Arnett, Karapatakis, and Mamatey 1994) or South Carolina Water Quality Standards (SCDHEC 1993). In general, the release concentrations would be comparable to those previously measured in Fourmile Branch (Arnett 1994). Lead, nickel, chromium, and copper were not detected in measurements performed in 1993 (Arnett 1994); the discharge concentrations of these chemicals would be comparable to those measured in 1992 (Arnett 1993). Zinc, which was not detected in 1993 in Fourmile Branch but was detected there in 1992, would be discharged at concentrations two orders of magnitude less than South Carolina Water Quality Standards, which are based on the taste and odor of drinking water. The maximum effluent discharge flow rate would be approximately 0.5 percent of the normal creek flow rates.

4.5 Utilities

DOE based its estimates of the annual consumption rates of water, electricity, steam, and fuel on past operational experience and the projected usage for each alternative. Table 4-14 lists these estimates. Next, DOE compared these annual consumption rates to the SRS utility capacities described in Table 4-15 to determine the potential for impacts. Existing capacities and distribution systems at the SRS would be adequate to support any of the alternatives; no new generation or treatment facilities would be necessary.

Table 4-14. Estimated annual utility consumption by alternative.a

(page 1)

Table 4-14. Estimated annual utility consumption by alternative.a

(page 2)

Table 4-15. Current capacities and usage and energy at the Savannah River Site.a

Over the 10-year period (1995 through 2004), DOE estimates that the smallest increase in total demand for utilities would result from the Processing to Plutonium Metal Alternative.
The largest increases would be associated with the No-Action and Vitrification (Defense Waste Processing Facility) Alternatives, which would place greater demands on utility systems because SRS facilities (e.g., F-Area and the proposed Defense Waste Processing Facility) would operate at higher levels and for longer periods than they would for the other alternatives, which would place these

facilities in standby modes more quickly.

As listed in Table 4-14, DOE estimates that implementation of the Vitrification (Defense Waste Processing Facility) Alternative would involve peak demands of approximately 25,200 megawatt-hours of electricity, 1,360 million liters (359 million gallons) of water, 120 million kilograms (265 million pounds) of steam, and 800,000 liters (211,000 gallons) of fuel. These changes would represent modest increases over baseline usage (ranging from 4 percent for electricity to 17 percent for fuel) and would be well within current system capabilities and usage limits. The other alternatives would result in smaller increases in energy usage and would have no adverse impact on utility services at SRS.

4.6 Waste Management

The SRS generates several different types of waste, including low-level waste, high-level waste, transuranic and mixed waste. SRS-generated low-level waste, prior to compacting, averages 19,000 cubic meters (671,000 cubic feet) per year, excluding waste associated with major decontamination and decommissioning and environmental restoration projects that DOE will perform in the future (WSRC 1994c). There are 51 waste tanks and 3 evaporators at SRS for storing and reducing the volume of liquid radioactive waste. On September 30, 1993, approximately 126,000 cubic meters (4,450,000 cubic feet) of high-level liquid radioactive waste were stored on the Site (WSRC 1994c). At the end of 1993, SRS had approximately 9,900 cubic meters (350,000 cubic feet) of transuranic waste in storage, and generates approximately 765 cubic meters (27,000 cubic feet) of this waste annually. Table 4-16 lists estimated generation rates of Defense Waste Processing Facility canisters for each alternative. These estimates are based on current and past SRS operations (WSRC 1994a), and include the waste associated with operations of facilities and storage of materials.

Table 4-16. Equivalent DWPF canister generation rates for each

alternative.

As listed in Tables 4-16 and 4-17, DOE estimates that, over the 10-year period, the smallest increase for all waste types would occur if it implemented the Processing to Plutonium Metal Alternative. The largest increase in saltstone [6,461 cubic meters (8,450 cubic yards) after 10 years] would result from implementing the Processing to Oxide Alternative, while the largest increase in low-level waste [14,371 cubic meters (18,796 cubic yards) after 10 years] would result from implementing the Processing to Oxide Alternative.

With the exception of vitrification, the impact on SRS waste management capacities from implementing any of the alternatives would be minimal because the Site can accommodate all the waste generated with existing and planned radioactive waste storage and disposal facilities. None of the alternatives is likely to generate substantial quantities of mixed waste.

4.7 Land Use and Transportation

None of the alternatives would impact SRS land use. Under the Plutonium to Oxide Alternative, a new facility containing equipment to process, package, and store the plutonium oxide could require approximately 4.5 acres of previously disturbed F-Area land.

During the construction of a new facility, occasional spills of oil and fuel could occur. In the event of spills, cleanup would be consistent with the SRS Spill Prevention, Control, and Countermeasures

Table 4-17. Waste generation rates for each alternative.a,b

Plan. Consistent with best management practices, DOE would mitigate erosion and fugitive dust by the constructing barriers to control soil runoff and by watering to lessen fugitive dust emissions.

Transportation impacts related to modification and construction activities would not be likely to increase measurably. Traffic would remain at or below current Site levels because workers for any new activities would come from the current SRS workforce.

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CHAPTER 5. CUMULATIVE IMPACTS

Chapter 3 describes Savannah River Site baseline environmental conditions. Chapter 4 describes the potential environmental consequences to the SRS and the surrounding region of the four alternatives under consideration. In addition to these impacts, this chapter considers cumulative impacts, which include the impacts of existing offsite (non-DOE) industrial facilities and potential impacts of planned SRS facilities. This cumulative impact assessment recognizes that possible environmental impacts of SRS actions could occur in a regional as well as a local context, and that conditions in the surrounding area could increase or decrease offsite impacts of such actions.

Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear powerplant a short distance across the Savannah River from the SRS, are minimal, but DOE has factored them into the analysis. Radiological impacts of the soon-to-be-discontinued operation of the Chem-Nuclear Services facility, a commercial low-level waste disposal facility just east of the SRS, are so miniscule that this assessment does not include them.

In the National Environmental Policy Act (NEPA) documents listed below DOE is evaluating a number of facilities that are existing, planned, or under construction at the SRS.

- Proposed facilities and actions in the SRS Defense Waste Processing Facility (DWPF) Supplemental eis

- Proposed facilities and actions in the SRS Waste Management eis

- Proposed facilities and actions in the Interim Management of Nuclear Materials eis

- Proposed facilities and actions in Appendix C (SRS Spent Nuclear Fuel Management Program) of the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement

To the extent that data were available from these impact assessments and were relevant, they have been included in the cumulative impact analyses that follow.

DOE has not included a number of other planned facilities in this cumulative impact analysis because decisions on these facilities involve major unresolved DOE policy issues. For example, this analysis does not consider DOE planning related to reconfiguring the nation's weapons complex.

This cumulative analysis does not attempt to present quantitative impacts for the Environmental Management Programmatic eis, the Foreign Research Reactor Spent Nuclear Fuel eis, or the Programmatic eis for Disposition of Weapons-Usable Fissile Materials.

Cumulative impacts have been determined for air quality, water

quality, occupational and public health, waste generation, and socioeconomics. Contributions by the preferred alternative and the other alternatives to the cumulative impacts of SRS operations on regional ecosystems and the Savannah River watershed (e.g., impacts on land use, surface water, groundwater, and wildlife) were too small to characterize.

5.1 Public and Worker Health

Table 5-1 summarizes the cumulative health effects of routine SRS operations, including those projected for radioactive releases associated with the treatment of F-Canyon plutonium solutions. In addition, Table 5-1 lists the radiological doses to the hypothetical maximally exposed individual and the offsite population and potential cancer fatalities for the public and workers due to exposure to radiation. These cumulative impacts could result in an additional latent cancer fatality risk of 1.0 * 10-7 to that individual and in a total of 0.014 additional cancer fatality to the 80-kilometer (50-mile) population from releases of radioactivity. The treatment of plutonium solutions would account for about 1 percent of these health effects. The cumulative impact could result in 0.24 additional latent cancer fatality to onsite workers; the treatment of plutonium solutions would account for approximately 22 percent of these health effects.

5.2 Air Resources

Table 5-2 compares the estimated cumulative concentrations of nonradiological air pollutants from the SRS to Federal and state regulatory standards. The listed values are the maximum modeled concentrations that would occur at ground level at the Site boundary. The data demonstrate that total estimated concentrations of nonradiological air pollutants from the SRS, including those from the treatment of plutonium solutions, would be well below the regulatory standards at the Site boundary.

Table 5-1. Estimated maximum annual cumulative radiological

doses and resulting health effects to offsite population and facility workers.

Table 5-2. Estimated maximum nonradiological cummulative ground-

level concentrations of criteria an toxic pollutants (micrograms per cubic meter) at the SRS boundary.a

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to a maximally exposed individual at the Site boundary. DOE has included the impacts of the two-unit Plant Vogtle in this cumulative total. The radiological emissions of the Chem-Nuclear low-level waste disposal facility just east of the SRS are very low and are not included. Table 5-3 lists the results of this analysis, using the 1993 emissions (1991 for Plant Vogtle) as the SRS baseline. The highest cumulative dose to the maximally exposed member of the public would be 0.00052 rem (0.52 millirem) per year, well below the regulatory standard (40 CFR Part 61) of 10 millirem per year. Summing the doses to maximally exposed individuals for the five actions or facilities listed in Table 5-3 is a conservative approach because it assumes that the maximally exposed individual would be the same person for each facility

or action. Physically, the difference in the geographic locations of the facilities would make it impossible for the maximally exposed individual to be the same person for each facility or action. Therefore, the total reported dose is a conservative overestimate of the cumulative dose to any individual.

Table 5-3. Estimated annual cumulative radiological doses and resulting health effects to offsite population from airborne releases.

The highest calculated annual collective dose to the offsite population from airborne emissions would be 0.38 person-rem. Adding the annual collective dose from current and projected activities at the SRS, including treatment of plutonium solutions, operation of the Defense Waste Processing Facility, and management of spent nuclear fuel, would yield a maximum annual cumulative dose of 24.1 person-rem from airborne sources, 1.5 percent of which would be attributable to the treatment of plutonium solutions. This annual dose would translate to 0.014 latent cancer fatality in the population within an 80-kilometer (50-mile) radius of the SRS.

5.3 Water Resources

Table 5-4 summarizes the estimated cumulative radiological doses from exposure to waterborne sources downstream of the SRS. The two major sources of radioactive liquid effluents from the Site would be process cooling water and steam condensate that could contain small quantities of radionuclides released to SRS streams that are tributaries of the Savannah River. Exposure pathways considered in this analysis include drinking water, fish ingestion, shoreline exposure, swimming, and boating. The ingestion of fish containing cesium-137 would contribute most of the exposure to both the maximally exposed individual and the offsite population. Plutonium and uranium isotopes ingested with drinking water would be secondary contributors.

Table 5-4. Estimated annual cumulative radiological doses and resulting health effects to offsite population from liquid releases.

The estimated annual dose to the maximally exposed individual from all actions would be 0.00041 rem, of which the treatment of plutonium solutions would represent much less than 1 percent. The estimated maximum annual collective dose to the population would be 3.9 person-rem, with the dose from treatment of plutonium solutions representing much less than 1 percent of the total dose. This cumulative dose could result in 0.0020 latent cancer fatalities in the exposed population.

5.4 Waste Generation

Table 5-5 lists maximum cumulative volumes of radioactive waste and mixed waste generated by the SRS for the listed projected activities. Existing operational values are based on the SRS 30-year waste forecast (WSRC 1994b) and Appendix C to the Draft Programmatic Spent Nuclear Fuel eis (DOE 1994a).

Table 5-5. Maximum estimated cumulative waste generation from

SRS operations, 1995 to 2004.

This analysis does not include environmental restoration and decontamination and decommissioning activities, which are likely to become an increasingly important part of the DOE mission in the future. Such activities, which are likely to produce large quantities of low-level radioactive waste, hazardous, and mixed waste, will undergo appropriate NEPA evaluation.

5.5 Socioeconomics

DOE expects proposed Defense Waste Processing Facility construction activities (including planned modifications and completion of support facilities) to create approximately 270 direct construction jobs during the peak years, 1999 and 2000 (DOE 1994d). No new operations jobs are likely to result from the DWPF coming on line. Indirect (non-SRS) employment from the construction and operation of the DWPF should peak between 1999 and 2000, with approximately 110 new jobs created per year in the six-county area around SRS.

Depending on the management alternative and sites selected, spent nuclear fuel activities at the SRS could require as many as 2,700 construction workers (DOE 1994c). Operations employment is not likely to increase as a result of spent nuclear fuel management activities. The nuclear materials management issues DOE is addressing in the related Interim Management of Nuclear Materials eis are not likely to create any new jobs at the SRS or to affect the regional economy in any substantive way.

The construction of the Consolidated Incineration Facility could require as many as 175 workers (peak year), most of whom would come from the existing SRS workforce. The construction of the Replacement High-Level Waste Evaporator could require as many as 70 workers in a given year (WSRC 1994b). DOE does not expect additional employment to result from the operation of either facility. DOE has not determined the workforce requirements associated with other SRS Waste Management eis projects under consideration, but they should have minimal additional impacts on the economy of the region.

The construction of Phase 1 of the Savannah River Research Campus, being built just outside the Site boundary, could require 150 workers. Once completed, in early 1995, the campus could employ an estimated 200 people (Saccone 1994). These additional jobs would have a minimal impact on socioeconomic resources in the region.

DOE believes that there would be no net increase in construction jobs or operation jobs associated with the implementation of any of the plutonium solution stabilization alternatives. The Processing to Plutonium Oxide Alternative would require the construction of a new Actinide Packaging Facility (or expansion of an existing facility) to convert low-fired oxide to high-fired (completely oxidized) oxide and to package the oxide in an inert atmosphere. The development of this facility could require as many as 150 construction workers in a given year. However, all construction jobs and operations jobs probably would be filled though the reassignment of existing SRS workers (e.g., transfer of workers from FB-Line to the new facility). Therefore, DOE does not anticipate measurable impacts to regional socioeconomic resources from changes in SRS employment levels.

The maximum potential change in employment associated with the proposed action and alternatives, construction and proposed operation of DWPF facilities, new waste management facilities, new spent nuclear fuel management activities, and the Savannah River Research Campus would occur around 2002, when approximately 3,000 (mostly construction) jobs would be created. This compares to a predicted regional labor force of 261,234 in 2002. This small increase, roughly 1 percent, in direct employment resulting from all these projects would have temporary impacts on the six-county region of influence.

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CHAPTER 6. SHORT-TERM USE VERSUS LONG-TERM RESOURCE COMMITMENTS

This section addresses the relationship between short-term uses of the environment and the maintenance of its long-term productivity.

Reinstituting activities at the F-Canyon and support facilities to accommodate the stabilization of plutonium solutions would result in the short-term resource uses described in Chapter 4. However, these activities would not be likely to compromise environmental resources beyond the 10-year duration of stabilization activities. As a result of normal operations, short-term use of the atmosphere as a receptor for emissions would have an incremental minimal effect on long-term global atmospheric conditions. DOE anticipates no increase in long-term resource commitments (e.g., electricity consumption).

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CHAPTER 7. IRREVERSIBLE OR IRRETRIEVABLE RESOURCE COMMITMENTS

Irreversible and irretrievable commitments of resources that could occur with the implementation of any of the alternatives to stabilize plutonium solutions currently stored in the F-Canyon at the Savannah River Site fall into the categories of materials and energy. The physical plant and facilities that would be required to implement the No-Action and Vitrification (Defense Waste Processing Facility) Alternatives would rely on existing facilities, so the resources typically required to construct new buildings and establish new engineering processes would not be required. The Processing to Metal Alternative would require minor modifications to FB-Line to provide new repackaging capabilities for the metal produced. The Processing to Oxide Alternative would involve more extensive modifications to FB-Line and potentially a new facility, which would require about 4.5 acres in F-Area. The Vitrification (F-Canyon) Alternative would require extensive modifications to the F-Canyon facility.

7.1 Materials

The construction of the Repackaging and Vault Facility would require about 4,600 cubic meters (6,000 cubic yards) of concrete and about 335 metric tons (370 tons) of steel. Chemicals such as nitric acid and tributyl phosphate would be committed for the various alternative processes. The required chemicals and materials are readily available. Strategic and critical materials (e.g., beryllium, cadmium, cobalt) would not be required in quantities that would seriously reduce the national or world supply.

Existing facilities that DOE would use for stabilization activities would have contaminated areas and equipment that would be unusable for recycling. This would include materials such as masonry, piping, metal structures and objects, flooring, and plastics.

7.2 Energy

Energy would be consumed under all alternatives to provide power to operate the F-Canyon buildings and the various process activities conducted in them. Steam would be used for applications such as evaporators and off-gas reactors. The fuel used to create electricity for the facilities would be purchased from commercial utilities. Small amounts of diesel fuel would also be used.

Annual electric consumption rates have been estimated for 1995 through 2004. The annual electric use estimate for the No-Action Alternative would be 21,974 million kilowatt-hours. For the Processing to Plutonium Metal Alternative the use would range between 12,197 and 26,284 million kilowatt-hours. For the Processing to Plutonium Oxide Alternative, annual use would range from 12,197 to 26,284 million kilowatt-hours. For the Vitrification (Defense Waste Processing Facility) Alternative, electric use

would range from 12,096 to 25,200 million kilowatt-hours annually. For the Vitrification (F-Canyon) Alternative, electric use would range from 15,231 to 25,307 million kilowatt-hours annually.

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CHAPTER 8. LAWS AND REQUIREMENTS

This chapter identifies and summarizes major laws, regulations, executive orders, and DOE Orders that might apply to the Proposed Action and its alternatives.

8.1 Federal Statutes and Regulations

NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) establishes a national policy promoting awareness of the environmental consequences of the activity of humans on the environment and promotes a consideration of environmental impacts during the planning and decisionmaking stages of a project. NEPA requires all agencies of the Federal Government to prepare a detailed statement on the environmental effects of proposed major Federal actions that could significantly affect the quality of the human environment.

DOE prepared this environmental impact statement (eis) in accordance with the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA (40 CFR Parts 1500 through 1508) and DOE's NEPA Implementing Procedures (10 CFR Part 1021). The eis discusses reasonable alternatives and their potential environmental consequences.

ATOMIC ENERGY ACT

The Atomic Energy Act of 1954 authorizes DOE to establish standards to protect health or minimize dangers to life or property with respect to activities under its jurisdiction. Through DOE Orders, regulations, and guidelines, the Department has established these environmental, health, and safety standards to ensure safe operations of its facilities.

CLeaN AIR ACT

The Clean Air Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Act requires each Federal agency with jurisdiction over any property or facility that might result in the discharge of air pollutants to comply with "all Federal, state, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety from any known or anticipated adverse effects of a regulated pollutant (42 USC Section 7409). The Act also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC Section 7411) and requires specific emission increases to be evaluated to prevent a significant deterioration in air quality (42 USC Section 7470).

Hazardous air pollutants, including radionuclides, are regulated

separately (42 USC Section 7412). Air emissions are regulated by EPA through regulations codified at 40 CFR Parts 50 through 99. However, EPA has delegated primary authority to the South Carolina Department of Health and Environmental Control (SCDHEC) for all of the Act's regulatory provisions except DOE radionuclide emissions (40 CFR Part 61 Subpart H). Under the authority of the South Carolina Pollution Act, SCDHEC has established the State's air pollution control program (R.61-62).

Airborne emissions would be associated with each of the alternatives, and these emissions would be subject to regulation under the Clean Air Act.

CLeaN WATER ACT

The Clean Water Act was enacted to "restore and maintain the chemical, physical and biological integrity of the Nation's water." The Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Act requires all branches of the Federal Government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, state, interstate, and local requirements.

In addition to setting water quality standards for the Nation's waterways, the Act supplies guidelines and limitations for effluent discharges from point-source discharges and provides authority for EPA to implement the National Pollutant Discharge Elimination System (NPDES) permitting program. EPA has overall responsibility (40 CFR Part 122), but has delegated primary enforcement authority to the SCDHEC for facilities in South Carolina. Under the South Carolina Pollution Control Act, SCDHEC enforces a wastewater treatment system permitting program (R.61-67).

RESOURCE CONSERVATION AND RECOVERY ACT

The treatment, storage, or disposal of hazardous and nonhazardous waste is regulated under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments of 1984, and the Federal Facility Compliance Act of 1992. Pursuant to Section 3006 of RCRA, any state that seeks to administer and enforce a hazardous waste program may apply for EPA authorization of its program. The EPA regulations implementing RCRA are at 40 CFR Parts 260 through 280. These regulations define hazardous wastes and specify hazardous waste transportation, handling, treatment, storage, and disposal requirements. The regulations imposed on a generator or a treatment, storage, or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, or disposed of. The method of treatment, storage, and disposal also impacts the extent and complexity of the requirements.

Historically, DOE chemically reprocessed reactor targets and spent fuel to recover valuable products and fissionable materials. As such, the recovered material was not a solid waste under RCRA. World events have resulted in significant changes in DOE direction and operations. With these changes, the DOE focus has changed from reprocessing and recovery of materials to storage and ultimate disposition. In particular, DOE announced in April 1992 that it intended to phase out reprocessing. This, in turn, has created uncertainty with regard to the regulatory status of these materials in relation to RCRA.

DOE has initiated discussion with environmental regulators on the potential applicability of RCRA to the materials discussed in this eis. On October 19, 1994, DOE representatives met with officials of the South Carolina Department of Health and Environmental Control to discuss the status of the plutonium solutions in F-Canyon. Further discussions with the regulators might be necessary to develop a path forward to meet any RCRA requirements that could apply to the Proposed Action or any alternatives.

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986

Under Subtitle A of this Act, Federal facilities provide various information (such as inventories of specific chemicals used or stored and releases that occur from these sites) to the State Emergency Response Commission and to the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. Implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988. DOE also requires compliance with Title III as matter of Agency policy. The requirements for this Act were promulgated by the EPA in 40 CFR Parts 350 through 372. SRS hazardous chemical inventory reports submitted to the South Carolina Department of Health and Environmental Control include the plutonium solutions in the F-Canyon. The chemical inventory could change depending on the alternative DOE implemented; however, subsequent reports would reflect any change to the inventory.

SAFE DRINKING WATER ACT

The primary objective of the Safe Drinking Water Act is to protect the quality of public water supplies and all sources of drinking water. The South Carolina Department of Health and Environmental Control has primary enforcement responsibility through the State Safe Drinking Water Act. SCDHEC administration and enforcement consist of construction permits, preliminary site inspections, final construction inspections, monthly sampling of drinking water, and regular operations and maintenance inspections of water supplies and facilities such as those at SRS (R.61-58).

AMERICAN INDIAN RELIGIOUS FREEDOM ACT, ARCHAEOLOGICAL RESOURCES PROTECTION ACT, NATIONAL HISTORIC PRESERVATION ACT, AND NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

The American Indian Religious Freedom Act, Archaeological Resources Protection Act, National Historic Preservation Act, and Native American Graves Protection and Repatriation Act require Federal agencies to consider the impacts that their actions could have on archaeological, historic, and cultural resources. DOE has determined that implementation of the activities associated with any alternative considered would not directly affect these resources.

ANADROMOUS FISH CONSERVATION ACT, BALD AND GOLDEN eaGLE PROTECTION ACT, ENDANGERED SPECIES ACT, FISH AND WILDLIFE COORDINATION ACT, AND MIGRATORY BIRD TReaTY ACT

The Anadromous Fish Conservation Act, Bald and Golden Eagle Protection Act, Endangered Species Act, Fish and Wildlife Coordination Act, and Migratory Bird Treaty Act require Federal agencies to consider the impacts that their actions could have on biological resources. Biological resources would not be affected

by the activities associated with the Proposed Action or the alternatives considered in this eis.

8.2 Executive Orders

EXECUTIVE ORDER 12088, "FEDERAL COMPLIANCE WITH POLLUTION CONTROL STANDARDS"

This order directs Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act.

EXECUTIVE ORDER 12856, "FEDERAL COMPLIANCE WITH RIGHT-TO-KNOW LAWS AND POLLUTION PREVENTION REQUIREMENTS"

This order directs Federal agencies to comply with the Emergency Planning and Community Right-to-Know Act of 1986 and with the Pollution Prevention Act of 1990.

EXECUTIVE ORDER 11514, "NATIONAL ENVIRONMENTAL POLICY ACT"

This order directs Federal agencies to continually monitor and control their activities to protect and enhance the quality of the environment. It also directs Federal agencies to develop procedures to ensure the fullest practicable provision of timely public information and understanding of those Federal plans and programs that could have environmental impacts to obtain the views of interested parties. DOE has issued regulations (10 CFR Part 1021) and DOE Order 5440.1E for compliance with this Executive Order.

EXECUTIVE ORDER 11988, "FLOODPLAIN MANAGEMENT"

This order directs Federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable. DOE has determined that implementation of the Proposed Action or any alternative considered would not directly affect a floodplain.

EXECUTIVE ORDER 11990, "PROTECTION OF WETLANDS"

This order directs governmental agencies to avoid, to the extent practicable, any short- and long-term adverse impacts on wetlands if there is a practicable alternative. DOE has determined that the Proposed Action or any alternative considered would not directly affect a wetland.

EXECUTIVE ORDER 12898, "FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS"

This order directs Federal agencies to achieve environmental justice by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. The order creates an Interagency Working Group on Environmental Justice and directs each Federal agency to develop strategies within prescribed time limits to identify and address environmental justice concerns. The order further directs each Federal agency to collect,

maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action and to make such information publicly available.

8.3 Department of Energy Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE Orders. The DOE regulations are generally found in Title 10 of the Code of Federal Regulations. These regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For this eis, relevant regulations include 10 CFR Part 835, Occupational Radiation Protection; 10 CFR Part 1021, Compliance with the National Environmental Policy Act; and 10 CFR Part 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements. DOE Orders generally set forth policies and the programs and internal procedures for implementing those policies. Applicable Orders pertaining to the activities associated with the alternatives discussed in this eis include:

- DOE Order 5440.1E, "National Environmental Policy Act Compliance Program" (November 10, 1992). This Order establishes authorities and responsibilities of DOE officials and sets forth internal procedures for implementing the NEPA.

- DOE Order 5480.1B, "Environment, Safety and Health Program for Department of Energy Operations" (September 23, 1986). This Order establishes the Environment, Safety and Health Program for DOE operations.

- DOE Order 5480.31, "Startup and Restart of Nuclear Facilities" (September 1993). This Order establishes authorities and responsibilities of Department officials for activities related to the startup or restart of DOE nuclear facilities.

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LIST OF PREPARERS AND CONTRIBUTORS

This list presents the individuals who contributed to the content of this environmental impact statement. The preparation of the eis was directed by R. T. Brock of the Department of Energy and W. J. Craig of Halliburton NUS Corporation. Halliburton NUS is the Technical Support Services Contractor to the DOE Savannah River Operations Office for major studies performed in accordance with the National Environmental Policy Act.

Some of the individuals listed below prepared specific sections in accordance with their technical qualifications. Other technical experts provided input to those sections through in-depth review and data verification. Still others provided overall technical or management reviews for their respective organizations.

NAME: YVONNE F. ABERNETHY

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Forest Economics and Management, Louisiana State University, 1984
- B.S., Forest Management, University of Tennessee, 1979

TECHNICAL EXPERIENCE: Twelve years experience in natural resource management and environmental planning.

EIS RESPONSIBILITY: Administrative lead; prepared utilitie section.

NAME: ADEL A. BAKR, Ph.D.

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- Ph.D., Groundwater Hydrology, New Mexico Institute of Mining and Technology, 1976
- M.S., Geophysics, the University of Alberta, 1971
- M.S., Isotope Hydrology, the University of Cairo, 1969
- B.S., Geology and Physics, the University of Assiout, 1963

TECHNICAL EXPERIENCE: Thirty years experience in water resources.

EIS RESPONSIBILITY: Provided technical input on water and geologic resources sections.

NAME: JOHN B. BLAND

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - M.A., Economics, University of South Carolina, 1982
- B.S., Mathematics, Wake Forest University, 1970

TECHNICAL EXPERIENCE: Eleven years in environmental and emergency management and planning, including emergency exercise development, control, and evaluation an environmental protection program planning.

EIS RESPONSIBILITY: Provided technical input on socioecono sections; prepared environmental justice sections.

NAME: RICHARD R. BOWERS, CHP

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.S., Chemistry, The Pennsylvania State University, 1955

TECHNICAL EXPERIENCE: Thirty-nine years experience in heal physics and radiological and biological effects.

EIS RESPONSIBILITY: Prepared public and worker radiological health sections.

NAME: ROBERT T. BROCK

AFFILIATION: U.S. Department of Energy, Savannah Operations Office

EDUCATION: - B.S., Nuclear Engineering, Univer of Tennessee, 1984

TECHNICAL EXPERIENCE: Ten years in refueling of nuclear reactors, chemical separations technology, and safety analysis.

EIS RESPONSIBILITY: eis Manager.

NAME: MARY M. CAVANAUGH

AFFILIATION: Halliburton NUS Corporation

TECHNICAL EXPERIENCE: Ten years experience in waste management.

EIS RESPONSIBILITY: Prepared portions of waste management consequences section; prepared hazardous and mixed waste quantity estimates for alternatives.

NAME: EMILY W. CHUMLEY

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.S., Nuclear Engineering, Mississ State University, 1969

TECHNICAL EXPERIENCE: More than 25 years in analysis desig consulting, quality assurance, and utility operation.

EIS RESPONSIBILITY: Provided technical input to Appendix B

NAME: WILLIAM J. CRAIG

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Planning, University of Tennessee, 1977
- B.S., Forestry, University of Tennessee, 1972

TECHNICAL EXPERIENCE: Seventeen years experience in environmental project management, nuclear fuel planning and analyses, natural resource management, and nuclea powerplant siting and relicensing.

EIS RESPONSIBILITY: Project Manager.

NAME: DANIEL M. EVANS

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Planning, University of Tennessee at Knoxville, 1985
- B.A., Political Science, Knox College, 1976

TECHNICAL EXPERIENCE: Seventeen years in NEPA project management and technical review, socioeconomic impact analysis, transportation impact analysis, traffic impact analysis.

EIS RESPONSIBILITY: Management reviewer for Halliburton NU Corporation.

NAME: PHILIP C. FULMER, Ph.D.

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- Ph.D., Nuclear Engineering, Texas University, 1993
- M.S., Health Physics, Texas A&M University, 1990
- B.S., Health Physics, Francis Marion College, 1989

TECHNICAL EXPERIENCE: Five years experience in radiation protection, internal radiation dosimetry, and external radiation dosimetry.

EIS RESPONSIBILITY: Technical lead for Final eis; provided technical input to public and worker radiological health sections.

NAME: ANDREW R. GRAINGER

AFFILIATION: U.S. Department of Energy, Savannah Operations Office

EDUCATION:
- M.S., Wildlife Ecology, Utah Stat University, 1978
- B.S., Natural Resources, Cornell University, 1975

TECHNICAL EXPERIENCE: Sixteen years in terrestrial ecology facility siting, wetlands ecology, endangered species

EIS RESPONSIBILITY: NEPA Specialist.

NAME: KRISTINE A. GUNTHER

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.B.A., The University of Alabama 1992
- B.A., Economics, Rhodes College, 1990

TECHNICAL EXPERIENCE: Two years experience in conducting socioeconomic studies.

EIS RESPONSIBILITY: Prepared socioeconomics section; provi technical input to environmental justice sections.

NAME: CONSTANCE M. HAGA

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- B.S., Meteorology, The Pennsylvan State University, 1986

TECHNICAL EXPERIENCE: Seven years experience in air qualit modeling and permitting and air emissions inventory.

EIS RESPONSIBILITY: Prepared nonradiological air resources sections; provided technical input to radiological air resources sections.

NAME: RICHARD E. HARRISON

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- B.S., Occupational Safety and Hea Murray State University, 1990

TECHNICAL EXPERIENCE: Four years experience in industrial

construction safety.

EIS RESPONSIBILITY: Prepared public and worker nonradiolog health sections.

NAME: EDWARD J. JACKSON

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Soil Science, University of Wisconsin, 1987
- B.S., Molecular Biology, University of Wisconsin, 1981

TECHNICAL EXPERIENCE: More than 5 years experience in contaminant transport and remediation o soils.

EIS RESPONSIBILITY: Prepared geological resources section.

NAME: KIRK H. JENKS

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- B.S., Chemistry, Virginia Polytec Institute and State University, 1975

TECHNICAL EXPERIENCE: Eighteen years experience in nuclear operations, emergency preparedness, and nuclear safety.

EIS RESPONSIBILITY: Prepared section on health effects fro accidents and Appendix B.

NAME: LAWRENCE J. KRIPPS

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Nuclear Engineering, Univers of Wisconsin, 1972
- B.S., Nuclear Engineering, University of Wisconsin, 1971

TECHNICAL EXPERIENCE: Twenty-two years experience performi and managing safety and reliability analyses and environmental and siting assessments of nuclear facilities and advanced energy projects.

EIS RESPONSIBILITY: Technical lead for Draft eis; technica reviewer.

NAME: THOMAS L. MARTIN, JR.

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Science Education, Universi Southern Mississippi, 1978
- B.S., Chemistry, Florida Technological

University, 1974
- Associate, Safety and Health Engineering Technology, Midlands Technical College, 1982

TECHNICAL EXPERIENCE: Fifteen years experience in occupati safety and health.

EIS RESPONSIBILITY: Provided technical input to public and nonradiological health sections.

NAME: KEVIN M. MEEHAN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.S., Mechanical Engineering, The Pennsylvania State University, 1990

TECHNICAL EXPERIENCE: Four years experience in safety engineering and safety analysis.

EIS RESPONSIBILITY: Provided technical input to Appendix B

NAME: LOUISE S. MOORE

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.A., Geography, University of Maryland, 1968

TECHNICAL EXPERIENCE: Twelve years experience in environme planning, socioeconomic studies, and cultural resource studies.

EIS RESPONSIBILITY: Provided technical input on cultural resources.

NAME: TISH B. MORGAN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - Masters Equivalent, Nuclear Physi Western Kentucky University, 1973
- B.S., Physics and Mathematics, Western Kentucky University, 1972

TECHNICAL EXPERIENCE: Twenty years experience in nuclear safety, accident analysis, risk assessment, and issue management.

EIS RESPONSIBILITY: Prepared Accidents sections and Append

NAME: JAMES L. OLIVER

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.S., Biology, Murray State University, 1971

TECHNICAL EXPERIENCE: Twenty-two years experience in environmental impact assessment, environmental research, project management, limnological studies, thermal effects, entrainment and impingement, ecology.

EIS RESPONSIBILITY: Management reviewer for Halliburton NU Corporation.

NAME: W. LEE POE

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Chemical Engineering, Unive of Alabama, 1951
- B.S., Chemistry, Tulane University, 1949

TECHNICAL EXPERIENCE: Forty-two years experience, most wor with nuclear materials at SRS. Experience includes 22 years providing full-time technical support for process in F- and H-Canyons, H- and FB-Line, a 235-F facilities.

EIS RESPONSIBILITY: Technical reviewer.

NAME: LINDA S. ROBINSON

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.B.A., Loyola College, 1987
- B.S., Earth Sciences, Texas Christian University, 1971

TECHNICAL EXPERIENCE: Twenty-one years in environmental consulting pertaining to geology, hydrology, and soils.

EIS RESPONSIBILITY: Prepared chapters on Short-Term Use Ve Long-Term Resource Commitments and on Irreversible or Irretrievable Resource Commitments.

NAME: ROBERT L. SCHLEGEL, PE

AFFILIATION: Halliburton NUS Corporation

EDUCATION:
- M.S., Nuclear Engineering, Columb University, 1961
- B.S., Chemical Engineering, Massachusetts Institute of Technology, 1959

TECHNICAL EXPERIENCE: Thirty-two years experience in radiological dose assessments.

EIS RESPONSIBILITY: Prepared radiological air resources se provided technical input to

nonradiological air resources sections.

NAME: PATRICIA L. SHAW-ALLEN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - M.S., Zoology/Ecotoxicology, Okla State University, 1990
- B.S., Wildlife Management, University of New Hampshire, 1987

TECHNICAL EXPERIENCE: More than 4 years experience in aqua toxicology/water quality, ecological risk assessments, natural resource management, and ecotoxicology.

EIS RESPONSIBILITY: Provided technical input on ecological resources.

NAME: JOHN O. SHIPMAN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.A., English, Georgetown Univers 1966

TECHNICAL EXPERIENCE: Twenty-seven years in environmental impact statements and impact analyses, technical writing and editing, and publications production.

EIS RESPONSIBILITY: Technical editor of eis; prepared Appe C.

NAME: CATHERINE J. THOMAS

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.A., Journalism, Texas A&M University, 1983

TECHNICAL EXPERIENCE: More than 10 years writing and editi for DOE-Savannah River procedures, NEPA documents, and newspapers.

EIS RESPONSIBILITY: Edited and reviewed Appendix A, Glossa List of Preparers, and References.

NAME: ALAN L. TOBLIN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - M.S., Chemical Engineering, Unive of Maryland, 1970
- B.E., Chemical Engineering, The Cooper Union, 1968

TECHNICAL EXPERIENCE: Twenty-two years of experience in analyzing radiological and chemical contaminant transport in water

resources.

EIS RESPONSIBILITY: Prepared water resources sections.

NAME: GILBERT H. WALDMAN

AFFILIATION: Halliburton NUS Corporation

EDUCATION: - B.S., Nuclear Engineering, Univer of Florida, 1991

TECHNICAL EXPERIENCE: Three years experience in dose model health effects and safety, radiaation verification, powerplant engineering, reactor operation, and health physics; Licensed Reactor Operator.

EIS RESPONSIBILITY: Provided technical input to water reso consequences section.

NAME: KARL E. WALTZER

AFFILIATION: U.S. Department of Energy, Savannah Operations Office

EDUCATION: - B.S., Mechanical Engineering, Wes Virginia University, 1979

TECHNICAL EXPERIENCE: Fifteen years nuclear industry experience in maintenance, waste management, safety analysis, and chemical separations technology.

EIS RESPONSIBILITY: Technical reviewer for Department of E

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GLOSSARY

abnormal transients
A state resulting from an unusual incident in which operating parameters affecting control of radioactive materials move out of the normal operating range.

absorbed dose
The energy deposited per unit mass by ionizing radiation. The unit of absorbed dose is the rad.

air quality
A measure of the quantity of pollutants in the air.

air quality standards
The prescribed quantity of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified area.

alpha (a) particle
A positively charged particle consisting of two protons and two neutrons that is emitted from the nucleus of certain nuclides during radioactive decay. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

ambient air
The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air in immediate proximity to emission sources.

aqueous
In liquid form (i.e., dissolved in water).

aquifer
A geologic formation that contains sufficient saturated permeable material to conduct groundwater and to yield worthwhile quantities of groundwater to wells and springs.

atmosphere
The layer of air surrounding the earth.

AXAIR89Q
A computer model used to analyze doses from accidental airborne radionuclide releases. Developed in accordance with U.S. Nuclear Regulatory Commission Regulatory Guide 1.145, Atmospheric Dispersion Models for Potential Accidental Consequence Assessments at Nuclear Power Plants, February 1993.

background exposure
See exposure to radiation.

background radiation
Normal radiation present in the lower atmosphere from cosmic rays and earth sources. Background radiation varies with location, depending on altitude and natural radioactivity present in the surrounding geology.

beta (b) particle
An elementary particle emitted from a nucleus during radioactive decay. It is negatively charged, is identical to an electron, and is easily stopped by a thin sheet of metal.

bounded
Producing greater or lesser consequences than other accidents; or would "bound" the remainder of the accidents.

burial ground
A place for burying unwanted radioactive materials in which the earth acts to contain or prevent the escape of radiation. In this eis, materials are incorporated into concrete to prevent the leaching of materials or movement in the underground environment.

button
Plutonium metal in a hemispherical shape, weighing about 1.8 kilograms (4 pounds).

yC
Degree Celsius. yC = \|F(5,9) - (yF - 32).

cancer
A malignant tumor of potentially unlimited growth, capable of invading surrounding tissue or spreading to other parts of the body by metastasis.

canister
A metal (stainless-steel) container in which nuclear material is sealed.

canyon
A heavily shielded building used in the chemical processing of radioactive materials to recover special isotopes for national defense or other programmatic purposes. Operation and maintenance are by remote control.

capable (fault)
Determination if a geological fault has moved at or near the ground surface within the past 35,000 years.

carcinogen
An agent capable of producing or inducing cancer.

carcinogenic
Capable of producing or inducing cancer.

cask
A heavily shielded massive container for holding nuclear materials during shipment.

cesium
Naturally occurring element with 55 protons in its nucleus. Some manmade isotopes of cesium are radioactive (e.g., cesium-134, cesium-137).

cladding
The material (generally aluminum in SRS reactors) that covers each tubular fuel and target assembly.

collective dose
The sum of the individual doses to all members of a specific

population.

committed effective dose equivalent
Used in cases when a person has an intake of radioactive material to denote that the dose is calculated for a period of 50 years following the intake. (See effective dose equivalent.)

community (environmental justice definition)
A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values, or exposed to industry that stimulates unwanted noise, smell, industrial traffic, particulate matter, or other nonaesthetic impacts.

concentration
The amount of a substance contained in a unit quantity of a sample.

condensate
Liquid water obtained by cooling the steam (overheads) produced in an evapo rator system.

constituents
Parts or components of a chemical system.

converting
The process for changing special isotopes into usable chemical forms to satisfy current or projected needs for a unique product.

criticality
A state in which a self-sustaining nuclear chain reaction is achieved.

cumulative effects
Additive environmental, health, and socioeconomic effects that result from a number of similar activities in an area.

curie (Ci)
A unit of radioactivity equal to 37,000,000,000 decays per second.

daughter
A nuclide formed by the radioactive decay of another nuclide, which is the "parent."

decay, radioactive
The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in the emission of nuclear radiation (alpha, beta, or gamma radiation).

decommissioning
The removal from service of facilities such as processing plants, waste tanks, and burial grounds, and the reduction or stabilization of radioactive contamination. Decommissioning concepts include:

- Decontaminate, dismantle, and return area to original condition without restrictions.
- Partially decontaminate, isolate remaining residues,

and continue surveillance and restrictions.

defense waste
Nuclear waste generated by government defense programs as distinguished from waste generated by commercial and medical facilities.

depleted uranium
A mixture of uranium isotopes where uranium-235 represents less than 0.7 percent of the uranium by mass.

design-basis accident (DBA)
A postulated accident scenario for establishing the need for certain design features; normally, the accident that causes the most severe consequence when engineered safety features function as intended.

disposal/disposition
After designation as "surplus"; movement; placement in an onsite or offsite facility after a decision that future uses are unlikely or undesirable; determining whether the disposal of items must be "retrievable" under public law.

dose rate
The radiation dose delivered per unit time (e.g., rem per year).

ecology
The science dealing with the relationship of all living things with each other and with the environment.

ecosystem
A complex of the community of living things and the environment forming a functioning whole in nature.

effective dose equivalent
A quantity used to estimate the biological effect of ionizing radiation. It is the sum over all body tissues of the product of absorbed dose, the quality factor (to account for the different penetrating abilities of the various types of radiation), and the tissue weighting factor (to account for the different radiosensitivity of the various tissues of the body).

effluent
Liquid or airborne material released to the environment. In common usage, however, the term "effluent" implies liquid releases.

effluent standards
Defined limits of effluent in terms of volume, content of contaminants, temperature, etc.

eis
Environmental impact statement; a legal document required by the National Environmental Policy Act (NEPA) of 1969, as amended, for Federal actions involving potentially significant environmental impacts.

element
One of the 105 known chemical substances that cannot be divided into simpler substances by chemical means. All isotopes of an element have the same atomic number (number of protons) but have a different number of neutrons.

Emergency Response Planning Guidelines (ERPG)

Values used to determine potential health effects from chemical accidents.

emission standards
Legally enforceable limits on the quantities and kinds of air contaminants that can be emitted into the atmosphere.

endangered species
Plants and animals in an area that are threatened with either extinction or serious depletion.

energy
The capacity to produce heat or do work.

environment
The sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

epicenter
The point on the earth's surface directly above the focus of an earthquake.

EPICODE
A computer model used to estimate the airborne concentration of toxic chemicals as a result of routine or accidental releases to the environment.

erosion
The process in which the actions of wind or water carry away soil and clay.

exceedence
A value over a prescribed limit.

exposure to radiation
The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is the exposure to ionizing radiation that occurs during a person's working hours. Population exposure is the exposure to a number of persons who inhabit an area.

yF
Degree Fahrenheit. F = yC - \|F(9,5) + 32.

fallout
The descent to earth and deposition on the ground of particulate matter (that might be radioactive) from the atmosphere.

fault
A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage of the earth's crust has occurred in the past.

fissile
Capable of being split or divided (fissioned) by the absorption of thermal neutrons. The most common fissile materials are uranium-233, uranium-235, and plutonium-239.

fission
The splitting of a heavy nucleus into two approximately equal parts, which are nuclei of lighter elements, accompanied by the

release of energy and generally one or more neutrons. Fission can occur spontaneously or can be induced by nuclear bombardment.

fission products
Nuclei from the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

floodplain
Level land built up by flowing stream deposition and periodically submerged by floodwater from that stream.

frit
Finely ground glass.

gamma (g) rays
High-energy, short-wavelength electromagnetic radiation accompanying fission, radioactive decay, or nuclear reactions. Gamma rays are very penetrating and require relatively thick shields to absorb the rays effectively.

geology
The science that deals with the earth: the materials, processes, environments, and history of the planet especially the lithosphere, including the rocks, their formation and structure.

glovebox
Large enclosure that separates workers from equipment used to process hazardous material but enables the workers to be in physical contact with the equipment; normally constructed of stainless steel with large acrylic/lead glass windows. Workers have access to equipment through the use of heavy-duty, lead-impregnated rubber gloves, the cuffs of which are sealed in portholes in the glovebox windows.

groundwater
The supply of fresh water under the earth's surface in an aquifer.

habitat
The place or type of site where a plant or animal naturally or normally lives and grows.

half-life (radiological)
The time in which half the atoms of a radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

heavy metals
Metallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

HEPA filter
High efficiency particulate air filter designed to remove 99.9 percent of particles as small as 0.3 micrometer in diameter from a flowing air stream.

high-fired oxide
Oxide chemical form of plutonium produced by heating the material to approximately 1,000-C. High-fired oxide is considered more chemically stable than low-fired oxide because

the higher heat removes moisture and other impurities more effectively.

high-level waste
The highly radioactive wastes that result from processing of defense materials at SRS.

historic resources
The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events, persons, or social or historic movements.

immobilization
Conversion of high-level waste into a form that will be resistant to environmental dispersion.

intensity (earthquake)
A numerical rating used to describe the effects of earthquake ground motion on people, structures, and the earth's surface. The numerical rating is based on an earthquake intensity scale such as the Richter Scale commonly used in the United States.

interim storage
Providing safe and secure capacity in the near term to support continuing operations in the interim period (10 years).

ion
An atom or molecule that has gained or lost one or more electrons to become electrically charged.

ion exchange
Process in which a solution containing soluble ions to be removed is passed over a solid ion-exchange medium, which removes the soluble ions by exchanging them with labile ions from the surface of the column. The process is reversible so that the trapped ions can be collected (eluted) and the column regenerated.

ion-exchange medium
A substance (e.g., a resin) that preferentially removes certain ions from a solution.

ionization
The process that creates ions. Nuclear radiation, X-rays, high temperatures, and electric discharges can cause ionization.

ionizing radiation
Radiation capable of displacing electrons from atoms or molecules to produce ions.

irradiation
Exposure to radiation.

ISC2
A computerized dispersion program used to calculate ground-level concentrations of air pollutants.

isotope
An atom of a chemical element with a specific atomic number and atomic weight. Isotopes of the same element have the same number of protons but different numbers of neutrons. Isotopes are identified by the name of the element and the total number

of protons and neutrons in the nucleus. For example, plutonium-239 is a plutonium atom with 239 protons and neutrons.

LADTAP
A computer program used to calculate individual and population doses from liquid pathways.

latent cancer fatalities
Deaths resulting from cancer that has become active following a latent period (i.e., a period of inactivity).

low-fired oxide
Oxide chemical form of plutonium produced by heating the material to approximately 550-C. Low-fired oxide is considered less chemically stable than high-fired oxide because the lower heat does not remove moisture and other impurities as effectively.

low-income communities
A community where 25 percent or more of the population is identified as living in poverty.

low-level waste
Radioactive waste not classified as high-level waste; the wastes (mostly salts) remaining after removal of the highly radioactive nuclides from the liquid high-level wastes for immobilization.

MAXIGASP
A computer program used to calculate doses of airborne releases of radioactivity to the maximally exposed member of the public.

maximum contaminant levels (MCLs)
The maximum permissible level of a contaminant in water that is delivered to a user of a public water system.

maximally exposed individual
A hypothetical person located to receive the maximum possible dose by a given exposure scenario.

migration
The natural travel of a material through the air, soil, or groundwater.

mitigate
To take practicable means to avoid or minimize environmental harm from a selected alternative.

monitoring
Continuing control and accountability, particularly of special nuclear materials such as plutonium-239 and highly enriched uranium, but also including oversight of hazardous or reactive compounds before they are disposed of or converted to a stable long-term storage form.

National Register of Historic Places
A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national importance.

natural radiation or natural radioactivity
Background radiation. Some elements are naturally

radioactive, whereas others are induced to become radioactive by bombardment in a reactor or accelerator.

NEPA
National Environmental Policy Act of 1969; it requires the preparation of an eis for Federal projects that could present significant impacts to the environment.

nonproliferation
The restriction of ability to easily access fissile materials in concentrations sufficient to assemble a nuclear weapon.

NOx
Oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO2). These are produced in the combustion of fossil fuels, and can constitute an air pollution problem.

NRC
Nuclear Regulatory Commission; the independent Federal commission that licenses and regulates nuclear facilities.

nuclear energy
The energy liberated by a nuclear reactor (fission or fusion) or by radioactive decay.

nuclear radiation
Radiation, usually alpha, beta, or gamma, that emanates from an unstable atomic nucleus.

nuclear reaction
An interaction between a photon, particle, or nucleus and a target nucleus, leading to the emission of one or more particles and photons.

nuclear reactor
A device in which a fission chain reaction is maintained, used for the irradiation of materials or the generation of electricity.

nuclide
An atomic nucleus specified by atomic weight, atomic number, and energy state; a radionuclide is a radioactive nuclide.

organic compounds
Chemical compounds containing carbon.

outfall
Place where liquid effluents enter the environment and are monitored.

oxide
A compound in which an element chemically combines with oxygen.

ozone
A compound of oxygen in which three oxygen atoms are chemically attached to each other.

particulates
Solid particles and liquid droplets small enough to become airborne.

passive safety system
A system that provides safety features requiring no human intervention or adverse condition to actuate.

pH
A measure of the hydrogen ion concentration in aqueous solution. Pure water has a pH of 7, acidic solutions have a pH less than 7, and basic solutions have a pH greater than 7.

people of color communities
A population classified by the U.S. Bureau of the Census as Black, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other nonwhite persons, the composition of which is at least equal to or greater than the state minority average of a defined area or jurisdiction.

permeability
Ability of liquid to flow through rock, groundwater, soil, or other substance.

person-rem
The radiation dose to a given population; the sum of the individual doses received by a population segment.

physiographic
Geographic regions based on geologic setting.

plutonium (Pu)
A transuranic, heavy (average atomic mass about 244 atomic mass units), silvery metal with 15 isotopes that is produced by the neutron irradiation of natural uranium. Plutonium-239 is used both in nuclear weapons and commercial nuclear power applications. Plutonium-238 is used to power onboard generators during manned and unmanned space flights.

plutonium solutions
Chemical solutions containing plutonium.

pollution
The addition of an undesirable agent to an ecosystem in excess of the rate at which natural processes can degrade, assimilate, or disperse it.

POPGASP
A computer mathematical model used to calculate doses of airborne releases of radioactivity to the population within 80 kilometers (50 miles) of the SRS.

precipitate
A solid (used as a noun).
To form a solid substance in a solution by a chemical reaction (used as a verb).

PUREX process
A chemical separation process to retrieve plutonium, uranium, and other radionuclides from reactor fuel and targets.

radiation
The emitted particles and photons from the nuclei of radioactive atoms; a shortened term for ionizing radiation or nuclear radiation as distinguished from nonionizing radiation (microwaves, ultraviolet rays, etc.).

radioactivity
The spontaneous decay of unstable atomic nuclei, accompanied by the emission of radiation.

radioisotopes
Radioactive isotopes. Some radioisotopes are naturally occurring (e.g., potassium-40) while others are produced by nuclear reactions.

radiolysis
The decomposition of a material (usually water) into different molecules due to ionizing radiation. In water, radiolysis results in the production of hydrogen gas and oxygen.

repository
A place for the disposal of immobilized high-level waste in isolation from the environment

resin
An ion-exchange medium; organic polymer used for the preferential removal of certain ions from a solution.

Richter Scale
A scale of measure used in the United States to quantify earthquake intensity.

risk
In accident analysis, the probability weighted consequence of an accident, defined as the accident frequency per year multiplied by the dose. The term "risk" is also used commonly in other applications to describe the probability of an event occurring.

runoff
The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually returns to streams. Runoff can carry pollutants into receiving waters.

saltstone
Low-radioactivity fraction of high-level waste from the in-tank precipitation process mixed with cement, flyash, and slag to form a concrete block.

seismicity
The tendency for earthquakes to occur.

shield
Material used to reduce the intensity of radiation that would irradiate personnel or equipment.

short-lived
A designation for radionuclides with relatively short half-lives (i.e., they decay to stable materials relatively quickly).

stabilization
The action of making a nuclear material more stable by converting its physical or chemical form or placing it in a more stable environment.

stack
A vertical pipe or flue designed to exhaust gases and suspended particulates.

strontium
Naturally occurring element with 38 protons in its nucleus. Some manmade isotopes of strontium are radioactive (e.g., strontium-89, strontium-90),

surface water
All water on the surface (streams, ponds, etc.), as distinguished from underground water.

tank farm
An installation of interconnected underground tanks for the storage of high-level radioactive liquid wastes.

target
In this eis, a tube of material placed in a reactor to absorb neutrons and be changed to a desired end product.

transuranic waste
Waste material containing more than a specified concentration of transuranic elements (presently, more than 10 nanocuries per gram of waste).

tritium
A radioactive isotope of hydrogen; its nucleus contains one proton and two electrons.

uninvolved worker
For this eis, an SRS worker who is not involved in the operation of a facility when a radioactive release occurred, and who is assumed to be 640 meters (2,100 feet) from the point of release.

uranium (U)
A heavy (average atomic mass of about 238 atomic mass units), silvery-white metal with 14 radioactive isotopes. One of the isotopes, uranium-235, is most commonly used as fuel for nuclear fission and another, uranium-238, is transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.

vault
A reinforced concrete structure for storing strategic nuclear materials used in national defense or other programmatic purposes.

vitrification
Incorporation of a material into a glass form.

vulnerability
Condition or weakness that could lead to exposure to the public, unnecessary or increased exposure to workers, or release of radioactive materials to the environment.

waste, radioactive
Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which there is no practical use or for which recovery is impractical.

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ACRONYMS AND ABBREVIATIONS

Acronyms

AIRFA	American Indian Religious Freedom Act
ALARA	as low as reasonably achievable
Am	americium
CAA	Clean Air Act
CFR	Code of Federal Regulations
Cm	curium
CWA	Clean Water Act
DBA	design-basis accident
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWPF	Defense Waste Processing Facility
eis	environmental impact statement
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FFCA	Federal Facilities Compliance Agreement
FWS	U.S. Fish and Wildlife Service
HEPA	high-efficiency particulate air (filter)
HNUS	Halliburton NUS Corporation
IAea	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IMNM	Interim Management of Nuclear Materials
lcf	latent cancer fatality
mrem	millirem (1/1000 rem)
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
PSD	Prevention of Significant Deterioration
Pu	plutonium
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
ROI	region of influence
SAR	Safety Analysis Report
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
TRU	transuranic
UNH	uranyl nitrate hexahydrate
WSRC	Westinghouse Savannah River Company

Abbreviations for measurements

cfm	cubic feet per minute
cfs	cubic feet per second
g	acceleration due to gravity (seismology)
g/L	grams per liter
gpm	gallons per minute
L	liter
lb	pound
mg	milligram
u	micron
uCi	microcurie
ug	microgram
C	degrees Celsius
F	degrees Fahrenheit

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METRIC SYSTEM

Typically, scientific reports use metric units; therefore, this eis presents metric units of measure (meters, liters, grams, etc.) rather than the more common U.S. Customary Units (feet, gallons, pounds, etc.). However, the text sections also provide U.S. Customary Units in parentheses for ease of understanding.

Many metric measurements presented include prefixes that denote a multiplication factor that is applied to the base standard (e.g., 1 kilometer = 1,000 meters). The following list presents these metric prefixes:

mega 1,000,000 (106; one million)
kilo 1,000 (103; one thousand)
hecto 100 (102; one hundred)
centi 0.01 (10-2; one one-hundredth)
milli 0.001 (10-3; one one-thousandth)
micro 0.000001 (10-6; one one-millionth)
nano 0.000000001 (10-9; one one-billionth)
pico 0.00000000001 (10-12; one one-quadrillionth)

DOE Order 5900.2A, "Use of the Metric System of Measurement" (3/26/92) prescribes the use of this system in DOE documents. The following list presents conversion factors for the metric units used in this eis as an aid to readers who are more familiar with U.S. Customary Units.

Conversion from Metric to U.S. Customary Units

1 meter = 3.281 feet = 39.37 inches = 1.094 yards
1 kilometer = 0.6214 mile
1 square meter = 10.764 square feet
1 square kilometer = 0.3861 square mile = 247.1 acres
1 liter = 61.025 cubic inches = 0.2642 gallon
1 cubic meter = 35.31 cubic feet = 1.308 cubic yards = 264.2 gallons

Discharge

1 cubic meter per second = 35.31 cubic feet per second = 15,850.3 gallons per minute

Mass

1 kilogram = 2.205 pounds (mass)
1 metric ton = 2,205 pounds = 1.1023 (short) tons

Pressure

1 Pascal = 0.02089 pound per square foot
1 kilogram (force) per square meter = 0.2048 pound (force) per square foot

Velocity

1 meter per second = 3.281 feet per second = 2.237 miles per hour
1 kilometer per hour = 0.6214 mile per hour

Temperature

-C to -F, -C - 1.8 + 32 (i.e., 20-C = 20 - 1.8 + 32 = 68-F)

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APPENDIX A. FACILITY AND PROCESS DESCRIPTION

A.1 F-Canyon Facility Description

The Savannah River Site (SRS) F-Canyon (see Figure A-1) is a reinforced concrete structure, 255 meters (836.6 feet) long, 37 meters (308 feet) wide, and 20 meters (121.4 feet) high. It is named for the two areas, or "canyons" that house the large equipment (e.g., tanks, process vessels, evaporators, etc.) used in the chemical separations processes performed in the facility. These areas resemble a canyon in that they are long (170 meters or 557.7 feet), narrow (an average of 6 meters or 19.7 feet), and deep (20 meters or 65.6 feet). The canyons are parallel, and open from floor to roof. A center section, which is divided into four floors or levels, separates the canyons. The center section contains office space, the control room for all facility operations, and various support equipment such as ventilation fans. Figure A-2 is a cross-section view of the F-Canyon facility. The processing operations involving high radiation levels such as dissolution, fission product separation, and high-level radioactive waste evaporation (these processes are discussed below in greater detail) are performed in the "hot" canyon, which has thick concrete walls to shield people outside the facility and in the center section from radiation. The final steps of the chemical separations process, which generally involve lower radiation levels, are performed in the "warm" canyon.

Services that are typical for a large industrial facility are also required to support F-Canyon operations. For example, steam is required to heat process vessels and is the motive force for transferring solutions through process cycles; lights, motors, control systems, etc. use electricity; compressed air provides pressure needed for various process monitoring systems (e.g., liquid level indicators) and powers some control systems; and a ventilation system provides conditioned air for the comfort of facility workers and for control of the environment for the operation of sensitive equipment.

A special separate ventilation system serves portions of the facility that contain the radioactive process equipment, such as the hot and warm canyons. This special system ensures the air pressure in areas with the process equipment is below the pressure of the air outside the facility and the area occupied by workers. This design helps prevent the release of radioactive material outside the facility by ensuring air always flows from the outside of the facility to the inside of the process areas. Air in the process areas is exhausted from the facility through a large filter that is designed to remove 99.5 percent of any airborne radioactive material before the air is discharged to the atmosphere [via a 61-meter-tall (200-foot) stack behind F-Canyon]. This atmospheric discharge is the pathway for the airborne radionuclide emissions associated with the normal operation of F-Canyon.

Figure A-1. F-Canyon and FB-Line facilities.

Figure A-2. F-Area Canyon building sections.

There are two pathways for liquid effluents from F-Canyon:

- Condensates from secondary evaporators (A-Line Outside Facilities) containing low levels of radionuclides are discharged to the Effluent Treatment Facility (ETF) where there is further decontamination, if necessary, before discharge to Fourmile Branch.

- The cooling water system provides cooling for the hot and warm canyon process vessels. Underground pipes carry water to the F-Canyon, where the cooling water system distributes it. The water passes through coils inside the vessels (Figure A-3 shows a standard canyon process vessel) and then flows back out of the F- Canyon. Constant monitoring would detect radioactivity in the water in the event of a cooling coil leak. If radioactivity were detected, the water would be diverted to a treatment facility where the radioactivity would be reduced below applicable limits before it was discharged to Fourmile Branch.

A.2 F-Canyon Chemical Separation Process (PUREX Process)

This section describes typical historic operations, not necessarily operations that DOE would resume in the alternatives discussed in this eis. The PUREX process consists of several major operations referred to as "unit operations," which yield two products, uranium-238 and plutonium-239 (in solution form). These unit operations are dissolution, head end, first cycle, second uranium cycle, and second plutonium cycle. Unit operations that support the product recovery process are high-activity waste, low-activity waste, and solvent recovery. Figure A-4 shows the general PUREX process flow. There are about 303,000 liters (80,000 gallons) of in process plutonium solutions stored in F-Canyon. No new material would be introduced to the process.

A.2.1 DISSOLUTION

Irradiated material, called targets, are brought into the south end of the hot canyon by rail car through an air lock. Each target consists of depleted uranium formed in the shape of a cylinder, which has been clad in aluminum. These targets have been irradiated in SRS production reactors to transform a portion of the depleted uranium into plutonium-239. Large water-filled casks, which are transported on rail cars, contain the targets (see Figure A-5). The targets are removed from the casks and loaded into a large tank called a dissolver. The aluminum cladding is removed from the targets with sodium hydroxide. The cladding solution is then transferred to the high-level waste tanks. Heated nitric acid in the tank dissolves the target, resulting in a solution containing depleted uranium, plutonium-239, and any fission products from the reactor irradiation process.

Figure A-3. Standard canyon process vessel.

Figure A-4. Historic PUREX Process Flow.

Figure A-5. Rail car with cask.

A.2.2 HEAD END

The head end process is performed in two steps to prepare the

target solution so that uranium and plutonium can be separated. First, gelatin is added to precipitate silica and other impurities. Then the solution is transferred to a centrifuge, where silica and other impurities are removed as waste. The clarified product solution from this process is adjusted with nitric acid and water in preparation for the first cycle unit operation in the PUREX process. The waste stream generated from the process is chemically neutralized and sent to the F-Area high-level waste tanks. The major components for this unit operation are a gelatin "strike" tank, a centrifuge feed tank, and a centrifuge.

A.2.3 FIRST CYCLE

First cycle operation, which occurs in the hot canyon, has two functions: (1) to remove fission products and other chemical impurities, and (2) to separate the solution into two product streams (i.e., uranium-238 and plutonium-239) for further processing. This separation process occurs as the product solution passes through a series of equipment consisting of a centrifugal contactor and mixer-settler banks. Before the introduction of the product solution, flows of solvent and acid solution are started through the equipment. When an equilibrium condition is established, the product solution is introduced. The chemical properties of the acid/solvent/product solutions in contact with each other cause the fission products to separate from the uranium and plutonium. Later in the first cycle process, the plutonium is separated from the uranium in a similar manner. The first cycle produces four process streams: plutonium-239 (with some residual fission products), which is sent to the second plutonium cycle; a uranium-238 solution (with some residual fission products), which is sent to the second uranium cycle; a solvent stream, which is sent to the solvent recovery cycle; and an aqueous acid stream, which is directed to the high-level waste tanks. This stream contains most of the fission products. The equipment for this unit operation consists of a centrifugal contactor, mixer-settler banks, decanter tanks, and hold tanks.

A.2.4 SECOND URANIUM CYCLE

The second uranium cycle (in the warm canyon) purifies the uranium solution coming from the first cycle and prepares the uranium for transfer to the A-Line. The purification process is a separation process that occurs in a manner similar to that described for first cycle. The uranium-238 product solution is transferred from the warm canyon to storage tanks in the A-Line facility, which is adjacent to the F-Canyon.

A.2.5 SECOND PLUTONIUM CYCLE

The second plutonium cycle (in the warm canyon) purifies the plutonium solution coming from the first cycle by removing residual fission products, and prepares the plutonium for transfer to FB-Line. The purification process is a separation process that occurs in a manner similar to the first cycle. The impurities are removed in an aqueous stream that goes to the low-activity waste unit operation for processing. The plutonium-239 product solution is transferred to hold tanks for use as FB-Line feed material.

A.2.6 HIGH- AND LOW-ACTIVITY WASTE

These unit operations reduce the volume of the aqueous streams containing fission products. The streams originate with the primary separation process unit operations, such as the first cycle. The fission products are separated and sent to the F-Area high-level waste tanks. The volume reduction process is accomplished using a series of evaporators in the hot and warm canyons.

A.2.7 SOLVENT RECOVERY

The primary purpose of this unit operation is to recover and recycle the solvent that is used in the first cycle. This operation reconditions and removes impurities from the solvent. The purified solvent is returned to the first cycle for reuse and the impurities are transferred to low-activity waste for processing.

A.3 FB-Line

The historic function of FB-Line was to convert plutonium-239 from a dilute nitrate solution stream to a high-purity, stable metal form or "button."

A.3.1 BUILDING DESCRIPTION

The FB-Line Facility is on the top of the F-Canyon structure (see Figure A-1). Its exterior walls and roof are poured reinforced concrete. The portion of the structure that contains process equipment is 39.3 meters (129 feet) long by 20.4 meters (67 feet) wide. The single-story extension to the north is about 10.6 meters (35 feet) wide by 6.1 meters (20 feet) long. The facility is designed such that a 0.3-meter (1-foot)-thick concrete wall provides radiation shielding for personnel working in the FB-Line. Tanks and reaction vessels are enclosed in engineered cabinets or gloveboxes to minimize the spread of contamination and to provide shielding from radiation (see Figure A-6).

A.3.2 FB-LINE PRIMARY PROCESSES

The FB-Line process includes purification and concentration of plutonium-239 by cation exchange, precipitation of plutonium as a trifluoride, conversion by heating in an oxygen atmosphere, and reduction with calcium to form plutonium buttons. The process has five steps: (1) cation exchange, (2) precipitation and filtration, (3) drying and conversion, (4) reduction, and (5) button finishing. Figure A-7 shows the typical process flow through the line.

A.3.2.1 Cation Exchange

The purpose of the cation exchange step is to concentrate the dilute plutonium product solution from the PUREX process second plutonium solvent extraction cycle. This is accomplished by transferring the solution from the storage tanks in the warm canyon to cation exchange feed receipt tanks and then to the cation exchange columns in FB-Line.

The plutonium feed is then allowed to flow through the cation exchange column, where resin absorbs higher charge cations (e.g.,

Pu3+). After the plutonium is deposited on the resin, an acidic solution is used to flush the plutonium from the column. The solution containing the plutonium is filtered and transferred to a product hold tank for sampling and analysis, and then to a concentrate feed tank for subsequent precipitation.

The primary cation exchange equipment consists of 14 process tanks; 4 ion-exchange columns (which are shielded to reduce radiation levels); and 4 filters. This equipment is inside engineered gloveboxes at the FB-Line facility.

A.3.2.2 Precipitation and Filtration

In this step of the process, hydrofluoric acid is added to the plutonium solution from the cation exchange process. This action causes plutonium trifluoride to form as a precipitate. The plutonium trifluoride precipitate is filtered out as a cake to remove excess nitrate. The plutonium trifluoride cake is then ready for the drying and conversion step. The 28 vessels associated with the precipitation and filtration process are in engineered gloveboxes in the FB-Line facility.

Figure A-6. A glovebox.

Figure A-7. FB-Line process Flow.

A.3.2.3 Drying and Conversion

When precipitation is complete, the filter cake of plutonium trifluoride is transferred to the FB-Line gloveboxes for drying and conversion to plutonium tetrafluoride. The cake is air-dried to remove residual moisture and then is placed in a conversion furnace. Residual water and other volatile materials vaporize at a low initial temperature; the vapors are drawn away by the vessel vent system. The temperature in the drying furnace is increased while the cake is blanketed in oxygen. This action converts the plutonium trifluoride to plutonium tetrafluoride powder.

Moisture must be sufficiently removed in the air drying and conversion operations to ensure the converted cake is dry enough to be safely mixed with calcium and heated in the reduction pressure chamber.

A.3.2.4 Reduction

The plutonium tetrafluoride powder from the conversion step is placed in a mixing and weighing vessel and weighed. The prepared powder is then mixed with metallic calcium and placed in a prepared reduction vessel, which is 16.5 centimeters (6.5 inches) in diameter and 30.4 centimeters (12 inches) high. The material is heated to about 500-C (932-F), which initiates a chemical reaction that causes the plutonium powder to form molten plutonium metal. The heavier plutonium metal sinks to the bottom of the reduction vessel and forms a "button."

After cooling to the ambient temperature, the reduction vessel is opened and the button removed. The reduction process is performed in the FB-Line gloveboxes.

A.3.2.5 Button Finishing

An acid solution rinse removes exterior impurities from the plutonium button. Next the button is rinsed in water to remove the acid. After water rinsing, the plutonium button is air-dried before it is sampled. After being sampled and weighed, it is placed inside a tinned steel can, which is crimp-sealed. The can is removed from the process cabinet in a plastic bag and placed in a second tinned steel can, which is also crimp-sealed. This package is then weighed and monitored for contamination and radiation. A leak test is performed and the canned buttons are placed in a shipping container and transferred to an FB-Line facility storage vault.

A.3.2.6 Bagless Packaging

The FB-Line would be modified for either the Processing to Metal or Processing to Oxide Alternative.

To accomplish Processing to Oxide, DOE would install the appropriate chemical adjustment tanks and filters and chemical reduction equipment in the existing FB-Line. In addition, the facility would be modified to install a glovebox(es) that would provide (1) the capability to package the oxide in an inert or dry atmosphere and (2) a system to remove the material containers for storage without the use of plastic bags.

To accomplish Processing to Metal, DOE would modify the FB-Line to provide (1) the capability to package the metal in an inert or dry atmosphere and (2) a system to remove the material containers for storage without the use of plastic tags.

A.4 F-Area Outside Facilities

The F-Area Outside Facilities are adjacent to the canyon facilities and provide direct support to building production operations. Process support operations include chemical storage, cold feed preparation, water handling, and acid recovery. The Outside Facilities also provide utilities, including the supply and distribution of water, electric power, and steam (see Figure A-8).

A.4.1 CHEMICAL STORAGE

The chemical storage facilities provide for the receipt, bulk storage, and transfer of fresh liquid chemicals, which are sampled and analyzed before being accepted for storage. The tanks that store nitric acid and aluminum nitrate are stainless steel; others are carbon steel. During receiving operations, personnel obtain samples, verify proper connections and valve lineup, operate transfer pumps, and confirm that the solution enters the correct tank.

The building consists of a storage area and a mixing area. The storage area is enclosed; the mixing area has open sides. Access roads surround the building and a railroad spur is on one side. The grounds also include two tank truck stations, a truck dock, a railroad dock, and a small storage area used for hydrazine mononitrate storage.

Figure A-8. F-Canyon, showing outside facilities.

Stored chemicals are pumped from the storage facilities to points of use in buildings. Smaller quantities are distributed to other parts of the plant through the use of a drum loading and dumpster filling station. Organic solvents and caustics are pumped directly from their respective storage tanks.

A.4.2 WATER HANDLING FACILITIES

The water handling facilities receive and store water that forms from steam condensates that originate in the acid recovery unit reboiler and general-purpose evaporator heaters. Deionized water from the powerhouse is also received and stored for use as process water. The facilities also receive low-activity waste water such as condensate from evaporators in the FA-Line. This water is recycled and used to provide process water and acidified water streams for the canyons via the Effluent Treatment Facility. Some water is discharged to Fourmile Branch after treatment. Tanks in this facility are also used to retain water pending analysis to permit disposal or re-evaporation, if necessary.

The cooling water system provides cooling for the hot and warm canyon process vessels. Underground pipes carry water to the F-Canyon, where it is distributed. The water passes through coils inside the vessels (Figure A-3 shows a standard canyon process vessel) and then flows back out of the F-Canyon. Constant monitoring detects radioactivity in the water in the event of a cooling coil leak. If radioactivity is detected, the water is diverted to a treatment facility where the radioactivity is reduced below applicable limits before it is discharged to Fourmile Branch.

The primary equipment for water handling consists of hold tanks, skimmer tanks, and heat exchangers. Hold tanks are mounted on concrete saddles in shallow pits (concrete pads) that drain to a sump. Heat exchangers and skimmer tanks are rack-mounted.

A.4.3 ACID RECOVERY UNIT

The Acid Recovery Unit concentrates nitric acid condensates for reuse. The condensate comes from acidic evaporation processes in F-Canyon such as high- and low-activity waste unit operations. Each acid recovery unit is a fractional distillation column that has a straight shell height of 8.2 meters (27 feet) and an outside diameter of 2 meters (6.5 feet). A reboiler is attached to the bottom side of the column. The Acid Recovery Unit Feed Tank receives condensates from the high-activity waste continuous evaporators; the low-activity waste condensate is brought in directly from the continuous evaporator. Canyon sample results or in-line monitors determine if there is radioactivity in the condensate before it reaches the feed tank or distillation column. After recovery, the concentrated acid is pumped to a storage tank for transfer to the canyon as required.

A.4.4 GENERAL-PURPOSE WASTE TANKS

This facility consists of eight storage tanks that have been grouped in two sets of two and one set of four to collect various aqueous wastes. The first set collects solutions from various sumps and catch tanks in the F-Canyon. The second set collects wastes from chemical storage tank areas. The third set collects

various wastewater from sumps and pits in the Outside Facilities. The aqueous waste in these tanks is transferred to other areas in the outside facilities for processing (e.g., the general-purpose evaporator).

A.4.5 GENERAL-PURPOSE EVAPORATOR

General-purpose evaporators concentrate aqueous waste (principally from the general-purpose waste tanks) that have radioactivity levels higher than disposal limits, but are low enough to enable evaporation in unshielded equipment. Each stainless-steel evaporator has a straight shell height of 4.8 meters (15.8 feet) and an outside diameter of 1.8 meters (6 feet). The evaporators are operated as flash evaporators with forced bottoms circulation. Evaporator bottoms are concentrated and retained for analysis before discharge to waste tanks.

A.4.6 WASTE HANDLING FACILITIES

The F-Area waste handling facilities are tanks used for the storage and transfer of high- and low-activity wastes, primarily from the F-Area laboratory facilities. Low-level wastes are transferred to the General-Purpose Evaporator for processing. High-level wastes are transferred to the laboratory waste evaporator in F-Canyon. The waste handling vessels and cells are enclosed by a concrete vault, which has a sloped floor and sump to collect leakage and a ventilation system consisting of two air heaters, eight roughing filters, eight high-efficiency particulate air (HEPA) filters, four dampers, and two exhausters.

A.5 New Facilities

A.5.1 F-CANYON VITRIFICATION FACILITY

The F-Canyon Vitrification Facility is partially constructed in the F-Canyon building. This facility would vitrify actinides such as plutonium (see Figure A-9). It would provide shielding, remote handling and viewing capability, process area ventilation, and removable rack/module type construction to allow the installation of completely tested process modules. The facility was originally designed to process californium-252. It consists of:

- Eight shielded hot cells; six shielded process rack positions; two shielded analytical [1.5 meters (5 feet) of concrete/1.5 meters (5 feet) of leaded glass]
- Computer room and cation column stream monitor room
- Column process pump and general instrument room
- Cold feed makeup, storage and delivery tankage
- Rack hot and cold water systems
- Small equipment entry sphincter
- Canyon equipment consisting of feed tank, waste tank, feed evaporator, and associated jumpers, samplers, etc.

- The hot canyon crane, which will be used as necessary for solid waste removal, product package removal, and other necessary work by removal of canyon cell covers over the rack area.

The facility would be modified to perform vitrification operations by removing some equipment, such as existing racks, and installing new equipment modules in two cells. The new equipment would include solution and glass feed systems, a melter, an off-gas system, and a glass canister feed and cap system. In addition, the existing in-cell crane, master-slave manipulators, transfer equipment, services, and utilities would be refurbished as necessary.

Figure A-9. F-Canyon Vitrification Facility process flow.

The following process descriptions for the vitrification of plutonium solutions are based on the use of common vitrification equipment in the F-Canyon facility. The process would be accomplished by adjusting or preparing the material for vitrification and then vitrifying the material.

- Feed Preparation. Plutonium solutions would be adjusted by concentrating the plutonium to achieve greater processing efficiency.

- Vitrification. The concentrated plutonium solutions would be fed to the F-Canyon Vitrification Facility melter where the solution would be evaporated and denitrated to an oxide. The oxide would be combined with molten glass. The melt would flow into stainless-steel canisters where it would solidify. The cooled canisters would be sealed, decontaminated, and overpacked for storage.

A.5.2 REPACKAGING AND VAULT FACILITY

The Repackaging and Vault Facility could include the capability to produce an oxide for a variety of nuclear materials, package the materials into primary containment vessels, and store them for an extended period (see Figure A-10). If this new facility were built, its area would be approximately 2,323 square meters (25,000 square feet); its location would be north of Building 235-F and east of Building 247-F.

Figure A-10. Repackaging and Vault Facility process flow.

The facility site would require approximately 14 acres during construction. The completed facility complex would take approximately 5 acres. An existing facility in F-Area could be modified to accomplish the APF heating and packaging functions.

The facility would include the following:

- Areas for loading and unloading shipping packages from trucks

- Temporary staging and storage areas for packages

- Gloveboxes for unloading material from the packages

- A furnace to produce oxide when required

- A bagless, inert, or dry atmosphere glovebox system for packaging or repackaging materials into primary containment vessels

- Nondestructive analysis equipment to measure nuclear material for accountability

- A vault area with equipment for remote handling, storage, and retrieval

Other process areas in the facility would be for waste collection and handling, equipment maintenance, analytical testing and inspection, shipment preparation, and decontamination of packages or equipment.

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APPENDIX B. ACCIDENTS

For this eis DOE reviewed the safety analysis reports and supporting accident analyses for the F-Area facilities that could be involved in each of the alternatives. This appendix summarizes only those accidents that potentially involve the plutonium solutions or subsequent stabilization and storage. In addition, only the consequences (resulting doses) from the potential release of the plutonium solutions or the stabilized and stored forms are included. Potential consequences from accidents involving other nuclear materials stored in F-Canyon (e.g., americium and curium solutions) are not included. These other materials are not considered relevant in making a direct comparison of the potential consequences from each alternative. DOE will discuss the impacts from other-than-plutonium solutions in the Interim Management of Nuclear Materials eis. This is appropriate because the contributions from these materials would not differ for the plutonium solution alternatives and, therefore, are not a discriminator among those alternatives.

For the alternatives that would involve new facilities or extensive modifications to existing facilities, no accident analyses exist. For such cases, DOE used accident analyses for existing facilities at SRS that have similar operations or that process and handle more hazardous forms of plutonium (e.g., plutonium-238). DOE believes that the types of accidents evaluated for the existing facilities would be comparable to those for new or modified facilities. In addition, DOE believes that the consequences from these accidents would exceed those expected from a new or modified facility. New or modified facilities probably would incorporate improved design features that would mitigate or reduce the consequences from such accidents.

B.1 General Accident Information

An "accident," as discussed in this appendix, is an unplanned and infrequent release of radioactive or hazardous materials resulting from "initiating" events and the additional failures resulting from the initiating event. In this case, an accident is an inadvertent release of radioactive or hazardous materials from their containers or confinement to the environment.1 Initiating events are typically defined in three broad categories:

- External initiators originate outside the facility and potentially affect the ability of the facility to maintain confinement of its materials. Examples of external initiators include aircraft crashes, nearby explosions, and hazardous material releases from nearby facilities that could affect the ability of personnel to manage the facility and its materials properly.

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1. For this appendix, "environment" includes areas within a facility occupied by workers as well as the area outward from the facility where the release occurs.

- Internal initiators originate within a facility and are usually the result of facility operation. Examples of internal initiators include equipment failures and human

errors.

- Natural phenomena initiators are natural occurrences such as weather-related (e.g., floods and tornadoes) and seismic events (i.e., earthquakes).

Sabotage and terrorist activities (i.e., intentional human initiators) might be either external or internal initiators. During the facility design process, designers attempt to identify the types of initiating events that could occur during and beyond the facility's expected life cycle and, when feasible, incorporate appropriate features in their designs to prevent the events from causing an accident or to mitigate the impacts from accidents that might occur. However, there is still a potential for a broad spectrum of accidents to occur at a chemical-nuclear facility.

The likelihood of an accident occurring and its consequences usually depends on the type of initiator(s) causing the accident, the frequency at which that initiator occurs, and the frequency of conditions that will lead to a release as a result of the initiating event. Accidents can be grouped into four categories -- anticipated accidents, unlikely accidents, extremely unlikely accidents, and not reasonably foreseeable accidents -- based on their estimated frequency or likelihood of occurrence. Table B-1 lists these accident categories and their corresponding frequency ranges. The accident frequencies are listed in terms of "incidents per year." For example, if an earthquake of sufficient magnitude to cause a release of material to the environment is likely to occur only once every 5,000 years, the frequency for this accident is presented as 1/5,000, which equals 0.0002 (or in scientific notation 2.0 - 10-4) per year (i.e., it falls into the "unlikely accident category").

Releases of radioactive or hazardous materials can occur at higher frequencies, but are considered "abnormal operating events" because their occurrence is expected, regardless of design features or administrative controls, during the life of the facility and they usually result in no substantial offsite consequences. An example of an abnormal operating event is a small leak of contaminated water from a valve stem. DOE takes extensive efforts to minimize the likelihood of these events by physical and administrative controls. In addition, SRS personnel are trained on how to respond to and mitigate the consequences of such events. The impacts from these releases are included in the calculations of impacts of routine operations. Events occurring within this frequency range are not considered "normal operations" as discussed in Section 4.1. However, the consequences of these types of events are included in reported offsite public doses. The SRS Environmental Report for

Table B-1. Accident frequency categories.a

1992 (Arnett, Karapatakis, and Mamatey 1993) reflects offsite contributions from any Site facilities that release radioactive material. In addition, radiological impacts to workers from normal operations and abnormal operating events are monitored and recorded by individual dosimetry and exposure records. It is inappropriate to apply accident analysis methods, such as very conservative meteorology, for abnormal operating events.

An overall perspective of the methodology of accident analyses contained in the source documents used to prepare this eis is in Section B.2. These source documents, such as safety analysis

reports, provide analyses for events considered to be reasonably foreseeable. Accidents in the not reasonably foreseeable accident frequency range (less than once in a million years) are not explicitly presented in this eis because their projected risks (consequence - frequency) are not likely to be greater than those from accidents analyzed under the other frequency ranges. That is, if a maximum release from a tank occurs with a frequency of once in 5,000 years, then the risk is much smaller for this event at a lower frequency of once in 10 million years because the consequences (i.e., the maximum release) are the same [consequences/5000 > consequences/10,000,000].

For example, the not reasonably foreseeable accidents frequency range includes accidents such as an aircraft crash or meteorite penetration of the F-Canyon structure. An aircraft crash into the F-Area would be of concern because it could result in a radioactive release of materials from the facilities. Based on the types of aircraft that could fly over or near the SRS, the estimated frequency (or likelihood) of an aircraft crash into any of the facilities considered in this eis is less than once in 10 million years. The consequences in terms of releases would not be likely to exceed those from a severe earthquake of a higher frequency. Therefore, the risk from an airplane crash would be bounded by that from an severe earthquake. The potential for a meteorite of sufficient size to penetrate the canyon structure and release radioactive or chemical material is less than the overall frequency of meteorites reaching the earth. The resulting release probably would be much smaller than that from an earthquake or fire; therefore, this risk would be bounded.

B.2 Accident Analysis Methodology

The accidents analyzed and summarized in this eis are those that would result from events that are considered "reasonably foreseeable" (expected to occur at least once in 1,000,000 years). The frequencies presented in the following tables are associated with the initial event (except as noted) that leads to a release of radioactive material. Conservative assumptions have been used in calculating the potential consequences (doses) that could result from such accidents. These consequences are conservative because the release of radioactivity from the facility, associated with the initiating event (e.g., earthquake) can occur only after the failure of multiple safety systems. The earthquake-induced release is postulated to occur in the following manner:

During a tank-to-tank solution transfer in the hot canyon an earthquake occurs. The transfer pipe fails or ruptures but the transfer continues and 50 percent of the contents of the tank spill to the floor of the canyon. Simultaneous with the transfer line rupture, the walls of the canyon crack to provide an unfiltered release pathway to the environment. In addition, the canyon ventilation system fails so that the hot canyon no longer maintains negative pressure (which enhances the release mechanism). After the radioactive material spills, a fraction becomes airborne and passes through the cracks in the canyon walls. This airborne radioactivity then migrates off the Site.
This scenario is conservative because tank-to-tank transfers do not occur all the time, so the earthquake would have to happen while a transfer was happening. In addition, the following failures are assumed to allow the release to reach the offsite population at the projected dose levels. The stainless-steel transfer pipe must fail. Operators fail to respond to stop the transfer or are unable to

stop the transfer. The canyon walls crack sufficiently to allow the escape of 10 percent of the airborne radioactive material. Power distribution and electrical relays associated with the ventilation system fail. All the released material escapes the facility in the first 2 hours and the meteorological conditions are such that only limited dispersion of the material has occurred by the time it reaches the SRS boundary.

The following sections describe the methodology DOE used to analyze the postulated radiological and hazardous material accident scenarios associated with the plutonium solutions in the F-Canyon, as well as the methodology used to select the accidents that present the greatest risks to SRS workers, the public, and the environment. The analytical method described in the following sections did not include emergency response actions to accident situations (e.g., evacuation of personnel to a safe distance or notification of members of the public to take appropriate response actions such as taking shelter) in the determination of potential impacts on workers or members of the public. To minimize potential human exposures and impacts on the environment from postulated accident scenarios should they occur, the SRS has established an Emergency Plan (WSRC 1994a) that governs responses to potential accidents. Section B.6 summarizes the SRS Emergency Plan.

B.2.1 IDENTIFICATION OF AFFECTED FACILITIES

The determination of the potential accidents that can be postulated for continued management or stabilization of the plutonium solutions currently stored in the F-Canyon requires identification of the facilities that support the canyon and those that could be involved in stabilizing the solutions; these facilities include the following:

- F-Canyon. This facility stores and manages the plutonium solutions discussed in this eis.

- FB-Line. Under certain alternatives, this facility, located in the F-Canyon building, would be involved with processing the plutonium solutions to form a solid material that DOE could safely store in appropriate SRS facilities. The FB-Line is capable of processing the solution into solid metal "buttons." The FB-Line vault stores plutonium metal buttons and some plutonium oxide materials. With certain modifications, the FB-Line could process the plutonium to form plutonium oxide, a powder-like substance.

- F-Area Outside Facilities. Several small facilities and processes that support the various facilities in the F-Area, including the F-Canyon and FB-Line. The primary purpose of the F-Outside Facilities is to provide bulk quantities of chemicals, some of which are hazardous, to other facilities in the F-Area. In addition, these facilities perform various recovery operations involving radioactive materials.

- F-Canyon Vitrification Facility. This facility would be able to convert plutonium solutions into small cylinders of plutonium-bearing borosilicate glass.

- New Repackaging and Vault Facility. DOE would use this facility to: (1) repackage plutonium vault metal into a configuration that would meet the new DOE standard for long-term storage of plutonium, and (2) store the repackaged

plutonium until the implementation of final disposition actions.

Appendix A of this eis describes the design, operation, and mission of these facilities as well as the other facilities in the scope of this eis.

B.2.2 IDENTIFICATION OF POTENTIAL ACCIDENTS

To support its decision to authorize operations at nuclear facilities, DOE requires the development of facility safety analysis reports (DOE 1992). Safety analysis reports are the primary authorization basis documents that DOE uses to define and control the parameters within which facilities must operate to ensure worker and public safety, and to comply with Departmental, Federal, state, and local requirements. To assist DOE in determining potential consequences associated with performing activities involving nuclear materials, a major portion of these reports and other facility safety analysis documentation deals with analyses of potential accident scenarios that could occur and the impacts those accidents could have on workers, the public, and the environment.

To determine the types of accident scenarios to be presented in this appendix, DOE performed an extensive review of existing safety documentation for the F-Canyon and the other facilities that either support canyon activities that could be involved with the stabilization of plutonium solutions or that would store stabilized materials. This review identified a spectrum of potential radiological accidents of varying probabilities (frequencies) that could result in a release of radioactive or hazardous materials from their containers or confinement to the environment. DOE will discuss the impacts from other-than-plutonium solutions in the Interim Management of Nuclear Materials eis. This is appropriate because the contribution from these materials would not differ for plutonium solution alternatives and, therefore, is not a discriminator among these alternatives.

Section B.2.3 discusses the methodology used to determine the expected consequences and risks from postulated radiological accidents. Section B.2.4 discusses the methodology used to determine the expected consequences from postulated accidents involving hazardous materials associated with safe storage or stabilization of the plutonium solutions in the F-Canyon. Sections B.2.5 and B.2.6 discuss the selection process used to identify the postulated radiological and hazardous material accidents, respectively, that would present the greatest risks to workers, the public, and the environment.

B.2.3 RADIOLOGICAL ACCIDENT ANALYSIS METHODOLOGY

Although existing safety analysis reports and other safety documentation for SRS facilities present potential accident consequences and risks associated with operating those facilities, the assumptions and methodologies used to develop the dose estimates in such documents have changed substantially over the last several years, making it difficult to compare directly the potential impacts presented in the safety analysis report for one facility to the impacts presented in the report for another facility in a quantifiable manner. For example, much of the documentation currently available was developed in the early 1980s using analytical

techniques and assumptions that have since been improved, making it difficult to compare directly the impacts presented in a 1980s document for a facility to impacts presented in a 1994 document for another facility that incorporates improved analytical techniques and methodologies. Therefore, to enable a meaningful comparison of the postulated accident impacts presented in the various documents, DOE "normalized" the information to facilitate direct comparison.

The normalization of information involves reducing the information to a single standard (so the reader can compare "apples to apples"). Because the accident scenarios analyzed in this appendix consider many radioactive isotopes, the common denominator used to enable a comparison between the consequences from each radionuclide is the curie, a basic measurement of radioactivity. The methodologies for estimating how much radioactive material could be released during an accident, including the isotopic breakdown of the release (i.e., "source term"), have not changed substantially since the 1980s when DOE developed the safety analyses for the facilities within the scope of this eis. The curie content can be directly measured or determined through sampling. Therefore, the source term releases (in curies per isotope) postulated in the various safety analysis documents are directly comparable.

To normalize the consequences from the various types of radiological accident scenarios analyzed in the "different-vintage" safety documents, DOE ran computer models using current methodologies and assumptions to determine the consequences resulting from a 1-curie release of each isotope postulated in an accidental release. This evaluation assumed the release of 1 curie of each isotope to the environment at ground level and at an elevated level, such as through an exhaust stack. Each evaluation was performed for the various facilities involved in the alternatives discussed in this eis. Using the computer models, the evaluation calculated doses to an uninvolved worker(2), the maximally exposed offsite individual(3), and the offsite population within 80 kilometers (50 miles) of the Site (Simpkins 1994a,b).

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2. An "uninvolved" worker (also referred to as a "colocated worker" is a worker not involved in the operation of the facility where a release occurred. This individual is assumed to be 640 meters (2,100 feet) from the point of release. This distance, as defined by in DOE (1994a), is consistent with the 0.6 kilometer (0.4-mile) "exclusion zone" established around commercial nuclear reactor facilities (NRC 1975). This analysis provides an added measure of conservatism by determining impacts to the uninvolved worker 640 meters (2,100 feet) from the point of release rather than from the area boundary, as recommended in DOE (1994a) and NRC (1975).

3. DOE assumes that the hypothetical "maximally exposed offsite individual" resides permanently at the Site boundary where he/she would recieve the largest exposure from the accident.

Two SRS-specific computer codes -- AXAIR89Q and LADTAP XL -- were used to calculate the doses from each of the 1-curie releases postulated. Both of these codes are used to perform accident analyses described in facility safety analysis reports and postulated accident impacts presented in other eiss developed for

the SRS.

The AXAIR89Q computer code (WSRC 1994b), which was developed in accordance with guidelines established by the Nuclear Regulatory Commission (NRC 1983) regarding the modeling of atmospheric releases, models the doses from airborne constituents of postulated accidental releases of radionuclides to the environment. The modeling of the various accidents postulated for the F-Area facilities associated with the different alternatives assumed conservative (99.5 percentile) meteorological conditions (e.g., direction and speed of prevailing wind). "Conservative meteorological conditions" are defined as those for which, for a given release, the concentration of radionuclides (and the resulting doses) at a fixed downwind location will not be exceeded 99.5 percent of the time. Usually, this means a stagnant weather condition where the wind does not act to disperse (and, therefore, dilute and spread more quickly) the material released.

The LADTAP XL computer code was developed to model aqueous (i.e., liquid) releases of radionuclides during routine operations and potential accidents. The modeling of the aqueous releases associated with the postulated accidents summarized in this appendix took no credit for the holdup of radionuclides within the soils surrounding the area where the accidents would occur. In other words, the modeling assumed that the entire release would discharge directly as a liquid to the ground, migrate to the Savannah River (either directly or through Fourmile Branch, as appropriate), and enter the drinking water supply.

The impacts (i.e., doses) to individuals from postulated accidental releases of radionuclides to the environment for the various facilities were calculated by multiplying the quantity of each isotope in the source term release (in curies per isotope) presented in the safety analysis documents by the doses calculated for a 1-curie release, as discussed in the previous paragraphs. For example, if a facility safety analysis report stated that 4.4 - 10-4 curie of strontium-90 was released at ground level in the F-Area, and the dose to the maximally exposed offsite individual from a 1-curie release of strontium-90 at the ground level in the F-Area is 1.0 - 10-1 millirem, then the actual dose to the maximally exposed offsite individual from the 4.4 - 10-4 curie is determined by multiplying 4.4 - 10-4 curie by 1 - 10-1 millirem per curie, resulting in a dose of 4.4 - 10-5 millirem. The total dose received would then equal the sum of the doses received from each radionuclide released during the accident. Section B.3 presents the doses to uninvolved workers, maximally exposed offsite individuals, and the offsite population surrounding the SRS postulated for the facility radiological accidents evaluated in this appendix.

As discussed above, this appendix presents risks to uninvolved workers and members of the public from radiological accidents involving the F-Canyon plutonium solutions in a quantitative fashion using such parameters as dose, accident frequency, and latent fatal cancers in the population (as discussed in Section B.3). However, it presents potential impacts to involved, or "close-in" workers,(4) from postulated accidents in a qualitative rather than a quantitative fashion. The following example illustrates this concept.

A typical methodology for attempting to calculate the dose to an involved worker is to assume that the material is released in a room occupied by the individual and that the material instantly disperses throughout the room. Because the worker would be in the room

when the release occurred, that individual probably would breathe some fraction of the radioactive (or hazardous) materials for a given number of seconds before evacuating the room. Typically, estimates of exposure time are based on assumptions about worker response to the incident (e.g., how long before the worker left the room, or whether the worker evacuated the room through an area of higher airborne concentrations). For example, consider the instance where an individual drops a vessel containing 2,000 grams (4.4 pounds) of plutonium oxide powder. Depending on the size of the room where the release occurred, the assumptions made on how much of the released powder became airborne and respirable, and the length of time the exposed individual remained in the room, the calculated dose to the individual could be anywhere between 80 rem and 78,000 rem (DOE 1994a). The uncertainty of estimation is extremely large, and no additional insight into the activity is available because the occurrence is accepted as undesirable without needing to perform the calculations. Historic evidence indicates that this would be a nonfatal accident resulting in room contamination with the potential for minor personnel contamination and assimilation. Presenting this wide range is not helpful in allowing comparisons of impacts among alternatives.

B.2.4 HAZARDOUS MATERIAL ACCIDENT ANALYSIS METHODOLOGY

Full understanding of the hazards associated with SRS nuclear facilities under the alternatives considered in this eis requires the analysis of potential accidents involving both hazardous and radiological materials. For chemically toxic materials, several government agencies recommend quantifying health effects that cause short-term consequences as threshold values of concentrations in air. Because the long-term health consequences of human exposure to hazardous materials are not as well understood as those related to radiation exposure, a determination of potential health effects from exposures to hazardous materials is more subjective than a determination of health effects from exposure to radiation. Therefore, the consequences from accidents involving hazardous materials

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4. An involved worker is a worker within 640 meters (2,100 feet) of the location where a pastulated accident occurs, and is usually directly involved in the activity or operation being evaluated.

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postulated in this appendix are in terms of airborne concentrations at various distances from the accident location.

To determine potential health effects to workers and members of the public that could result from accidents involving hazardous materials, DOE determined the airborne concentrations of the hazardous materials released during an accident where the uninvolved worker and offsite individual are located [i.e., 640 meters (2,100 feet) and the nearest Site boundary, respectively] and compared them to Emergency Response Planning Guidelines (ERPG) values established by the American Industrial Hygiene Association (AIHA 1991). These values, which depend on the material or chemical being considered, are established for three general severity levels to ensure that the necessary emergency actions occur to minimize worker and public exposures after accidents. These severity levels include the following:

- ERPG-1 Values. Exposure to airborne concentrations greater than ERPG-1 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.

- ERPG-2 Values. Exposure to airborne concentrations greater than ERPG-2 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impair one's ability to take protective action.

- ERPG-3 Values. Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

Because all hazardous materials do not have ERPG values, DOE could not use such values to estimate potential impacts on the public from each hazardous material accident postulated for the SRS facilities discussed in this appendix. Therefore, for chemicals that do not have ERPG values, the assessment compared airborne concentrations of hazardous materials resulting from postulated accidents to the most restrictive available exposure limits established by other guidelines to control worker exposures to hazardous materials. Table B-2 lists the hierarchy of exposure limits that DOE used to evaluate potential health effects resulting from postulated hazardous material accidents.

Table B-2. Hierarchy of established limits and guidelines used to determine impacts from postulated hazardous material accidents.

B.2.5 SELECTION OF RADIOLOGICAL ACCIDENTS

As with any activity, a large number of potential accident scenarios can be postulated for each SRS facility; to attempt to analyze all potential accident scenarios and their impacts would not be cost-effective or meaningful. However, a broad spectrum of abnormal events and accidents can be identified and analyzed for a facility to provide a reasonable understanding of the risks associated with performing activities in that facility. Safety analysis reports and other safety documentation usually analyze a broad spectrum of accidents that are considered reasonably foreseeable (i.e., they are expected to occur at least once every 1,000,000 years) and estimate their potential impacts on workers, the environment, and the public.

For this eis, the term "bounding accident" represents postulated events or accidents that have higher risks (i.e., consequences - frequencies) than other accidents postulated within the same frequency range. For example, the accident scenario within each frequency range defined in Table B-1 postulated to present the highest risk to the maximally exposed offsite individual is a bounding accident because its risk is higher than the risk of other accidents in the same frequency range. A consideration of the risks associated with bounding events or accidents for a facility can establish an understanding of the overall risk to workers, members of the public, and the environment from operating the facility. In addition, the risks of different facilities can be compared relatively by comparing the risks

associated with the bounding accidents for each facility. Figure B-1 shows the concept of bounding risk accidents.

Each of the radiological event tables in this appendix lists the bounding risk events first. There are some facilities for which there are no reasonably foreseeable accidents in some of the frequency ranges (e.g., material stored in a vault might have only a low-consequence anticipated event, and a high-consequence but extremely unlikely event), but not the other binning range. The frequencies listed are usually the frequency of the initiating event (e.g., earthquake). In some cases (e.g., plutonium solutions) the frequency is constructed using an "event tree." This technique asks a series of "yes-no" questions and then estimates the frequency for the "yes" and the "no" answers. In a hypothetical fire, the first question asks "Is a heat source available?" If the yes answer is estimated to occur fewer than three times per year, the frequency would be 3. Next, the answers to the questions "Is the flammable material outside its normal container?" and then "Is the material heated above the fire point?" must also be yes before the fire is projected to occur. The projections are assumed to be 10 percent and 7 percent. Finally, the presence of an ignition source must also be yes to have the fire (e.g., available 5 percent of the time). The overall frequency answers are calculated or estimated based on the actual facility conditions and technical judgment of the analysts. For this example, the frequency would be approximately the product of the numbers or (3 - 0.1 - 0.07 - 0.05 @ 0.001) or once in a thousand years.

Section B.3 identifies the bounding accidents postulated for the facilities that manage materials considered in this eis. In addition, Section B.3 identifies the consequences of nonbounding radiological accidents presented in the various facility safety analysis reports and documentation to provide a complete picture of the accidents considered.

Figure B-1. Methodology used to determine bounding risk accidents

for the various nuclear facilities.

B.2.6 SELECTION OF HAZARDOUS MATERIAL ACCIDENTS

Because of the many types of materials and chemicals at the Site and the varying quantities of these materials in different locations, the analysis of potential accident scenarios involving hazardous materials was limited to substances categorized by the U.S. Environmental Protection Agency as "Extremely Hazardous Substances" (40 CFR Part 355), as designated under the Emergency Planning and Community Right-to-Know Act of 1986. Although materials not categorized as Extremely Hazardous Substances can affect the health and safety of workers and the public if released in sufficient quantities and forms, the Site has implemented programs in accordance with DOE Order requirements (e.g., DOE 1985, 1987, 1993) that incorporate programmatic and management requirements of other government agencies, such as the Occupational Safety and Health Administration. While these materials might present hazards to workers or the public if accidentally released to the environment, their impacts are likely to be bounded by potential impacts from accidents involving Extremely Hazardous Substances; therefore, this appendix does not analyze them.

Although existing safety analysis reports and supporting safety documentation for SRS nuclear facilities include detailed information on postulated radiological accidents, recent

requirements (DOE 1992) require safety analysis reports to postulate the impacts associated with hazardous material accidents to the same level of detail they use to analyze radiological accident scenarios. Because the Site is not yet in full compliance with these requirements, the only information that usually exists for a facility related to hazardous materials includes a list of those materials and their respective quantities.

To determine the potential impacts on individuals at different positions (e.g., uninvolved workers and the maximally exposed offsite individual), DOE used a bounding approach to determine potential impacts from postulated accidents in the F-Area involving Extremely Hazardous Substances; the amounts of such substances and their locations were determined from the SRS Tier Two Emergency and Hazardous Chemical Inventory Report (WSRC 1994c). This annual report identifies the chemicals at the Site that are hazardous or that require the establishment of emergency response procedures. Following identification of the amounts and locations of the Extremely Hazardous Substances in F-Area, DOE calculated the airborne concentrations at 640 meters (2,100 feet) from the point of release and the nearest Site boundary (i.e., locations of the uninvolved worker and offsite individual, respectively) that would be likely from a release of the maximum inventory of each Extremely Hazardous Substance in any single location in F-Area. EPICodeTM (Emergency Prediction and Information Code), a commercially available computer code for modeling the routine or accidental releases of hazardous chemicals to the environment, calculated the airborne concentrations at the different locations (Homann 1988).

In addition to modeling the release of the maximum amount of a given material in a single location in F-Area, DOE also modeled a release of the total quantity of each Extremely Hazardous Substance in F-Area as though it were in a single container. Although the likelihood of such a release is not reasonably foreseeable, the impacts from this type of release probably would bound the impacts from all other postulated releases in the area. In addition, although unlikely, the potential exists for a severe seismic event in F-Area to release a large portion of each material from its different locations.

Section B.4 identifies potential accident scenarios involving hazardous materials postulated for F-Area. In addition, Section B.4 compares the estimated airborne concentrations of materials released during postulated accidents to the appropriate guidelines presented in Table B-2 to enable an assessment of potential impacts to workers and the public.

B.3 Postulated Facility Accidents Involving Radioactive Materials

This section presents potential impacts from postulated radiological accidents at the facilities that could be involved with safe management of the plutonium solutions being stored in the F-Canyon. For each facility, it presents the impacts of the bounding radiological accidents (calculated using the methodology described in Section B.2.3). In addition, it summarizes the impacts from other postulated radiological accidents presented in safety analysis reports and other facility safety documentation to provide a complete picture of the types of accidents considered reasonably foreseeable at each facility in the scope of this eis.

B.3.1 POSTULATED RADIOLOGICAL ACCIDENTS FOR F-ARea FACILITIES

The primary purpose of many of the facilities in the F-Area at the Site was to support the recovery of plutonium-239 in the F-Canyon. To provide perspective on the types of accidents that could occur at these facilities, it is necessary to understand the general activities performed. Appendix A discusses the design, operation, and past missions of the various facilities analyzed in this appendix.

For all F-Area facility accidents summarized in the following sections, with the exception of a severe earthquake-induced release of radionuclides to the environment, the accident impacts are independent of each other. In other words, DOE assumes that the accidents are not caused by a common initiator and, therefore, their consequences and risks are not additive. However, a severe seismic event (i.e., earthquake) 5 is considered a common-cause initiator because it could cause the simultaneous release of radioactive and hazardous materials from each nuclear facility in F-Area. Therefore, the determination of the consequences to workers and members of the public from such an earthquake in F-Area would require the adding together of the consequences of the earthquake from the materials released from each facility in the scope of this eis. Table B-3 lists the postulated radiological impacts on the uninvolved worker, the maximally exposed offsite individual, and the offsite population from a severe earthquake-induced release of radioactive materials from these facilities in their current mode of operation (No-Action Alternative). Table B-4 lists the impacts postulated from a severe earthquake in F-Area to each facility in a fully operational mode. The facility and process descriptions in Appendix A might be helpful in understanding the accident analyses.

Table B-3. Postulated cumulative radiological impacts in the event of a severe e

$Table B-4 Postulated cumulative radiological impacts in the event of a severe earthquake in the F-Area for facilities in their fully operational mode of operation.

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5. New nuclear facilities constructed at the Site are designed to be seismically "rugged" to withstand ground accelerations equal to or greater than 0.2 times the force of gravity, or 0.2g (a "design-basis earthquake"). The magnitude of such an earthquake could cause several structural damage that could lead to partial structural collapse an unmitigated releases of material to the environment. Older facilities not constructed to the same standards would be likely to exhibit more substantial damage.

B.3.1.1 F-Canyon

Because the F-Canyon was designed to process radioactive materials rather than store them for extended periods of time, the potential consequences presented in this section are based on the assumption that the radioactive solutions in the canyon would not remain in the facility for longer than 180 days from the time the fuel or targets were dissolved. However, because canyon operations were suspended in the middle of a processing cycle, the solutions currently in the facility have been there far longer than intended (more than 2 years), thus increasing the uncertainty associated with continued management or further processing of the material as time passes. The likelihood for potential accidents and the consequences that

could result from continuing to manage them in their current form and condition could increase substantially because of changes in management activities implemented to ensure the material remains within approved parameters and conditions. Because the canyon was never intended to store radioactive solutions for longer than 180 days, there is the potential for accidents other than those considered in existing safety analyses to occur and for the frequencies of the accidents postulated in this appendix to increase. However, because of the uncertainties associated with continuing to store the solutions for long periods without processing, quantification of the actual changes in risk that could occur with continued storage of these solutions is difficult. Table B-5 lists nuclides and maximum isotopic curie fractions.

Table B-5. Source term isotopic distribution.

Current operations at the F-Canyon do not include dissolution of reactor-irradiated materials or transfers of solutions to the FB- or FA-Line facilities for further processing. Table B-6 summarizes the impacts from the potential radiological accidents considered in this appendix associated with current operations at the canyon. Table B-7 summarizes the increased risk of latent fatal cancers associated with the radiological accidents listed in Table B-6. Latent fatal cancers are determined using guidance provided by the International Commission on Radiological Protection (ICRP 1991) and the Nuclear Regulatory Commission (10 CFR Part 20). For prompt doses of less than 20 rem, latent fatal cancers are calculated by multiplying the consequences of an accident (in terms of dose) by 5.0 - 10-4 cancer per rem for the public or 4.0 - 10-4 cancer per rem for workers. For prompt doses of more than 20 rem, 1.0 - 10-3 cancer per rem and 8.0 - 10-4 cancer per rem are used for the public and workers, respectively. The risk of latent fatal cancers (per year) accounts for accident frequency and is equal to the number of latent fatal cancers (per accident) multiplied by the accident frequency (in terms of accidents per year).

No fatalities to involved or "close-in" workers from the accident scenarios postulated under current or full operations in the F-Canyon are a likely result of exposure to radiation. With the exception of accidents 1, 2, 6, and 8 in Table B-6, releases from the accidents are likely to be contained within the processing area and filtered through the canyon ventilation system. Because the ventilation system flows from the areas of lowest to highest radioactivity, and because releases exhaust through an exhaust stack after passing through a filtration system, the doses received by workers from these accidents are not likely to be substantially larger than those received during routine operations. For the postulated accidents where the release is not likely to be maintained within the ventilation system (i.e., airborne releases from the ground level or liquid releases), involved worker exposures would be unlikely to result in adverse health effects. For an inadvertent nuclear criticality in the processing vessels, the doses to involved workers would be reduced due to the shielding between the vessels and the locations that workers could occupy.

Although the likelihood for an involved worker fatality due to radiation exposure following a severe earthquake is minimal, there is a potential that the earthquake itself could inflict significant injuries, including death, on involved workers. For example, involved workers could be injured due to flying debris caused by the earthquake.

Although not a direct cause of the accident scenarios postulated for the F-Canyon, worker doses would be likely to occur as a result of cleanup activities after postulated accidents. However, doses to individuals probably would be maintained within the limits established for worker exposures from routine operations.

Table B-6. Postulated radiological events and accidents involving plutonium solutions for operations at F-Canyon.

Table B-7. Increased risk of latent fatal cancers from the radiological events and accidents postulated for operations at the F-Canyon.

Although DOE has not yet performed accident analyses for the F-Canyon Vitrification Facility, the postulated accidents for F-Canyon would be representative of this new facility because the source terms would be comparable.

B.3.1.2 FB-Line Facility

The FB-Line is not currently processing plutonium solutions and its vessels are empty. The current mission of the FB-Line is to store solid plutonium materials, such as buttons and scrap materials, in its vaults.

The resumption of processing activities at the FB-Line would introduce the potential for different types of radiological accident scenarios than those that currently exist. For example, it would introduce potential accidents associated with processing F-Canyon solutions and forming new plutonium buttons. Table B-8 summarizes postulated radiological accidents for the FB-Line under full operating conditions to process buttons and their impacts on workers and members of the public. Table B-9 summarizes the risk of latent fatal cancers associated with the radiological accidents postulated for processing buttons in the FB-Line.

In addition to processing F-Canyon solutions to form metal buttons, the FB-Line, with certain modifications, could process the solutions to form plutonium oxide powder. Although specific analyses have not been developed for the FB-Line to analyze the processing of plutonium solutions to form oxide powder, Phase II of the HB-Line facility was designed to process neptunium and plutonium solutions to form plutonium-239 oxide. A comparison of the accidents listed in Table B-8 and the safety analysis report for the HB-Line facility (Meehan 1994) determined that the accident consequences associated with producing plutonium oxide powder would probably not be greater than those for producing metal buttons, although some of the postulated accident scenarios would change. For example, plutonium in its metal form is more flammable than in its oxide powder form. Therefore, the likelihood of a fire involving plutonium oxide would probably be lower than that for metal. In addition, DOE must consider the fact that a plutonium oxide powder is significantly more dispersible than a solid metal piece of plutonium. For example, if two similar storage containers, one containing a plutonium metal button and the other containing plutonium oxide powder, were dropped and ruptured, the resulting exposures to workers and members of the public could be significantly higher from the container storing the powder than from the container storing the metal button. However, as stated above, DOE does not believe that the overall risks

associated with processing the plutonium solutions to metal or oxide powder would be significantly different.

Table B-8. Postulated radiological events and accidents associated with processing of plutonium solutions to metal(a) at the FB-Line.

Table B-9. Increased risk of latent fatal cancers from the radiological events and accidents postulated for processing of plutonium solutions to metal(a) at the FB-Line facility.

With the exception of an inadvertent nuclear criticality during processing, no fatalities to involved workers from the accident scenarios postulated under current or full operations in the FB-Line would be likely as a result of exposure to radiation. Current operations primarily involve storage activities in the FB-Line vault(s). Because access to storage areas in the FB-Line is strictly limited, the number of individuals who could receive impacts from an accidental release of material in a storage vault would be limited. Under full operations, potential accidents resulting from processing, such as a fire or uncontrolled reaction, would not result in substantial exposures. Based on historic accident information, such as that in the 200-Area incident data base, exposures to involved workers are likely to be within limits established for routine operations if emergency response actions are implemented for an accident. For an inadvertent nuclear criticality during processing in the FB-Line, the radiation field generated by the criticality could lead to involved worker fatalities. Of the approximate 74 persons who could be in the FB-Line facility during processing activities, about 56 would be in areas where they could receive substantial doses from a criticality. Of these 56 individuals, an estimated 4 workers could receive lethal doses of radiation, while the other individuals would be exposed to varying nonlethal levels of radiation.

As with the postulated accidents discussed above for the F-Canyon, there is a potential that a severe earthquake could inflict significant nonradiation-induced injuries, including death, on involved workers. For example, involved workers could be injured by flying debris due to the earthquake.

Although not a direct cause of the accident scenarios postulated for the FB-Line, worker doses could be incurred as a result of cleanup activities following postulated accidents. However, doses to individuals would be maintained within the limits established for worker exposures resulting from routine operations.

B.3.1.3 F-Area Outside Facilities

The primary purpose of the F-Area Outside Facilities is to provide bulk quantities of chemicals, some of which are hazardous, to other facilities in F-Area. Although they were not specifically designed to withstand severe external or natural phenomena events, DOE anticipates that the design of the facilities would limit potential consequences of accidents initiated by such events. Although most materials stored in the F-Area Outside Facilities are nonradioactive, some chemicals received from facilities such as the F-Area Canyon contain small amounts of radioactive material. The Outside Facilities are operational and continue to provide support to other facilities in F-Area, as needed.

Table B-10 summarizes the potential consequences associated with postulated radiological accidents for these facilities. Table B-11 summarizes the risk of latent fatal cancers associated with the

Table B-10. Postulated radiological events and accidents for full operations at the F-Area Outside Facilities.

Table B-11. Increased risk and latent fatal cancers from the radiological events and accidents postulated for full operations at the F-Outside Facilities.

radiological accidents postulated for these facilities. No fatalities to involved workers from the accident scenarios postulated for the F-Area Outside Facilities would be likely a result of exposure to radiation, and DOE anticipates that doses received from the accidents listed in Table B-10 would be minimal. Although the likelihood for an involved worker fatality due to radiation exposure after a severe earthquake would be minimal, the earthquake itself could inflict significant injuries, including death, on involved workers. For example, involved workers could be injured from flying debris caused by the earthquake. For a tornado-initiated release, no worker injuries or exposures to workers resulting from material released due to the tornado, or injuries from the tornado itself, are likely. DOE bases this conclusion on the condition that workers would receive proper notification of severe weather conditions in the SRS area in accordance with emergency plans (WSRC 1994a); this would enable workers to take the necessary precautions, such as placing the facility in a safe shutdown condition and taking shelter until the weather passed.

Although not a direct cause of the accident scenarios postulated for the F-Area Outside Facilities, DOE anticipates that workers would incur doses as a result of performing cleanup activities after a postulated accident. However, doses to individuals would be maintained within the exposure limits established for worker exposures from routine operations.

B.3.1.4 235-Storage Vaults

The current mission of the 235-F Storage Vaults is to store plutonium-bearing products safely. Table B-12 summarizes postulated radiological accidents for the 235-F facility. Table B-13 summarizes the risk of increased latent fatal cancers associated with the radiological accidents postulated for this facility.

With the exception of an inadvertent nuclear criticality in the storage vaults, no fatalities to involved workers from the accident scenarios postulated for the 235-F facility would be likely as a result of exposure to radiation. Because the number of individuals permitted in the storage vaults is strictly limited, the number of individuals who could be affected by the postulated accidents would be limited. Based on historic accident information (e.g., the 200-Area incident data base), exposures to involved workers are likely to be within limits established for routine operations, even if the inventories of materials in the vaults increased as a result of stabilization of materials at other SRS facilities. For an inadvertent nuclear criticality in the vaults, the radiation field generated by the criticality could lead to involved worker fatalities. No more than two involved workers would be likely to receive lethal doses of radiation; a limited number of additional individuals could

receive exposures significantly above the annual administrative limit established for routine operations.

Table B-12. Postulated radiological events and accidents for storage operations at the 235-F Facility Storage Vaults.

Table B-13. Increased risk of latent fatal cancers from the radiological events and accidents postulated for storage operations at the 235-F Storage Vaults.

As with the postulated accidents discussed above for the other facilities, there is a potential that a severe earthquake could inflict significant nonradiation-induced injuries, including death, on involved workers. In addition, although cleanup activities would not be a direct cause of the accident scenarios postulated, they could cause worker doses after such accidents. However, doses to individuals would be within the limits established for worker exposures from routine operations.

Postulated radiological accidents involving the 235-F storage vaults would be representative of the new repackaging and storage vaults because the mission and source term would be similar. One exception would be the probable elimination of the storage container rupture accident due to plutonium repackaging.

B.4 Postulated Accidents Involving Extremely Hazardous Substances

Based on a review of current inventories at the various facilities in F-Area (DOE 1994b), DOE determined that seven Extremely Hazardous Substances are in use in the area. Table B-14 lists the total annual maximum and average daily quantities of these substances based on 1-year inventories. In addition, Table B-14 lists the maximum amounts of each substance in a single location in F-Area.

Table B-14. Inventories of Extremely Hazardous Substances(a) in F-Area.

To determine airborne concentrations at 640 meters (2,100 feet) and the nearest Site boundary (the locations of the uninvolved worker and maximally exposed offsite individual, respectively), DOE assumed an inadvertent release of the maximum amount of each material in a single location to the environment. The EPICodeTM computer code (discussed in Section B.2.6) was used to model the release of each material. Table B-15 lists the results of the analyses and compares the expected airborne concentrations at the uninvolved worker and offsite individual locations to the different threshold Emergency Response and Planning Guidelines (ERPGs), or their equivalents.

Table B-15. Impacts from potential non-seismic-initiated releases of Extremely Hazardous Substances in F-Area.

Because a severe seismic event has the potential to initiate releases of the same types of materials from different locations in F-Area, DOE analyzed a release of the maximum daily inventory (listed in Table B-14) to the environment. Table B-16 lists the results of these analyses. A total release of the entire inventory of a particular material from F-Area to the environment is extremely unlikely,

especially if the material is in several different locations, facilities, or buildings in the area. However, the assumption of a total release of the maximum inventories in the area provides a bounding estimate for the largest airborne concentrations DOE could expect following a severe seismic event.

As listed in Tables B-15 and B-16, the airborne concentrations for a gaseous release of hydrogen fluoride (hydrofluoric acid) exceed the ERPG-3 threshold limits at 640 meters (2,100 feet) from the point of release. As described in Section B.2.4, ERPG-3 threshold values represent the airborne concentration at which an individual would experience or develop life-threatening health effects if exposed for longer than 1 hour. Because individuals could be notified and evacuated to a safe

Table B-16. Impacts from potential releases of Extremely Hazardous Substances in F-Area resulting from a severe earthquake.

location (e.g., inside a building with adequate ventilation) within 1 hour of an inadvertent release of hydrogen fluoride, DOE does not expect any life-threatening or long-term health effects to uninvolved workers. Uninvolved workers could experience mild burning of the lungs from inhaling airborne concentrations at the nearest SRS boundary would be below ERPG-1 threshold values, no measurable health effects would be likely to members of the public. However, for involved workers, there is a potential for serious worker injury and potential fatalities because of the large concentrations expected at locations close to the point of release that could hinder personnel from taking the appropriate emergency response actions.

In the event of a severe earthquake, Table B-16 indicates that a release of the total quantities of nitric acid in the F-Area would exceed ERPG-3 values at a distance of 640 meters (2,100 feet) and ERPG-1 values at the nearest Site boundary. As discussed in Section B.2.4, the health effects from being exposed to ERPG-1 threshold values for longer than 1 hour would be minor (e.g., irritation of the eyes and objectionable odor). In addition, because some time would be required for airborne concentrations at the nearest Site boundary, emergency actions could notify members of the public about appropriate responses to avoid these minor effects. For uninvolved and involved workers, although ERPG-3 threshold values would be exceeded, no worker fatalities from exposure to the acid would be likely, although some individuals could experience significant short-term health effects, such as burning of the lungs and irritation of the skin. Because this scenario assumed that all nitric acid in the F-Area was released from a single location during a severe earthquake, airborne concentrations would be lower than those listed in Table B-16.

B.5 Secondary Impacts from Postulated Accidents

The primary focus of accident analyses performed to support the operation of a facility is to determine the magnitude of the consequences of postulated accident scenarios on public and worker health and safety. However, DOE recognizes that accidents involving releases of materials could adversely affect the surrounding environment. For this appendix, postulated impacts on the environment from potential accident scenarios are "secondary impacts."

To determine the greatest secondary impacts that could occur to the environment from the postulated accidents, DOE evaluated each radiological accident scenario. The following sections qualitatively summarize the results of the evaluations.

B.5.1 BIOTIC RESOURCES

Limited areas of surface contamination would occur in the immediate area around the affected facility if a postulated accident took place. Terrestrial biota in or near the contaminated area could be exposed to small quantities of radioactive materials and ionizing radiation until the affected areas could be decontaminated. DOE believes that impacts on biotic resources from the accidents analyzed in this appendix would be minor.

B.5.2 WATER RESOURCES

No adverse impacts on water quality from any of the accident scenarios considered in this appendix are likely. Although some scenarios include liquid releases to the environment, consequences from these releases would be limited. Although contamination could reach groundwater supplies, the slow rate at which this contamination would to migrate to the groundwater would limit both the prompt and cumulative impacts on the environment and individuals exposed to groundwater.

B.5.3 ECONOMIC IMPACTS

With the exception of severe accident scenarios, such as those initiated by severe earthquakes, limited economic impacts are likely as a result of the accident scenarios postulated in this appendix. Cleanup of contamination would be localized at the facility where the accident occurred, and DOE believes that the current workforce could perform the cleanup activities. In addition, DOE expects that offsite contamination would be limited or would not occur. Severe accidents, such as a breach of the F-Canyon, would cause DOE to incur substantially larger economic impacts to either repair the facilities or place them in a condition that minimized further risks to workers and the public.

B.5.4 NATIONAL DEFENSE

Because the facilities considered in this eis represent redundant (or potentially redundant) processing and conversion capabilities on the Site or with other DOE facilities, none of the postulated accident scenarios in this appendix is likely to impact the defense capabilities of the United States.

B.5.5 ENVIRONMENTAL CONTAMINATION

Contamination of the environment from the accidents postulated in this appendix would be limited to the immediate area surrounding the facility where the accident occurred. All of the postulated accidents would result in minimal offsite contamination.

B.5.6 THREATENED AND ENDANGERED SPECIES

There are no habitats of Federally listed threatened or endangered species in the immediate vicinity of the SRS facilities considered in this eis. Because the accident scenarios postulated in this appendix would result in only localized contamination, DOE does not expect these accidents to affect any threatened or endangered species.

B.5.7 LAND USE

Because the accidents postulated in this appendix would result in only localized contamination around the facility where an accident occurred, and minimal offsite contamination is likely, DOE expects no impacts on land use.

B.5.8 TREATY RIGHTS

The environmental impacts of each accident postulated in this appendix would be maintained within the SRS boundaries and the area where the particular accident scenario occurred. Because there are no Native American lands within the Site boundaries, treaty rights would not be affected.

B.6 Accident Mitigation

Although DOE expends extensive efforts and large amounts of capital to prevent accidents involving radioactive and hazardous materials, accidents and inadvertent releases to the environment can still occur. Therefore, an important part of the accident analysis process is the identification of actions that can mitigate consequences from accidents if they occur.6 This section summarizes the SRS Emergency Plan, which governs responses to accident situations that affect Site employees or the offsite population.

The Savannah River Site Emergency Plan (WSRC 1994a) defines appropriate response measures for the management of Site emergencies (e.g., radiological or hazardous material accidents). It incorporates into one document the entire process designed to respond to and mitigate the consequences of a potential accident. For example, it establishes protective action guidelines for accidents involving chemical and radiological releases to keep onsite and offsite exposures as low as possible. It accomplishes minimization or prevention of exposures by minimizing the time spent in the vicinity of the hazard or the release plume, keeping personnel as far from the hazard or plume as possible (e.g., using physical barricades and evacuation), and taking advantage of available shelter.

Emergencies that could cause activation of all or portions of this plan and the SRS Emergency Response Office include the following:

- Events (operational, transportation, etc.) with the potential to cause releases above allowable limits of radiological or hazardous materials.

- Events such as fires, explosions, tornadoes, hurricanes, earthquakes, dam failures, etc., that affect or could affect safety systems designed to protect Site and offsite populations and the environment.

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6. This analysis takes no credit for accident response under the SRS Emergency Plan in determining the potential consequences and risks to workers or members of the public presented in other sections of this appendix.

- Events such as bomb threats, hostage situations, etc., that reduce the security posture of the Site.

- Events created by proximity to other facilities such as the Vogtle Electric Generating Plant (a commercial nuclear plant across the Savannah River from the Site) or nearby commercial chemical facilities.

Depending on the types of postulated accidents and the potential impacts that could result from those accidents, emergencies are classified in several categories in accordance with requirements defined in the DOE 5500 Series of Orders, as follows:

- Alerts are confined within the affected facility boundary; no measurable impacts to workers or members of the public outside the facility boundary are likely.

- Site Area Emergencies are events that are in progress or that have occurred involving actual or likely major failures of facility safety or safeguards systems needed for the protection of onsite personnel, the public, the environment, or national security; because they have the potential to impact workers at colocated facilities or members of the public in the SRS vicinity, these situations require notification of and coordination of responses with the appropriate local authorities.

- General Emergencies produce consequences that require the implementation of protective actions to minimize impacts to both workers and the public; full mobilization of all available onsite and offsite resources is usually required to deal with the event and its consequences.

In accordance with the Site Emergency Plan, DOE conducts frequent drills and exercises at the SRS to develop, maintain, and test response capabilities, and validate the adequacy of emergency facilities, equipment, communications, procedures, and training. For example, drills occur periodically for the following accident scenarios in the facilities or facility areas: facility/area evacuations; shelter protection; toxic gas releases; nuclear incident monitor alarms (following an inadvertent nuclear criticality); fire alarms; medical emergencies; and personnel accountability (to ensure that all personnel have safely evacuated a facility or area following an emergency). DOE and Westinghouse Savannah River Company conduct and evaluate periodic drills with the following organizations or groups to ensure that they continue to maintain (from both a personnel and an equipment standpoint) the capability to respond adequately to emergency situations: first aid teams; rescue teams fire wardens and firefighting teams; SRS medical and health protection personnel and personnel from the Eisenhower Army Medical Center; SRS and local communications personnel and systems; and SRS security forces.

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APPENDIX C. RESPONSES TO PUBLIC COMMENTS

The U.S. Department of Energy published the Draft F-Canyon Plutonium Solutions Environmental Impact Statement (DOE/eis-0219D) in August 1994. DOE announced the availability of the Draft eis for public review and comment in the Federal Register on September 9, 1994 (59 FR 174, pages 46627-46628); this announcement initiated the 45-day comment period. DOE held three hearings to receive oral and written comments and to exchange information with the public on the Draft eis: in Columbia, South Carolina, on October 4, 1994; North Augusta, South Carolina, on October 6, 1994; and Savannah, Georgia, on October 11, 1994. The public comment period ended on October 24, 1994. DOE has made this Final eis available for review in Reading Rooms in Washington, D.C., and Aiken, South Carolina, and has distributed it to individuals, organizations, and Federal, state, and local officials who commented on the Draft eis and to others on the DOE National Environmental Policy Act distribution list.

During the comment period, seven persons presented formal comments at the three public hearings: two in Columbia, four in North Augusta, and one in Savannah. In addition, a number of other individuals participated with DOE representatives in informal discussions during these hearings. DOE received no written comments at the hearings. DOE received 19 letters related to the Draft eis; of the letters, 4 were from Federal agencies, 4 were from South Carolina agencies, and 1 was from a Georgia agency. Although a toll-free telephone number was available to receive voice-mail or facsimile transmissions, DOE received no telephone comments on this eis.

A revision to the text of the eis caused by comment is indicated by a change bar along with the appropriate comment number in the margin. Tables C-1, C-2, C-3, and C-4 list the government agencies, elected official, private organizations, and individuals, respectively, who submitted comments.

This appendix includes copies of all comment letters (L1 through L19) received by DOE and the transcripts of the oral presentations (H1 through H7) made at the public hearings. It also presents the DOE responses to the comments, as described below. All of the letters and comments are presented in the order they were received. DOE has responded to those that requested clarification or those that resulted in changes to the text of the eis. Several of the comment letters were from Federal or state agencies responsible for reviewing environmental impact statements. If such a letter indicates that the agency had no comments on the eis (see letters L4, L7, L9, and L12), DOE has presented that letter without including a response. Similarly, DOE has not provided responses to a number of letters

Table C-1. Government agencies commenting on draft environmental impact statement.

Table C-2. Elected officials commenting on draft environmental impact statement.

Table C-3. Private organizations commenting on draft environmental impact statement.

Table C-4. Individuals commenting on draft environmental impact statement.

and comments (L1, L11, H2, H3, H4, H5, and H6) that expressed an opinion either in general or about one of the alternatives. DOE appreciates the time and effort of everyone who participated in this process.

Comment letter L1, Paul D. Coverdell, U.S. Senator

Figure (Letter L1)

Comment letter L2, South Carolina Department of Archives and History (Ian D. Hill, State Historic Preservation Officer)

Figure (Letter L2)

Response to comment letter L2:

L2-1 A Programmatic Memorandum of Agreement (PMOA) between the DOE Savannah River Field Office (DOE-SR), the South Carolina Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation ratified on August 14, 1990, is the instrument for the management of cultural resources at SRS. DOE-SR uses the PMOA to identify cultural resources, assess them in terms of eligibility for the National Register of Historic Places, and develop mitigation plans for affected resources in consultation with the SHPO. DOE would comply with the stipulations of the PMOA for all activities related to the proposed action or the alternatives discussed in this eis.

Comment letter L3, Michael R. Williams

Figure (Letter L3)

Response to comment letter L3:

L3-1 This eis addresses a proposed action and alternatives that would reduce the risk inherent in continuing to store plutonium solutions in the F-Canyon in a liquid form. Because the manufacture and use of mixed-oxide fuel would not be necessary to achieve this safety goal, the eis does not consider this action. DOE is evaluating potential uses of plutonium that is surplus to the defense requirements of the United States in its eis on Storage and Disposition of Weapons-Usable Fissile Nuclear Materials, which is in preparation. The alternatives considered in that eis include the potential use of a nuclear reactor to burn existing inventories of plutonium to eliminate their availability for weapons use. Residual plutonium would thus be contained in highly radioactive spent fuel, making access extremely difficult and reducing the risk of proliferation. This is the "spent fuel standard" for protection of material. The U.S. Nonproliferation and Export Control Policy announced by the President on September 27, 1993, does not encourage processing of plutonium for nuclear explosive or nuclear power uses.

Comment letter L4, U.S. Department of the Army, Corps of Engineers, Charleston District (Clarence A. Ham, Chief, Regulatory Branch)

Figure (Letter L4.)

Comment letter L5, Scott H. Richardson, South Carolina House of Representatives

Figure (Letter L5.)

Responses to comment letter L5:

L5-1 DOE has estimated impacts on water resources in Section 4.4 of the eis. The doses from each alternative would be small in comparison to the drinking water standard (4 millirem per year).

L5-2 As discussed in Chapters 1 and 2, the plutonium solutions currently in F-Canyon have been kept in storage conditions that weapons production operations did not anticipate. With regard to the material stored in the L-Reactor Disassembly Basin, DOE is preparing an eis on the Interim Management of Nuclear Materials at the SRS, which will develop strategies for dealing with that material.

L5-3 Although the topic of spent nuclear fuel is outside the scope of this eis, DOE is developing several other eiss, both for its nationwide complex and for the Savannah River Site, that deal with this important and controversial subject. Section 1.3 of this eis describes the efforts to develop these documents.

Comment letter L6, Thomas M. Slack

Figure (Letter L6.)

Response to comment letter L6:

L6-1 DOE will evaluate the use of a formal Statistical Process Control (SPC) program for the selected stabilization method. The implementation of a formal SPC program will depend on the costs required, the derived improvements or benefits to safety, and the time required for development and installation of associated equipment. DOE considers the implementation of such a program to be an "enhancement" for safety and process control versus a "requirement" for stabilization actions.

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor)

Figure (Letter L7)

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor) (continued)

Figure (Letter L7 Page 2 of 6)

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor) (continued)

Figure (Letter L7 Page 3 of 6)

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor) (continued)

Figure (Letter L7 Page 4 of 6)

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor) (continued)

Figure (Letter L7 Page 5 of 6)

Comment letter L7, South Carolina Governor's Office (Rodney P. Grizzle, Grants Services Supervisor) (continued)

Figure (Letter L7 Page 6 of 6)

Comment letter L8, Nazir S. Khalil

Figure (Letter L8.)

Responses to comment letter L8:

L8-1 All of the plutonium solutions are physically in tanks in the F-Canyon facility. Figure 2.3 shows the various steps of the PUREX process at which these solutions are stored. In accordance with the requirements of the Atomic Energy Act, information about the amount of plutonium in each tank is classified.

L8-2 The plutonium solutions represent much less than 10 percent of the plutonium inventory at the SRS, which DOE has acknowledged at 2.1 metric tons. Similarly, the solutions represent much less than 1 percent of the total nationwide DOE inventory of plutonium.

L8-3 As stated in Section 2.8.5, there would be differences between the level of personnel knowledge and training required for each alternative. The No-Action and Processing to Metal Alternatives would involve activities similar to past SRS activities (processing and storage). DOE could use existing SRS training and qualification programs to maintain core competence; this does not imply that the programs would be the same.

L8-4 The commenter is correct that DOE has not yet developed waste acceptance criteria for vitrified high-level waste containing significant quantities of plutonium, while it has developed such criteria for the expected glass product from the Defense Waste Processing Facility, which will contain trace quantities of plutonium. DOE would have to address this technical issue during the technology development process for the vitrification of wastes containing significant quantities of plutonium if it selected the Vitrification (Defense Waste Processing Facility) or Vitrification (F-Canyon) Alternative.

L8-5 In the Federal Register of October 28, 1994, DOE proposed to separate the Reconfiguration Programmatic eis (Peis) into two Peiss: a Tritium Supply and Recycling Peis to be completed in November 1995, and a Stockpile Stewardship and Management Peis. At this time, their effects on SRS employment are unknown. During the development of these two Peiss, DOE will analyze cumulative impacts on SRS employment.

Comment letter L9, U.S. Department of the Interior, Office of Environmental Policy and Compliance (James H. Lee, Regional Environmental Officer)

Comment letter L10, Citizens for Nuclear Technology Awareness (William C. Reinig, Vice Chairman)

Figure (Letter L10 Page 1 of 2)

Comment letter L10, Citizens for Nuclear Technology Awareness (William C. Reinig, Vice Chairman) (continued)

Figure (Letter L10 Page 2 of 2)

Responses to comment letter L10:

L10-1 DOE is preparing this eis on a expedited schedule so it can make an informed decision, with input from its stakeholders, in a timely fashion. DOE recognizes the risks involved in continuing to store the plutonium solutions in tanks in the F-Canyon facility, and continues to monitor and manage solution chemistry.

L10-2 DOE acknowledges that the risks from continued storage could be underestimated. DOE used a variety of information sources to estimate the consequences (and impacts) from potential accident scenarios involving the plutonium solutions and stabilization alternatives. The development of the accident analyses used conventional "event tree" and "fault tree" logic. Many frequency and consequence estimates for the accidents were derived from the Site's operational data base of occurrences over the past 40 years. DOE believes the analysis accurately reflects the risks from stabilization using the conventional process (i.e., processing to metal). In addition, DOE extrapolated existing data to estimate the risk associated with other stabilization alternatives. For the other alternatives, DOE believes the risks identified would be conservative (i.e., higher than actual). DOE believes that it could make improvements in equipment or process designs for the implementation of these alternatives to reduce risk further. DOE acknowledges that historic experience listed in the data base has limitations for estimating the risk (impacts) from continued storage (i.e., No Action). However, DOE has taken compensatory actions to mitigate further or maintain the historic level of risk associated with temporary storage.

L10-3 DOE could implement the proposed action early in 1995; until that time the Department would store the plutonium solutions in their current form and location. If DOE implemented an alternative other than the proposed action, the plutonium solutions would remain in their current forms and locations for longer periods. However, if a situation arose that required emergency action, DOE would respond immediately to the situation and consult with the Council on Environmental Quality (CEQ) regarding alternative arrangements for compliance with NEPA, as required by the CEQ regulations.

L10-4 See the response to Comment L10-2. DOE believes that stabilization actions would result in a physical and chemical form of plutonium that would have less risk

associated with storage than the current liquid form.

L10-5 Comment noted. DOE considers this to be an accurate statement of a previous review. (Assessment of Interim Storage of Plutonium Solutions in F-Canyon and Mark-31 Targets in L-Basin at the Savannah River Site, SRS-FCAN-94-01, U.S. Department of Energy, Office of Environment, Safety and Health, Washington, D.C., July 29, 1994).

L10-6 DOE believes that core competency is a relevant factor in the decisionmaking process. DOE considers the maintenance of core competency at current levels to be a requirement of responsible management, regardless of which alternatives DOE chooses to implement. Many of the activities involved with the storage or stabilization of these solutions would require operator actions. If DOE selected a processing alternative, the facility would undergo an operational readiness evaluation, which would include safety assessments, operator training, and the qualifications of the facility staff.

Comment letter L11, David C. Losey

Figure (Letter L11)

Comment letter L12, Georgia State Clearinghouse (Charles H. Badger, Administrator, Office of Planing and Budget)

Figure (Letter L12)

Comment letter L13, U.S. Department of Commerce, National Marine Fisheries Service (Andreas Mager, Jr., Assistant Regional Director, Habitat Conservation Division)

Figure (Letter L13 Page 1 of 2)

Comment letter L13, U.S. Department of Commerce, National Marine Fisheries Service (Andreas Mager, Jr., Assistant Regional Director, Habitat Conservation Division) (continued)

Figure (Letter L13 Page 2 of 2)

Responses to comment letter L13:

L13-1 DOE has reviewed any modifications to alternative stabilization techniques to determine impacts to applicable environmental resources, including anadromous fish and threatened and endangered species.

Comment letter L14, Robert H. Wilcox

Figure (Letter L14)

Responses to comment letter L14:

L14-1 DOE believes that restarting processing activities in F-Canyon after an extended period during which no processing occurred would not be the continuation of an ongoing activity. Therefore, DOE has determined that, to ensure compliance with NEPA, in the absence of an emergency condition there should be no processing before the completion of the eis process.

L14-2 DOE used a variety of information sources to estimate the impacts from potential accident scenarios involving the plutonium solutions and stabilization alternatives. The development of the accident analyses used conventional "event tree" and "fault tree" logic. Many frequency and consequence estimates for the accidents were derived from the Site's operational data base of occurrences over the past 40 years. DOE believes the analysis accurately reflects the risks from stabilization using the conventional process (i.e., processing to metal). In addition, DOE extrapolated existing data to estimate the risk associated with other stabilization alternatives. For the other alternatives, DOE believes the risks identified would be conservative (i.e., higher than actual). DOE believes that it could make improvements in equipment or process designs for the implementation of these alternatives to reduce risk further. DOE acknowledges that historic experience listed in the data base has limitations for estimating the risk (impacts) from continued storage (i.e., No Action). DOE acknowledges that the risks from continued storage are probably underestimated in the eis analysis despite the compensatory actions taken to minimize the known risks with the materials. This is because DOE cannot predict the impacts of potential accidents and therefore has not included accident impacts in the analysis in this eis. Historically, the root cause of a number of serious incidents can be attributed to the unexpected effects of abnormally long process shutdowns involving material in a production process (e.g., the explosion of the americium column at Hanford, the Tomsk incident in Russia, and the reactor incident at the SRS in which reactor neutronics were altered as a result of the buildup of decay products in target materials during an abnormally long midcycle shutdown). However, DOE has no basis for quantifying the risk associated with the potential continued deterioration of these materials during long-term storage because the Department has no significant experience or data to utilize for such an analysis.

L14-3 Potential environmental impacts associated with the ultimate disposal or alternative uses of the stabilized material is beyond the scope if this interim-period eis which only addresses the need to stabilize the F-Canyon plutonium solutions. DOE would evaluate a proposal to burn the plutonium in a nuclear power reactor in separate National Environmental Policy Act documentation.

L14-4 Comment noted.

Comment letter L15, U.S. Environmental Protection Agency, Region IV (Heinz J. Mueller, Chief, Environmental Policy Section)

Figure (Letter L15 Page 1 of 2)

Comment letter L15, U.S. Environmental Protection Agency, Region IV (Heinz J. Mueller, Chief, Environmental Policy Section) (continued)

Figure (Letter L15 Page 2 of 2)

Responses to comment letter L15:

L15-1 DOE has addressed this comment in the introduction of Chapter 4.

L15-2 DOE is evaluating the possibility of nominating certain SRS facilities for the National Register of Historic Places, and agrees that the major SRS facilities, including F-Canyon, are relevant to the broad historic theme of nuclear weapons production during the Cold War. In this regard, these facilities meet one of the criteria for listing on the National Register of Historic Places; however, they do not meet other National Register criteria, such as being more than 50 years old. DOE will continue the process of evaluating SRS facilities to determine their eligibility for nomination to the National Register.

Comment letter L16, Energy Research Foundation and Natural Resource Defense Council (Brian Costner and Andrew Caputo)

Figure (Letter L16 Page 1 of 4)

Comment letter L16, Energy Research Foundation and Natural Resource Defense Council (Brian Costner and Andrew Caputo) (continued)

Figure (Letter L16 Page 2 of 4)

Comment letter L16, Energy Research Foundation and Natural Resource Defense Council (Brian Costner and Andrew Caputo) (continued)

Figure (Letter L16 Page 3 of 4)

Comment letter L16, Energy Research Foundation and Natural Resource Defense Council (Brian Costner and Andrew Caputo) (continued)

Figure (Letter L16 Page 4 of 4)

Responses to comment letter L16:

L16-1 DOE believes the level of detail in this eis is sufficient to convey the potential environmental impacts of the proposed action and alternatives to the interested public, other government agencies, and the decisionmaker(s). DOE has revised the eis to include an additional stabilization alternative (see the response to Comment L16-6).

L16-2 As indicated in Section 1.1, the Defense Nuclear Facilities Safety Board and the Department specifically identified the problem with the F-Canyon solutions as especially urgent and recommended that DOE expedite preparations to stabilize this material. The plutonium solutions currently in storage are susceptible to release from a range of facility accidents. These accidents could be the result of human error, equipment failure, or natural phenomena (e.g., earthquake). The release of the material during an accident could result in radiation exposures to workers or the public. By taking action to convert the plutonium solutions into a solid form, DOE can eliminate the risks from storing plutonium in a liquid form. Solutions of fissile radioactive material inherently represent a greater risk of release and criticality than solid forms. In addition, maintaining such solutions in a safe configuration requires more frequent surveillance (i.e., sampling) and technical vigilance (i.e., adding materials required to maintain the appropriate chemistry).

Converting the solutions to a solid form would give DOE a form that is safer and easier to manage.

DOE believes that continued indefinite storage of plutonium in a liquid form represents an unacceptable risk to its workers, the public, and the environment. DOE has a number of other nuclear materials at the SRS with chemical or physical forms or storage configuration that pose similar concerns. DOE is evaluating alternatives for converting these materials to different forms or placing them in configurations that are safer for continued storage. DOE is preparing an eis on the Interim Management of Nuclear Materials at the SRS to address these materials. DOE chose to prepare a separate eis on an expedited basis to address the F-Canyon plutonium solutions specifically for two primary reasons:

1. DOE has existing capabilities at the SRS to convert the solutions to a safer form for continued storage. This eis identifies the alternative that would use these capabilities as the preferred alternative.

2. The selection of a stabilization alternative for the plutonium solutions in F-Canyon can be independent of decisions on all other materials stored at SRS. That selection neither precludes nor prejudges alternatives for similar materials at the Site. The selection of a stabilization alternative now for the F-Canyon plutonium solutions does not mean that DOE would select the same alternative for other materials at the SRS. DOE has revised Sections 1.1 and 1.2 to reflect this information more clearly.

L16-3 DOE has chosen to consider alternatives for the stabilization of the F-Canyon plutonium solutions on an accelerated schedule in relation to other nuclear materials currently in storage at the SRS. As described in the response to Comment L16-2, the Defense Nuclear Facilities Safety Board considered the F-Canyon solutions to be an especially urgent safety concern. The report of the DOE risk assessment team (referenced in Section 1.1) describes difficulties that DOE has encountered in maintaining the solutions in a safe configuration. DOE cannot determine a precise date when it would have to take action to stabilize these solutions to prevent an accident and the attendant unnecessary exposures of workers (and potentially the public); however, DOE believes that stabilizing the solutions will prevent such an event from occurring. The Department's decisionmaking process on the approach to accelerating the stabilization of the F-Canyon plutonium solutions was based on a balance of the need for urgency with the need to ensure adequate public input to the decision. The selected approach offered the advantage of a complete analysis under NEPA while providing a minimum of 2 to 3 months acceleration based on the extremely aggressive schedule for the Interim Management of Nuclear Materials eis. The issuance of that eis in draft, however, has been delayed one to two months due to corrections and improvements in the technical data and other changes.

L16-4 This eis addresses the full range of reasonable alternatives for converting plutonium in a liquid form to a solid more stable form. DOE does not consider the operation of the second plutonium cycle to be an

alternative that would satisfy the purpose of this eis. Section 2.6 and Appendix A describe the operation of the second plutonium cycle. This purification step would be part of the action to prepare the plutonium solutions for conversion (i.e., stabilization). The actual stabilization activities, as discussed in the alternative descriptions in Chapter 2, would be the conversion of the plutonium in liquid form to plutonium metal, plutonium oxide, or plutonium in glass. The operation of the second plutonium cycle alone would not do anything to stabilize the material and, therefore, would not fulfill the need for DOE action. As acknowledged in the letter from the SRS Manager (Fiori, M.P., 1994, "F-Canyon National Environmental Policy Act (NEPA) Considerations," interoffice memorandum to L. C. Sjostrom, U.S. Department of Energy, Washington, D.C., July 26), DOE could achieve some risk reduction through the operation of the second plutonium cycle, but the letter is clear that this action would not achieve the goal of stabilizing the material. An inherent assumption in the action proposed by the Manager's letter was that, because the operation of the second plutonium cycle would be required anyway as a precursor to stabilization, there would be a benefit to operating the cycle to improve the chemistry of the plutonium solutions. This was not an alternative to the stabilization of the solutions because the processing of all the F-Canyon plutonium-bearing solutions through the second plutonium cycle would have increased the plutonium concentrations of the solutions and removed material such as uranium, which acts as a neutron poison for criticality control.

DOE does not believe that processing these solutions to metal and storing the metal in vaults in protected areas of the SRS, which would add a few kilograms to the U.S. inventory of many metric tons, would be a proliferation risk. Further, DOE believes that this proposed action is fully consistent with the Presidential Nonproliferation and Export Control Policy, the objectives of which include the placement "...of fissile materials from dismantled nuclear weapons and within civil nuclear programs. Under this approach, the U.S. will ... seek to eliminate where possible the accumulation of stockpiles of highly-enriched uranium or plutonium, and to ensure that where these materials already exist they are subject to the highest standards of safety, security, and international accountability" (White House press release, September 27, 1993). Furthermore, in accordance with the provision in this Policy to submit U.S. fissile material surplus to U.S. national security requirements to inspection by the International Atomic Energy Agency (IAea), the Department intends to offer this material along with other material at the SRS for IAea inspection when the material is in a form and consolidated in a storage facility suitable for safe and effective monitoring by the IAea. The timely stabilization and consolidation of this and other plutonium-bearing materials at the SRS will speed the day when this can be achieved and the F-Canyon and FB-Line plutonium processing facilities can be flushed of bulk residual materials, de-staffed, and shut down unless they are needed for missions such as the ultimate disposition of plutonium.

L16-5 A facility to produce high-fired plutonium oxide does not exist. There are no plans or efforts under way at other

DOE sites to develop this capability. The DOE standard for the long-term storage of plutonium no longer requires high-firing of the oxide; the alternative of processing to an oxide has been modified to reflect this (see Section 2.3). DOE used the term "high-fired oxide" in the Draft eis because at the time it felt that heating the oxide to a particular temperature was required to achieve a satisfactory storage condition. However, DOE has determined heating would achieve a condition in which less than 0.5 percent of the weight of material would be lost after heating for a specified time (rather than at a specific temperature). As indicated, further evaluations would be required if DOE selected this alternative as the most economical and practical way to provide the needed capability (i.e., modify FB-Line or construct a new facility in F-Area).

L16-6 DOE acknowledges that a vitrification alternative using a small-scale melter in F-Canyon is reasonable, and has therefore included this alternative and its impacts in the Final eis (see Section 2.5).

L16-7 DOE has included additional information in Section 1.1 to address this comment.

L16-8 In accordance with the Atomic Energy Act, detailed information on the concentrations and amounts of plutonium stored in individual tanks is classified. DOE has provided the approximate quantity of plutonium solutions in liters (and gallons), and considers this the most meaningful representation of the scope of the problem and the most understandable to the general public. DOE has added a table to the accident analysis section of the eis (Appendix B) to identify the maximum radionuclide composition of any of the solutions in F-Canyon.

L16-9 DOE has incorporated additional information and detail on her actions throughout the eis.

L16-10 As indicated in the response to comment L16-4, the department, in accordance with the President's Nonproliferation and Export Control Policy, intends to offer this material for inspection by the International Atomic Energy Agency. The Department has already offered surplus fissile material at the Oak Ridge and Hanford Sites for inspection and is working to make additional material available for inspection. The timing for offering material for IAea safeguards depends on meeting requirements to facilitate effective IAea inspections with a minimum of radiation exposure and risk to the inspectors and workers. These include the material being well characterized, in an appropriate form and storage container, sufficient quantities of material consolidated in a relatively static storage situation, equipment available (cameras and seals) for surveillance, space and support for IAea nondestructive analysis equipment, etc. The SRS is working with the DOE Office of Nonproliferation and National Security to scope the activities and facility modifications required to permit effective and safe inspection of material at the Site. For the plutonium, preparations for inspections are likely to take several years and will depend on how fast plutonium-bearing materials can be stabilized, storage can be consolidated, and the actions required to meet the Department's plutonium storage standard likely to be issued

shortly can be implemented. In the meantime, any material involved with the stabilization is fully monitored in the Department's accountability system, which provides traceability of the material through processing and into storage. DOE is not proposing to produce additional plutonium (which would require the operation of a production reactor), but to stabilize plutonium currently stored in liquid form. DOE believes that this stabilization is the proper course of action to ensure the safety of workers and the public and, therefore, provides the international community a positive example of responsible management of Cold War legacy materials.

L16-11 DOE based the estimated processing time associated with the preferred alternative on the material quantities involved and the processing capacities of the required F-Canyon and FB-Line equipment, as well as a deliberate approach to processing to ensure proper facility operation and personnel responses to processing events. DOE will perform the appropriate readiness reviews to ensure compliance with training, environment, and Operational Safety Requirements. Therefore, the processing schedule is related to safety concerns, as is the case for managing any material that represents a health and safety concern if handled inappropriately.

L16-12 As stated in Chapter 8, there is uncertainty in relation to the regulatory status of the F-Canyon plutonium solutions and other materials stored at the SRS that were (or from which DOE recovered) valuable products and fissionable materials. Environmental regulators are aware of this uncertainty regarding regulatory applicability. The need for DOE action described in this eis is related to the safe management of the existing plutonium solutions, not the creation of new material or the use of existing material. As described in Section 1.3, DOE is preparing an eis on the Storage and Disposition of Weapons-Usable Fissile Materials to examine the environmental impacts of various strategies for the disposition of surplus plutonium and highly enriched uranium, including the use of plutonium to manufacture mixed-oxide fuels for use in power reactors. In the meantime, SRS has been working with the appropriate regulatory organizations to ensure that they stay fully apprised of the plans for material stabilization, the nature of the materials involved, and the methods of storage pending decisions on disposition.

L16-13 DOE has revised Section 2.2 to provide an explanation of the standard (U.S. Department of Energy Criteria for Storage of Plutonium Metals and Oxides, DOE-STD-3013-99).

L16-14 The processing of the F-Canyon plutonium solutions to metal (the preferred alternative) would require the operation of both the canyon second plutonium cycle and FB-Line (shown in Figure 2-4 and described in Appendix A). The operation of the dissolver tanks, the head end, and the first cycle would not be required. As stated in the eis, a decision to proceed with the proposed action would not affect decisions related to the stabilization of materials described in the Interim Management of Nuclear Materials eis because such decisions would involve different facilities and entail commitments of additional resources.

L16-15 In accordance with direction from the Assistant

Secretary for Defense Programs, the SRS would not attempt to meet the chemical or isotopic purity specifications previously required for nuclear weapons production. In practical terms, this direction would have little effect on the final form of plutonium metal and no effect on the magnitude of environmental impacts. DOE would use the same processing regime and the metal would still be usable in weapons and would require the same safeguards and security during storage.

L16-16 The Defense Nuclear Facilities Safety Board (DNFSB) recommended: "That preparations be expedited to process the dissolved plutonium and trans-plutonium isotopes in tanks at the Savannah River Site into forms safer for interim storage. The Board considers this problem to be especially urgent."

DOE does not consider the reference to DNFSB Recommendation 94-1 to be misleading. That document does state that a broad range of "...hazards could arise within two to three years unless certain problems are corrected." It goes on to point out, however, that the "...Board is especially concerned about..." several situations, the first of which is the solutions in F-Canyon. DOE has chosen to emphasize the plutonium solutions in this eis because of the quantities of such solutions and the potential hazards associated with such quantities. DOE is preparing an eis on the Interim Management of Nuclear Materials, which deals with the americium and curium solutions in F-Canyon.

L16-17 DOE has modified Section 1.1 to include transuranic, low-level, hazardous, and mixed waste.

L16-18 DOE has updated the information on Chem-Nuclear Systems and Plant Vogtle to reflect more recent monitoring results. DOE has incorporated the most recent information available. In some cases, such as for nonradiological air quality, sufficient information was not available in more current reports to support analyses. In those cases DOE used the older information.

L16-19 DOE has modified Section 4.4 (previously 4.5) to clarify the use of drinking water standards as a comparison rather than as a regulatory requirement.

Comment letter L17, Mary T. Kelly (League of Women Voters of South Carolina)

Figure (Letter L17)

Responses to comment letter L17:

L17-1 DOE has seriously considered other methods to reduce risk, as described in Section 2.6 (which was Section 2.5 in the Draft eis). In addition, DOE analyzed vitrification of the plutonium solutions using a modified portion of F-Canyon as an alternative to the historic processing method (see the new Section 2.5).

L17-2 DOE would store the small quantity of plutonium metals resulting from the implementation of the proposed action or alternatives at the SRS and would safeguard this material as part of the 2.1 metric tons of plutonium currently stored at the Site, subject to strict control and

accountability standards. The ultimate storage or disposition of this material and other surplus fissile materials is the subject of the Storage and Disposition of Weapons-Usable Fissile Materials eis, which is in preparation. The purpose of this eis is to describe the potential environmental impacts of the proposed action and the alternatives; therefore it does not present a detailed description of costs, which will be a consideration in the decision on stabilization of the plutonium solutions. Certain alternatives would require facility modifications or construction of new facilities, as described in Chapter 2. The implementation of the proposed action would not require upgrades of existing facilities. The primary factor in the decisionmaking process for stabilizing this material would be the schedule for stabilization and, thus, the reduction in risk associated with this material in its current form and condition.

Comment letter L18, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (Kenneth W. Holt, National Center for Environmental Health)

Figure (Letter L18 Page 1 of 2)

Comment letter L18, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (Kenneth W. Holt, National Center for Environmental Health) (continued)

Figure (Letter L18 Page 1 of 2)

Responses to comment letter L18:

L18-1 After review, DOE agrees that the Glossary did not include several terms ("collective dose" and others) that were appropriate. For this Final eis, these terms have been listed in the Glossary and marked with change bars.

L18-2 DOE has added references in Section 4.1 to the appropriate sections on air resources (Section 4.3) and water resources (Section 4.4). The DOE Public Reading Rooms in Washington, D.C., and Aiken, South Carolina, contain complete copies of all data used to derive the values listed in the eis tables. DOE has modified Section 4.1.1 to address the meaningfulness of any differences in dose estimates between the tables.

L18-3 Section 4.1 refers to the document from which DOE took the worker doses. The Glossary defines the maximally exposed individual. Further, DOE has modified Section 4.2 to include references to the eis sections that discuss air and water resources (Sections 4.3 and 4.4); those sections provide more information on the derivation of the data.

L18-4 DOE based the value of 145,700 deaths on data from the Centers for Disease Control and Prevention, as discussed in Chapter 3 of the eis. DOE has modified Section 3.5.1 to explain the derivation of these potential 145,700 lifetime cancer deaths in the population surrounding the SRS.

L18-5 DOE agrees that the use of different units of measurement can be confusing and has, therefore, modified these tables to reflect a consistent use of rem.

Comment letter L19, Donald A. Orth

Figure (Letter L19.)

Responses to comment letter L19:

L19-1 DOE believes that restarting processing activities in F-Canyon after an extended period during which no processing occurred would not be the continuation of an ongoing activity. Therefore, DOE has determined that, to ensure compliance with NEPA, in the absence of an emergency condition there should be no processing before the completion of the eis process. DOE could have chosen continued processing as the No-Action Alternative. However, the Department believes that continued storage of the material in solution form more accurately reflects the current situation and the alternative of No Action.

L19-2 DOE will perform an Operational Readiness Review (ORR) before implementing any stabilization alternative. As part of the ORR, DOE would review procedures and programs that would respond to abnormal events (including accidents). The objective of the review process is to preclude such events from occurring due to human error and to ensure the planning of mitigative actions in the event of equipment failures or natural phenomena.

Oral comment H1, Wayne Gaul, Rust Federal Services (Columbia, October 4)

Figure (Letter H1.)

Response to oral comment H1:

H1 This eis reports all doses resulting from internal exposures to radiation as committed effective dose equivalents (CEDE) that are assigned to the year of intake. In 1992, DOE adopted and required the use of the committed effective dose equivalent as the official quantity of reported dose for internal exposures and this eis conforms to that requirement. Section 3.5.1 has been modified to clarify the use of CEDE and a definition of CEDE has been include in the Glossary.

Oral comment H2, Tolly Honeycutt (Columbia, October 4)

Figure (Letter H2.)

Oral comment H3, Michael F. Sujka (North Augusta, October 6)

Figure (Letter H3.)

Oral comment H4, J. W. Morris (North Augusta, October 6) Oral comment H5 Mrs. Virgi

Figure (Letter H4. and H5)

Oral comment H6, Frank O'Brien (North Augusta, October 6)

Figure (Letter H6.)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 1 of 6)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 2 of 6)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 3 of 6)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 4 of 6)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 5 of 6)

Oral comment H7, Frederick Nadelman (Savannah, October 11)

Figure (Letter H7. PAge 6 of 6)

Response to oral comment H7:

H7-1 The underground storage of plutonium is a long-term disposition issue. DOE is addressing this issue in its eis on Storage and Disposition of Weapons-Usable Fissile Nuclear Materials, which is in preparation.

H7-2 DOE suspended chemical operations in the F- (and H-) Canyon in 1992 to address a potential safety concern. That concern was addressed; however, before the resumption of processing, the Secretary of Energy directed SRS to phase out defense-related chemical separations activities.

H7-3 The Savannah River Site is in transition from production to cleanup. DOE will address the issues associated with waste management, environmental restoration, and cleanup activities in programmatic and site-specific waste management eiss.

H7-4 DOE does store spent fuel in water-filled basins at the SRS, but it does not bury such material. This material is included in the Programmatic Spent Nuclear Fuel and Idaho National Engineering Laboratory eis, which is in preparation.

H7-5 DOE has not produced plutonium for weapons (or any other) purposes since 1988, and has not processed or recycled plutonium to weapons-usable form since 1992. As described in the response to Comment L16-4, DOE, in accordance with the U.S. Nonproliferation and Export Control policy, intends to offer plutonium materials designated as surplus to the weapons stockpile for inspection by the International Atomic Energy Agency.

H7-6 In December 1991, about 5,700 curies of tritium were released in SRS cooling water that leaked from heat exchanger coils at K-Reactor.

Savannah River Operations Office

Record of Decision: Stabilization of Plutonium Solutions Stored in the F-Canyon Fac

at the Savannah River Site, Aiken, SC.

AGENCY: U.S. Department of Energy

ACTION: Record of Decision, Stabilization of Plutonium Solutions Stored in the F-Ca Facility at the Savannah River Site, Aiken, South Carolina

SUMMARY: The U.S. Department of Energy (DOE) has prepared and issued a Final Environmental Impact Statement (eis) (DOE/eis-0219, December 30, 1994), to assess the potential environmental impacts of stabilizing approximately 80,000 gallons of plutonium solutions currently stored in tanks in the F-Canyon chemical separations facility at the Savannah River Site (SRS) near Aiken, South Carolina. As long as the plutonium remains in solution there is a risk of releases and subsequent radiation exposure to workers, the public, and the environment from accidental criticality incidents, leaks, and disruptions of engineered systems from earthquakes. The Department has evaluated the impacts of alternative methods that would achieve stabilization of the solutions. The analysis reveals that the potential environmental impacts implementing alternatives that would eliminate the risk inherent in storing plutonium in liquid from are small. Further, the impacts differ little among the alternatives. DOE currently has available the capability to process the plutonium solutions to a metal form. Given this existing capability, the potential for environmental releases that exists as a result of storing the plutonium in liquid form, and the relative lack of environmental advantages to implementing other options, DOE has decided to process the plutonium solutions to metal form using the F-Canyon and FB-Line facilities at the SRS. DOE has committed that this plutonium metal will not be used for nuclear explosive purposes and intends to offer it for inspection by the International Atomic Energy Agency.

During the time the SRS was actively involved in nuclear material production, DOE transferred irradiated fuels and targets from SRS reactors to disassembly basins, which are water-filled pools, to allow short-lived radioactive isotopes to decay. From the pools, DOE transferred the fuel and targets to canyon facilities in F- and H- Areas, where they were chemically dissolved into liquid solutions. The useful isotopes were recovered, converted to a solid form, and either shipped to other DOE facilities or stored at the SRS. This chemicla reprocessing activity has been suspended since 1992, and plutonium solutions have been stored in tanks in the F-Canyon facility since that time. The Final F-Canyon Plutonium Solutions eis examines alternative methods for stabilizing these solutions.

FOR FURTHER INFORMATION CONTACT: For further information on the stabilization of F-Canyon plutonium solutions or to recieve a copy of the Final eis contact:

A.B. Gould, Jr
NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
P.O. Box 5031
Aiken, South Carolina 29804-5031
(800) 242-8269

For further information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Assistance (EH-4.2)
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585
(202) 586-4600, or leave a message at (800) 472-2756.

SUPPLEMENTARY INFORMATION:

I. Background

DOE prepared this Record of Decision in accordance with the regulations of the Council on Environmental Quality for implementing NEPA (40 CFR Parts 1500-1508) and DOE's NEPA Implementing Procedures (10 CFR Part 1021). This Record of Decision is based on DOE's Final F-Canyon Plutonium Solutions Environmental Impact Statement, Savannah River Site, Aiken, South Carolina (DOE/eis-0219).

The SRS occupies approximately 800 kilometers (300 square miles) adjacent to the Savannah River Site, mostly in Aiken and Barnwell Counties of South Carolina, about 40 kilometers (25 miles) southeast of Augusta, Georgia, and about 32 kilometers (20 miles) south of Aiken, South Carolina. When established in the early 1950s, SRS's primary mission was to produce nuclear materials to support the defense, research, and medical programs of the United Stat The present mission emphasizes waste management, environmental restoration, transition activities, and decontamination and decommissioning of facilities that are no longer needed for nuclear materials production.

In March 1992, DOE suspended chemical processing operations in the F-Canyon to address a potential safety concern. That concern was addressed: however, prior to the resumption of processing, the Secretary of Energy directed that SRS phase out chemical separations activities (i.e., reprocessing). Non-safety-related facility operations have remained shut down since that time (March 1992). Approximately 303,000 liters (80,000 gallons) of the solutions containing plutonium have remained in tanks in F-Canyon since the suspension of operation.

In September 1992, the SRS completed a plan that described the actions that DOE would have to take to phase out reprocessing. The plan included actions for removing the material that remained in the canyons as a result of the suspension of chemical separation activities in March 1992. In February 1993, the Site requested approval from DOE to restart F-Canyon after the completion of operational readiness reviews conducted as part of the response to the above mentioned March 1992 safety concern. The SRS made this startup request in light of the Secretary's direction to accelerate the transition of F-Area reprocessing facilities to a standby condition and because all contemplated actions were typical of previous facility operations.

During this same time period, DOE was drafting new requirements for operational readiness reviews neccesary for the startup or restart of nuclear facilities. Under these requirements, facilities had to be able to demonstrate the capability to perform satisfactorily in relation to a broad range of topics associated with the safe operation of a nuclear facility. DOE promuglated these requirements in DOE Order 5480.31, "Startup and Restart of Nuclear Facilities," which it issued in September 1993. DOE decided that the SRS should apply these requirements to the restart of the F- and H- Canyons and in November 1993, determined that the Site should hold the proposed F-Canyon (and FB-Line) restart in abeyance until it had completed a restart review in accordance with the New Order. In January 1994, DOE determined that unless there was an emergency condition, there should be no processing in F-Canyon before the copmpletion of an environmental impact statement.

On March 17, 1994, DOE published a Notice of Intent (59 FR 12588) to prepare an environmental imapct statement on teh interim management of nuclear materials at the SRS. The proposed DOE interim management actions are to stabilize those nuclear materails at the SRS that represent a health or safety concern for the pubic, workers, and the environment and to convert certain materials to a usable form to support DOE program needs. These proposed interim actions would be carried out while DOE makes and implements long-term decisions on the disposition of nuclear materials. DOE is addressing its long-term decisions in a Programmatic Environmental Imapct Statement for

Storage and Disposition of Weapons-Usable Fissile Materials, for which it issued an NOI on June 21, 1994 (59 FR 31985). DOE expects that it could require 10 years jor more to make and implement these long-term decisions.

In May 1994, the Manager of the Savannah River Operations Office recommended that the DOE Assisstant Secretary for Defense Programs seek alternative arangements for compliance with the National Environmental Policy Act (NEPA) under the emergency provisions of the Council on Environmental Quality NEPA Regulations, 40 CFR Part 1506.11, to allow immediate stabilization of the plutonium solutions in F-Canyon and the Mark-31 targets stored in the L-Reactor Disassembly Basin. The recommendation was based on the Manager's determination that the materials present risks to workers, the public, and the environement in the form of radiation exposure from normal operations and potential accidents, which DOE could reduce by converting the material to a solid stable form.

The Assistant Secretary for Defense Programs endorsed the Savannah River Operations Office Manager's request and asked that the DOE Office of Environment, Safety and Health perform an independent evaluation to determine if stabilization actions should proceed in advance of the completion of the Interim Management of Nuclear Materials eis. The DOE Office of Environment, Safety and Health performed this independent evaluation in June 1994. The report from the evaluation characterized the following potential facility accidents to be of serious significance: (1) the potential for inadvertent criticality of plutonium due to precipitation of plutonium from the F-Canyon plutonium solutions, and (2) potential radiological releases to the environment due to leakage of plutonium solutions through tank cooling coils. The loss of experienced facility personnel through resignation and retirement was an issue of marginal concern, with the recognition that this could become a serious concern if teh current trend continued. The report did not include the Mark-31 targets in the materials of serious concern. DOE evaluated the request to pursue alternative arrangements for compliance with NEPA under the emergency provisions of 40 CFR 1506.11 in light of the Office of Environment, Safety and Health's evaluation and determined that the appropriate action would be to accelerate the evaluation of stabilization alternatives for the F-Canyon plutonium solutions by preparing a separate environmental impact statement on an accelerated schedule.

The vulnerabilities associated with the continued storage of the plutonium in solution have also been documented by the Defense Nuclear Facilities Safety Board (DNFSB). In April 1994, the DNFSB "concluded from observations and discussions with others that imminent hazards could arise within two to three years unless certain problems are corrected.. The Board is especially concerned about..(s)everal large tanks in the F-Canyon at the Savannah River Site (that) contain tens of thousands of gallons of solutions of plutonium and trans-plutonium isotopes... If an earthquake or other accident were to breach the tanks, F-Canyon would become so contaminated that cleanup would be practically impossible. Containmnet of the radioactive materials under such circumstances would be highly uncertain...therefore, the Board recommends.. (t)hat preparations be expedited to process the dissolved plutonium and trans-plutonium isotopes in tanks in the F-Canyon at the Savannah River Site into forms safer for interim storage. The Board considers this to be especially urgent."

While the Defense Nuclear Facilities Safety Board noted that no emergency presently exists, the Board also noted that the plutonium solutions in F-Canyon could present an imminent hazard within two or three years. Given that even the shortest time to complete stabilization is almost two years, the Department concluded that expediting the decision to stabilize plutonium solutions was prudent.

As noted above, DOE determined that there are safety concerns associated with plutonium solutions stored in F-Canyon that warrant consideration of actions prior to the issuance of a Record of Decision for the Interim Management of

Nuclear Materials eis. Therefore, DOE decided to prepare the F-Canyon Plutonium Solutions eis on an expedited basis. On August 23, 1994, DOE published a notice in the Federal Register amending the NOI for the Interim Management of Nuclear Materials at the SRS. The notice explained DOE's decision to prepare the F-Canyon Plutonium Solutions eis.

The NOI for the Interim Management of Nuclear Materials eis requested public comments and suggestions for DOE to consider in its determination of the scope of that eis, and announced a public scoping period that ended on May 31, 1994. DOE held scoping meetings in Savannah, Georgia, North Augusts and Columbia, South Carolina, on May 12, 17, and 19, 1994, respectively. As a result of this public scoping process, DOE has recieved comments applicable to the stabilization of F-Canyon plutonium solutions from individuals, organizations, and government agencies, and has considered these comments in the preparation of the F-Canyon Plutonium Solutions eis.

On September 9, 1994, the U.S Environmental Protection Agency published a Notice of Availibility (NOA) in the Federal Register (59 FR 174, pages 46643-46644), which started the public comment perios on the Draft F-Canyon Plutonium Solutions eis; DOE published a corresponding NOA for the Draft eis on September 9, 1994 (59 FR 174, pages 46627-46628). The public comment period ended on October 24, 1994.

DOE revised the Draft eis in response to written and oral comments recieved during the public comment period from individuals, organizations, and Federal and state agencies. Public hearings were held in Columbia and North Augusta, South Carolina, and Savannah, Georgia (October 4, 6, and 11, 1994, respectively). On December 30, 1994, EPA published a Notice of Availability of the Final F-Canyon Plutonium Solution eis in the Federal Register (59 FR 250, pae 67706), following distribution of approximately 400 copies to government officials and interested groups and individuals.

The Department of Energy recieved letters from the following organizations following the distribution of teh Final eis: (1) the South Carolina Department of Transportation; (2) the Centers for Disease Control, U.S. Department of Health and Human Services; (3) the National Oceanic and Atmospheric Administration, U.S. Department of Commerce; and, (4) the U.S. Environmental Protection Agency (EPA), Region IV. The EPA Region IV letter indicates that a comment on the Draft eis concerning impacts to ecological systems is only partially addressed in the Final eis. The Final eis briefly considered the potential for impacts to ecological systems and concluded that none of the alternatives discussed in the eis would affect threatened or endagered species or any of the flora or fauna routinely found in the vicinity of F-Canyon areas. Therefore, DOE did not include a detailed analysis of the impacts in ecological systems in the Final eis. DOE will be discussing with EPA how to better represent/analyze potential impacts of emissions on ecosystems. The EPA Region IV letter states that the preferred alternative will have the least overall impact and that EPA supports DOE's action. The National Oceanic and Atmospheric Administration concluded that no federally-listed threatened or endangered species under its jurisdiction would be affected by the proposed action. The other organization had no comments on the Final eis, and indicated they supported DOE's action plans or provided neither an indication of support nor opposition of DOE's action plans.

II. Alternatives

The proposed action addressed in the Final F-Canyon Plutonium Solutions eis is to stabilize the plutonium solutions int order to eliminate the risks inherent in storing this plutonium in liquid form. DOE examined four alternatives for stabilizing the solutions, ans a no-action alternative, in teh Final eis.

A. No Action. DOE would continue to manage the existing 303,000 liter (80,000 gallon) inventory of solutions in stainless steel tanks in the F-Canyon. The solutions would be monitored and corrective actions taken, as

necessary, to minimize the potential for precipitation of the plutonium and the possibility of an inadvertent criticality. This action would continue for the 10-year time period evaluated in the Final eis.

B. Process to Plutonium Metal (the preferred alternative). Under this alternative, DOE would use the existing F-Canyon and FB-Line processes and equipment to convert the plutonium solutions to metal. The metal would be a chemically stable form of plutonium that DOE could produce without modifying the existing equipment. Because there is no need for additional plutonium for weapons, DOE would attempt to meet previous isotopic or chemical purity specifications that were applicable for weapons production. In addition, DOE has made a commitment that plutonium-239 from stabilization actions would not be used for nuclear explosive purposes. The plutonium metal would be packaged and stored, similar to other plutonium metal already in vault storage. DOE expects stabilization could be accomplished under the other alternatives. In conjunction with stabilizing the solutions to metal, DOE would undertake a project to modify a portion of the FB-Line facility to provide the capability to repackage the plutonium metal into a configuration that meets the recently issued DOE standard for long-term storage of plutonium (U.S. Department of Energy Criteria for Storage of Plutonium Metals and Oxides, DOE-STD-3013-94, Washington, D.C.). The new storage standard requires plutonium to be packaged in a form that is stable over an extended period (e.g., 20 years) without human intervention. Plutonium metal would be packaged in sealed metal cans without the presence of plastics. Current SRS plutonium metal packaging requires the use of plastic around an inner can for contamination control purposes. DOE estimates that it could accomplish the modifications to the FB-Line packaging capability by late 1997 at a cost of approximately $3 million. Alternatively, while the solutions are stabilized to metal, DOE could modify a different vault facility to provide the necessary equipment to repackage the metal to meet long-term storage requirements. DOE estimates this could cost between $70 million and $150 million and that it could complete repackaging by the end of 2001.

The stabilization to metal alternative would produce a solid form of plutonium that would be safer and easier to store in the shortest period of time. As a result, this is DOE's preferred alternative.

C. Processing to Plutonium Oxide. DOE would modify the FB-Line to support conversion of the plutonium solutions to a plutonium oxide and to package the material for storage. The objective would be to produce a material form and packaging coonfiguration that met the new DOE standard for long-term storage of plutonium. If the extent of the FB-Line modifications necessary to convert the plutonium solutions to a plutonium oxide and to package the material to meet the long-term storage standard were economically and physically impratical, DOE would perform the stabilization in two phases. DOE would modify FB-Line to be able to convert the material initially to an oxide form and package it in FB-Line. At the same time, DOE would design and construct a new facility to process, package, and store the oxide in accordance with the new standard. DOE estimates that the minimally required modifications to FB-Line to provide the solution-to-oxide conversion capability would cost $7 million and take three years to complete. Following completion and modification, DOE would operate the FB-Line for approximately 9 months to convert and package the oxide for storage. Repackaging the oxide to meet the new plutonium storage standard would not occur for another three years when the new facility for packaging were available. This new facility is estimated to cost between $70 million and $150 million; repackaging of the oxide could also be completed by the end of 2001.

D. Vitrification in the Defense Waste Processing Facility. DOE would transfer the plutonium solutions to the SRS waste tank farm. Before transfer, the solutions would be adjusted to ensure the safety of the material in the tanks. DOE has identified several concepts for adjusting the solutions: diluting the solutions with water and chemicals to achieve very low plutonium concentration, diluting the solutions with depleted uranium, or adding iron

and manganese or other neutron poisons such as gadolinium. In the waste tanks, high-activity waste would settle to the bottom of the tank in the form of sludge. DOE would transfer highly radioactive sludge to the Defense Waste Processing Facility, where it would be vitrified (converted to a glass-like substance) and stored on the Site until DOE made and implemented final disposition decisions.

DOE estimates it would take approximately six years to perform the technical studie training, and qualification efforts necessary to ensure safe operations for transferring the solutions for subsequent vitrification under this alternative. The solutions would not be transferred to the high-level waste tanks until all studies for vitrification were final. After these studies were completed, DOE estimates that it would take an additional three years to complete the process of transferring all the plutonium solutions to the high-level waste tanks because of the limited availability of tank space and criticality concerns. The plutonium solutions would remain in the high-level waste tanks until DOE transferred the contents to the Defense Waste Processing Facility for vitrification.

E. Vitrification in F-Canyon. Under this alternative, DOE would vitrify the plutonium into a borosilicate glass matrix using an F-Canyon vitrification facility. Modifications to the F-Canyon would be necessary, and include the installation of a geometrically favorable evaporator to concentrate plutonium solution, and equipment to convert the concentrated plutonium solution to a glass matrix using technology similar to that to be used on a larger scale in the Defense Waste Processing Facility. The capital costs of these modifications would be about $27 million; the facility could be available by January 1999.

When the modifications to the F-Canyon to install the vitrification facility were completed, the plutonium solutions would be transferred to the facility and evaporated. This concentrated plutonium solution would be fed, along with finely ground glass (frit), to a melter to produce a borasilicate glass containing the plutonium. The molten glass would be poured into stainless steel packages and stored in an existing vault at the SRS until final disposition decisions were made and implemented.

Although the vitrification of this plutonium could begin as early as January 1999, DOE analyzed the Vitrification in F-Canyon Alternative as though it began during the first six months of 2000. The Final eis describes its environmental consequences, which are largely independent of the schedule for vitrification.

F. Other Activities for Reduction of Risk. In addition to the alternatives analyzed in detail in the Final F-Canyon Plutonium Solutions eis to stabilize the plutonium solutions, DOE identified other activities that have the potential to reduce the risk associated with storing the plutonium solutions in liquid form. These activities are: (1) transporting the solutions to H-Canyon for stabilization, (2) purification of the solutions by processing those that have the greatest criticality risk through the second plutonium cycle in F-Canyon, (3) risk reduction activities identified in the DOE Office of Environment, Safety and Health Assessment of Interim Storage of Plutonium Solutions in F-Canyon and Mark-31 Targets in L-Basin at the Savannah River Site (DOE-EH-0397P/SRS-FCAN-94-01), and (4) shipment of the solutions off the Site for stabilization. Activities that involve transportation of the plutonium solutions would involve all the risks and costs associated with the alternatives for stabilization plus the risks and costs assocciated with transportation of radioactive liquids. Activities such as purification of the plutonium solutions by operating the second plutonium cycle in F-Canyon would reduce but not eliminate the risks associated with storing liquid plutonium solutions. In addition, operation of only the second plutonium cycle to purify plutonium solutions would require process development work and establishment of operating parameters, because the F-Canyon process has never been operated in this manner. One important issue associated with this

aproach would be unprecedented high levels of radiation in the second cycle portion of the facility due to the greatly increased presence of fission products.

III. Environmental Impacts of Alternatives

The Final F-Canyon Plutonium Solutions eis evalulated the environmental impacts of the alternatives, including the no action alternative. DOE analyzed the potential impacts that would result from implementation of the alternatives and believes there would be minimal impacts in the areas of geologic resources, ecological and cultural resources socioeconomics, aesthetics and scenic resources, and noise. This is because implementation of each of the alternatives would occur within the F-Area and mostly within the F-Canyon building. In light of planned SRS workforce reductions, any jobs associated with implementation of any of the alternatives could be filled through reassignment of current workers, resulting in no discernible impact on the regional economy.

Radiological health effects on workers from normal operations would be small for any alternative, much less than one additional cancer death (0.2 latent cancer fatalities for the no action alternative and less for the other alternatives) during the lifetimes of the affected individuals. The effect on the general public could be at most 0.0006 additional cancer deaths (or the processing to oxide and vitrification in F-Canyon alternatives, and less for the other alternatives) in the general population within 80 kilometers (50 miles) of the SRS. This is to say that no latent cancer fatalities in either workers or the general population are expected to occur as a result of routine operations. DOE expects similarily small adverse nonradiological health effects to workers and the public from emissions of toxic pollutants. Because discharges and emissions would vary little among the alternatives, public health effects would vary little among alternatives. The analysis in the eis shows that these potential small impacts would not disproportionately affect minority or low income populations.

Implementation of any of the alternatives, including the No Action alternative, would result in a risk of accidents. The Final eis evaluates a spectrum of potential accidents for each alternative. To enable a relative comparison of potential impacts among the alternatives, the accident with the highest reasonably foreseeable consequence for each alternative was assumed to occur and the maximum potential effects (latent cancer fatalities) were calculated. The projected frequency of these high-consequence accidents ranged from once in 17,000 years for a plutonium solutions fire involving solvents to once in 5,000 years for a severe earthquake. The maximum potential effect accident, although with a low probability, during the storage of plutonium solutions (for the periods prior to stabilization and for the No Action alternative) and during F-Canyon operation for stabilization is about 6 latent cancer fatalities to the exposed offsite population. For the stabilization actions involving FB-Line operations (processing to metal or processing to oxide), the maximum potenttial effect from an accident is less than 2 latent cancer fatalities in the exposed offsite population. Following stabilization and during stabilized plutonium storage, the maximum potential effect from an accident is less than 1 latent cancer fatality in the exposed offsite population.

The SRS generates several different types of waste, including low-level waste, high-level waste, transuranic waste and mixed waste. The Final eis lists estimates of waste generation for each alternative. DOE estimates that the smallest increase for all waste types would occur if the processing to plutonium metal altenative were implemented. Implementation of tis alternative would eventuallly result in high-level waste equivalent to 40 Defense Waste Processing Facility (DWPF) high-level waste canisters. The largest increase in high-level waste would occur if the vitrification in DWPF alternative were implemented. The largest increase in saltstone and low-level waste generation would result from implementing the processing to oxide

alternative. None of the alternatives is expected to generate substantial quantities of mixed waste. With the exception of vitrification in DWPF, the impact on SRS waste management capacities from implementing any of the alternatives would be minimal because the Site can accomodate all the waste generated with existing and planned radioactive waste storage and disposal faciliti

It would not be appropriate under any of the alternatives that would result in stabilized plutonium to characterize the stabilized plutonium as waste. The alternatives for the disposition of surplus weapons-usable plutonium are currently being examined in a programmatic environmental impact statement that is scheduled for completion early next year. The nitric acid that is associated with the plutonium solutions likewise should not be characterized as waste. The nitric acid historically was introduced into the separations process to dissolve irradiated materials and provide for criticality/radiological safety by maintaining the plutonium in solution pending stabilization. The nitric acid continues to serve this vital safety fuction. The South Carolina Department of Health and Environmental Control (SCDHEC) agrees with DOE that the F-Canyon plutonium solutions should not be regualted as a mixed waste (Letter, R. Lewis Shaw, SCDHEC to Frank R. McCoy, III, DOE, January 26, 1995).

IV. Other Factors

In addition to examining the enironmental impacts of the aternatives, DOE also considered other factors related to the stabilization of the F-Canyon plutonium solutions. These factors are: (1) new facilities that would be required, (2) security and nuclear nonproliferation, (3) implementation schedule, (4) technology availability and technical feasibility, (5) labor availability and core competency, (6) degree of reliance on aging facilities, and (7) post-stabilization custodial care required. The processing to plutonium metal alternative would be most advategeous for all factors except: (2) security and nuclear nonproliferation and (6) reliance on aging facilities.

The processing to oxide and vitrification alternatives would involve minimal reliance on aging facilities because they would use new facilities for the final step involved in stabilizing the plutonium and for storing the plutonium after of completion of stabilization. The processing to metal alternative would use existing facilities to stabilze the plutonium solutions.

The vitrification alternatives would be preferable from the security and nuclear nonproliferation standpoint because vitrification would produce a form of material least likely to be used in manufacturing a nuclear weapon. However, a proliferator could recover the plutonium from the vitrified (glass) matrix if the necessary resources and proper technology were available. The processing to metal alternative would result in a form of plutonium that closely resembles materials used in weapons production. DOE does not believe that processing these solutions to metal and storing the metal in vaults in protected areas of the SRS, adding appreciably less than one percent to the U.S. inventory of many metric tons, would constitute a proliferation risk. DOE has committed to not using plutonium-239 and weapons-usable highly enriched uranium separated or stabilized during the phaseout, shutdown, and cleanout of weapons complex facilties for nuclear explosive purposes. This prohibition would apply to the plutonium metal produced as a result of the decision to process the F-Canyon plutonium solutions to metal. DOE believes that the processing to metal alternative is fully consistent with the Presidential Nonproliferation and Export Control Policy, under which the United States "... will seek to eliminate where possible the accumulation of stockpiles of highly-enriched uranium or plutonium, and to ensure that where these materials already exist they are subject to the highest standards of safety, security, and international accountability." Furthermore, in accordance with the provision in this Policy to submit U.S. fissile material surplus to the national security requirements to inspection by the International Atomic Energy Agency (IAea), the Department intends to offer this material

along with other material at the SRS for IAea inspection when the material is in a form and consolidated in a storage facility suitable for safe and effective monitoring by the IAea.

V. Environmentally Preferable Alternative

As shown in the Final F-Canyon Plutonium Solutions eis, the potential environmental impacts of implementing any of the alternatives are generally small and within the same range. DOE believes that any of the action alternatives would be preferable to the no action alternative because the inherent risk of storing plutonium in liquid form would be eliminated. DOE considers the processing to metal alternative the environmentally preferable plutonium in solution in the shortest period of time. While the plutonium remians in solution, there is a risk of releases and subsequent radiation expsure to workers, the public, and the environment from accidental criticality incidents, leaks, and disruptions to engineered systems from earthquakes.

VI. Decision

DOE has decided to implement the preferred alternative, processing the F-Canyon plutonium solutions to metal, as discussed in the Final F-Canyon Plutonium Solutions eis. Concurrent with the processing, packaging and storage of the metal, which is expected to take about 20 months, DOE will undertake activities to modify part of the FB-Line facility to provide the capability to repackage the plutonium metal into a configuration that meets the DOE standard for long-term storage of plutonium. The plutonium metal resulting from this action will not be used for nuclear explosive purposes.

VII. Mitigation

The F-Canyon and FB-Line facilities that will be used to process the plutonium solutions to metal incorporate engineered features to limit the potential impacts of facility operations to workers, the public and the environment. All of the engineered systems and administrative controls are subject to the startup requirements fo DOE Order 5480.31, which will assure, prior to startup, the safe operation of the facilities. No other mitigation measures have been identified; therefore, DOE need not prepare a Mitigation Action Plan.

VIII. Conclusion

DOE has determined that the F-Canyon and FB-Line facilities should be operated to process to metal approximately 303,000 liters (80,000) gallons of plutonium solutions currently stored in F-Canyon. In reaching this decision, DOE considered the analysis of the potential environmental impacts alternatives for stabilizing this material in the Final F-Canyon Plutonium Solutions eis. This action will produce a solid form of plutonium that will be safer and easier to store than a liquid solution. It will take less time than other alternatives and will therefore eliminate more quickly the risk inherent in storing plutonium in liquid form. The plutonium metal resulting from this action will be stored at the Savannah River Site pending decisions on its disposition and will not be used for nuclear explosive purposes.

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Thomas Grumbly
Assistant Secretary for Environmental Management